



## Summative Evaluation Executive Summary of Studies 1-3

*Knight Williams Inc.*

Valerie Knight-Williams, Ed.D.  
Divan Williams Jr., J.D.  
Rachael Teel, MEd  
Gabriel Simmons  
Sauleh Rahbari

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# Table of Contents

<b>Introduction</b>	<b>3</b>
<b>Summative evaluation study 1: Impact of the giant screen film with a general audience</b>	<b>5</b>
Phase 1: On-site theater evaluation of the film's immediate appeal and learning value	6
Phase 2: Discussion group explorations of Viewers' connections with the film	11
Phase 3: Follow-up evaluation of extended impact	15
Discussion	19
<b>Summative evaluation study 2: Impact of the giant screen film with a student audience</b>	<b>26</b>
Phase 1: Pre-post assessment of the film's immediate appeal and learning value	28
Phase 2: Follow-up evaluation of extended impact	33
Discussion	36
<b>Summative evaluation study 3: Evaluation of the national and local educator workshops and partner outreach activities</b>	<b>43</b>
Phase 1: Museum Educator National Workshop: Evaluation of educator feedback	44
Phase 2: Evaluation of educator feedback on the <i>Mysteries of the Unseen World</i> local workshops, film, and educational resources	50
Phase 3: Museum educator post report findings	58
Discussion	64

# Introduction

*Mysteries of the Unseen World* is a National Geographic project centered on a giant screen film that highlights the sciences used *to illuminate the amazing worlds around us, invisible to the naked eye.*<sup>1</sup> As described on the National Geographic project website:

*Mysteries of the Unseen World* reveals phenomena that can't be seen with the naked eye, taking audiences into earthly worlds secreted away in different dimensions of time and scale.

Experience events that unfold too slowly for human perception; "see" the beauty, drama, and even humor of phenomena that occur in the flash of a microsecond; enter a microscopic world once reserved for scientists, but now made accessible to the rest of us; and begin to understand that what we actually see is only a fraction of what there is to see on Earth.

High-speed and time-lapse photography, electron microscopy, and nanotechnology are just a few of the advancements in science that allow us to see a universe of things, events, creatures, and processes we never even knew existed. These technologies give us new "superpowers" to see beyond what's in front of us.

Visually stunning and rooted in cutting-edge research, *Mysteries of the Unseen World* will leave audiences in thrall as they begin to understand the enormity of the world they can't see—a world that exists in the air they breathe, on their bodies, and in all of the events that occur around them minute by minute and nanosecond by nanosecond. And with this understanding comes a new appreciation of the wonder and possibilities of science.

<http://movies.nationalgeographic.com/movies/mysteries-of-the-unseen-world/about-the-film/>

In 2009 National Geographic was awarded a grant from the National Science Foundation (NSF) which provided funding for the film, related educational programming and outreach, and independent formative and summative evaluation. Beginning in 2013 the film debuted in science center theaters within and beyond the U.S., with some of these theaters also booking a hands-on kiosk developed by National Geographic for use in theater lobbies or surrounding museum spaces to help extend viewers' interest in and learning from the film. The project further included an outreach program involving educators from 17 partner museums who were invited to attend the Museum Educator National Workshop and participate in an awardee program designed to promote the film, related events, and education resources among local and underserved audiences. These educational resources included: a Museum Educator Guide, videos and classroom activities accessible from the project website, an iPad app, and a customized package of materials for use in the Engineer in the Classroom program.

As part of the NSF funding for the project, the independent evaluation firm, Knight Williams Inc. conducted the project's summative evaluation in the form of four separate studies. The first study focused on the immediate and longer-term impact of the film on a general audience that viewed the film in a local science center theater context on their own accord. The second study focused on the immediate and longer-term impact of the film on middle school students who viewed the film at their local science center as part of a school field trip. The third study examined the implementation, effectiveness, and longer-term impact of the

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<sup>1</sup> Text in this Introduction in italics, other than titles, is borrowed from the project description section of the NSF proposal.

Museum Educator National Workshop, focusing on the educators who participated in the workshop and those they respectively trained in their local settings, as well as educators who didn't attend the training but saw the film and used or planned to use the educational resources.

Below, we summarize findings and discussion points for each of the three studies relating to the film and educational outreach. For further details about the methods and findings of each study, please see the full reports.

## Summative evaluation study 1: Impact of the giant screen film with a general audience

The Study 1 summative evaluation examined general audience members' experience with *Mysteries of the Unseen World* when they self-selected to view the film in a giant screen theater located in a U.S. science center. The evaluation centered on five key questions based on direction provided by National Geographic relating to the film's goals and consultation of the following materials for context and further specification: the film and script, the project's original NSF proposal, the evaluation team's original and revised summative evaluation plan, the project's Impact and Indicator statements submitted to the NSF, the formative evaluation reports on the film's rough cuts completed by Multimedia Research in 2012, and Knight Williams' prior summative evaluations focused on general audiences' learning from giant screen films produced by National Geographic. The five key questions were:

- 1) *How appealing and engaging did Viewers find the film?*
- 2) *Did Viewers find the film content to be clearly presented?*
- 3) *What did Viewers learn from viewing the film?*
- 4) *Did viewing the film impact Viewers' STEM interests and perceptions?*
- 5) *What was the film's motivational impact on Viewers within a few weeks of viewing?*

To assess the five areas of impact, the evaluation was conducted in three phases, as follows<sup>2</sup>:

- **Phase 1: On-site theater evaluation of the film's immediate appeal and learning value**  
The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by Viewer performance on a post-viewing questionnaire, compared to the performance of a separate sample of Viewers asked to complete the same knowledge questions prior to seeing the film.
- **Phase 2: Discussion group explorations of Viewers' connections with the film**  
Immediately following four separate showings of the film, Knight Williams facilitated group discussions with Viewers who completed a post-viewing questionnaire in Phase 1 to allow for a more in-depth exploration of the film's immediate impact among family audiences.
- **Phase 3: Follow-up evaluation of extended impact**  
To understand the longer-term impact of the film on Viewers and whether and how they took actions related to the film a few weeks within viewing, a follow-up online questionnaire was sent via email to the Viewers who had indicated that they were willing to be contacted approximately 15-20 days after they viewed *Mysteries of the Unseen World*.

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<sup>2</sup> Though presented as a separate section in the full report, some information from Phase 4: Site documentation is briefly considered in the introduction to Phase 1: On-site theater evaluation of the film's immediate appeal and learning value.

## Labels used in reporting on film sections

In *Mysteries of the Unseen Worlds* opening sequence, narrator Forrest Whitaker describes the 4 main sections of the film, saying: “*Imagine if for one day we could see what [the family and their friends] can’t... all that’s too slow, too fast, too small, or simply invisible.*” Replicating the structure of *Mysteries of the Unseen World*, which also used animated title cards to highlight the four main sections of the film, the following four labels are used throughout this evaluation:

- *Invisible*: The part of the film focused on the electromagnetic spectrum and other animals’ ways of seeing, among other topics.
- *Too Slow*: The part of the film focused on things that happen too slowly for us to see, such as decomposition and plant growth, among other topics.
- *Too Fast*: The part of the film focused on things that happen too quickly for us to see, such as lightning strikes and dragonfly flight patterns, among other topics.
- *Too Small*: The part of the film focused on things that are too small for us to see, including butterfly scales, spider silk, and the nanoworld, among other topics.

## Phase 1: On-site theater evaluation of the film’s immediate appeal and learning value

Phase 1 of the Study 1 summative evaluation focused on 450 adult and youth who self-selected to view *Mysteries of the Unseen World* at the Lawrence Hall of Science during the last week of May 2015 and Discovery Place during the first week of August 2015. The evaluation team conducted the evaluation at the theater sites during weekday and weekend showings of the film to help ensure the evaluation recruited a balance of participants who visited the theater at different days and times. The evaluation was based on a separate-sample pre-test/post-test design which examined the appeal and immediate educational impact of the film as assessed by adult and youth performance on a post-viewing questionnaire completed within minutes of seeing the film (Viewers), as compared to the performance of a separate sample of viewers who completed the same set of content questions prior to seeing the film (Pre-Viewers).

The pre-viewing questionnaire included demographic and background questions about visitors’ age, gender, ethnicity/race, educational level, number of giant screen films seen, and included a short knowledge assessment of content covered in the film. The post-viewing questionnaire included the same demographic, background, and film content questions asked in the pre-viewing questionnaire, as well as questions that asked for Viewers’ reactions to the film with respect to appeal, entertainment value, clarity, information and science density, and learning value.

Statistical analyses were conducted on all quantitative data generated from the evaluation. To explore for possible significant differences within and between the Viewer and Pre-Viewer groups, t-tests, Chi-Square, Kruskal-Wallis, and Mann-Whitney tests were applied as appropriate, reporting statistically significant findings at  $p \leq .05$ . To help determine whether a significant difference was a difference of practical concern, effect sizes were also computed and reported in the text where appropriate. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both

deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Sample

Of the 450 adults and youth that participated in the evaluation, 229 Viewers and 221 Pre-Viewers completed questionnaires that subsequently formed the basis for the evaluation report. Chi-square analyses indicated that the two groups did not differ significantly with respect to 3 of the 5 measured variables, including: gender, age group, education, and number of giant screen films viewed. Differences were found for race and education, however, such that the Viewing group included a significantly higher percentage of minority respondents and respondents with a higher level of education than did the Pre-Viewing group. The Viewer portion of the sample included: Somewhat more females (58%) than males (42%); A wide range of ages, spanning 8-76 years, with a mean age of 35.; A racial distribution comprising 58% White, 17% Asian, 11% African-American, 1% Native American or Alaskan Native, 5% multiracial, and 6% Other Viewers. About one-tenth of the participants (11%) were of Hispanic Origin. The sample also included a combination of high school through graduate level educated respondents, including: 23% with a high school education or less (includes youth Viewers), 43% with some college education or a college degree, and 32% with some graduate school education or a graduate degree. The Viewer group also included a combination of frequent vs. occasional Viewers of giant screen films, including 44% who reported they had seen only 0-2 films prior to seeing *Mysteries of the Unseen World* and 55% who reported they had seen 3 or more films.

## Findings

This section presents the Phase 1 evaluation findings relating to the following four questions: 1) How appealing and engaging did Viewers find the film? 2) Did Viewers find the film content to be clearly presented? 3) What did Viewers learn from the film? 4) How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?

### Question 1: How appealing and engaging did Viewers find the film?

To assess the film's overall appeal, Viewers were asked to rate how much they liked *Mysteries of the Unseen World* and to rate the film's entertainment value with respect to visual excitement and impact on curiosity. They were also asked to rate their engagement with the film's storyline and their likelihood of recommending the film to others. Finally, they were asked to describe what they liked and didn't like about the film. These findings are presented below in 1.1 through 1.3.

**1.1 How did Viewers rate the film in terms of overall likeability, visual excitement, impact on curiosity, interest in the story, and likelihood of recommending the film?** When asked to rate *Mysteries of the Unseen World* for overall appeal and engagement using a scale from 1.0 (rated the lowest) to 7.0 (rated the highest), Viewers generally indicated they: liked the film (median rating 7.0), found it visually exciting (median rating 7.0), felt it increased their curiosity about things they couldn't see with their own eyes (median rating 7.0), thought the story was interesting (median rating 7.0), and expected they were likely recommend the film to others (median rating 7.0).

Mann-Whitney tests indicated a few subgroup differences, as follows. Compared to Viewers aged 19-40, Viewers 41 years and older gave significantly higher ratings to their overall liking of the program ( $U = 3218$

$p = .014$ ,  $r = .18$ ), the program's storytelling ( $U = 3040$ ,  $p = .005$ ,  $r = .21$ ), level of visual excitement ( $U = 3208$ ,  $p = .011$ ,  $r = .19$ ), their likelihood of recommending the program ( $U = 2940$ ,  $p = .001$ ,  $r = .26$ ), and their level of curiosity about things they can't see with their own eyes ( $U = 3079$ ,  $p = .003$ ,  $r = .23$ ). The effect sizes in each case were considered small effects. Similarly, compared to youth Viewers aged 7-18, Viewers 41 years and older gave significantly higher ratings to two items, their overall liking of the program ( $U = 1685$ ,  $p = .001$ ,  $r = .28$ ) and the film's overall clarity ( $U = 1670$ ,  $p = .002$ ,  $r = .26$ ). The effect sizes in each case were again considered small effects. Finally, Mann-Whitney tests also found that females rated their curiosity about things they can't see with their own eyes significantly higher than did males ( $U = 5118$ ,  $p = .001$ ,  $r = .22$ ), though here again, the effect size was small

**1.2 What did Viewers like most about the film?** When asked to describe what they liked most about *Mysteries of the Unseen World*, almost all (98%) of the Viewers identified at least one thing about the film that they found appealing, with many citing two or more elements. About one-third of Viewers commented on the educational value of the film (34%), explaining that they learned a lot, enjoyed learning, and/or found something interesting. At the same time, a third of Viewers shared positive feedback about the film's visual elements (33%) – which some described as “beautiful,” “colorful,” and “incredible” – as well as the film's giant screen format. Around a quarter of Viewers said they liked one or more things about the film's presentation of information (26%), including the pacing, narration, examples provided, and overall structure, among other elements. Just under a fifth most liked something in the *Too Small* section (19%), including the film's discussion of the nanoscale. Just over one-sixth indicated that they liked something they learned about past and future technological innovations (17%), while less than one-sixth each liked something in the *Too Fast* section (15%) and/or something the film showed them about the unseen world (14%). Less than one-tenth each liked something in the *Too Slow* section (9%) and/or the *Invisible* section (8%). A slightly smaller group explained that they liked that the film was science-based (6%), and a handful each shared general praise (5%) or indicated that they liked everything about the film (3%). Just under a sixth of Viewers shared miscellaneous responses (15%), and a handful declined to answer the question (2%).

**1.3 What did Viewers not like about the film?** When asked what they did not like about the film, the largest groups of Viewers indicated that they liked everything, with more than one-quarter declining to answer the question (27%) and a fifth explaining that there wasn't anything they disliked (20%). About a sixth disliked something about the giant screen theater or experience (16%), with some criticizing the size or layout of the theater and others explaining that the viewing experience made them “dizzy” or “nauseous.” A tenth thought *Mysteries of the Unseen World* was too short and/or said they would have liked more information (10%). Just under a tenth disliked something about the film's audiovisuals elements (9%), including the music, the narrator/narration, and/or the imagery in general. At the same time, a slightly smaller group pointed to “gross” or “scary” elements in the film (8%), such as the decomposing rat, what they learned in the *Too Small* section, and the scenes with the snake and the owl. Less than a tenth each found something about *Mysteries of the Unseen World* confusing or hard to follow (4%), indicated that the film was boring or uninteresting (3%), noted that they didn't like the pacing (3%), and/or explained that they disliked something about the nanoscale scenes (3%). Finally, a tenth shared miscellaneous comments (10%).



## Question 2: Did Viewers find the film content to be clearly presented?

Viewers were asked to rate how successful they found the film in terms of overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations. These findings are presented below in 2.1 through 2.2.

**2.1 How did Viewers feel about the film's overall clarity and the ease or difficulty of following the film visually?** Using a scale from 1 (confusing) to 7 (clear), Viewers generally indicated they found the film to offer a clear as opposed to confusing presentation (median rating 7.0). Similarly, using a scale from 1 (visually hard to follow) to 7 (visually easy to follow) they also generally indicated they found the film visually easy to follow (median rating 7.0). A Mann-Whitney test found one subgroup difference for the later item in that more frequent viewers of IMAX films rated the film to be visually easier to follow than did less frequent viewers, though the effect size was small ( $U = 5397$ ,  $p = .015$ ,  $r = .16$ ).

**2.2 How did Viewers feel about the film's pacing, amount of information and science, and level of scientific explanations?** Viewers rated *Mysteries of the Unseen World* for how they felt about the pacing of the film, the amount of information and science, and the level of scientific explanations, using a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being "just right" in each case. Overall, Viewers generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were all about right (median rating 4.0 each). Mann-Whitney tests further indicated a few subgroup differences, as follows. First, less frequent viewers of IMAX films rated the film's amount of information ( $U = 5564$ ,  $p = .037$ ,  $r = .14$ ), amount of science ( $U = 5391$ ,  $p = .012$ ,  $r = .17$ ), and level of scientific explanations ( $U = 5363$ ,  $p = .011$ ,  $r = .17$ ) significantly higher than did more frequent viewers, though the effect sizes in each case were small. In addition, Mann-Whitney tests revealed that females rated the film's level of scientific explanations significantly higher than did males ( $U = 5428$ ,  $p = .025$ ,  $r = .15$ ), although here again the effect size was small.

## Question 3: What did Viewers learn from the film?

The learning value of *Mysteries of the Unseen World* was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, Viewers were asked to rate how much they thought they learned from *Mysteries of the Unseen World*. Second, they were invited to comment on the most interesting things they learned from the film. Third, they were asked to rate how much they thought they learned from the film about science and technology topics. Fourth, in order to assess knowledge gains relating to the content of the film, Viewers and Pre-Viewers both completed a 35 point "quiz" type assessment that included true/false, multiple choice, and short answer questions. These findings are presented below in 3.1 through 3.5.

**3.1 How much did Viewers think they learned from the film?** Overall, Viewers indicated that they thought they learned a lot from *Mysteries of the Unseen World*. On a scale from 1 (learned nothing) to 7 (learned a lot) the median rating was 7.0. Mann-Whitney tests did indicate one subgroup difference as females rated their overall learning from the film significantly higher than did males though the effect size was small ( $U = 5443$ ,  $p = .028$ ,  $r = .15$ ). The median ratings in each case were 7.0.

### 3.2 What was the impact of the film on Viewers' self-perceived knowledge of the unseen world?

Viewers who had just seen the film rated their knowledge of the unseen world significantly higher than did Pre-Viewers and the effect size was large ( $U = 13559$ ,  $p = .001$ ,  $r = .40$ ). On a scale from 1 (know nothing) to 7 (know a lot) the median rating for Viewers was 5.0 compared to 3.0 for Pre-Viewers.

**3.3 What did Viewers think were the most interesting things they learned from the film?** When asked to describe the most interesting things they learned from watching *Mysteries of the Unseen World*, more than nine-tenths (94%) of Viewers identified one or more new subjects of interest. Nearly half of Viewers commented on something interesting in the *Too Small* section of the film (47%), while about a quarter pointed to something in the *Too Fast* section (24%). Just over one-fifth each pointed to the following: something from the *Invisible* section (21%), nanotechnology (21%), and seeing the unseen world and/or knowing that so much is unseen (21%). Just over a tenth were most interested in technology other than nanotech (11%), and less than a tenth were most interested in something in the *Too Slow* section (7%). Finally, a tenth of Viewers shared miscellaneous responses (10%), and less than a tenth declined to answer the question (6%).

### 3.4 How much did Viewers think they learned from the film about science and technology topics?

Using a scale from 1 (learned nothing) to 4 (learned a lot), Viewers generally indicated that they learned a lot (median rating 4.0 each) from the film about four of the film's five main topic areas, including: 1) the kinds of discoveries we can make about nature using new technologies, 2) the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, 3) the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and 4) the properties and possibilities of the nanoworld. They also thought they learned a fair amount (median rating 3.0) about the kinds of light waves humans and other animals see.

**3.5 What was the film's impact on Viewers' knowledge of the unseen world?** To evaluate the impact of *Mysteries of the Unseen World* on Viewers' knowledge of content covered in the film, both Viewers and Pre-Viewers were asked to complete a 35 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for a general audience. Overall Viewers significantly outperformed Pre-Viewers on a content assessment designed to assess learning from the film in five topic areas. An independent samples t-test showed that Viewers scored significantly higher than Pre-Viewers, and the effect size was large ( $t(384) = 19.5$ ,  $p < .001$ ,  $d = 1.84$ , 95% CI [11.1, 13.5]). Out of a total possible score of 35, Viewers averaged 28.4 correct responses, while Pre-Viewers averaged 16.0 correct responses.

In addition to this higher overall score, Viewers also significantly outperformed Pre-Viewers for each of the five main topic areas assessed, as follows: For *The types of light waves that humans and other animals see*, out of a total possible score of 6, Viewers averaged 5.1 correct responses while Pre-Viewers averaged 3.4 ( $t(431) = 9.93$ ,  $p < .001$ ,  $d = 0.94$ , 95% CI [1.4, 2.0]). For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 8, Viewers averaged 6 correct responses while Pre-Viewers averaged 2.8 ( $t(430) = 16.3$ ,  $p < .001$ ,  $d = 1.54$ , 95% CI [2.8, 3.5]). For *Discoveries scientists have been able to make about nature through new technologies*, out of a total possible score of 6, Viewers averaged 5.4 correct responses while Pre-Viewers averaged 3.2 ( $t(347) = 14.7$ ,  $p < .001$ ,  $d = 1.39$ , 95% CI [1.9, 2.5]). For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, Viewers averaged 9.5 correct responses while Pre-Viewers averaged 5.5 ( $t(424) = 10.72$ ,  $p < .001$ ,  $d = 1.01$ , 95% CI [3.3, 4.8]). Finally, for *Properties and*

*possibilities of the nanoscale*, out of a total possible score of 3, Viewers averaged 2.4 correct responses while Pre-Viewers averaged 1.2 ( $t(422) = 13.5, p < .001, d = 1.27, 95\% CI [1.0, 1.4]$ ). The effect sizes in all instances were large effects.

#### **Question 4: How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?**

Question 4 considers the film's immediate impact on Viewers' interest in the unseen world, as well as if and how they thought they would "see" the world differently after watching *Mysteries of the Unseen World*. These findings are presented below in 4.1 through 4.2.

**4.1 What was the film's impact on Viewers' interest in the unseen world?** Viewers who had just seen the film rated their interest in the unseen world significantly higher than did Pre-Viewers who had yet to do so, although the effect size was small ( $U = 20434, p = .001, r = .18$ ). Using a scale from 1 (not at all interested) to 7 (very interested) there was a point difference in the median ratings between the two groups (7.0 vs. 6.0 respectively).

**4.2 Did Viewers think they would "see" the world differently after watching the film?** When asked if they thought they would "see" the world around them differently as a result of watching the film, the majority of Viewers said *Yes* (85%), while just under a tenth each said *No* (8%) or identified as *Unsure* (6%). Those who said *Yes* were asked how they would "see" the world differently. More than a quarter of Viewers explained that they would generally be more aware, knowledgeable, or conscious of the world around them and the things they cannot see (26%), and less than a fifth of Viewers indicated that they would think about something from the *Too Small* section (17%). Less than a tenth each said they would feel awe, respect, or appreciation for nature and the world around them (8%), noted that they would wonder, be more curious, or imagine more (7%), explained that they would think about man's place in nature and the complexity of life (7%), and described how they would think about something from the *Invisible*, *Too Fast*, and/or *Too Slow* sections of the film (7%). A slightly smaller group said they would observe or study the world more carefully (6%). Finally, less than a tenth of Viewers shared miscellaneous responses (9%).

Those who said *No* were asked why not. The largest group explained that they were already knowledgeable about the topics in the film (5%), while a handful each said they were limited by (human) sight and experience (1%) or shared miscellaneous responses (1%). And finally, those who were *Unsure* were asked why this was the case. A handful each said they were already knowledgeable of the topics in the film (1%), explained that the film wouldn't be on their minds (1%), or shared miscellaneous responses (2%).

## **Phase 2: Discussion group explorations of Viewers' connections with the film**

Immediately following four separate showings of *Mysteries of the Unseen World*, a trained moderator conducted four group discussion sessions with family groups to explore their reactions to the film. Recruitment for the sessions focused on families because the project team expected that *Mysteries of the Unseen World* would be a particularly appealing and effective learning medium for families. Recruitment

occurred as Viewers exited the theater and was purposive, focusing on family groups with youth as opposed to young children.

All four sessions were held in an open room located adjacent to the theater exit area and were led by the same moderator. The sessions ran approximately 50-60 minutes, which included time for recruiting and settling participants into the discussion room, introductions, an ice-breaker activity, discussion, wrap-up, and providing an honorarium in the form of a \$25 gift certificate to the science center gift store.

## Sample information

Twenty-nine (29) Viewers participated in the group discussion. Across the four discussion groups, there were a somewhat higher percentage of females (59%) to males (41%). Nearly three-quarters (72%) of the participants were adults while just over one-quarter (28%) were youth 17 years or younger. The average age of the adults was 38 while the average age of the youth was 11. The majority of the participants were White (62%), with 10% Asian, 10% African-American, 3% Native American or Alaskan Native, and 10% reporting Other. One-tenth (10%) of the group identified themselves as Hispanic or Latino. The majority of participants had a graduate degree or some graduate experience (69%), with 27% having a high school degree or less and 3% having a college degree. Finally, the majority of participants had previously seen 1 or more giant screen films prior to seeing *Mysteries of the Unseen World*, with two-thirds (62%) having seen 3 or more. Overall the group indicated it was very interested in the unseen world (median 7.0) and somewhat knowledgeable (median 5.0).

## Findings

This section presents the Phase 2 evaluation findings relating to the following six questions: 1) Who in the family drove the decision to see the film and why? 2) How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them? 3) What new questions or curiosities did Viewers have about the world around them as a result of seeing the film? 4) How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do? 5) How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film? 6) Did Viewers have any other feedback on the film that they would like to share?

### **Question 1: Who in the family drove the decision to see the film and why?**

Most of the families that participated in the group sessions indicated that the children in their families were the key decision makers as to which film they would see, whether it was a matter of the child directly choosing or their choosing based on what they thought was in their child's best interest. Only a couple of families made the decision based on what the parents/guardians wanted to see. For these families, the parents, most often the mother, indicated they made the decision for the family, in each case factoring in what they thought was in their children's best interest or the family at large.

When asked to describe their reasons for seeing the *Mysteries of the Unseen World* film the Viewers most often pointed to the film's: focus on the unseen world or science more broadly, diverse topic areas, and/or the attention given to unusual animals and plants or to time-lapse photography. A couple of families

indicated they chose the film through a process of elimination as they didn't want to see the other film playing at Discovery Place at the time.

## **Question 2: How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?**

To help break the ice and explore what Viewers noticed about the film's visuals, the moderator asked Viewers to draw any visuals from the film that stood out for them. They were encouraged: to enjoy the drawing activity, to not worry about creating works of art, and to view the activity as an informal "ice breaker" exercise that would also give the producers some sense of Viewers' visual impressions from the film. To accommodate anyone who might be uncomfortable drawing, the moderator also offered the option of using words or labeling their pictures for ease of interpretation. To this suggestion, a couple of Viewers qualified, while laughing, that they would draw pictures of visuals that they personally could figure out how to draw, as some of the film's visuals were complex.

Both adult and youth Viewers seemed engaged in the drawing activity, with most commenting that they found it to be a "fun," "creative," "personal," or "interesting" way to reflect on the film. While they were drawing their pictures, many Viewers observed that the film left a "strong," "lasting," or "powerful" visual impression on them and/or that the film's visuals "sparked" new "curiosities" or "questions."

No one particular visual stood out for a majority of the 29 Viewers; instead, Viewers choose a wide range of different visuals with 8 of these visuals being drawn by 10% or more of the group. Nearly one-third of the Viewers (31%) drew a picture of a raindrop hitting/bouncing in a puddle. A few Viewers each (14%) drew a picture of: a dragonfly, details of butterfly wings/scales, gold particles attacking cancer cells, an elevator to space, and/or a graphene/carbon tube. A couple of Viewers each (10%) drew a picture of: light waves and a time-lapse of flower blooming. One Viewer each (3%) drew a picture of: a lizard looking at a robot lizard, a balloon bursting from a push pin, a lightning strike, a strawberry decomposing, a spider climbing on spider web, a bee pollinating a flower, and hummingbird wings.

Each of the film's four sections was represented across the Viewers' drawings, but some sections were represented more than others. Two-thirds of the drawings related to visuals shown in the *Too Small* section of the film (62%), including the scenes about the nanoworld, compared to a slightly smaller group (58%) that related to the *Too Fast* section of the film (58%). One-seventh of the drawings related to visuals from the *Too Slow* section (14%) and one-tenth to the *Invisible* section (10%).<sup>3</sup>

Most of the adults and youth indicated that the film as a whole impressed them visually. They variously described the film's visuals as: "to the point," "clear to understand," "stunning," "artistic," "scientific," "broadly appealing to all ages," and "unique." The Viewers also described their reactions to the film's visuals in diverse ways, ranging from experiencing an "emotional rush" to feeling like the visuals were "easy to follow," to liking how the film showed the "inner workings or movements" of everyday phenomena, to appreciating that the visuals weren't "scary," although a few youth and adults alike observed some images like the germs and eyelash mites were "gross" or "creepy." Others observed that the visuals offered them "a change of perspective" or allowed them to more easily "relate" to what was being shown or reflected that some images lingered and/or "stuck in their minds."

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<sup>3</sup> Note that some Viewers drew more than one picture, resulting in the percentages adding up to more than 100%

Several adults discussed the experience of watching the film on the giant screen, which at Discovery Place was in a dome theater. Some Viewers raised negative experiences, although no one issue stood out as a problem among the Viewers as a whole. These issues, raised by a few Viewers, included that the film seemed “*out of focus*,” “*blurry*,” “*dark*,” “*overstimulating*,” or “*motion sickness*” producing. Other Viewers, meanwhile, felt the giant screen experience was bearable for them, with one Viewer describing her viewing experience as “*tolerable*” compared to other giant screen films that often “*throw things*” at the audience. More often though, Viewers felt the giant screen experience “*maximized*” and was “*central*” to their enjoyment of the film’s visuals. One Viewer described that she felt like she was “*there and that she was moving the whole time*” while another observed that he appreciated the long “*lingering*” moments that allowed Viewers to “*experience*” and even “*study*” what was happening, as in the high-speed photographic examples of the rain drops bouncing on water and the balloon popping. A number of Viewers similarly pointed to appreciating that the images “*zoomed in*” or “*surrounded*” them which gave them a real sense of “*detail*,” “*context*” and/or “*scale*” and even an “*emotional rush*.”

Across the groups, the Viewers pointed to a wide range of different visual images or sequences that stood out for them, some of which were the same as those depicted in the pictures they chose to draw, though many Viewers also described other visuals. The air traffic/flight patterns, dragonfly, and elevator to space visuals were each mentioned by several Viewers. A few Viewers mentioned visual sequences that showed how animals use light waves, the flea in the dog’s coat, or the use of nano gold in nanotechnology. Individual Viewers pointed to the following additional visuals: the balloon popping from the push pin, seeing microorganisms in action, the animation of nano gold used to treat cancer cells, the water droplet bouncing in a puddle, the strawberry decomposing, the animation of atoms moving, and the gecko robots.

### **Question 3: What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?**

More than half of the Viewers indicated they had new questions or curiosities related to content in the nanoworld section of the film. Their comments most often focused on the possibilities of using nanotechnology, including the use of gold at the nano level for medical treatments, the composition and uses of graphene and carbon tubes, the applications for space travel, and what is currently possible in terms of moving and splitting atoms. Several adults also raised concerns about the ethics of nanotechnology and the relative benefits to humanity. A few individuals also commented on wanting to know more about other topics such as the types of colleges that offer nanotechnology coursework. At the same time, a couple of Viewers, one adult and one youth, raised curiosities or questions related to the *Too Small* section of the film, with the youth wanting to know more about seeing deep inside the scales of butterflies and the adult wanting to know about how electron microscopy works, and two youth focused on the idea of wanting to know more about making or using animal robots.

### **Question 4: How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?**

Viewers mentioned a variety of different ways they would go about seeking information on new questions or curiosities the film raised for them. Most were able to come up with at least a starting point, although a few Viewers said they weren’t sure how they would frame or direct their search. Those who listed a starting

point most often described turning to: online searching, Google searches, National Geographic resources, science-based publications or websites, video or film resources, and/or their local library.

### **Question 5: How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film?**

In three of the four groups, there was time for a final question about the film's use of human characters. Several adult and youth Viewers reflected that the human characters provided "*context*" and/or "*relevance*" for the content that was featured and that it helped to promote the idea that they were watching a story unfold. At the same time, several Viewers reflected that they felt that the film could have gone further in leveraging the human characters or at least strengthening the "*relevance*" of the human characters in specific scenes. Some Viewers didn't see the role that the characters played in demonstrating or transitioning the film content's about the unseen world. Specific scenes they commented on involved the skateboarding scenes, the boy nearly hit by the fire truck, the picture of head lice, and the transition from showing the slime mold. Finally, while recognizing the role that the human characters played in the film a few adults qualified they personally didn't feel a "*connection*" to them.

### **Question 6: Did Viewers have any other feedback on the film that they would like to share?**

When offered the chance to provide any other feedback on the film, Viewers in three of the four groups made comments about wanting the film to be longer. Most often they elaborated that they felt they wanted additional depth on specific topics rather than an overview of many different topics. Additionally, a few Viewers across the groups commented that the pace seemed too fast in places. Finally, a few mothers noted that the film caused them to think about careers for their children based on the film content, and a couple of mothers explained that the film was relevant to their young children, with both noting that they talked to their children throughout the film about what was on the screen.

## **Phase 3: Follow-up evaluation of extended impact**

To explore the longer-term impact of the *Mysteries of the Unseen World* film, a follow-up online questionnaire was sent to Viewers who: a) completed a post-viewing questionnaire, b) but did not participate in a discussion group, and who c) indicated that they were willing to be contacted via email and an online questionnaire to provide feedback on the film within 15-20 days. These Viewers were informed of the opportunity to provide feedback via a small piece of paper stapled to the post-viewing questionnaire, which was subsequently removed and separated from the questionnaire. The invitation requested that respondents share their name and email address if they were interested in participating in the brief online questionnaire, and informed them they would be provided a \$10 gift certificate to amazon.com as a thank you for their participation.

An email with a link to the online questionnaire was sent to Viewers who provided contact information within 15-20 days of their seeing the film. The email was sent via the independent evaluation firm's [Constant Contact](#) account. A total of 72 out of 136 respondents opened the email request within the one-week

evaluation period, and 25 of these 72 recipients completed the online evaluation request, resulting in a completion rate of 35%.

## Sample

Twenty-five (25) Viewers completed the follow-up questionnaire. There was a higher percentage of females (72%) to males (28%). Nearly all (92%) of the participants were adults while just under one-tenth (8%) were youth 17 years or younger. The average age of the adults was 43 while the average age of youth was 14. As with the Phase 1 questionnaire evaluation, the majority of the participants were White (56%), with 24% Asian, 4% African-American, and 12% Other, including 2 Viewers who noted that they were Dominican. Just over one-tenth (12%) of the group identified themselves as Hispanic or Latino. The largest group of participants indicated that they had a graduate degree (36%), with 4% having attended some graduate school, 16% having a college degree, 28% having attended some college, 8% having a high school degree, and 8% having attended some high school. Additionally, the largest group of participants indicated that they had seen 3 or 4 giant screen films prior to seeing *Mysteries of the Unseen World* (40%), with 20% having seen 1 or 2, 28% having seen 5 or more, and 12% having seen none.

## Findings

This section presents the Phase 3 evaluation findings relating to the following six questions: 1) How much did Viewers continue to think about the film within a few weeks of viewing? 2) How much did Viewers look into topics from the film within a few weeks of viewing? 3) Did the film change how Viewers think or feel about science or technology? 4) Did Viewers “see” the world differently a few weeks after watching the film? 5) What activities did Viewers do within a few weeks of watching the film? 6) What additional feedback did Viewers share a few weeks after watching the film?

### **Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?**

Nearly all of the Viewers indicated that they thought about the film in the weeks since viewing (96%). More than four-fifths thought about the film a little or moderate amount (84%), and just over a tenth thought about the film quite a bit to a lot (12%). Less than one-tenth didn't think about the film at all (4%). When asked to describe what they thought about from the film in the weeks since watching, more than a third of Viewers pointed to something from the *Too Small* section (36%), including a few who thought about the nanoworld. More than one-tenth each explained that they thought about the *Too Fast* section (12%), the unseen world in general (12%), and/or what they liked about the film (12%), with some calling it “cool” and “entertaining,” for example. Slightly less than a tenth each described having thought about the *Invisible* section (8%), the *Too Slow* section (8%), the film's educational goals (8%), and/or what they liked about the film's visuals (8%). Finally, just over a tenth of Viewers shared miscellaneous responses (12%), and a fifth declined to answer the question (20%).



## Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?

Viewers were asked if they looked into (e.g., talked to someone about, read about, watched videos, or researched online) topics from the film since viewing *Mysteries of the Unseen World* a few weeks earlier. More than half of Viewers looked into one or more of the topics from the film (56%). About a sixth of Viewers looked into 1 topic (16%) and a fifth looked into 2 topics (20%). Less than one-tenth each looked into 3 (4%), 4 (8%), or 5 topics (8%). None of the Viewers looked into more than 5 topics, and more than two-fifths didn't look into any topics (44%).

The largest group of Viewers noted that they looked into *the invisible world/things you can't see* (44%). About one-sixth each looked into *time-lapse photography (to help us see things too slow to see)* (16%), *the kinds of discoveries we can make about nature using new technologies* (16%), and *the kinds of inventions (e.g., devices/materials) we can create by studying/imitating nature* (16%). At the same time, just over one-tenth each looked into *electron microscopy (to help us see things too small to see)* (12%) and *high-speed photography (to help us see things too fast to see)* (12%). Less than a tenth each looked into: *the kinds of light waves humans and other animals use to see* (8%), *the properties of the nanoworld* (8%), *the things that nanotechnology makes possible (e.g., new materials, devices)* (4%), and *the kinds of jobs/careers that use the science or technology shown in the film* (4%). Finally, although none of the Viewers checked a box on the follow-up questionnaire to indicate that they looked into *other* topics from the film, one Viewer (4%) wrote in that s/he looked into "*Pluto*."

When asked to explain what they looked into, more than a tenth of Viewers shared feedback about who they talked to (12%), rather than what they discussed (for example, "*Talked to my husband about these amazing things*" and "*Conversation with friends and family about the topics have been interesting*"). A group of the same size mentioned having looked into topics from the film (12%), as in, "*I watched the film 'Gratitude' with time-lapsed photography,*" "*I began to look into the kinds of technology we can create by imitating nature, such as dragonfly wings, while being able to use nanotechnology to make them super efficient,*" and "*Drones,*" which likely referred to an animation of dragonfly drones. Just under a tenth described having viewed other films (8%), as in, "*I looked more into other documentaries with similar themes.*"

## Question 3: Did the film change how Viewers think or feel about science or technology?

Nearly two-thirds of Viewers thought seeing the film changed how they think or feel about science or technology (64%), while more than a third said it did not (36%). Those who said *Yes* were asked how seeing the film changed how they think or feel. More than a quarter described having a greater awareness or appreciation of the world around them (28%), while just under a quarter said they thought about science, technology, and what the future holds (24%). More than a tenth of Viewers shared miscellaneous responses (12%). Those who said *No* were asked why they didn't think or feel differently. More than a quarter explained that they were knowledgeable of or interested in the unseen world prior to seeing the film (28%), one Viewer shared a miscellaneous response (4%), and one declined to answer the question (4%).

#### **Question 4: Did Viewers “see” the world differently a few weeks after watching the film?**

Next, Viewers were asked if they had seen the world around them differently since watching *Mysteries of the Unseen World*. More than four-fifths of Viewers indicated that they *did see* the world differently (84%), while one-sixth said they did not (16%). Those who said *Yes* were asked to provide one or more examples of how they had seen the world differently since viewing the film. The largest group – nearly half of Viewers – explained that they watched things, paid closer attention, or observed the world more carefully (48%). A fifth noted that they had a different perspective or looked at things differently since viewing the film (20%), and about a sixth reported thinking about the things they can’t see (16%). Those who indicated that they *did not* see the world differently were asked why this was the case. A few explained that they were already knowledgeable (8%), and one each said they hadn’t thought about the film (4%) or were too busy (4%).

#### **Question 5: What activities did Viewers do within a few weeks of watching the film?**

When asked what activities they did related to the film within a few weeks of viewing, the largest group of Viewers, nearly three-quarters, *talked to others* about the film (72%). At the same about, one-fifth each explained that they *saw something* on TV or in a movie that made them think of the film (20%) and/or *read something* that made them think of the film (20%). Less than one-tenth each *did something online* related to the film (8%) and/or *heard something* that made them think of the film (4%). More information about each of these activities is shared below.

- Talked to others about the film (72%)  
When asked who they talked to and what they talked about, the Viewers shared a range of responses. Nearly two-thirds of Viewers described who they talked to (60%), including friends and family members who saw the film with them and people who did not. More than a quarter of Viewers described having talked about the general content or style of the film (28%), including a few Viewers who recommended the film to others. A sixth talked about the *Too Small* section (16%), and less than one-tenth each talked about the *Invisible* section (8%) and/or the *Too Fast* section (4%). About a tenth talked about miscellaneous topics (8%), just under a quarter said they didn’t talk to anyone (24%), and one Viewer declined to answer the question (4%).
- Saw something on television or in a movie that made them think of the film (20%)  
When asked what they saw that reminded them of the film, Viewers pointed to a variety of topics and a range of platforms, including TV shows, online videos, and computer screensavers.
- Read something that made them think of the film (20%)  
When asked what they read that reminded them of the film, Viewers pointed to nonfiction books – including two Viewers who were reminded of the film by the same book, *Insiders Extreme Weather*, for readers in grades 3-7 – and *National Geographic* articles.
- Did something online related to the film (8%)  
Both Viewers who did something online indicated that they looked for more information about the film on social media (8%) and that they visited the film’s website (8%), with one viewer noting, “*I was checking where it was currently showing.*” One of the Viewers also searched something from the film

online (4%), saying, “Just tried to learn more about the film and its development process, particularly the type of exposure and photography used to shoot it.” None of the Viewers indicated that they downloaded the *Mysteries of the Unseen World* app from iTunes, “liked” the film’s Facebook page, posted the film’s trailer on their Facebook page, tweeted or blogged or used Facebook to discuss the film with others, or did another online activity. Finally, one Viewer explained that s/he intended to visit the film’s website in the future, saying, “I will eventually look at the website.”

- Heard something on the radio or while listening to music that made them think of the film (4%)  
When asked what they heard that reminded them of the film, one viewer explained, “I have music from the Navajo people and listening to it reminds me of nature---how Native Americans view nature and how they are part of a larger world.”

### **Question 6: What additional feedback did Viewers share a few weeks after watching the film?**

After completing the follow-up questionnaire, more than a quarter of Viewers opted to share additional feedback about their experience with the film since viewing (28%). A fifth commented on *Mysteries of the Unseen World* (20%), saying they enjoyed it, thought it could be longer, and/or that they shared it with their children, among other responses. Additionally, a handful of Viewers shared miscellaneous comments about their experience with the film since viewing (8%), commenting on their personal interests and their thoughts about the follow-up questionnaire.

## **Discussion**

The evaluation results indicate that the *Mysteries of the Unseen World* film was a successful informal science learning initiative with the audience recruited for Study 1 of the summative evaluation, meeting the project’s goals in each of the five impact areas detailed in the introduction of this evaluation: 1) appeal and engagement, 2) clarity of presentation, 3) knowledge acquisition, 4) STEM interest and perceptions, and 5) motivational impact.

The findings in this report show that *Mysteries of the Unseen World* appealed to and engaged Viewers recruited for the evaluation. Overall, Viewers liked the film, found it visually exciting, thought the story was interesting, and expected to recommend the film to others. In general, they also found it well paced, clear, and visually easy to follow. Additionally, Viewers generally indicated that the film increased their curiosity about things they can’t see with their own eyes and that it struck the right balance in terms of the amount of information, amount of science, and level of scientific explanations provided. Furthermore, *Mysteries of the Unseen World* had a significant impact on Viewers’ knowledge of the content covered in the film, increased their interest in the film’s STEM content, and increased their interest in and awareness of the unseen world. Finally, the majority of Viewers who completed the follow-up questionnaire indicated that they had done one or more activities related to the film in the weeks since viewing.

It is notable that relatively few subgroup differences were found across the evaluation. The few that were found involved older Viewers (41 years and older) tending to rate some individual aspects of the film higher than younger Viewers, including, in the case of Viewers aged 19-40, the program’s storytelling, level of visual excitement, their likelihood of recommending the program, and their level of curiosity about things they can’t see with their own eyes. Similarly, compared to youth Viewers aged 7-18, Viewers 41 years and

older tended to give significantly higher ratings to their overall liking of the program and the film's overall clarity. A few gender differences were also found, as females tended to rate their learning from the film significantly higher than did males, as well as their own level of curiosity about the unseen world after viewing. Meanwhile, females also tended to find the scientific explanations in the film significantly more advanced than did males. Finally, more frequent viewers of IMAX films tended to rate the film as visually easier to follow than did less frequent viewers, while less frequent viewers tended to rate the film's amount of information and science significantly higher and find the film's level of scientific explanations significantly more advanced.

In each of these cases though, it is important to bear in mind that the effect sizes were small, and Viewers ratings were very positive across all subgroups. Therefore, taken together with the film's overall lack of other major subgroup differences, the findings indicate that *Mysteries of the Unseen World* was well received by and successful with both males and females, as well as with individuals of varying ages, educational levels, and number of IMAX films viewed.

It is also important to note that, although this evaluation wasn't designed to consider format differences, as other giant screen studies have done<sup>4</sup>, *Mysteries of the Unseen World* showed in many different theater types (including IMAX, IMAX Dome, and 3D). For this report, the film was evaluated in two different theater types, with one being a giant screen dome theater and the other a National Geographic 3D theater with a smaller screen. Recognizing that the evaluation was not designed to assess the role of theater or screen type on Viewers' experience with the film, the evaluation found no significant differences in Viewers' ratings of the film at the two theaters/locations. Thus, *Mysteries of the Unseen World* was well received by and successful with Viewers who saw the film in a dome theater and in a 3D theater with a smaller screen.

Below, we briefly summarize aspects of the film that stood out for Viewers in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions. Reflecting on the findings that stood out from this vantage point, we highlight 11 themes, each of which we briefly discuss below with sample comments that capture the spirit of the theme:

➔ ***I liked the educational value/learned a lot from the film:*** When asked what they liked most about *Mysteries of the Unseen World*, the largest group of Viewers pointed to the film's educational value (as in, "*Learned so much. Felt like a real scientist!*" and "*A lot of interesting information that I didn't know before*"). In addition to appreciating the film's educational value, Viewers generally thought that they learned a lot from the film overall and that they learned a lot about specific STEM topics, including: *the kinds of discoveries we can make about nature using new technologies; the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature; the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes); and the properties and possibilities of the nanoworld.* As a group, they also thought they learned a fair amount about *the kinds of light waves humans and other animals see.*

The evaluation of the film's impact on Viewers' knowledge indicates that Viewers' perceptions of these personal knowledge gains were generally accurate. As detailed in this report, the Viewer group significantly outperformed the Pre-Viewer group overall *and* on each of the following five topics: *Types of light waves that humans and other animals see, Technologies used to see and study things that humans can't see with normal vision, Discoveries scientists have been able to*

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<sup>4</sup> Heimlich, J. E., Sickler, J., Yocco, V., & Storksdiack, M. (2010). Influence of immersion on visitor learning: Maya skies research report. *Edgewater, MD: Institute for Learning Innovation.*

*make about nature through new technologies, Things scientists can learn from nature to make innovative materials and devices, and Properties and possibilities of the nanoscale.*

- **I like that the film showed me and enabled me to see the unseen world:** Throughout their responses, many Viewers indicated that they liked being able to see the unseen world (as in, “*Saw things I literally could not imagine*” and “*It showed all of things that are around us that we can’t see, which is fascinating*”). Viewers often pointed to the specific things the film showed them about the unseen world as being what they liked most about the film (as in, “*seeing things move slowly and fast*” and “*too small, liked the things they showed*”). Some Viewers also appreciated how seeing the unseen would or did provide a new perspective on their surroundings, as in, “*The film made me realize that the ‘naked eye’ perhaps wasn’t intended to see all that there is to see in nature and other places*” and “*When I see the droplets of water or the flowers blooming, I could remember the scenes of the movie where you have shown in minute details about them.*” Additionally, one of the Viewers who participated in a group discussion explained that the film’s title and the idea of being able to see the unseen world were what attracted her family to the theater in the first place, saying: “*I got the tickets, but my 6 year old is fascinated with all this germs and what is the unseen world and what you can’t see with your eyes... He is fascinated with all that, and my daughter is getting into that too... So that’s what I thought would interest them... when you say “unseen” it is automatic, like what is there that we haven’t see? The title itself is very... it attracts you to it. It kinda makes you want to know more about... what is there? When you draw the curtain, people want to look behind.*”
- **The film increased interest in and curiosity about the unseen world:** Viewers who had just seen the film rated their interest in the unseen world significantly higher than did Pre-Viewers, and throughout their questionnaires a number of Viewers noted that the film increased their curiosity about the unseen world around them (as in, “*Ask more ‘questions’ like how is that dragonfly able to fly as it does?*”). Additionally, the majority of discussion group Viewers eagerly identified new questions or curiosities they had about the world around them as a result of watching the film, with the largest group pointing to questions about nanotechnology, considered below.
- **The nanotechnology section inspired new questions for me:** In the discussion sessions and post-viewing questionnaires, a number of Viewers indicated they had questions or curiosities related to content in the nanoworld section of the film. Their comments focused on the possibilities of using nanotechnology, including the use of gold at the nano level for medical treatments, the composition and uses of graphene and carbon tubes, the applications for space travel, and what is currently possible in terms of moving and splitting atoms (for example, “*I wish there was a little more explaining about the nanotechnology they referred to at the end*” and “*With the gold part of medicine, I’d like to know how far they are, have they started to do trials, etc.?*”). Some Viewers also raised concerns about the ethics of nanotechnology and the relative benefits to humanity, as in, “*The concept of humans playing with nanotechnology makes me nervous because we don’t really fully understand it and the room for error is great.*”
- **I was particularly interested in the content of the Too Small section:** In comparison with the *Too Fast*, *Too Slow*, and *Invisible* sections of the film, Viewers more often pointed to content from the *Too Small* section when asked questions about the film, including: what they liked most, what they found most interesting, if and how they thought they would “see” the world differently after viewing, and what they thought about in the weeks since seeing the film in the theater. Additionally, when

discussion group Viewers were asked to draw visuals from the film that stood out to them, the majority of their drawings depicted content and scenes from the *Too Small* section.

Though these findings indicate that Viewers were particularly interested in the content of the *Too Small* section, further research would be needed to determine the extent to which this content stood out because the *Too Small* section was the final section of the film (as one discussion group participant noted, “*I drew the space elevator, probably because it was one of the last images I saw and it was in my head*”) and/or because the *Too Small* section was the longest of the four sections (approximately 14 minutes long) and likely contained more visuals, information, and ideas that might “stick” with Viewers.

- **I wanted even more information:** Throughout the post-viewing and follow-up questionnaires, a number of Viewers expressed an interest in learning more, either wishing the film had provided more information (as in, “*I could have used a bit more detail*” and “*this topic should be more in detail to comprehend*”) or that the film had been longer (as in, “*It was extremely pleasant - wish it was longer!*”). When offered the chance to provide additional feedback at the end of the group discussions, Viewers in three of the four groups also shared comments about wanting the film to be longer. Most often they elaborated that they wanted additional depth on specific topics rather than an overview of many different topics (for example, “*Make the video a little longer and put more detail or more explanation on the different parts*”), and in one of the groups the majority of discussion participants agreed they would be willing to watch a forty minute version of the film on a specific topic, such as nanotechnology, suggested by one Viewer in the session.
- **I could relate to the everyday examples in the film:** Though they weren’t specifically asked for feedback on the choice of examples shared throughout the film, some Viewers explained that they liked the film’s use of “*everyday objects*” and “*experiences*” because they “*could relate to them.*” One Viewer elaborated, saying, “*For instance it wasn’t something that’s happening inside forests or deep in the sea. This helps us to pay more attention to around us.*” One Viewer noted that s/he like how the exploration of the everyday gave these objects and experiences greater “*relevance,*” while another explained that s/he thought the everyday examples would spark more curiosity in his or her daily life (as in, “*Having a more curious mind when looking at simple things or everyday things*”).
- **I thought the visuals were beautiful:** Viewers generally shared positive feedback about the film’s visuals, describing them as “*beautiful,*” “*colorful,*” and “*amazing.*” For many Viewers, the visuals were what they said they liked most about the film, as in “*Colors—especially butterflies, the scene with glass and loved the water drops. Pitcher of milk was beautiful. I also liked how visually stimulating it was, it made it more interesting how colorful it was.*”

In the questionnaires and discussion group sessions, Viewers variously described the visuals as: “*to the point,*” “*clear to understand,*” “*stunning,*” “*artistic,*” “*stimulating,*” “*scientific,*” “*broadly appealing to all ages,*” and “*unique.*” Viewers also described their reactions to the film’s visuals in diverse ways, ranging from experiencing an “*emotional rush,*” to appreciating that the visuals were “*easy to follow,*” to liking how the film showed the “*inner workings or movements*” of everyday phenomena. Others observed that the visuals offered them “*a change of perspective,*” allowed them to more easily “*relate*” to what was being shown, “*stuck in their minds,*” or helped them “*better grasp the subject.*”

Finally, in one of the discussion groups, an adult woman explained her reaction to her husband's interest in seeing the film as she was concerned that *Mysteries of the Unseen World* would not be as pretty and photographically stunning as other IMAX films she had seen, though she was pleasantly surprised: *"One of the things I appreciated, so why I like IMAX, is visually because it's pretty and the photography is stunning and the animals, and so that's what I like and so when her (her husband) suggested that we see this, I was like...hmmm...I don't know if I'm going to get the experience that I like with all the pretty pictures, but it did a really good job and I was really impressed and really stunned at how artistic it was in addition to being scientific."*

- ➔ **The film was well suited to the giant screen format.** Some Viewers commented on the experience of watching the film on the giant screen, as experienced at Discovery Place on a dome theater. Most often, these Viewers felt the giant screen experience maximized and was central to their enjoyment of the film's visuals, as in *"Visually powerful, IMAX format"* and *"I...enjoyed the IMAX experience and delivery of information."* Additionally, one discussion group participant described that she felt like she was *"there and that she was moving the whole time,"* while another shared an appreciation for the long *"lingering"* moments that allowed Viewers to *"experience"* and even *"study"* what was happening, as in the high-speed photographic examples of the rain drops bouncing on water and the balloon popping, among other responses.

Meanwhile some Viewers raised negative experiences about their viewing the film on the giant screen, although no one issue stood out as a problem among the Viewers as a whole and few comments related specifically to the film itself. These issues, raised by a handful of Viewers, included that the film seemed *"out of focus or blurry"* and that it made them *"dizzy"* or *"nauseous."* Other Viewers, meanwhile, felt the giant screen experience was bearable, with some Viewers noting that they adjusted to the experience (as in, *"It took me some time to focus on the screen but that was IMAX not the film itself"*) and one discussion group Viewer describing her experience as *"tolerable"* compared to other giant screen films that often *"throw things"* at the audience.

- ➔ **Since viewing the film, I will see (or have seen) the world differently.** Nearly nine-tenths of Viewers reported immediately after viewing that they thought they would *"see"* the world differently as a result of watching the film (85%). A few weeks later, roughly the same proportion of Viewers who completed a follow-up survey indicated that they *had* seen the world differently in the weeks since viewing (84%). In both cases their comments included examples like, *"I will understand and acknowledge the unseen world"* and *"I see the world at a much 'smaller' level, knowing that some of the materials and substance that we use are formed on a microscopic level and we can make better materials by going even smaller."*

Just under one-tenth of Viewers leaving the theater thought they would not *"see"* the world differently (8%), and a slightly smaller group of Viewers were unsure (6%), compared to the one-sixth of follow-up Viewers who indicated that they had not *"seen"* the world differently in the weeks since viewing the film (16%). In both groups of Viewers, those who thought they would not or did not *"see"* the world differently most often explained that this was because they were already knowledgeable of the unseen world (as in, *"Already aware, but still loved seeing [the film]."*)

- ➔ **I would be interested in learning more about the film's online resources, but I might need encouragement.** Viewers who participated in the group discussion sessions and indicated that they had new questions or curiosities after viewing most often said they thought they would go online for

more information (with several noting that they would “Google” their question) and/or that they would turn to online or print-based resources from National Geographic, suggesting that Viewers were generally open to extending their learning and engagement with the film beyond the theater experience.

Furthermore, when asked about the activities they had done in the weeks since viewing *Mysteries of the Unseen World*, the majority of Viewers indicated that they had talked to others about the film. Smaller groups explained that they saw something on TV/in a movie or read something that reminded them of the film. However, relatively few of the follow-up Viewers explained that they did an online activity related to the film in the weeks after viewing. A handful each noted that they had looked for more information about the film on social media and/or had visited the film’s website. None of the Viewers indicated that they downloaded the *Mysteries of the Unseen World* app from iTunes, “liked” the film’s Facebook page, posted the film’s trailer on their Facebook page, tweeted or blogged or used Facebook to discuss the film with others, or did another online activity. Additionally, although the discussion sessions were not geared specifically to a consideration of the website, a few Viewers in each group added to the conversation that they hadn’t thought about searching out the film website on their own accord, but might have if the film or ancillary materials (e.g., signage, brochures, kiosk) had drawn their attention to it. In one group, the discussion moved toward the use of social media to promote or extend the film’s impact through the use of hashtags. Future giant screen evaluations might look at the role that social media can play not only in promoting a film but also in directing audience members to additional information and resources. As noted by one group discussion Viewer, “*I think especially with what media can do today. I think that anything that can supplement that experience... if I want to dive off into nanotechnology or into the dragonfly wings or whatever. There could be resources online that could go into those that are probably at a lower cost of production, but pieces that will allow you to dive in a little bit more would be extremely valuable.*”

The above list of 11 themes are ones that we found to be most pertinent to the goals of the current evaluation, and with possible implications for future work produced by National Geographic and other groups focused on producing giant screen films funded by the NSF. As always, caution should be taken in drawing broad implications from any one evaluation. In this case, *Mysteries of the Unseen World* is a multi-faceted giant screen media project, which presented many alternative ways to evaluate the project’s success in meeting its informal science learning goals.

The findings from *Mysteries of the Unseen World* offer broader implications for other giant screen film projects aiming to informally educate the public about science facts, concepts, or research. Although the evaluation was conducted at only two theater sites due to scheduling/availability and to allow for in-depth group discussions, the findings add further support to a conclusion reached in a review of 10 giant screen films funded by the NSF (Flagg, 2005):<sup>5</sup>

*Summative evaluations of 10 giant screen films indicate that the NSF’s grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers’ understanding of what scientists do; and positively impacts viewers’ actions after a museum visit.*

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<sup>5</sup> Flagg, B. (2005). Beyond entertainment: Educational impact of films and companion materials. *Big Frame*, 22(2), 50-56.



This evaluation assessed Viewers' scientific knowledge of the unseen world, their interest in and attitude toward the unseen world, their understanding of what scientists do, and the extent to which a subgroup of Viewers ultimately pursued actions subsequent to their theater visit. In each of these areas, the film was found to be successful.

## Final remarks

Beyond confirming that the film met the project's goals in each of the 5 impact areas, and in addition to the issues raised in the discussion above, this evaluation also raises new issues for consideration around three aspects of the giant screen viewing experience that have received little or no evaluation attention to date: the use of human characters in a fictional storyline; the use of a cross-promotional project kiosk; and the impact of immersive visualizations on Viewers' imaginations.

First, *Mysteries of the Unseen World's* narrative was structured by a fictional story about a family and their friends. Though these human characters were a topic of consideration in the group discussion sessions, Viewers were not asked to share their thoughts about the characters in the post-viewing or follow-up questionnaires. Given that discussion group participants generally provided diverse feedback about the characters (for example, "*I think in certain instances it helped set the context for what you were looking at,*" "*I didn't think they were that relevant to what was going on,*" and "*There wasn't a connection to the individuals*") and given the lack of research on fictional human characters in educational giant screen films, this is a subject that might be considered in future research.

Second, though Viewers were not asked about their interest in or interaction with the *Mysteries of the Unseen World* kiosk at the evaluation site that hosted the kiosk in their lobby, one family in a group discussion session explained that they decided to see the film after the son and daughter noticed and interacted with the kiosk. Though the family didn't plan to see an IMAX film at the theater that day, the kiosk piqued their interest to learn more about the film which prompted them to walk to the nearby lobby area where the film tickets were being sold. Here they in turn noticed the film poster and brochures, which further increased their interest in seeing the film and ultimately help confirm their decision. Future research might explore the use of similar kiosks across a variety of theater sites, considering their impact on film ticket sales and Viewer engagement with film content, among other topics.

Finally, though it was not directly addressed in the questionnaires and discussion group sessions, a number of Viewers indicated that seeing things that are too fast, too slow, too small, and invisible to the naked eye inspired them to imagine the unseen world around them (as in, "*I'll look around and imagine that there's much more I could be seeing*"). Further research might examine the extent to which the immersive qualities of the giant screen format impact Viewers' imaginations across audience members of various ages and backgrounds, and the influence of imagination on knowledge gains, among other topics.

## Summative evaluation study 2: Impact of the giant screen film with a student audience

The Study 2 summative evaluation examined middle school students' experience with *Mysteries of the Unseen World* when the film was viewed at their local science center during part of a school field trip. The evaluation centered on five key questions based on direction provided by National Geographic relating to the film's goals and consultation of the following materials for context and further specification: the film and script, the project's original NSF proposal, the evaluation team's original and revised summative evaluation plan, the project's Impact and Indicator statements submitted to the NSF, the formative evaluation reports on the film's rough cuts completed by Multimedia Research in 2012, and Knight Williams' prior summative evaluations focused on middle school students' learning from giant screen films produced by National Geographic. The five key questions were:

- 1) *How appealing and engaging did students find the film?*
- 2) *Did students find the film content to be clearly presented?*
- 3) *What did students learn from viewing the film?*
- 4) *Did viewing the film impact students' STEM interests and perceptions?*
- 5) *What was the film's motivational impact on students within a few weeks of viewing?*

To assess these five questions, the evaluation was conducted in two phases, as follows:

- **Phase 1: Pre-post questionnaire assessment of the film's immediate appeal and learning value**  
The evaluation used a quasi-experimental one group pretest/posttest design to examine the appeal and immediate educational impact of the film. One week prior to seeing the film students in eight middle school classes completed a pre-viewing/pretest questionnaire that included demographic and background questions about students' gender, ethnicity/race, number of IMAX films seen, and interest in and knowledge of the film's main topic areas. The questionnaire also included a short knowledge quiz of content covered in the film. One day after seeing the film, all eight classes completed a post-viewing/posttest questionnaire. The questionnaires collectively addressed the impact questions 1-4, described above.
- **Phase 2: Follow-up evaluation of extended impact**  
Approximately 15-20 days after students viewed the film they were asked to complete a brief questionnaire exploring the film's longer-term impact.

Statistical analyses were conducted on all quantitative data generated from the evaluation. Differences in student ratings and scores from pre to posttest as well as subgroup differences are noted where significant differences of less than .05 were found. To explore for significant differences, the analyses used t-tests and Mann-Whitney tests, as appropriate. Demographic and background variables used in the

subgroup analyses included: gender, location/grade, and number of IMAX films viewed. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Sample information

Beginning in January 2015, Knight Williams and National Geographic staff collaborated to locate middle school teacher representatives whose classes were scheduled to see or expressed an interest in seeing *Mysteries of the Unseen World* during the spring of the 2014-2015 school year at a partner science center. Working from a list of four partner sites that were showing *Mysteries of the Unseen World* in the spring and had middle school classes booked to see the film, the evaluation team used the following four criteria to help select schools to participate in the evaluation: 1) The schools' scheduled viewing had to occur one month before the end of the school year to ensure time for completion of the Phase 2 follow-up, and during a timeframe that did not include school holidays to ensure no disruptions to the evaluation process; 2) The schools had to have a minimum of two classes scheduled to see the film; 3) The schools were public schools; and 4) The schools served a diverse cross-section of students from different backgrounds and metropolitan areas.

In March and April of 2015, the evaluation team located two middle schools that fit the above evaluation criteria. The two participating schools were respectively located in the Alabaster, Alabama and San Jose, California metropolitan areas. The supervising teachers in each case confirmed they were interested in and able to complete all of the required evaluation activities within the requested evaluation timeframe, from the initial pretesting of students one week prior to seeing the film through to the follow-up questionnaire 15-20 days later. To ease the burden of the evaluator requests for the above set of activities, both schools that participated in the evaluation were provided honoraria.

During the month of May 2015, a total of four classes from each school attended a field trip to either the McWane Science Center in Birmingham, Alabama or the Tech Museum of Innovation in San Jose, California, respectively. In both cases students viewed the film on a dome screen as both science centers host an IMAX dome theater. A total of 194 students from 8 classrooms completed both the pretest and posttest questionnaires, of which 90% (n=174) also completed a follow-up questionnaire 15-20 days later. The sample included:

- A balance of boys and girls (50% each).
- An age range that spanned 11-14 years, with a mean and median age of 12.
- A racial/ethnic distribution comprising 55% White, 10% Asian, 4% African-American, 13% mixed-race, and 14% Other. Sixteen percent (16%) of the students were of Hispanic origin.
- A comparable number of students from each of the two participating schools in California (54%) and Alabama (46%).
- A combination of frequent vs. occasional viewers of giant screen films, including 45% who reported they had seen only 0-2 films prior to seeing *Mysteries of the Unseen World* and 55% who reported they had seen 3 or more films.
- A majority of students who felt they knew a little about the five main topics featured in the film (median ratings 2.0 across),

- A majority of students who felt they knew were a little or fairly interested in the film's topics, with the discoveries about nature, inventions by studying nature, and technologies to see the unseen world being rated somewhat higher overall (median ratings 3.0) than the light waves or nanoworld properties and possibilities (median ratings 2.0).
- A combination of students that indicated they were not at all or slightly interested (35%) somewhat interested (33%) or very or extremely interested (32%) in a future job/career involving science,

## **Phase 1: Pre-post assessment of the film's immediate appeal and learning value**

### **Findings**

This section summarizes the Phase 1 evaluation findings relating to the following four questions: 1) How appealing and engaging did students find the film? 2) How successful did students find the film in terms of: overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations? 3) What did students learn from the film? 4) How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?

#### **Question 1: How appealing and engaging did students find the film?**

To assess the film's overall appeal, students were asked to rate how much they liked *Mysteries of the Unseen World* and to rate the film's entertainment value with respect to visual excitement and impact on curiosity. They were also asked to rate their engagement with the film's storyline and their likelihood of recommending the film to others their age. Finally, they were asked to describe what they liked and didn't like about the film. These findings are presented below in 1.1 through 1.3.

**1.1 How did students rate the film in terms of overall likeability, visual excitement, impact on curiosity, engagement with the storyline, and likelihood of recommending the film?** When asked to rate the film on a seven point scale with 1 being lowest and 7 being highest, the students indicated they generally liked *Mysteries of the Unseen World* (median rating 6.5), found it visually exciting (median rating 6.0), indicated that the film increased their curiosity (median rating 6.0), and thought they would recommend the film to others their age (median rating 6.0). They also generally found the film's story about the family and their friends somewhat engaging (median rating 5.0).

Mann-Whitney tests determined a few subgroup differences for this set of questions. First, boys indicated that watching the film increased their curiosity significantly more than did girls, though the effect size was small ( $U = 3929$   $p = .045$ ,  $r = .14$ ). Second, 6th graders in California found the film's story about the family/friends significantly more engaging than did the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama though the effect size was small ( $U = 3642$   $p = .008$ ,  $r = .19$ ). The 6<sup>th</sup> graders also indicated they were significantly more likely to recommend the film than did the 7<sup>th</sup> and 8<sup>th</sup> graders though here again, the effect size was small ( $U = 3775$   $p = .017$ ,  $r = .17$ ).

**1.2 What did students like about the film?** When asked to describe what they liked most about *Mysteries of the Unseen World*, the majority (95%) of students identified at least one thing about the film that they found appealing, with many citing two or more elements. Nearly three-tenths of students commented on the educational value of the film (29%), while just over one-quarter explained that they most liked something the film showed them about the unseen world (26%). More than one-fifth of students indicated that they most liked something in the *Too Small* section (22%), while around one-sixth each explained that they most liked something in the *Invisible* section (18%) and/or something in the *Too Fast* section (17%). Slightly less than one-sixth most liked something in the *Too Slow* section (15%). About one-seventh each pointed to something they learned about past and future technological innovations (14%) and/or something to do with the audiovisual aspects of giant screen filmmaking (14%). Slightly smaller groups specifically described something about the film as “cool” (13%) and/or explained that they most liked an aspect of the presentation of information (12%). Finally, less than one-tenth each indicated that they liked everything in the film (4%), explained that they liked nothing (2%), noted that they did not know what they liked most about the film (1%), or declined to provide a response (2%). A handful shared miscellaneous responses (7%), including 2 students who indicated that they most liked something in the trailer for another IMAX film, *Humpback Whales*.

**1.3 What did students not like about the film?** Nearly one-third of students indicated that there was *nothing* they disliked about the *Mysteries of the Unseen World* (32%). One-fifth of students pointed to elements they considered “gross” (20%), including scenes focused on the mites on our eyelashes, particles in the air we breathe, decomposition, and close-ups of small organisms. One-tenth of students explained that they were physically uncomfortable during the screening (10%), with most explaining that the film gave them “a headache,” made them “dizzy,” or “hurt their eyes.” Just under a tenth of students indicated that they didn’t like an aspect of the filmmaking (9%), while a slightly smaller group noted that they thought the film was too short and/or wanted more information (7%). A handful each said they didn’t know what they did not like (4%), found the film boring or uninteresting (3%), thought parts were confusing (2%), and/or thought the film was too long (2%). Finally, a tenth shared miscellaneous responses (10%), and just under a tenth declined to answer the question (7%).

**Question 2: How successful did students find the film in terms of:  
overall clarity, visual clarity, pacing, density of information, density of science,  
and level of scientific explanations?**

Students were asked to rate how successful they found the film in terms of overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations. These findings are presented below in 2.1 through 2.2.

**2.1 How did students feel about the film’s overall clarity and the ease or difficulty of following the film visually?** Using a scale from 1 (confusing) to 7 (clear), students generally indicated they found the film fairly clear (median rating 6.0). Similarly, using a scale from 1 (visually hard to follow) to 7 (visually easy to follow) they also indicated that they thought the visuals were fairly easy to follow (median rating 6.0).

**2.2 How did students feel about the film’s pacing, amount of information and science, and level of scientific explanations?** Students rated *Mysteries of the Unseen World* for how they felt about the pacing of the film, the amount of information in the film, and the amount of science and level of scientific

explanations on a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being just right in each case. Overall students generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were about right (median rating 4.0 each). In addition, Mann-Whitney tests revealed that girls found the film's level of scientific explanations significantly more advanced than did boys although here again the effect size was small ( $U = 3854$ ,  $p = .018$ ,  $r = .17$ ).

### Question 3: What did students learn from the film?

The learning value of *Mysteries of the Unseen World* was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, students were asked to rate how much they thought they learned from *Mysteries of the Unseen World*. Second, they were invited to comment on the most interesting things they learned from the film. Third, they were asked to rate how successful they thought the film was in communicating science and technology themes, and how much they thought they learned from the film about science and technology topics. Fourth, in order to assess knowledge gains relating to the content of the film, students completed a 40 point "quiz" type assessment that included true/false, multiple choice, and short answer questions before and after viewing the film. These findings are presented below in 3.1 through 3.5.

**3.1 How much did students think they learned from the film?** Using a scale from 1.0 (learned nothing) to 7.0 (learned a lot), overall students indicated that they learned a considerable amount from watching *Mysteries of the Unseen World* (median rating, 6.0).

**3.2 What did students think were the most interesting things learned from the film?** When asked to describe the most interesting things they learned from *Mysteries of the Unseen World*, nine-tenths (90%) of students identified one or more new subjects of interest. More than a quarter pointed to technological innovations (27%), while a slightly smaller group said they learned something interesting in the *Too Small* section (26%). Just over a fifth of students indicated that they learned something interesting in the *Invisible* section (21%). Slightly less than one-sixth of students pointed to something they learned in the *Too Fast* section (16%), and less than a tenth shared something interesting they learned in the *Too Slow* section (7%). A handful said they didn't know what they found most interesting in the film (3%), and less than a tenth declined to answer the question (7%). Finally, one-seventh of students shared miscellaneous responses (14%).

**3.3 How successful did students think the film was in communicating specific themes about science and technology?** Asked to rate the film's success in communicating five key science and technology content themes on a scale from 1 (not at all successful) to 7 (very successful), the students generally thought the film was successful in each regard (median rating 6.0 each), including that: *scientists have invented technology to look at things in nature that we cannot see with our own eyes*, *technology opens up new frontiers to explore*, *technology reveals things about nature that could change our understanding of the planet we live on*, *there is a lot to learn from the invisible worlds that surround us*, and that *when we study nature we discover new things that could improve our lives*.

**3.4 How much did students think they learned from the film about science and technology topics?** Overall, when asked to rate the amount they felt they learned about five specific topics using a scale from 1 (learned nothing) to 4 (learned a lot), students generally indicated that they learned a lot (median rating 4.0 each) about two topics: *the kinds of discoveries we can make about nature using new technologies* and *the*

kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature. They also thought they learned a fair amount (median rating 3.0 each) about the following three topics: *the kinds of light waves humans and other animals see*, *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)*, and *the properties and possibilities of the nanoworld*. Mann-Whitney tests found one subgroup difference in this question set in that 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama rated the amount they learned from the film about the nanoworld significantly higher than did 6<sup>th</sup> graders in California though here again, the effect size was small ( $U = 3734$   $p = .01$ ,  $r = .19$ ).

**3.5 What was the film's impact on students' knowledge of unseen worlds?** To evaluate the impact of *Mysteries of the Unseen World* on students' knowledge of content covered in the film, students were asked to complete a 40 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions one week before seeing the film and then one day after viewing. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for middle school students.

Overall the evaluation found students made significant gains in their content learning from *Mysteries of the Unseen World*. A paired sample t-test showed that students' scores were significantly higher after watching the film than before, and the effect size was large ( $t(193) = 32.5$ ,  $p < .001$ ,  $d = 1.96$ , 95% CI [13.2, 15.0]). Where students averaged 17 out of 40 correct answers on the pre-viewing questionnaire, they scored 31 correct responses on the post-viewing questionnaire.

In addition to this higher overall score, students also scored significantly higher on each of the five main topic areas assessed, as follows: For *The types of light waves that humans and other animals see*, out of a total possible score of 6, students averaged 3.1 correct answers before seeing the film and 5.0 correct answers after ( $t(193) = 11.8$ ,  $p < .001$ ,  $d = 1.18$ , 95% CI [1.6, 2.2]). For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 10, students averaged 3.4 correct answers before the film and 7.1 after ( $t(193) = 11.8$ ,  $p < .001$ ,  $d = 1.53$ , 95% CI [1.6, 2.2]). For the *Discoveries scientists have been able to make about nature through new technologies*, out of a total possible score of 6, students averaged 2.1 correct answers before seeing the film and 4.4 after ( $t(193) = 21.5$ ,  $p < .001$ ,  $d = 2.01$ , 95% CI [2.0, 2.4]). For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, students average 6.0 correct answers before seeing the film and 10 after ( $t(193) = 15.2$ ,  $p < .001$ ,  $d = 1.13$ , 95% CI [3.5, 4.6]). Finally, for *Properties and possibilities of the nanoscale*, out of a total possible score of 6, students averaged 2.2 correct answers before seeing the film and 4.1 correct answers after ( $t(193) = 15.4$ ,  $p < .001$ ,  $d = 1.23$ , 95% CI [1.9, 2.5]). The effect sizes in each case were large.

#### **Question 4: How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?**

Question 4 considers the film's immediate impact on students' interest in science and technology, science and technology jobs/careers, and students' thoughts about if and how they thought they would "see" the world differently after viewing *Mysteries of the Unseen World*. These findings are presented below in 4.1 through 4.3.

**4.1 What was the film's impact on students' interest in science and technology topics?** Using a scale from 1 (decreased strongly) to 7 (increased strongly), students generally indicated that the film increased their interest in the subject of *the properties and possibilities of the nanoworld* (median rating 6.0) and somewhat increased their interest (median rating 5.0 each) in the following four additional topics: *the kinds of light waves humans and other animals see, the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, and the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes).*

**4.2 What was the film's impact on students' interest in a job/career involving science or technology?** After viewing *Mysteries of the Unseen World*, students were asked to rate how much the film increased or decreased their interest in a future job/career involving science or technology on a scale from 1.0 (decreased strongly) to 7.0 (increased strongly), with 4.0 being neither increased nor decreased. Overall students indicated that viewing the film somewhat increased (median rating 5.0) students' interest in a future job/career involving science or technology.

When asked to identify sections of the film that influenced their interest in a job/career in science or technology, more than a tenth of students pointed to something in the nanotechnology section (11%), while just under a tenth commented on a scene highlighting technology inspired by nature (9%). Slightly smaller groups explained that they were impacted by something in the *Invisible* section (7%) and/or pointed to the *Too Small* section (6%). At the same time, a handful each noted that they were impacted by what they learned about something *Too Fast* (5%), high-powered microscopes (5%), and/or something in the *Too Slow* section (3%). One-seventh of students provided miscellaneous responses (14%), and a tenth said they weren't influenced by any part of *Mysteries of the Unseen World* (10%), including 2 students who noted that they were *already* interested in this career path prior to seeing the film. Finally, less than a tenth said they didn't know which sections of the film influenced their interest in a job/career in science or technology (6%), and more than a third of students declined to answer the question (35%).

**4.3 Did students think they would "see" the world differently after watching the film?** When students were asked if they thought they would "see" the world around them differently as a result of watching the film, nearly three-fourths of students said *Yes* (72%), while a tenth said *No* (10%) and nearly two-fifths identified as *Unsure* (18%). Those who said *Yes* were asked how they would "see" the world differently. One-fifth of students explained that they would generally have more knowledge and awareness of unseen worlds (20%), just under a fifth said they would think about things from the *Too Small* section (17%), and more than one-seventh said they would think about something from the *Invisible* section (15%). Less than one-tenth each explained that they would observe more (4%), would think about things from the *Too Fast* section (3%), would be inspired to learn more (3%), would think about things from the *Too Slow* section (2%), or provided miscellaneous responses (8%).

Those who said *No* were asked why not. A handful each explained that they would be limited by (human) sight and experience (3%), that they were already knowledgeable (2%), that they weren't impacted by the film (2%), or said the world around them would remain the same (1%). A similarly small group shared miscellaneous responses (2%).

And finally, those who were *Unsure* were asked why this was the case. A handful each explained that they would be limited by (human) sight and experience (4%), said they were unsure (4%), noted that the subject of the film wouldn't be on their minds (3%), indicated that they were already knowledgeable (2%), or said



they didn't understand something in the film or needed to learn more (1%). A similarly small group provided miscellaneous responses (2%).

## Phase 2: Follow-up evaluation of extended impact

### Findings

This section summarizes the Phase 2 evaluation findings relating to the following five questions: 1) How much did students continue to think about the film within a few weeks of viewing? 2) How much did students look into topics from the film within a few weeks of viewing? 3) Did the film change how students think or feel about science or technology? 4) Did students "see" the world differently a few weeks after viewing the film? 5) What activities did students do within a few weeks of viewing the film?

#### Question 1: How much did students continue to think about the film within a few weeks of viewing?

The majority of students indicated that they thought about the film in the weeks since viewing (80%). More than half thought about the film a little or a moderate amount (53%), and more than a quarter thought about the film quite a bit to a lot (26%). A fifth of students indicated that they hadn't thought about the film (20%).

When asked to describe what they thought about from the film in the weeks since viewing, about one-sixth explained that they thought about things from the *Too Small* section (17%), while a slightly smaller group thought about things from the *Invisible* section (16%). More than a tenth of students thought about technology (13%), and less than a tenth thought about things from the *Too Fast* section (7%). A handful each said they thought about something related to unseen worlds (5%) and/or things from the *Too Slow* section (4%). Finally, more than one-seventh shared miscellaneous feedback (15%).

#### Question 2: How much did students look into topics from the film within a few weeks of viewing?

When asked to rate the extent to which they looked into 5 science and technology topics after viewing the film, about three-fifth each indicated that they looked into *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature* (60%) and *the kinds of discoveries we can make about nature using new technologies* (59%). More than half each explained that they looked into *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)* (55%), *the kinds of light waves humans and other animals see* (52%), and *the properties and possibilities of the nanoworld* (51%).

Next, students were asked if they looked into (e.g., talked to someone about, read about, watched videos, or researched online) 5 additional topics from the film: 1) *the invisible world*, 2) *time-lapse photograph*, 3) *high-speed photography*, 4) *things nanotechnology makes possible*, and 5) *electron microscopy*.

Nearly three-quarters of students looked into at least of 1 of these 5 topics (72%). Just under one-quarter looked into 1 topic (24%), and about a sixth each looked into 2 (17%) or 3 (17%) topics. Less than a tenth each looked into 4 (8%) or 5 topics (6%). More than a quarter didn't look into any topics (28%).

More than two-fifths of students (43% each) indicated that they looked into: *the invisible world/things you can't see*, *time-lapse photography (to help see things too slow to see)*, and *high-speed photography (to help see things too fast to see)*. More than a quarter said they looked into *the things that nanotechnology makes possible (e.g., new materials, devices)* (28%), while about a sixth noted that they looked into *electron microscopy (to help see things too small to see)* (17%).

### **Question 3: Did the film change how students think or feel about science or technology?**

Nearly two-thirds of students thought seeing the film changed how they think or feel about science or technology (64%), while about a third said it did not (35%). Those who said *Yes* were asked how seeing the film changed how they think or feel. More than a tenth said they now think or feel differently about technology, including nanotechnology (15%). A slightly smaller group commented on things they learned about unseen worlds (12%), while a tenth each explained that they think or feel differently about science (10%) and/or the world in general (10%). A handful each described being more interested in a science or technology job/career (5%) and/or commented on observing or imitating nature (4%). A tenth of students shared miscellaneous responses (10%).

Those who said *No* were asked why they didn't think or feel differently. Less than a tenth each explained that they didn't care about the film or didn't like science (7%) and/or that the film didn't impact them in that way (7%). A slightly smaller group said they hadn't thought about it or didn't remember (5%), and a handful indicated that they didn't know why they didn't think or feel differently (3%).

### **Question 4: Did students "see" the world differently a few weeks after viewing the film?**

Next, students were asked if they had seen the world around them differently after watching *Mysteries of the Unseen World*. Nearly three-fifths of students indicated that they *did see* the world differently (59%), while two-fifths said they did not (40%). Those who said *Yes* were asked to provide one or more examples of how they had seen the world differently since viewing the film. Nearly one-fifth of students described being more aware of things that are *Invisible* (18%), while a slightly smaller group described being more aware of and knowledgeable about things that are *Too Small* (17%). Just under a tenth expressed a new appreciation for things that are *Too Fast* and/or *Too Slow* to see with the naked eye (9%), and a handful expressed having more general knowledge and awareness of the world around them (6%). Just under a tenth of students shared miscellaneous responses (9%).

Those student who indicated that they *did not* see the world differently were asked why this was the case. A tenth explained that they hadn't thought about or forgot about the film (10%), and less than a tenth said the world around them remained the same (8%). A handful each explained that they were already knowledgeable (3%) or said they didn't know (3%). Finally, more than a tenth shared miscellaneous responses (13%).

## Question 5: What activities did students do within a few weeks of viewing the film?

When asked if they did ten specific activities within a month of viewing the film, more than two-thirds of students indicated that they did at least one activity in that time frame (70%). About a third did one activity (32%), nearly one-fifth did two activities (18%), and just over a tenth did three activities (11%). A handful each did four (3%), five (2%), six (2%), nine (1%), and ten activities (2%). None of the students did seven or eight activities (0% each). Finally, less than a third of students indicated that they did not do any of the activities (30%).

The largest group of students, more than half, *talked to others* about the film (55%). At the same time, around a quarter explained that they *saw something* on TV or in a movie that made them think of the film (26%), and a fifth *thought about jobs/careers* that use the science or technology shown in the film (20%). More than a tenth each *read something* that made them think of the film (14%) and/or *looked into something* from the film (13%). Less than a tenth each *tried an exploration/experiment* (6%), looked for information about the film on *social media* (5%), *visited the film's website* (5%), *heard something* that made them think of the film (5%), or *downloaded the app* (3%). More information about the activities done by the students is presented below, from highest frequency to lowest frequency among students.

- Talked to others about the film (55%)  
When asked what they talked about with others, nearly one-fifth said they talked about the film in general (18%), while a slightly smaller group explained that they talked about things from the *Too Small* section (14%). A tenth talked to others about things from the *Invisible* section (10%), and a handful talked to others about technology (6%). Finally, about a tenth of students talked about miscellaneous subjects (9%), including things from the *Too Fast* and/or *Too Slow* sections, among other topics.
- Saw something on television or in a movie that made them think of the film (26%)  
When asked what they saw that reminded them of the film, students pointed to a variety of topics and a range of platforms, including films, television shows, commercials, and online videos.
- Thought about or looked into jobs/careers that use the science or technology shown in the film (20%)  
When asked what they thought about or looked into, students shared a range of responses about careers in science, engineering, computer design, and photography, among others.
- Read something that made them think of the film (14%)  
When asked what they read that reminded them of the film, students pointed to a variety of topics and a range of sources, including magazines, books, and articles.
- Looked into or followed up on something from the film (13%)  
When asked what they looked into or followed up on from the film, students pointed to a range of topics, including time-lapse and high-speed photography, things from the *Too Small* and/or *Invisible* sections, the nanoworld, nanotechnology, and technological inspiration from nature.

- Tried an exploration or experiment based on something in the film (6%)  
When asked about their exploration or experiment, a few students pointed to experimenting with or noticing water drops, one mentioned that s/he noticed small things, another commented on being inspired by the trailer for *Humpback Whales*, and one gave an example of something s/he explored online.
- Looked for more information about the film on social media (e.g., Facebook, Twitter) (5%)  
When students were asked which social media sites they looked at and what they found, one pointed to Instagram, another mentioned Twitter, and a few described what they looked up (“bugs” and “plants”).
- Went online to the *Mysteries of the Unseen World* website (5%)  
When asked what they did at the website, a few students shared general information about their online activities, such as “I looked around at the different articles and other movies,” “I looked at stuff,” and “had trouble with tech tag log in.”
- Heard something on the radio or while listening to music that made them think of the film (5%)  
When asked what they heard that reminded them of the film, a few students pointed to specific topics (“bugs,” “bacteria,” “x-rays,” and “waves”).
- Downloaded the *Mysteries of the Unseen World* app from iTunes (3%)  
When asked how they used the app, one student explained that s/he “explored it.”

## Discussion

The evaluation results indicate that the *Mysteries of the Unseen World* film was a successful informal science learning initiative with the students recruited for Study 2 of the summative evaluation, meeting the project’s goals in each of the five impact areas detailed in the introduction of this report: 1) appeal and engagement, 2) clarity of presentation, 3) knowledge acquisition, 4) STEM interest and perceptions, and 5) motivational impact.

The findings in Study 2 show that *Mysteries of the Unseen World* appealed to and engaged the students who participated in the evaluation. Overall, they liked the film, found it visually exciting, indicated that it increased their curiosity, and thought they would recommend it to others their age. Additionally, the students generally found the film well-paced, fairly clear, and fairly easy to follow visually. As a group, they also indicated that the film struck the right balance in terms of the amount of information, amount of science, and level of scientific explanations provided. Furthermore, *Mysteries of the Unseen World* had a significant impact on students’ knowledge of the content covered in the film, increased their interest in and awareness of the unseen world, and increased their interest in STEM careers and the film’s STEM content. Finally, the majority of students who completed the follow-up questionnaire indicated that they thought about the film in the weeks after viewing, that they looked into topics from the film, and that they did one or more activities related to the film post-viewing.

Mann-Whitney tests found a few subgroup differences across the evaluation. First, with respect to gender, boys indicated that watching the film increased their curiosity significantly more than did girls, meanwhile,

girls found the film's level of scientific explanations to be significantly more advanced than did boys. Second, with respect to grade level/location, the evaluation found that the 6th graders in California found the film's story about the family/friends significantly more engaging than did 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama and they also indicated they were significantly more likely to recommend the film. Meanwhile, the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama rated their learning about the properties and possibilities of the nanoworld significantly higher than did the 6<sup>th</sup> graders from California.

For each of these subgroup differences though, it is important to bear in mind that the effect sizes were small, and students' ratings were very positive across all subgroups. Therefore, taken together with the film's overall lack of other major subgroup differences, the findings indicate that *Mysteries of the Unseen World* was well received by and successful with both boys and girls, as well as with students from different middle school grades (6<sup>th</sup>-8<sup>th</sup>).

Although this evaluation wasn't designed to consider theater type, location, or screen format differences, as other giant screen studies have done<sup>6</sup>, *Mysteries of the Unseen World* showed in many different theater types (including IMAX, IMAX Dome, and 3D). Recognizing that the evaluation was not designed to specifically assess these differences, both of the Study 2 evaluation sites were giant screen dome theaters that were selected for reasons detailed in the introduction of this report. Although a couple of differences, with small effects, were found for the California 6<sup>th</sup> graders compared to the Alabama 7<sup>th</sup> and 8<sup>th</sup> graders, these differences could relate to any number of age, school, location, or other factors not explored in the evaluation. There were no other apparent differences in students' ratings of the film at the two locations.

Below, we briefly summarize aspects of the film that stood out for students in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions. Reflecting on the findings that stood out from this vantage point, we highlight 12 themes, each of which we briefly discuss below with sample comments that capture the spirit of the theme:

➡ ***I liked the educational value/learned from the film:*** When asked what they liked most about *Mysteries of the Unseen World*, the largest group of students pointed to the film's educational value (as in, "I liked all of the information and details given because I did not know most of it" and "I liked how it was very educational. It told us all the different topics there are"). Additionally, students generally thought that they learned a considerable amount from the film and that they learned a lot about specific STEM topics, including: *the kinds of discoveries we can make about nature using new technologies* and *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature*. They also thought they learned a fair amount about other STEM topics, including: *the kinds of light waves humans and other animals see, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and the properties and possibilities of the nanoworld*.

The evaluation of the film's impact on students' knowledge indicates that their perceptions of these personal knowledge gains were generally accurate. As detailed in this report, the evaluation found that students made significant gains from pre-viewing to post-viewing in learning from the film overall and on each of the following five topics: *Types of light waves that humans and other animals see, Technologies used to see and study things that humans can't see with normal vision, Discoveries scientists have been able to make about nature through new technologies, Things scientists can*

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<sup>6</sup> Heimlich, J. E., Sickler, J., Yocco, V., & Storksdiack, M. (2010). Influence of immersion on visitor learning: Maya skies research report. *Edgewater, MD: Institute for Learning Innovation*.

*learn from nature to make innovative materials and devices, and Properties and possibilities of the nanoscale.*

Finally, some students noted that the film challenged and taught them while being well-explained/easy to understand. For example, “*I liked the fact that the information was advanced but I still knew what they meant,*” and “*It gave very descriptive details that could allow us to understand what it wanted us to know.*”

- **I wanted even more information.** Throughout the post-viewing and follow-up questionnaires, a number of students expressed an interest in learning more, either wishing the film had provided more information (as in, “*I wanted to see more things in each category*” and “*I wish it gave more examples*”) or that the film had been longer (as in, “*It was too short. I wanted to learn more*”).
- **I like that the film showed me and enabled me to see the unseen world.** Throughout their responses to the questionnaires, many students indicated that they liked that the film showed them the unseen world (as in, “*I liked the way it showed how other bugs see because well you don’t get to see through your eyes like that every day*” and “*I liked how it showed rain drops falling and bouncing*”), with several noting that the ability to see things they “*don’t get to experience...on a daily basis*” and may “*never see again*” was particularly appealing. Additionally, a number of students explained that seeing the unseen world gave them a new perspective on their surroundings (as in, “*Now I know what [the objects around us look] like and how they work*” and “*I will think about all that’s going on around me that I can’t actually see*”).
- **Since viewing the film, I will see (or have seen) the world differently.** Nearly three-quarters of students reported immediately after viewing that they thought they would “see” the world differently as a result of viewing the film (72%). A few weeks later, a slightly smaller group indicated they *had* seen the world differently in the weeks since viewing (59%). In both cases their comments included examples like, “*I will see it differently because I know more than I use to know*” and “*I have seen the world differently because how I know how many things are going [on] around the world,*” as well as specific examples of things from the film that they would see and think about (or had seen and thought about) in a new way.

Immediately after viewing the film, one-tenth of students thought they would not “see” the world differently (10%), and about a fifth were unsure (18%), compared to the two-fifths of follow-up students who indicated that they had not “seen” the world differently in the weeks since viewing the film (40%). Students who thought they would not or did not “see” the world differently most often explained that this was because they were limited by human sight and experience (as in, “*because since I still physically see the same, I don’t think about it differently either*”) or that they hadn’t thought about the film in the weeks since viewing (as in, “*I forgot about the movie*”).

- **The film was well suited to the giant screen format.** Some students commented on the experience of watching the film on the giant screen. Most often, they felt the giant screen experience maximized and was central to their enjoyment of the film’s visuals, as in “*I liked how it made you have the feeling that you were there every step of the way*” and “*It felt like we were inside of the film.*”

Meanwhile some students raised negative experiences about their viewing the film on the giant screen, although no one issue stood out as a problem among the students as a whole. These issues, raised by a handful of students, included that the viewing experience made them “dizzy” or “nauseous” and that “the sound was too loud.” Meanwhile, one student felt the giant screen experience was bearable, noting that s/he enjoyed the film in spite of his or her physical discomfort (as in, “The film was constantly moving, making my eyes hurt (loved it though),” and a few commented on the setup and shape of the theater rather than the IMAX experience itself (as in, “Projector was too close at Tech museum” and “I did not like the way the theatre was shaped. I know this is something you cannot change, I just got very dizzy and did not like it 100%).

- ➔ **I was particularly interested in the content of the Too Small section:** In comparison with the *Too Fast*, *Too Slow*, and *Invisible* sections of the film, students more often pointed to content from the *Too Small* section when asked questions about the film, including: what they liked most, what they found most interesting, if and how they thought they would “see” the world differently after viewing, what they thought about from the film in the weeks after watching, and what they talked about with others after viewing.

Though these findings indicate that students were particularly interested in the content of the *Too Small* section, further research would be needed to determine the extent to which this content stood out because the *Too Small* section was the final section of the film and/or because the *Too Small* section was the longest of the four sections (approximately 14 minutes long) and likely contained more visuals, information, and ideas that might “stick” with students.

- ➔ **I was interested in the technology featured in the film:** In both the post-viewing and follow-up questionnaires, students generally indicated that they were interested in the technology featured in the film, including x-rays, time-lapse and high-speed photography, microscopes, inventions imitating nature, and nanotechnology, among other innovations. Several also expressed excitement about technological advances that have yet to be made (as in, “I liked how it told us all the things our future could have” and “more excited for technology”). Additionally, when asked in the follow-up questionnaire if seeing *Mysteries of the Unseen World* changed how they think or feel about science or technology, the majority of students said *Yes*, with the largest subgroup explaining that the film changed how they think or feel specifically about technology, and nanotechnology in particular (as in, “Now I know that things can be built extremely small, I’m thinking of possible things that are to come” and “I started thinking about the nanoworld and its possibilities”). A handful of students also raised concerns about the ethics of nanotechnology and the relative benefits to humanity, as in, “I didn’t like that people are inventing things with nanotechnology that are just luxuries when there are kids starving in Africa. They should spend their money on that and not on an elevator to space!!!”

Additionally, it should be noted that, although students were generally interested in learning about technology, the range of technology and the density of information presented in the film may have confused some students. For example, in the content assessment section, some students appeared to have been confused about the difference between a compound microscope and an electron microscope. After viewing the film, just over a fifth of students (22%) correctly answered *False* to the true/false statement *A compound microscope uses electrons to produce magnified images*. However, when given the opportunity to explain the differences between compound and electron microscopes in a later question, more than half of the post-viewing students were able to do so

successfully (with 62% giving a full explanation in response to the question *When might a scientist use an electron microscope over a compound microscope?* and 55% being able to share an example).

- ➔ **The film increased my curiosity about and interest in science and technology.** Students generally agreed that the film increased their curiosity, with many pointing to an increased curiosity about science and technology topics in particular (as in, “*Well the film made me curious to know more about visibility and things like that*”). Additionally, the film generally increased students’ interest in *the properties and possibilities of the nanoworld*. It also slightly increased their interest in each of the following science and technology topics: *the kinds of light waves humans and other animals see, the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, and the kinds of technologies that help us see and study the invisible world (things we can’t see with our own human eyes).*
- ➔ **After viewing the film, my interest in a job or career in science or technology somewhat increased.** Prior to viewing *Mysteries of the Unseen World*, students generally indicated that the film slightly increased their interest in a future job/career in science or technology. However, in the weeks after viewing, a number of students indicated that they thought about or looked into jobs or careers that use the science shown in the film. When asked what they thought about or looked into, students shared a range of responses about careers in science, engineering, computer design, and photography, among others areas of interest, as in, “*Thought about being a robot scientist*” and “*I thought about what cool jobs there are in the nanoworld.*”
- ➔ **I thought the film or an aspect of the film was “cool!”** Throughout their post-viewing and follow-up questionnaires, many students indicated that the film or something about it was “cool.” They frequently pointed to what the film showed them about unseen worlds (as in, “*Seeing how bees and mosquitoes see. It was cool!*”), knowledge gained (as in, “*I thought it was really cool to know that droplets float!*”), technological advancements (as in, “*I liked the part where they taught us about how they can move atoms and I thought that was cool!*”), and the very existence of the unseen world (as in, “*That some things are too small for the human brain to comprehend. It’s cool!*”), among other topics deemed “cool” by the students.
- ➔ **I was somewhat engaged by the story about the family and their friends.** In general, students indicated that they found the film’s story about the family and their friends somewhat engaging. Some students explained that it was a “*nice idea*” and an “*interesting way*” of structuring the film, while others said they “*disliked*” or “*[didn’t] remember*” the storyline, and/or that they thought it was “*boring*” or “*[a distraction] from the real important stuff.*” At the same time, several students had mixed feelings about the storyline, as in, “*It did not relate, but kept the film moving.*” Given this diverse feedback, the use and value of fictional human characters in educational giant screen films may be an area for future research.
- ➔ **I was confused by the trailer for Humpback Whales.** Feedback from a handful of students indicated that they thought the trailer for *Humpback Whales* – which was shown before *Mysteries of the Unseen World* at one of the evaluation sites – was part of the main attraction. Though the reasons for this confusion are unknown, it may have to do with the language in the film’s trailer, which opens with, “*Hidden within our planet’s ocean is another world,*” and later continues with, “*Join us as we follow a*



*brilliant team of scientists and rescuers on an adventure into this hidden world, where new discoveries will take your breath away.”* For students who were aware that they were seeing a film called *Mysteries of the Unseen World*, the trailer’s language about “*hidden worlds*” may have been somewhat confusing.

The above list of 12 themes are ones that we found to be most pertinent to the goals of the current evaluation, and with possible implications for future work produced by National Geographic and other groups focused on producing giant screen films funded by the NSF. As always, caution should be taken in drawing broad implications from any one evaluation. In this case, *Mysteries of the Unseen World* is a multi-faceted giant screen media project, which presented many alternative ways to evaluate the project’s success in meeting its informal science learning goals.

The findings from *Mysteries of the Unseen World* offer broader implications for other giant screen film projects aiming to informally educate students about science facts, concepts, or research. Although the evaluation was conducted at only two theater sites due to scheduling/availability and budget, the findings add further support to a conclusion reached in a review of 10 giant screen films funded by the NSF (Flagg, 2005):<sup>7</sup>

*Summative evaluations of 10 giant screen films indicate that the NSF’s grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers’ understanding of what scientists do; and positively impacts viewers’ actions after a museum visit.*

This evaluation assessed students’ scientific knowledge of the unseen world, their interest in and attitude toward the unseen world, their understanding of what scientists do, and the extent to which the students ultimately pursued actions in the weeks after viewing the film. In each of these areas, the film was found to be successful.

## Final remarks

Beyond confirming that the film met the project’s goals in each of the five impact areas, this evaluation also raises new issues for consideration around three aspects of the giant screen viewing experience that have received little evaluation attention to date: the use of a cross-promotional project kiosk, students’ access to and interest in online resources, and the impact of immersive visualization on students’ imaginations.

First, though students were not asked about their interest in or interaction with the *Mysteries of the Unseen World* kiosk at the two evaluation sites, both science centers hosted the kiosk, as did many other sites around the country. Future research might explore the use of similar kiosks across a variety of theater sites, considering the impact on students’ initial interest in a film and their post-viewing engagement with a film’s content, among other topics.

Second, though the majority of students ultimately made some connection to the film, thought about it further, or pursued a follow-up activity within a few weeks of viewing, relatively few noted that they followed up on *Mysteries of the Unseen World* online. A few students indicated that they looked for more information about the film on social media, a handful said they visited the film’s website, and a couple explained that

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<sup>7</sup> Flagg, B. (2005). Beyond entertainment: Educational impact of films and companion materials. *Big Frame*, 22(2), 50-56.

they downloaded the *Mysteries of the Unseen World* app from iTunes. Future work could assess students' access to and interest in using these materials and/or could consider how to maximize the visibility and use of a project's online resources, among other areas for research.

Finally, though it was not directly addressed in the questionnaires, a number of students indicated that seeing things that are too fast, too slow, too small, and invisible to the naked eye inspired them to imagine the unseen world around them (as in, "*I try to imagine how a mosquito would see me in different temperatures*" and "*I will imagine I am a bee*"). Further research might examine the extent to which the immersive qualities of the giant screen format impact the imaginations of students of various ages and backgrounds, as well as the influence of imagination on knowledge gains, among other subjects.

## **Summative evaluation study 3: Evaluation of the national and local educator workshops and partner outreach activities**

The *Mysteries of the Unseen World* giant screen film project marked the first time that National Geographic implemented a program in which select partner organizations were offered a \$2,600 outreach award along with an all-expense trip to DC for the 2-day Museum Educator National Workshop, in exchange for a certain level of commitment from the partners. National Geographic required award recipients to:

- Share their outreach plan with National Geographic
- Utilize \$1,000 of the grant to enable underserved students to see the film
- Disseminate and promote the film's outreach materials to their educator network
- Reach educators via local workshops (either dedicated workshops around this film's content or integrating this film's content into existing educator workshops)
- Execute two types of educator surveys, one for local workshop attendees and one for non-workshop attendees in their educator network
- Complete the follow-up questionnaire, the "post report"

The Study 3 summative evaluation captured the experiences of the museum staff that initially attended the Museum Educator National Workshop hosted by National Geographic and then returned to their institutions to promote the film, conduct outreach with public and student audiences, and train teachers to use the materials with their own students. This study further captured the value of these local educator workshops, measuring impact on the teachers that attended. Finally, the evaluation process gathered feedback from educators who did not attend the local educator workshops but who saw the *Mysteries of the Unseen World* film and used or potentially used the educational resources.

To assess these efforts, the evaluation was conducted in 3 phases, as follows:

- **Phase 1: Museum Educator National Workshop: Evaluation of educator feedback**  
On October 24 and 25, 2013, National Geographic hosted a Museum Educator National Workshop to introduce the educational materials and film outreach strategies to 20 museum educators. In the Phase 1 evaluation, Knight Williams assessed the appeal and effectiveness of this workshop as perceived by the educators who attended. All workshop participants were asked to complete a questionnaire about their experience during the workshop, focusing on: the appeal and comprehensibility of the film and the subject matter covered; the usefulness of the presentation and materials to their educational needs and to meeting science curriculum standards; the anticipated gains and challenges of implementing the featured activities; and the motivational impact from attending the workshop.
- **Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources**  
Following the Museum Educator National Workshop, the partner organizations were expected to implement a number of activities upon the film's premiere at their respective institutions. Those who

“activated” the *Mysteries of the Unseen World* outreach awards in this capacity received funds in order to promote the film, conduct outreach, and train local teachers on use of the film’s companion materials. As a condition of the award program, each partner organization was responsible for recruiting educators to attend their local workshop. Additionally, each museum distributed an online survey to their network of educators that saw the film but did not attend a local workshop in order to assess their perceptions of the film and use of companion materials. The Phase 2 evaluation considers feedback from both groups of educators about the local workshops, the film, and the educational resources.

- **Phase 3: Museum educator post report findings**

As part of the awardee reporting requirement, staff at the 11 *Mysteries of the Unseen World* partner organizations that activated the outreach award completed a follow-up post report about their: experience participating in the grantee program, use of the *Mysteries of the Unseen World* materials, satisfaction with the materials (challenges and highlights), and perception of the effectiveness of the film and activities in meeting the project’s learning objectives. In addition, as the partner organizations received funds to help with their outreach promotion and efforts to draw local and underserved audiences to see the film, the evaluation also considers whether and how the participating sites: disseminated and promoted *Mysteries of the Unseen World* education materials to educators; hosted local educator workshops or integrated *Mysteries of the Unseen World* materials into existing educator workshops; drew underserved audiences to see the film and engage in outreach; used the kiosk to engage visitors and the factors that influenced their decision to order or not order the kiosk; and used the educational materials to engage visitors and students.

## **Phase 1: Museum Educator National Workshop: Evaluation of educator feedback**

### **Method**

Phase 1 presents the findings from an evaluation of the 20 museum educators who attended National Geographic’s *Mysteries of the Unseen World* Museum Educator National Workshop at the National Geographic Society (NGS) headquarters in Washington, DC on October 24 and 25, 2013.

The museum educators provided feedback through a written survey administered at the end of the 2-day workshop. The survey was developed collaboratively by National Geographic Education and Knight Williams Inc. The survey was then administered by National Geographic to the museum educators at the end of the workshop, after which the surveys were sent to Knight Williams for analysis and reporting. Basic descriptive statistics were performed on the quantitative data generated from the survey questions. Content analyses were performed on the qualitative data generated in the open-ended questions. The analysis was both deductive, drawing on the workshop’s objectives, and inductive, by looking for overall themes, keywords, and key phrases. All analyses were conducted by two independent coders. Any differences that emerged in coding were resolved with the assistance of a third coder.

## Findings

This section summarizes the Phase 1 evaluation findings relating to the following five questions: 1) What was the value of the workshop? 2) What ideas and resources did museum educators gain from the workshop? 3) What did museum educators think of the workshop's organization, length, and density of programming? 4) What did museum educators think about the *Mysteries of the Unseen World* film? 5) What were museum educators' final reflections and thoughts moving forward?

### Question 1: What was the value of the workshop?

The 20 museum educators were invited to complete a set of written questions about the value of the workshop and its individual sessions, their main "take-aways" from the working groups, the clarity of the goals of the educational outreach program, and how well they felt the workshop prepared them to use the educational resources and outreach award. These findings are presented below in 1.1 through 1.6.

**1.1 What were the most useful aspects of the workshop?** The museum educators pointed to a range of elements that they found most useful about the workshop, both personally and on the institutional/educational level. Nearly two-thirds indicated that the opportunity to network and brainstorm was the most useful part of the workshop (65%), while another two-thirds felt that the resources and corresponding activities were especially useful (65%). Smaller groups commented on the value of the film (30%), the opportunity to collaborate with National Geographic (10%), and the workshop's focus on marketing (5%).

**1.2 What were the least useful aspects of the workshop?** When asked what they found *least* useful about the workshop, the largest group pointed to the difficulty of incorporating information from the nanotechnology session into educational programming (20%). Smaller groups commented on time management (10%), the website review (10%), and the scientist profile videos (10%). One each felt that the videos (5%) and the lens activity with the candle (5%) were the least useful parts of the workshop. Finally, one museum educator – who provided multiple answers – felt that s/he would have benefited from more information overall (5%), including additional examples of lessons and activities, more useful lectures/speeches, and a more relevant dinner speech. One-fifth of the museum educators indicated that they found the entire workshop useful (20%) and another fifth left the question blank (20%).

**1.3 What were the relative values of the workshop sessions?** The museum educators were also asked to rate the value of the sessions they participated in over the course of the two-day workshop. On the first day, the 3D screening of *Mysteries of the Unseen World* and the session on engaging children with the nano world were the most highly rated, each receiving a median rating of 5.0 (extremely valuable) on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable). The break out session to augment, modify, and brainstorm activities had the lowest median rating, 4.0 (very valuable), and the session focused on the Museum Educator Guide fell in the middle, with a median rating of 4.5. On the second day of the workshop, the session on the effective use of media for learning and the working group to share effective strategies to engage the public with films were the most highly rated, each receiving a median rating of 5.0 (extremely valuable). The outreach awards info session received the lowest median rating of the day's sessions, 4.0 (very valuable).

**1.4 What were the main “take-aways” from the working groups?** When asked to describe the main “take-aways” from their working groups, the largest group of museum educators pointed to the wealth of ideas gained to develop their local programs and activities (45%). More than a third cited the opportunity to learn about how to use the *Mysteries of the Unseen World* materials to reach out to and inform educators (35%), and a fifth pointed to the opportunity to network with, brainstorm with, and gain inspiration from their peers (20%). A tenth pointed to the value of resources gained (10%), and one museum educator commented on the value of the outreach award funding (5%).

**1.5 Were the outreach goals for *Mysteries of the Unseen World* made clear?** After the workshop, the museum educators generally felt that they had a *good understanding of the goals of the *Mysteries of the Unseen World* educational outreach program.*

**1.6 Did the museum educators feel prepared to use the educational resources and outreach award?** In general, the museum educators felt *adequately prepared* to use the educational resources and implement the outreach award. When given the opportunity to provide additional feedback to these two questions, all those who responded (20% of all museum educators) pointed to internal institutional challenges, rather than a lack of preparation or effectiveness by the workshop’s organizers.

## **Question 2: What ideas and resources did museum educators gain from the workshop?**

The 20 museum educators were invited to complete a set of written questions about the ideas and resources gained – their value (or lack thereof), how they intend to use them, and suggestions for how National Geographic might further support their implementation. These findings are presented below in 2.1 through 2.6.

**2.1 What were the most valuable ideas gained from the workshop?** The museum educators pointed to a number of valuable ideas gained from the workshop. The largest group of museum educators, nearly two-thirds, pointed to the teaching strategies shared throughout the workshop (60%), including ways to incorporate media and hands-on activities, the use of local experts, ways to reframe topics for various groups, and/or ways to reach out to at risk communities. Just under a third of museum educators indicated that they valued the focus on a specific subject covered during the workshop and/or film (30%), such as nanotechnology and the electromagnetic spectrum. One quarter said that the ideas they gained from other museum educators were among the most valuable gained during the workshop (25%), though some felt that additional time to learn about other programs or reflect on a personal level would have been helpful, and another quarter pointed to the value of ideas shared about engaging with and marketing to teachers (25%). Finally, a tenth of museum educators commented on the value of the outreach awards (10%).

**2.2 What were the most valuable resources gained from the workshop?** The museum educators also indicated that they gained a number of valuable resources from the workshop. The largest group pointed to National Geographic’s online resources (60%). Just over one-third of museum educators pointed to the value of the Museum Educator Guide (35%) and a sixth commented on the value of a CD provided by National Geographic – containing old issues of the magazine – and other digital files (15%). A tenth each mentioned the value of the contacts made (10%) and the *Mysteries of the Unseen World* iPad app (10%), and one each (5% each) found information about organizing an educator workshop, the outreach award, and the video clips and photos to be among the most valuable resources gained from the workshop.

**2.3 What workshop resources did museum educators think they were unlikely to recommend to others?** When asked if there were any workshop resources that they would not recommend to others, the majority of museum educators said *No* (60%). The remaining museum educators declined to answer the question (40%).

**2.4 What ideas and resources did museum educators think they were most likely to use in events and activities?** When asked which ideas and resources they were likely to use in their events and activities, the largest group pointed to the camp and/or field trip activities (25%). One-fifth indicated that they plan to use the table and cart activities (20%), and another fifth simply pointed to general activities discussed at the workshop (20%). Nearly one-sixth each specifically pointed to the nanotechnology activities (15%) or the kiosk (15%) and its components, and a tenth each indicated that they would likely use the Museum Educator Guide (10%), the website (10%), the film (10%), and a miscellaneous activities (10%). One said that s/he would likely use photos of microscopic images (5%) and another pointed to the workshop for educators (5%).

**2.5 What ideas and resources did museum educators think they were most likely to use in outreach to educators?** When asked what ideas and resources they would be most likely to use in their outreach to educators in their market, the largest group of museum educators pointed to using the film or footage from the film (25%). Another quarter described an intent to use the film's related materials (25%), specifically mentioning the website, Museum Educator Guide, poster, and kiosk. One-fifth each commented on the value of the workshop's resources and ideas as they relate to professional development workshops for educators (20%), curriculum ideas (20%), and their reasons for incorporating the new resources and ideas into their outreach to educators (20%). Finally, two museum educators pointed to the CDs containing issues of *National Geographic* magazine (10%), and one mentioned the possibility of using the resources/ideas with a homeschool program (5%).

**2.6 Did museum educators have suggestions regarding further support from National Geographic?** When asked what National Geographic could do to further support their efforts to integrate these new ideas and resources into their educational setting(s), the largest group, nearly half of museum educators, pointed to an interest in additional resources (45%), including web materials, images, kits for teachers, and kiosk components. A quarter advocated for a dynamic relationship with National Geographic and/or other workshop attendees (25%). A few museum educators said they were not sure (10%), one suggested that National Geographic continue these workshops (5%), and one requested that National Geographic provide funding for educator screenings/workshops (5%).

### **Question 3: What did museum educators think of the workshop's organization, length, and density of programming?**

The 20 museum educators were also invited to complete a set of written questions about the organization, length, and programming of the workshop. These findings are presented below in 3.1 through 3.3.

**3.1 How did museum educators find the workshop's organization?** Overall, the museum educators felt the workshop was well run and organized.

### **3.2 What did museum educators think about the workshop's length and its use of their time?**

Overall, the museum educators felt the workshop was a good use of their time. When asked how they felt about the length of the two-day workshop, they generally indicated that it was just right.

**3.3 What did museum educators think about the density of the workshop?** In terms of the programming of the workshop, the museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right. When asked to elaborate, a number of museum educators expressed a desire to have done *more* at the workshop – more activities, more discussion sessions, and a longer workshop overall. Specifically, one quarter commented on the discussion and networking element of the workshop (25%), expressing an interest in dedicating more time to discussions/networking and providing additional suggestions for future workshops. Another quarter pointed to the workshop activities (25%), commenting on their enjoyment of the activities that took place and their desire to do more, and one tenth suggested that National Geographic lengthen future workshops (10%). One each provided miscellaneous programming advice (5%) or commented on his/her enjoyment of the workshop (5%).

## **Question 4: What did museum educators think about the *Mysteries of the Unseen World* film?**

The 20 museum educators were next invited to complete a set of written questions about the appeal, visual interest, clarity, and learning value of the *Mysteries of the Unseen World* film, which they screened on the first day of the workshop. These findings are presented below in 4.1 through 4.5.

**4.1 How did museum educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, learning value for students, and likelihood of recommending the film?** Overall, the museum educators indicated that they liked *Mysteries of the Unseen World*, found the film visually exciting, and thought the presentation was clear. They also generally thought it had a high learning value for students at their museums or science centers, and that they would recommend it to their colleagues.

**4.2 What did museum educator think were the film's most appealing aspects?** When asked what they liked most about the film, the largest groups of museum educators pointed to the accessibility of the film's informative content (60%) and its imagery and visuals (45%). The smallest group commented on the strength of the film's narrative and presentation (20%).

**4.3 What did museum educators think were the film's least appealing aspects?** When asked what they disliked about the film, the largest group of museum educators indicated that the film's examination and imagery of the science behind "seeing the unseen world" could have been stronger (35%). About a sixth felt that the four-part narrative was lacking in some way (15%), and a tenth thought the film would have benefited from a more personal storyline (10%). The remaining museum educators gave miscellaneous answers (20%) or declined to answer the question (20%).

**4.4 How did museum educators rate relative appeal of the film's four acts?** In terms of the appeal of the individual acts, in general the museum educators found "Invisible light rays" and "Electron microscopy/nanotechnology" to be extremely interesting. "Too slow" was the lowest rated act, at very



interesting, and “Too fast” fell in the middle of the group, between very interesting and extremely interesting.

**4.5 How did museum educators rate the film’s success in conveying STEM-related education content?** When asked to rate the success of individual acts in conveying STEM-related content, the museum educators generally indicated that they found all four acts to be extremely successful.

## **Question 5: What were museum educators’ final reflections and thoughts moving forward?**

Finally, the 20 museum educators were invited to complete a set of written questions addressing any final thoughts or suggestions regarding future work with National Geographic. Their feedback is summarized below in 5.1 through 5.3.

**5.1 What did museum educators think was missing from the workshop?** When asked if there was anything *missing* from the workshop that they might have found useful, the largest group of museum educators, just over a third mentioned something about the logistics (35%), such as the reorganization of the schedule, shared contact lists, additional venue space, follow-up workshop sessions, and the inclusion of an offsite visit in DC. Nearly a third of museum educators expressed an interest in receiving additional information about marketing to and training educational professionals (30%). One-fifth thought that the workshop would have benefited from additional resources (20%), from images to subject-specific activities. Finally, one museum educator said s/he was unsure at this time (5%).

**5.2 Were museum educators interested in additional resources from National Geographic Education?** After learning about some of the resources available on the National Geographic Education website, museum educators were asked to provide information about other types of resources they might find useful. The largest group praised the existing resources (20%), approximately one-sixth requested physical resources (15%), and a group of the same size requested content that could be shared online (15%). A tenth each requested materials from potential partners (10%) or discussed the general value of educational materials (10%). One requested activities for museums (5%), another requested resources for adults (5%), and one said s/he was unsure (5%).

**5.3 Were museum educators interested in additional resources from National Geographic Entertainment?** Finally, the museum educators were asked to consider their future needs as they relate to National Geographic Entertainment films, and to provide information about additional resources they might like to see developed. The largest group, one-quarter, pointed to the value of shareable films and their promotional resources (25%). Just under a sixth each suggested specific topics for future productions (15%), commented on the value of curriculum resources (15%), and/or expressed an interest in workshops and professional development materials (15%). Smaller groups pointed to the value of film-related activities (10%), commented on the timing of the release of associated materials (5%), and/or praised National Geographic’s existing resources (5%). Finally, one museum educator said s/he was unsure (5%).

## **Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources**

Following the Museum Educator National Workshop held in Washington D.C. in 2013, the partner organizations were asked to implement a number of activities upon the film's premiere at their respective institutions. Those who "activated" the *Mysteries of the Unseen World* outreach awards in this capacity received funds in order to promote the film, conduct outreach, and train local teachers on use of the film's companion materials. As a condition of the award program, each partner organization was responsible for recruiting educators to attend their local workshop and disseminating an online survey developed by the project's independent evaluation team to gather participant feedback. Additionally, each partner museum was asked to distribute a separate but similar online survey to their network of teachers who saw the film, but *didn't* participate in the workshop, in order to gather non-workshop participants' feedback on the film and their perceptions of and expected use of the companion materials. To account for the educators' different experiences with the *Mysteries of the Unseen World* resources, those who attended the workshop and saw the film are referred to as "Workshop attendees" in the report while those who only saw the film are referred to as "Film only attendees." The findings from both survey efforts are presented in this section to allow for an informal comparison between the two.

### **Method**

The independent evaluation team of Knight Williams Inc. worked with National Geographic to develop two surveys that gathered educator feedback on three main areas relating to the *Mysteries of the Unseen* local workshop goals and related educator outreach: 1) What feedback did educators share about the local workshops? 2) What feedback did educators share about the film and educational resources? 3) How had educators used the resources and/or how did they intend to use them within 12 months? The first survey, for Workshop attendees, was prepared as an online form that could be emailed directly to workshop participants at the conclusion of the workshop or administered as a paper version on site. The evaluation team worked with National Geographic and the workshop coordinators at four of the six partner science center sites scheduled to conduct local workshops between February 2014 and February 2015. The workshop coordinators in each case distributed the post-workshop questionnaire to participants following the workshop, either via email or paper form as worked best for the participants in each case. The second survey, for Film only attendees, was also prepared as an online form that the partner educators could email directly to their local educator contacts who had seen the film but not participated in a workshop. The two surveys were similar in content, although the survey for Film only attendees asked the educators for input on their interest in attending workshops since they didn't actually attend one at their local science center. The workshop organizers hoped to learn from these educators how prepared they felt to use the resources without having attended a workshop but having seen the film, and to explore their views on the potential value they saw in participating in local vs. virtual workshops via webinar.

Basic descriptive statistics were provided on the quantitative data generated from the evaluation. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the workshop objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Educator background information

### Workshop attendees

Workshop attendees who provided feedback in the Phase 2 evaluation participated in a workshop at one of four organizations. The majority participated in a workshop at either the Buffalo Museum of Science (37%) or Thanksgiving Point (30%), followed by Perot Museum of Nature and Science (16%) and the Center of Science and Industry (11%). More than a third of Workshop attendees identified as elementary school teachers/ instructors (37%). About a fifth of the educators were middle school teachers/instructors (21%) and just over a tenth were high school teachers/instructors (11%). Less than a tenth each explained that they were another kind of informal educator (5%), a college or university teacher/instructor/professor (5%), or a museum or science center-based educator (2%). None of the workshop attendees were homeschooling parents, and just over a tenth identified as another kind of educator, including “*2nd Grade Spanish Immersion Class*,” “*Special Education Preschool Teacher*,” “*early childhood education specialist, supporting providers and programs*,” “*High School Equivalency Instructor*,” and “*District Science Coordinator*.”

The Workshop attendees were asked about their familiarity with the *Mysteries of the World* STEM content presented at the workshop prior to attending. The largest group, more than a third, said they were slightly familiar (35%), while more than a quarter indicated that they were moderately familiar (27%) and more than a tenth noted that they were very familiar (13%). About one-sixth of educators were not at all familiar with STEM content prior to the workshop (16%).

Workshop attendees were asked to share their prior experience teaching students the STEM content presented in the film and resources. Nearly a third said they had (some or a lot of) experience teaching this content (32%), while a handful each said they didn’t have much experience (6%) or that they were not sure (2%). More than a fifth said they hadn’t taught the STEM content (22%) and nearly two-fifths declined to answer the question (38%).

### Film only attendees

Film only attendees who provided feedback in the Phase 2 evaluation saw the film at one of two organizations. The majority of educators saw the film at the Saint Louis Science Center (76%), while remaining educators saw the film at the Buffalo Museum of Science (24%). The majority of Film only attendees identified as elementary school teachers/instructors (55%). About a fifth identified as middle school teachers/instructors (21%), and a handful indicated that they were high school teachers/instructors (3%). About a seventh explained that they were another kind of educator (14%), such as: “*STEAM coordinator*,” “*Assistant Superintendent*,” “*parent*,” and “*early childhood educator*.” None of the Film only attendees identified as a college or university teacher/instructor/professor, a homeschooling parent, a museum or science center-based educator, or another informal educator.

Film only attendees were asked about their familiarity with the *Mysteries of the Unseen World* STEM content in the film and resources prior to seeing the film or reviewing the resources. Two-fifths said they were slightly familiar with the STEM content (41%), while more than a quarter indicated that they were moderately familiar (28%) with the material. A tenth were very familiar (10%) and less than a tenth were not at all familiar (7%).

Film only attendees were asked to share their prior experience teaching students the STEM content presented in the film and resources. More than two-fifths said they had taught some of this STEM content (41%) (for example, “*the electromagnetic spectrum*,” “*things that are too small to see with the naked eye*,” and “*electron microscopy*”), and one said s/he wasn’t interested in teaching STEM (3%). About a fifth explained that they hadn’t taught any of the STEM content (21%), and more than a third declined to answer the question (34%).

## Findings

This section summarizes the Phase 2 evaluation findings relating to the following four questions: 1) What feedback did Workshop attendees share about the local workshops? 2) What feedback did educators share about the film and educational resources? 3) How had educators used the resources and/or how did they intend to use them within 12 months? 4) What feedback did Film only attendees share about future workshops related to *Mysteries of the Unseen World*?

### Question 1: What feedback did Workshop attendees share about the local workshops?

Workshop attendees were asked to comment on how they learned about their local workshop and why they decided to attend. They were also invited to rate the workshop they attended in terms of whether or not it was well run and organized, gave them a good overview of the educational goals of the film and resources, was a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person. Finally, they were asked if the workshop met their expectations and if there were topics it omitted or didn’t cover in enough depth. These findings are presented below in 1.1 through 1.3.

**1.1 How did Workshop attendees learn about the local workshops and why did they attend?** The largest group of Workshop attendees, two-fifths, indicated that they heard about their local workshop directly from the coordinating museum or science center (40%), while a quarter explained that they heard about it from a school or school district (25%). About a tenth heard about it from their coworkers or colleagues (11%), while smaller groups of less than a tenth each pointed to other groups or organizations (6%), friends (5%), or state-level education staff or offices (3%). About one-seventh shared miscellaneous responses (14%).

When asked why they decided to attend their local workshop and what they were hoping to gain, more than half of the Workshop attendees pointed to the value of gaining new teaching strategies, curriculum ideas, and resources (54%), while nearly two-fifths explained that they wanted to see the film and/or visit the museum or science center (38%). Just under a third said the content looked interesting or that they wanted to learn (30%). Less than a tenth each commented on credit hours or recertification points (8%), noted that the workshop would be a good opportunity to network (6%), said they like National Geographic programs (5%), explained that the museum generally coordinates valuable workshops (5%), said they were interested in the topic of microorganisms (5%), or shared miscellaneous responses (6%).

**1.2 How did Workshop attendees rate the local workshops?** Overall, the Workshop attendees strongly agreed that their local workshops were well run and organized, gave them a good overview of the

educational goals of the film and resources, were a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person.

**1.3 Did the local workshops meet Workshop attendees' expectations, and did they think any topics were omitted or not covered well enough?** The majority of Workshop attendees indicated that their local workshop met or exceeded their expectations (90%), while about a tenth shared criticisms of one or more aspects of the workshop (11%) and less than a tenth shared miscellaneous responses (6%).

## **Question 2: What feedback did educators share about the film and educational resources?**

Workshop attendees who saw *Mysteries of the Unseen World* at their local workshops and Film only attendees who saw it at a science center or museum outside of a workshop were asked to rate the film in terms of overall likeability, visual excitement, clarity of presentation, the likelihood that it would engage and educate their students, and their likelihood of recommending the film. Both groups were also invited to rate the value of the educational resources.

Additionally, Workshop attendees were invited to rate the extent to which they felt they had *learned valuable ways to use the resources* at the workshop and whether or not they thought the workshop should have spent *more time going over the resources*. Finally, Workshop attendees and Film only attendees rated the extent to which they felt *prepared to begin using the resources*, the extent to which they thought the resources would help their students learn about *phenomena that are too fast, slow, or small to see with the naked eye*, and the extent to which they thought the resources would help their students *explore advances in nanoscience and nanotechnology*. These findings are presented below in 2.1 through 2.3.

**2.1 How did educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, likelihood of engaging and educating students, and likelihood of recommending the film?** Workshop attendees and Film only attendees both generally indicated that they liked the film, found it visually exciting, and thought the presentation was clear. Both groups also thought it would engage their students, that their students would learn a lot from the film, and that they would recommend it to their colleagues.

### **2.2 How did educators rate the value of the educational resources?**

Workshop attendees: Workshop attendees who had used the resources generally thought the online activities/lessons and the iPad app/game were both extremely valuable. Overall, they found the educator DVD, Museum Educator Guide and poster, website, online videos, standards sheet, and “fun facts” handout to be very valuable.

Film only attendees: Film only attendees who had used the resources generally found the educator DVD, website, and online videos to be between very and extremely valuable. Overall, they also indicated that the following resources were each very valuable: the Museum Educator Guide, the standards sheet, the online activities and lessons, and the iPad app/game. Finally, they noted that they generally found the poster and “fun facts” handout to be moderately valuable.

### **2.3 How did educators rate the workshop’s coverage of the educational resources, their level of comfort in using the resources, and the potential impact on students?**

Workshop attendees: Overall, Workshop attendees agreed that they *learned valuable ways to use the resources in [their] local setting*, that they felt *adequately prepared to begin using the resources*, that *the resources will help their students learn about phenomena that are too fast, slow, or small to see with the naked eye*, and that *the resources will help [their] students explore advances in nanoscience and nanotechnology*. They were generally neutral about if they would have *preferred the workshop spend more time going over the resources*.

Film only attendees: At the same time, Film only attendees who indicated that they had used the resources somewhat agreed to agreed that *the resources have helped (or will help) their students explore advances in nanoscience and nanotechnology*. They also somewhat agreed that they felt (or feel) *adequately prepared to begin using the resources* and that *the resources have helped (or will help) their students learn about phenomena that are too fast, slow, or small to see with the naked eye*.

### **Question 3: How had educators used the resources and/or how did they intend to use them within 12 months?**

Workshop attendees and Film only attendees were both asked which if any of the *Mysteries of the Unseen World* activities they had done or planned to do within 12 months. They were also asked to comment on the resources they had used or planned to use within the same timeframe, how they used or foresaw using them, the number of students they had reached or thought they would reach with the resources, the challenges or obstacles they had encountered or thought they might encounter, and whether they expected to use the film and its educational resources to encourage students’ interest in STEM or STEM careers. Finally, they were asked if their use of the film and its educational resources had or would help facilitate outreach among underserved students. These findings are presented below in 3.1 through 3.5.

#### **3.1 Which activities had educators done and/or did they plan to do within 12 months?**

Workshop attendees: When asked which activities they planned to do within 12 months, more than four-fifths of Workshop attendees explained that they planned to use the *Mysteries of the Unseen World* resources with their students (81%), while a slightly smaller group of just under three-quarters planned to share the resources with other educators (73%). A third each planned to book a field trip with their students to see the film (33%) and/or participate in *Mysteries of the Unseen World* events at the science center or museum that hosted the workshop (33%). A handful planned to conduct a workshop for other educators on use of the resources (2%) and/or share miscellaneous responses (5%), such as “*visit with my family*” and “*possibly try to book film*.”

Film only attendees: Film only attendees were asked which activities they had done or planned to do within 12 months. Of activities they *had* done, the largest group of about a third had shared the resources with other educators (31%). About a fifth had participated in *Mysteries of the Unseen World* activities or events at their local science center or museum (21%), and a handful each had taken their students to see the film (3%) and/or used the resources with their students (3%). In terms of what they planned to do, the largest group of Film only attendees, two-thirds, indicated that they intended to use the resources with their students within 12 months (66%). More than half planned to share the resources with other educators

(55%), and more than a third said they would take their students to see the film (38%). More than a quarter explained that they would participate in *Mysteries of the Unseen World* activities or events at their local science center or museum (28%), and about a fifth said they would conduct a workshop for other educators on the use of the resources (21%). None of the Film only attendees pointed to other activities they had done or would do within 12 months.

### **3.2 Which resources had educators used or did they plan to use within 12 months, how did they use or foresee using them, and how many students did they reach or think they would reach?**

Workshop attendees: Nearly three-quarters each (68% each) thought they would use the website and online videos. Slightly smaller groups pointed to the “fun facts” handout (60%), educator DVD (59%), and/or online activities and lessons (57%). About half pointed to the Museum Educator Guide and poster (51%) while nearly one-third pointed to the iPad app/game (30%) and one-fifth to the standards sheet (22%). The majority expected to use these resources in a classroom or afterschool setting, and the majority expected to use them in elementary or middle school programming. Fifty (50) Workshop attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 6,498 students. From those who provided estimates, responses ranged from a low of 20 to a high of 1,000, averaging 130 per Workshop attendee.

Film only attendees: A tenth each of Film only attendees indicated that they had used the Museum Educator Guide (10%), poster (10%), and “fun facts” handout (10%). Less than a tenth explained that they had used the educator DVD (7%), website (7%), online videos (7%), online activities and lessons (3%), and iPad app/game (3%). The Film only attendees also indicated which resources they planned to use, with the largest group, about a third, pointing to the poster (31%). Just under a quarter each thought they would use the website (24%) and online videos (24%), while about a fifth each planned to use the educator DVD (21%), “fun facts” handout (21%), and/or the online activities and lessons (21%). About a sixth each indicated they would use the Museum Educator Guide (17%) and/or the standards sheet (17%), and a slightly smaller group thought they would use the iPad app/game (14%). The largest group expected to use these resources in a classroom or afterschool setting, and the largest groups expected to use them in elementary or middle school programming. Thirteen (13) Film only attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 894 students. From those who provided estimates, responses ranged from a low of 7 to a high of 150, averaging 69 per Film only attendee.

### **3.3 What challenges or obstacles did educators encounter or think they might encounter in implementing the resources?**

Workshop attendees: When asked what challenges or obstacles they thought they might face in implementing the *Mysteries of the Unseen World* resources, Workshop attendees shared a range of comments. Of those who pointed to a specific challenge or obstacle, about a fifth commented on time constraints and scheduling challenges (21%). Less than one-tenth each said they might face challenges with the technology (6%), find that the content isn’t the right level for their students (6%), face financial obstacles (6%), and/or have trouble adapting the resources (5%). Nearly a third declined to answer the question (30%), more than a tenth said they didn’t think they would face any challenges (13%), and about a sixth shared miscellaneous responses (17%), including a few who said they weren’t sure what obstacles they might face.

Film only attendees: When asked what challenges or obstacles they had encountered or thought they might face in implementing the *Mysteries of the Unseen World* resources, the largest groups of Film only attendees declined to answer the question (69%) or said they hadn't encountered or didn't think they would face any challenges (10%). A handful each explained that the content might be too advanced (7%), said they wouldn't be using the resources (3%), or pointed to financial obstacles (3%) or trouble with challenges with technology (3%).

### **3.4 Did educators expect to use the film and/or educational resources to encourage students' interest in STEM or STEM careers?**

Workshop attendees: Workshop attendees were asked if they expected to use the film and/or its educational resources to encourage students' interest in STEM or STEM careers. Nearly half said *Yes* (49%), about a third said they were *Not sure* (32%), and less than a tenth each said *No* (2%) or noted that the question was *Not Applicable* to their setting (8%). Next, the Workshop attendees were invited to explain how they might use the film and/or its educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. One-sixth each described how they would use the resources to encourage interest in STEM (16%) and/or STEM careers (16%), and less than a tenth talked about the value of the film (8%). More than half declined to answer the question (54%), a handful explained that the resources weren't applicable to their teaching field or students (3%), and just over a tenth provided miscellaneous responses (10%).

Film only attendees: Film only attendees were asked if they had used or expected to use the film and/or educational resources to encourage students' interest in STEM or STEM careers. None of the Film only attendees indicated that they had used the resources in this way. More than a third said they planned to use the resources to encourage students' interest in STEM or STEM careers (38%), while one-seventh said they did not plan to use the resources in this manner (14%). A tenth said they were *Not sure* (10%), and more than a quarter noted that the question was *Not Applicable* to their setting (28%). Next, the Film only attendees were invited to explain how they might use the film and/or educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. More than a fifth said they would or might use the resources in their program or curriculum (21%), while less than a tenth each said they were planning to show the film (7%) or said they would share the resources with other educators (3%). Just under half declined to answer the question (45%), one-sixth explained that the resources weren't applicable to their teaching field or students (17%), and one-seventh shared miscellaneous responses (14%).

### **3.5 Did educators think their use of the film and/or educational resources had or would help facilitate outreach among underserved students?**

Workshop attendees: When asked if and how their work with the film and its resources might contribute to the project goal of facilitating outreach among underserved students, about a third said they would (or would like to) be working with underserved youth (30%) and just over a tenth said they would not (13%). A sixth shared miscellaneous responses (16%), less than a tenth said they were unsure (6%), and more than a third declined to answer the question (35%). Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources.



**Film only attendees:** Film only attendees were asked if and how their work with the film and its resources had or might contribute to the project goal of facilitating outreach among underserved students. About a third said they would (or would like to) be working with underserved youth (31%) and just over one-sixth said they would not (17%). Nearly half declined to answer the question (48%) and a tenth shared miscellaneous responses (10%). Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources.

#### **Question 4: What feedback did Film only attendees share about future workshops related to *Mysteries of the Unseen World*?**

Film only attendees were first asked why they did not participate in the local *Mysteries of the Unseen World* workshop that was held in their area earlier in the year. Next, they were invited to rate aspects of the opportunity to attend a local workshop, to note the likelihood that they would participate in a future workshop (if it were to be offered), what they would hope to gain from this future workshop, and what topics they would want to have covered. They were also asked to note their preference for a local workshop or a webinar, if National Geographic was to coordinate one or the other in the future. Finally, they were invited to describe how they thought they would use the *Mysteries of the Unseen World* resources without having attended a workshop or a webinar. These findings are presented below in 4.1 through 4.5.

**4.1 Why didn't Film only attendees participate in local workshops in their areas?** The Film only attendees were asked why they didn't attend the *Mysteries of the Unseen World* local workshop held in their area earlier in the year. More than three-quarters said they didn't know about the workshop (76%). A tenth pointed a timing issue (10%) and less than a tenth noted that they don't teach the topics in the film (7%). One said s/he did attend (3%), though the workshop this educator planned to attend was shortened to just a film screening when a local sports team made national playoffs the same evening and the workshop coordinator received a "*rash of cancellations*." Finally, one-seventh of Film only attendees declined to answer the question (14%).

#### **4.2 How did Film only attendees rate aspects of the opportunity to attend a local workshop?**

Overall, the Film only attendees somewhat agreed that: *they would like (or would have liked) the opportunity to attend a local workshop that spends time going over the resources, they would find (or would have found) a workshop on the film and resources to be a good use of my time, and they would like (or would have liked) to attend a workshop that showed me ways to use the resources in my local setting.* They also fell between being neutral and somewhat agreeing that *they would like (or would have liked) to attend a workshop that explained the educational goals of the film and resources and that they would likely obtain knowledge about the film and resources at a workshop that would be difficult to obtain without being there in person.*

#### **4.3 How likely were Film only attendees to participate in a future *Mysteries of the Unseen World* workshop, what would they hope to gain from the experience, and what topics would they want to have covered?**

When Film only attendees were asked about their likelihood of participating in a future *Mysteries of the Unseen World* workshop, if it were offered again in their area, nearly two-fifths each said they would be moderately likely (38%) or very likely (38%) to participate. One-tenth indicated that they were not at all likely (10%), and less than a tenth each were slightly likely (7%) or extremely likely (3%).

Film only attendees were then asked, if they were to participate in a future workshop on the *Mysteries of the Unseen World* film and resources, what they would hope to gain. About a third each pointed to teaching ideas (31%) and/or resources, including information about where to find them and how to use them (31%). A tenth said they would hope to gain more information about the topics featured in the film (10%), and less than one-tenth each explained that they would like to gain information about STEM careers (7%) or shared miscellaneous responses (7%). More than a quarter declined to answer the question (28%).

When asked what topics they would want covered, more than a quarter of Film only attendees explained that, if they were to attend a workshop in the future, they would want to be sure that it would cover STEM content in sufficient depth (28%). About a sixth pointed to information about the resources (17%), and a tenth identified teaching ideas (10%). One said s/he would want to be sure the workshop would cover information about “*STEM careers in nanotechnology*” (3%), while another was “*unsure*” (3%). More than half of the Film only attendees declined to answer the question (52%).

#### **4.4 In the future, would Film only attendees prefer to participate in a local workshop or a webinar?**

When Film only attendees were asked if they would prefer a local workshop or a webinar, if National Geographic could offer one or the other, the largest group of nearly two-fifths pointed to a preference for the local workshop (38%). Just under a third said they had no preference and that either option would be fine (31%). About one-seventh explained that they would prefer a webinar (14%), and a tenth said neither, they would prefer to review the resources and plan on their own (10%). None said that they were not sufficiently interested in the topic (0%).

**4.5 Without having attended a local workshop or webinar, how did Film only attendees think they would determine which resources to use?** When asked how they would or had determined which *Mysteries of the Unseen World* resources to use in their educational settings, without the benefit of having attended a local workshop or webinar, more than a quarter said they would review the resources to determine the best use for their classroom or students (28%), while a tenth pointed to specific resources they would use (10%). Less than a tenth each said they were not sure (7%) or that they wouldn't use the resources (7%), and one-seventh shared miscellaneous responses (14%). Nearly two-fifths declined to answer the question (38%).

## **Phase 3: Museum educator post report findings**

As part of the awardee reporting requirement, educators from the awardee sites that participated in the Museum Educator National Workshop were asked to complete a post report at the end of their award about their: experience participating in the awardee program, use of the *Mysteries of the Unseen World* materials to engage visitors and students, satisfaction with the materials, perception of the effectiveness of the film and activities in meeting the project's learning objectives, efforts to disseminate and promote the materials to local educators, and efforts to draw underserved audiences to see the film and engage in outreach.

The evaluation team edited a draft version of the *Outreach Award Post Report* initially developed by National Geographic for this purpose and then collaborated with the outreach coordinator from National Geographic to ensure the partners had access to the report forms well in advance of the completion of their awards. A total of 11 of the 17 museum partners that attended the Museum Educator National Workshop activated the outreach award. These 11 partners all completed the follow-up “post report,” for a response rate of 100% of those sites that activated an award.

Basic descriptive statistics were provided on the quantitative data generated from the report forms. Many of the reach-focused statistics below are based on estimates provided by the museum partners. For total values from the partners of 1000 or greater, the reported total values were rounded to three significant figures in the text for ease of interpretation. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the outreach award objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Findings

This section summarizes the Phase 3 evaluation findings relating to the following eight questions: 1) What was the overall reach of *Mysteries of the Unseen World*, as facilitated by partner organizations? 2) What was the reach of the *Mysteries of the Unseen World* field trips to partner organizations? 3) How did the partner organizations reach out to underserved communities? 4) How many local workshops were coordinated by the partners, and how many educators attended? 5) What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached? 6) What feedback did partners share about the value, distribution, and use of the *Mysteries of the Unseen World* media and materials? 7) How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring? 8) What feedback did partners have about the outreach award requirements and the project overall?

### **Question 1: What was the overall reach of *Mysteries of the Unseen World*, as facilitated by partner organizations?**

To assess the overall reach of the project, the 11 partner organizations estimated the number of educators and students reached by their marketing and outreach efforts. They reported reaching approximately 42,200 educators and 998,000 students. The reported number of educators reached ranged from 29 to 25,915 per organization, the reported number of students reached ranged from 122 to 647,875, and the partners averaged reaching 3,837 educators and 90,678 students each. When invited to elaborate, a number of museum educators shared feedback on their educator-focused marketing and outreach efforts related to *Mysteries of the Unseen World* (including emails, letters, preview passes, conferences, and distribution of the project materials, among other methods) and/or how they estimated the number of educators and students reached.

### **Question 2: What was the reach of the *Mysteries of the Unseen World* field trips to partner organizations?**

Nine (9) of the 11 partners estimated the number of field trips groups that attended screenings of *Mysteries of the Unseen World* at their organizations, for a total approximation of 852 groups. The number of field trips hosted by each partner ranged from 1 to 297 and averaged 95 per partner that provided information. One partner declined to answer the question and another explained that, although they did not track the number of groups, they could provide information about individual attendees.

Ten (10) of the 11 partner organizations estimated the number of educators and students reached through field trips, for a total approximation of 7,740 educators (and chaperones) and 41,800 students. The number

of educators reached by the 10 partners ranged from 2 to 3,329 and averaged 774 per partner that provided information, and the number of students reached by the 10 partners ranged from 20 to 10,987 and averaged 4,177 per partner that provided information.

Three (3) of the partner organizations were able to specify the grade range of the students who attended field trip screenings. Together, these 3 organizations estimated reaching 761 students in grades K-4, 4,050 students in grades 5-8, 31 students in grades 9-12, and 545 other students.

### **Question 3: How did the partner organizations reach out to underserved communities?**

The partner organizations were each asked to detail how they used the *Mysteries of the Unseen World* Underserved Community Outreach grant of \$1,000 to support underserved students. Additionally, they were asked to estimate the number of educators and students reached through this funding, as well as the number of students who saw the film with assistance from this funding. Finally, they were asked to share additional feedback about the value of the Underserved Community Outreach funding. These findings are presented below in 3.1 through 3.4.

**3.1 How did partner organizations use the Underserved Community Outreach funding to support underserved students?** When asked how they used the \$1,000 Underserved Community Outreach grant to support underserved students, 9 of the 10 partner organizations noted that the funding was used to pay for tickets to see *Mysteries of the Unseen World*, with many partners also providing the students admission to their science center or museum. Additionally, a number described having used some of the funding to coordinate the students' transportation to and from their site and/or to reach underserved students through the film's other educational materials. One of the grantees explained that they weren't able to use the funding and another described some of the challenges they faced in working with the grant, including liability and the timing of their showings.

**3.2 How many educators and students were reached through the Underserved Community Outreach funding?** Together, the 10 organizations that indicated they used the Underserved Community Outreach grant reported having reached approximately 692 educators and 7,450 students through activities supported by this funding. The number of educators reached by these 10 partners ranged from 2 to 400 and averaged 69, and the number of students reached by the 10 partners ranged from 20 to 4,000 and averaged 745. One grantee elaborated, "*While not all 4000 students received the funding, the vast majority of the groups were supported at least in part by subsidized access. Our survey responses from teachers tell us that, without the funding for students in need, none of their students would be able to take the trip.*"

**3.3 How many students saw the film with assistance from the Underserved Community Outreach funding?** Together, the 10 organizations that indicated they used the Underserved Community Outreach grant reported that approximately 5,570 students saw *Mysteries of the Unseen World* with assistance through this funding. The number of students who saw the film with assistance from this funding ranged from 20 to 4,000 and averaged 557 per partner.

**3.4 Did partners have additional feedback about the value of the Underserved Community Outreach funding?** When invited to share additional feedback about the value of the Underserved Community Outreach funding to their organizations, comments from the partners were entirely positive. The majority

described how the funding helped them subsidize film tickets, museum tickets, and/or transportation costs, benefitting the students, the schools, and the partner organizations.

#### **Question 4: How many local workshops were coordinated by the partners, and how many educators attended?**

The 11 partner organizations coordinated 11 educator workshops dedicated solely to *Mysteries of the Unseen World*, reaching a total of 758 educators. The number of educators reached ranged per workshop ranged from 3 to 230 and averaged 69 per workshop. At the same time, the partners coordinated an additional 23 educator workshops that included *Mysteries of the Unseen World* in addition to other programming, reaching 1,280 educators. The number of educators reached ranged per workshop ranged from 43 to 364 and averaged 55 per workshop.

#### **Question 5: What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached?**

**Number of events and event types:** Ten (10) of the 11 partner organizations coordinated other educator and student events that featured *Mysteries of the Unseen World* in some way. Together, they planned a total of 24 other events (that is, events other than the educator workshops considered in the previous section) for the general public, students, educators, board members, and/or policy makers.

**Content featured:** Three-quarters of the 24 events planned by the partners featured the subject of nanotechnology (75%). Two (2) partners noted that their events featured “all” of the *Mysteries of the Unseen World* content (8%), and 1 event each focused on the following subjects: biology (4%), electron microscopy (4%), and infrared light (4%).

**Resources used:** The partners described using a range of the *Mysteries of the Unseen World* resources at the 24 events. Nearly three-quarters of the events featured the film on giant screen and/or DVD (71%), while just under three-fifths made use of the Museum Educator Guide and activities (58%). A third of the events used the poster (33%), a fifth used online videos and/or the film’s trailer (21%), and about one-sixth used the “fun facts” handout (17%). Just over a tenth used other materials (13%), including “*NatGeo Kids and other NatGeo giveaways*,” the “*FEI Guide*,” and “*materials from NISE network Nano day*.”

**Number of educators and students in attendance:** The partners were able to estimate educator attendance at 20 of the 24 events, for an approximate total of 1,820 educators. The number of educators per event ranged from a low of 2 to a high of 700, with an average of 91 per event. The partners were also able to estimate student attendance at 8 of the 24 events, for an approximate total of 2,380. The number of students per event ranged from a low of 20 to a high of 900, with an average of 297 per event. Finally, though the information was unsolicited, one partner noted that their public Nano Days event drew 100 members of the general public.

## **Question 6: What feedback did partners share about the value, distribution, and use of the *Mysteries of the Unseen World* media and materials?**

First, the partners were asked to rate the value of the educator DVD, Museum Educator Guide, poster, and “fun facts” handout, and to provide the number of each they distributed, the audiences they shared these resources with, and how they thought they were used (if known). Next, they were asked to comment on their use of the lobby kiosk and to rate the value of the kiosk. Finally, they were asked to rate the value of 6 additional *Mysteries of the Unseen World* resources: the giant screen film, the standards sheet, the website, the online videos, the online activities and lessons, and the iPad app/game. These findings are presented below in 6.1 through 6.3.

### **6.1 How were the DVD, Museum Educator Guide, poster, and “fun facts” handout valued by the partners, distributed, and used?**

**Educator DVD:** Overall, the partners found the educator DVD to be very valuable. Ten (10) of the 11 partner organizations were able to detail the number of educator DVDs they distributed, for an approximate total of 4,040. Responses ranged from a low of 29 to a high of 2,000, and averaged 404. The partners noted that they shared the DVDs primarily with educators.

**Museum Educator Guide:** Overall, the partners found the Museum Educator Guide to be very valuable. Six (6) of the 11 partner organizations were able to detail the number of Museum Educator Guides they distributed, for an approximate total of 3,080. Responses ranged from a low of 29 to a high of 2,000, and averaged 513. The partners noted that they only shared the resource with educators.

**Poster:** Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of posters they distributed, for an approximate total of 2,680. Responses ranged from a low of 29 to a high of 1,000, and averaged 298. The partners noted that the posters were primarily shared with educators.

**“Fun facts” handout:** Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of “fun facts” handouts they distributed, for an approximate total of 3,760. Responses ranged from a low of 29 to a high of 1,500, and averaged 417. The partners noted that they were primarily shared with educators.

**6.2 How did partners use and value the lobby kiosk?** When partners were asked if their organization chose to host the kiosk, 10 said *Yes*, while the remaining partner said *No*. Those who used it explained that they put in their lobbies to promote the film, entertain audiences while they waited to enter the theater, and connect the film to other exhibits, among other responses. In general, the partners found the kiosk to be very valuable to their organizations. When invited to comment on the value that the kiosk brought (or did not bring), some partners described its value in terms of use by potential film viewers, museum visitors, and members, while other described liking previous National Geographic materials more than the kiosk and having trouble with the kiosk’s iPads.

**6.3 How did partners rate the value of the other *Mysteries of the Unseen World* media and materials?** The partners generally thought the giant screen film was extremely valuable to their organizations. Additionally, they indicated that each of the following materials was very valuable: the

standards sheet, the website, the online videos, and the online activities and lessons. Finally, they generally found the iPad app/game to be between slightly and moderately valuable.

### **Question 7: How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring?**

Partner organizations were asked if and how they used the activities in the Museum Educator Guide, which activities they used, and the number of educators and students reached. They were also asked to comment on the value of the activities. Their feedback is summarized below in 7.1 through 7.2.

**7.1 Did partners use the activities?** All but two of the partner organizations used activities from the Museum Educator Guide. Those who utilized the activities in the Museum Educator Guide described using them in a variety of ways (for example, with field trips and in curriculums) and finding them “*useful*,” “*simple*,” and “*easy to implement*.” One partner noted that some of the activities “*took too much time*.” Those who didn’t use the activities said they either adapted some of the concepts or hadn’t found the right group to share them with.

**7.2 Which activities did the partners use, how many educators and students were reached, and what value did the activities bring?** Electron Microscope Image Scavenger Hunt was used by 9 of the partners, and Zoom and Too Slow were each used by 5 of the partners. Playing with Perspective was used by 4 of the partners, while Faster, Slower and Playing with Light were each used by 3 of the partners. Two (2) of the partners used the Too Fast activity, and 1 of the partners used each of the following activities: Making Waves, Too Small, Invisible, Mosquito Maze, and Perspective. None of the partners used the Careers activity.

When asked to comment on the value that the activities did (or did not) bring to the educators and/or students they reached, some of the partners described how the educators and students really enjoyed and were engaged by the activities. At the same time, other partners described how they used the activities in their exhibits and their trainings, and how they modified or were inspired by them. Finally, one of the partners expressed dissatisfaction with the activities, saying, “*Some just took too much time. I really like the Robot ones so much better. Better variety of time requirements and can easily be modified to all ages. Kit will help immensely!*”

### **Question 8: What feedback did partners have about the outreach award requirements and the project overall?**

First, partner organizations were asked to rate the outreach award requirements in terms of how reasonable or unreasonable they found them. Next, they were invited to rate the ease of accomplishing the outreach award deliverables. Third, they were asked whether they thought they would be likely to participate in this program again. Fourth, they were invited to share suggestions for future programs, and finally they were given the opportunity to provide additional feedback about the program. Their feedback is summarized below in 8.1 through 8.5.

**8.1 How reasonable did partners find the outreach award requirements?** When asked how reasonable they thought the outreach award requirements were, 6 partners said they were very reasonable. Three (3) of the partners thought they were somewhat reasonable, and 2 thought they were somewhat unreasonable. None of the partners thought the requirements were not at all reasonable or neither reasonable or unreasonable.

**8.2 How did partners rate the ease of accomplishing the outreach award deliverables?** The partners generally felt that it was very easy to share their outreach plan with National Geographic and that it was easy to utilize \$1000 for underserved students, disseminate and promote materials, and integrate *Mysteries of the Unseen World* into existing workshops. Overall, the partners indicated that it *was neither easy nor difficult* to host dedicated educator workshops and complete the post report. Finally, the partners noted that it was generally very difficult to ensure response to the educator survey. Those who rated this element lowest conducted their programs early in the grant period when they were asked to complete an online survey form developed internally by National Geographic. When the independent evaluation for the NSF grant began several weeks later, they were then asked to use an updated version of the form that would be sent to the independent evaluator instead of National Geographic. This shift in strategy likely caused some initial confusion and additional burden to the survey requirement that did not affect partners that commenced their outreach later in the grant period and were only instructed to use the independent evaluation form.

**8.3 Did the partners think they would be likely to participate in this award program again?** When asked if they would participate in this National Geographic award program again, 9 of the 11 partners said *Yes*, while 2 explained that *It would depend*. Those who said *Yes* praised the resources, the support from National Geographic, and the value of the opportunity for local educators. Those who said *It would depend* commented on the challenges of meeting some of the requirements and the amount of time they invested.

**8.4 Did the partners have suggestions for future programs?** When asked what changes they thought National Geographic should make the program moving forward, the partners shared a range of suggestions, including: altering the educator survey component, disconnecting activities from the kiosk, facilitating discussions among the partners, developing more activities, connecting to the Next Generation Science Standards, particularly cross cutting concepts, and making the project more interdisciplinary.

**8.5 Did the partners have additional feedback to share about the project?** When invited to share additional feedback about their experience conducting outreach on behalf of *Mysteries of the Unseen World*, many partners shared positive comments about the opportunity and their experience in with the project. Additionally, one reiterated that their organization had trouble using the funding and another suggested working with shorter films.

## Discussion

The evaluation findings indicate that the *Mysteries of the Unseen World* educational program was well received by the educator audiences who shared feedback for the Study 3 summative evaluation. Below, we briefly summarize aspects of the project that stood out to educators in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions.



First, we consider feedback about the film shared by the educators, including museum educators who attended the Museum Educator National Workshop, educators who saw the film at their local workshop (Workshop attendees), and educators who saw the film at their local science center or museum but did not attend a local workshop (Film only attendees). Second, we examine themes that emerged from the feedback shared by museum educators about the Museum Educator National Workshop and the *Mysteries of the Unseen World* educational resources, as detailed in Phase 1. Third, we discuss themes that emerged in the feedback from Workshop attendees and Film only attendees about the local workshops, educators' interest in similar workshops and webinars, and their thoughts about and plans for the educational resources, as detailed in Phase 2. Fourth and finally, we look at themes that emerged in partner organizations' responses to questions about their outreach and marketing efforts, use of the resources, and thoughts about the outreach award program, as detailed in Phase 3. Though feedback from the educators is generally separated by educator group in these last 3 parts of our discussion, where possible their comments and suggestions are considered concurrently for ease of review.

### **Educator feedback about the film**

Overall, the *Mysteries of the Unseen World* film was consistently praised by the educators, including museum educators who attended the Museum Educator National Workshop, educators who saw the film at a local workshop (Workshop attendees), and educators who saw the film at their local science center or museum but did not attend a workshop (Film only attendees).

- In general, all three groups of educators indicated that they liked the film, found it visually exciting, and thought its presentation was clear. Overall, they also thought it had high learning and engagement values for their students, and that they would recommend it to their colleagues. Feedback from educators included comments like: *“Perfect for a science center”* and *“[The filmmakers did a] great job...this is a tough subject for such a large format.”*
- The three groups of educators pointed to a number of elements that they particularly liked about the film including the accessibility of the film content (as in, *“Made abstract content concrete. Covered a range of content aligned with standards- how eye works, light, waves, nano”*) and the film's visuals and imagery (as in, *“Visually stimulating photos and videos keep [students'] attention”*).
- Additionally, almost all of the partners who completed the post reports at the conclusion of the outreach award period indicated that they thought the film had been extremely valuable to their organizations. As one partner noted, commenting on the film and its educational resources, *“The material package (promotional and educational) for this film was incredibly compelling and exceptionally valuable. It was one of the strongest packages we've seen for any film.”*

### **Feedback from museum educators**

In general, the 20 museum educators who attended the Museum Educator National Workshop greatly valued the opportunity to participate in and learn from the experience. Their responses also point to a few issues that may be worth considering when planning future workshops and related educational programming, outreach, and educator networking.

- Though the museum educators generally indicated that the workshop was well run and organized, their feedback also suggests small logistical changes that could be implemented in the planning of future workshops. For example:
  - A few museum educators indicated that the schedule could have benefitted from some tweaking and, perhaps, a tighter agenda (as in “*maybe reorganizing*” and “*better-dedicated time to actually running through the majority of the activities without saying, ‘now go ahead and flip through the rest of the materials’*”).
  - When asked to comment on the workshop’s programming, one participant wrote, “*I wish the award had been explained earlier in the workshop; it would have given me a framework through which to view information given on the first day.*” Though the workshop organizers likely assumed that participants would come to the workshop with knowledge of the outreach awards (which were available to all participating institutions), this museum educator’s response indicates otherwise. An overview at the beginning of the workshop, if it wasn’t provided, would have been useful for this particular participant, and may have also helped others who could have benefitted from a quick refresher.
  
- In general, the museum educators valued the opportunity to network and brainstorm with their peers, and many also felt they would have benefitted from additional time to learn from other workshop attendees. Future workshop efforts might explore additional ways to strengthen this community of museum educators, who seemed receptive to further networking. For example:
  - Setting aside more time for formal and informal networking during the workshop and encouraging post-workshop networking could help fulfill the educators’ desire to learn even more from the other workshop attendees. One of the partners echoed this feedback about learning from the other museums and science centers in a post report submitted at the conclusion of the project, saying “*It would be great to hear from other institutions about what they did with their award.*” Post-workshop networking could be facilitated by, for example, hosting a follow up event or online forum or distributing a shared contact list. These types of in-person or remote follow-up extensions could serve to strengthen the educators’ relationships with one another and with National Geographic, and, in turn, help National Geographic generate even more useful ideas and resources in the future.
  
- The museum educators often requested additional ideas and resources.
  - Though the museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right, two-fifths (40%) also expressed a desire to have done *more* at the workshop – more activities, more discussion sessions, and a longer workshop overall – indicating that they are open to gaining as much as possible from these types of workshops.
  - The museum educators pointed to a wide range of useful teaching strategies shared over the course of the workshop, indicating that each market is likely to value and use the content in a slightly different way. Some mentioned the importance of “*low budget activities*” that can be conducted without special equipment, others stressed the need for “*shareable tools and*

resources,” and a few pointed to the value of resources, like the kiosk, with components that can be rotated in and out, depending on a museum’s preferences and capabilities. In general, it seems that the greater the range of ideas and resources provided, the more likely it is that museum educators will be able to make use of one or more of them.

- ➔ The outreach team might want to find additional ways to incorporate unanswered questions from the *Mysteries of the Unseen World* film into the accompanying educational resources.
  - When asked what they disliked about the film, more than a third (35%) of museum educators indicated that the film’s examination and imagery of the science behind “seeing the unseen world” could have been stronger. Though directed at the film, the educators’ feedback points to the opportunity for this topic to be examined more fully, not only in the Museum Educator Guide and other film-related resources, but also in the local programming designed to reinforce and extend the film’s STEM content.
- ➔ It seems that some museum educators might appreciate additional support in implementing their outreach awards.
  - A handful of museum educators indicated that they felt “*unprepared*” to use the *Mysteries of the Unseen World* educational resources and/or to implement the outreach award. When given the opportunity to elaborate, all those who responded (20% of all museum educators) pointed to internal institutional challenges, indicating that the outreach team may want to follow up with museum educators individually to answer questions or help strategize or customize implementation ideas.
  - When asked if there was anything missing from the workshop nearly a third (30%) of museum educators expressed an interest in receiving additional information about marketing to and training educational professionals. This may be another area where the workshop and outreach teams may want to provide guidance.

### **Feedback from Workshop attendees and Film only attendees**

In general, the Workshop attendees indicated that the local workshops were well-run, a good use of their time, and that they allowed them to gain knowledge that would have been difficult to obtain without being there in person (*as in, “I liked the hands on activities afterward. I couldn’t have gained the same depth of knowledge by reading about them”*). Said one of the Workshop attendees, speaking about the overall experience, *“It was an awesome workshop. I have been to many (over 35 years in education) and it was one of the best ran workshops I have attended.”*

Below, we highlight some of the feedback from the Workshop attendees and Film only attendees that National Geographic may want to consider if and when they coordinate similar projects in the future.

- ➔ Given the educators’ consistent enthusiasm for the workshops and their general willingness to attend them either in person or virtually, with some also observing the added value that comes with *seeing* the resources in terms of feeling prepared to use them, future workshop organizers might want to look into taping one of the workshops and sharing it as a webinar to reach a broader network of educators.

Though this will require taking into account the technological capabilities of the partner organizations and the attendance and scheduling of their local workshops, the educators surveyed in the evaluation would support National Geographic's efforts to explore additional workshop options.

- When asked how they would determine which resources to use in their educational settings without the benefit of having attended a workshop, the largest groups of Film only attendees who answered the question knew which resources they wanted to use and/or thought they would be able to research the best materials for their educational settings without assistance. However, those who attended a local workshop agreed that they felt adequately prepared to begin using the resources, while those who did not only somewhat agreed that this was the case. Reflecting on the value of actually seeing how the resources might be implemented, one Workshop attendee observed that the workshop provided the extra 'nudge' needed to feel confident with the information covered, as in, *"It is like I have been told a child needs to be introduced to a vegetable 5-7 times before they will eat it sometimes I feel like I have to be exposed to new teaching techniques a number of times to feel competent to teach it."*
  - When asked if they would prefer a local workshop or a webinar in the future, the largest group of Film only attendees expressed a preference for in-person workshops (as in, *"I learn better by seeing and hearing in person. I would feel like I couldn't ask questions at a webinar"* and *"I focus better in person"*). However, some of the Film only attendees pointed out that a webinar might be *"more convenient"* as *"scheduling to be out of the office can be difficult."* Given this interest – and depending on the technological capabilities of the partners and the attendance and scheduling of their local workshops – if National Geographic were to coordinate a similar project, they might want to look into taping one of the workshops and sharing it as a webinar. Future evaluations might also look into the educators' interest in and familiarity with webinars, as well as the benefits and challenges of sharing workshop material in this manner.
  - As an informal comparison only, there were small apparent differences in how the two groups of educators rated the value of the educational resources, among those who indicated the resources were applicable to their settings. Where the Workshop attendee group generally found the online activities/lessons and the iPad app/game to be extremely valuable, the Film only attendees thought both resources were very valuable. Additionally, while the Film only attendees generally rated the educator DVD, website, and online videos as more valuable than the other resources (between very and extremely valuable each), the Workshop attendees thought all three resources were very valuable. Finally, the Film only attendees gave one of the lowest ratings to the "fun facts" handout (finding it moderately valuable), while the Workshop attendees felt the resources was very valuable. The extent to which these apparent differences are meaningful and point to recommendations on how to communicate information about the handout, for example, to educators who don't attend a workshop, is beyond the scope of the evaluation, but the issue may be worth exploring prior to developing and promoting film-related materials in the future that are to be accessed by those not having the benefit of attending a workshop and seeing the materials demonstrated in person or remotely via webinar.
- ➡ Future workshop organizers might consider providing partner organizations with an outreach toolkit or other support to help them reach a broader network of educators in their areas when they are recruiting participants for their local workshops.

- When asked why they did not attend the local workshop in their area, the largest group of Film only attendees indicated that they didn't know about it. The group as a whole also somewhat agreed that they would have been interested in the opportunity, and the majority indicated that if another workshop were to take place in their area they would be moderately to extremely likely to attend. Though it is unknown how many of these interested Film only attendees would have come to their local workshop if they had known about it, it's possible that the partners could have done more outreach to local educators. In the future, the outreach team might consider assisting with this effort by providing partners with an outreach toolkit containing templates for a mass email, flyer, and press release, among other resources, with the goal of making it easier for partners to promote the workshop among educators in their areas.
  
- The largest groups of Workshop attendees and Film only attendees that participated in the evaluation noted that they were elementary educators and that they planned to use the resources with elementary students, indicating that many educators were willing to adapt resources targeted at middle school students for use in their elementary-level classrooms. As one educator explained, "*All the activities presented can be easily adapted to different grade levels and to different learning styles.*" Future film efforts may want to consider sharing such recommendations with educators for adapting the materials for different ages.
  - It is not known whether the teaching levels of the educators who participated in the two different surveys (Workshop attendees vs. Film attendees) were representative of the full group of educators that attended the local workshops or saw the film across the partner sites. Balancing against the additional burdens this may place on partner organizations, future outreach and evaluation efforts might aim to track and report on this information by, for example, requesting that partners request teacher grade level in their workshop registration forms and provide a breakdown of the same information from the list of educators (who only saw the film) to whom they sent a survey requests.
  
- Many of the elementary school educators that participated in the evaluation did not, however, seem to recognize that the Museum Educator Guide contains activities specifically designed for the elementary school level. To help connect such educators to these activities, it may be worth brainstorming ways to help ensure educators can be easily directed to the resources designed for their students. As one possibility, it might be worth encouraging the partner organizations to reach out to targeted educators (if possible) when planning their local workshops, to help direct them to the age-appropriate resources and share ideas for implementation or modification.
  - Throughout their surveys, a number of Workshop and Film only attendees indicated that the film and its resources weren't at the ideal level for their students, with many finding *them "too advanced"* and a smaller group saying that they had hoped to gain "*activities for use in the upper levels.*"
  - However, even though the targeted age range of the project wasn't ideal for all of their students, some educators pointed out that *Mysteries of the Unseen World* could still be a positive educational experience, as in, "*The younger the students, the less they are likely to become engaged by some of the details, since they don't have the background to understand the nature of*

*light and color. Nonetheless, the film could get them questioning and wondering if the teacher follows up on the ideas."*

- ➔ Overall, Workshop attendees and Film only attendees valued the resources and had specific plans for their use, particularly in regards to influencing students' interest in STEM or STEM careers. However, the outreach team will likely want to investigate why a number of educators had trouble playing the educator DVD.
  - In general, both groups of educators explained that they would use or had used the resources to influence students' interest in STEM and/or STEM careers in 4 main ways:
    - by preparing students to see the film (as in, "*Will be using many of the DVD activities/online activities to prepare students to watch MUW*");
    - supplementing the information in the film through hands-on activities (as in, "*The videos will be used to help explain what students are experiencing in the hands-on activities, either before or after the activity*");
    - adding to other lessons (as in, "*We are studying plants and I plan to use the time lapse app to record beans sprouting*"); and/or
    - using the resources to enhance their career days (as in, "*Our 'career day' will happen in January at school, and these resources will be implemented into our forensics presentation, so thank you*" and "*We have already had community day in which they met several people in various careers. I will build on that prior knowledge by adding these types of careers*").
  - Some of the most frequently cited resources among Workshop attendees who planned to use the resources and Film only attendees who planned to use them or already had were, in no particular order: the Museum Educator Guide, poster, "fun facts" handout, the website, the online videos, and the educator DVD. However, a number of educators reported having difficulty playing the DVD, which the outreach team will likely want to look into, if they haven't done so already.
- ➔ Future film-related media projects might want to gather metadata about the use of the iPad app/game when considering the creation of similar resources for future projects.
  - Though those who used the iPad app/game generally found it valuable, large groups of Workshop attendees and Film only attendees indicated that they had not used or did not plan to use the iPad app/game. Additionally, some of the educators expressed confusion about how to access to the resource (as in, "*Where is the iPad app/game? Do I need to download that? Is an iPad required? Can a Chromebook, or other technological tool be used instead?*") or explained that their classrooms didn't use iPads (as in, "*I do not have access to iPads where I teach*"). Given the likely availability of metadata about the downloads and use of the iPad app, National Geographic might want to review this information when considering the creation of similar resources on future projects.

### **Feedback from the partner organizations**

In general, the 11 partner organizations that "activated" the outreach award and completed the post report felt that their involvement in the project was a positive experience. Below, we highlight some of their

accomplishments, comments, and suggestions that National Geographic might want to consider if and when similar projects are coordinated in the future.

- ➡ If resources allow, future outreach teams might work more closely with partners to coordinate the timing of the outreach award, consider the best way to gather data from the partners' reservation systems, and determine the extent of the impact of the Museum Educator National Workshop on the partners' outreach and marketing efforts.
  - Overall, the partner organizations estimated reaching approximately 42,200 educators and 998,000 students with their marketing and outreach efforts (which included emails, letters, preview passes, conferences, and distribution of the project materials, among other methods). Additionally, of those who were able to provide estimates, the group as a whole hosted an estimated 852 field trip groups, reaching approximately 7,740 educators or chaperones and 41,800 students. A few of the partners were able to estimate grade ranges reached with the field trip screenings (approximately 761 students in grades K-4, 4,050 students in grades 5-8, 31 students in grades 9-12, and 545 other students). Some of the partners described that their numbers weren't final or that they could have done more if they had more time after the Museum Educator National Workshop (as in, *"To date, this is the number of attendees to the film"* and *"Unfortunately, I did not have enough time to plan and implement some of the outreach award deliverables. In my case, the film was being released about 2 weeks after I attended the [national] workshop"*). In light of this feedback, outreach teams on future projects might want to look for ways to give partners more time to complete the post report and/or more time to ramp up their outreach activities after the National Workshop.
  - Other partners noted that their reservation systems didn't capture all of the information asked for on the post report (as in, *"We do not have a way of knowing how many trips there were, but we can tell you how many students and teachers/chaperones saw the film on a field trip"* and *"Grade levels are not listed in our current reservation detail"*). If capturing this information is a high priority for future projects, the outreach team might consider working with each partner to determine the kinds of information their reservation systems can collect, as well as if and how additional data might be gathered.
  - Though responses from museum educators considered in Phase 1 indicate that the group as a whole valued the opportunity to participate in and learn from the Museum Educator National Workshop, further evaluation efforts might examine how much of the partners' outreach was done through channels established prior to attending the National Workshop and how much was directly influenced by ideas, resources, and/or motivation gained at the workshop.
- ➡ Future outreach teams might consider working with each partner to set organizational goals for outreach to underserved communities, such as targeted numbers of students and educators to reach and/or how the resources might be best used with these audiences.
  - The partners described how the Underserved Community Outreach grant benefited students, schools, and the partner organizations, and said it helped them reach new audiences, as in, *"Funding for underserved audience is something that we get increasing requests from schools"*

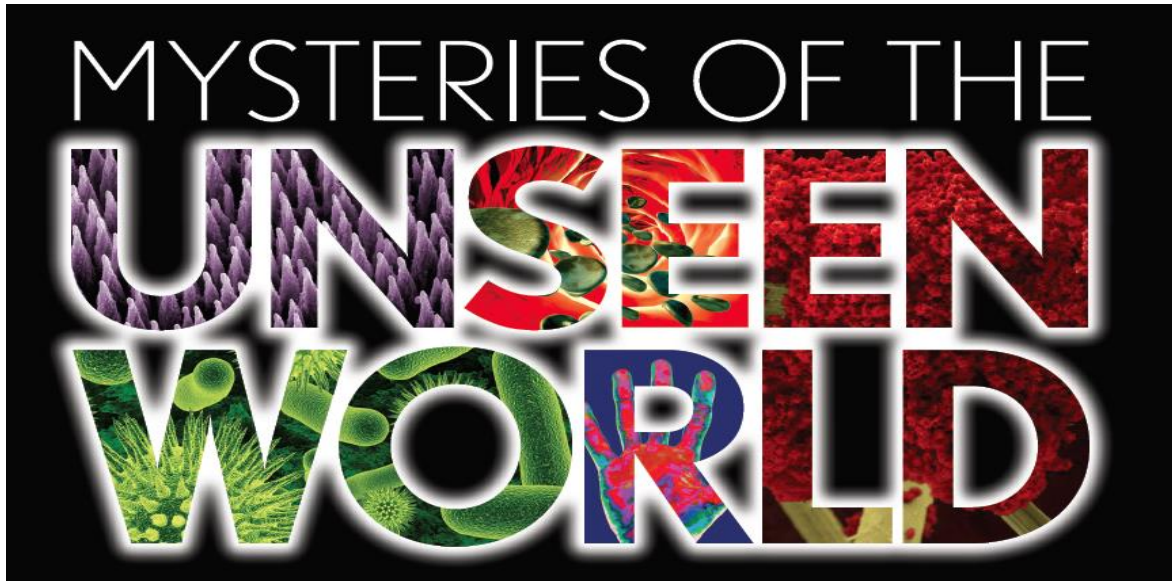
*every year...Programs like this allow students to participate in activities and enrichment that they would not normally get to."*

- As a group, the partners indicated that they reached approximately 692 educators and 7,450 students through the project's Underserved Community Outreach grant, and that approximately 5,570 students saw the film with assistance through this funding. In general, the partners described using the funding to pay for or subsidize ticket costs and to fund transportation, with some reaching underserved students through the film's other educational materials (as in, "*Spent \$1020 on field trips and classroom supplies for 2 Title One schools*").
- The numbers of underserved students and educators reached ranged widely by partner – for example, the number of students reached and the number of students who saw the film both ranged from a low of 20 to a high of 4,000 per partner, and the number of educators reached ranged from 2 to 400. Though best use of the funding cannot be determined in this evaluation (particularly when considering both the number of students reached and the impact(s) of said outreach), some of the partners indicated that they found ways to make the most of the funding that worked especially well for their organizations. These partners observed that the funding helped them reach more students (for example, "*For most, we were able to just cover the movie cost for the students. If we were to cover museum and movie admission, we would only be able to have served 71 individuals, but because we found other ways to cover their admission costs, we were able to serve more than 3 times that amount,*") and/or build on content featured in the film (as in, "*I also did a post-visit and follow-up [with students who saw the film] with some of the educator activities provided by Nat Geo*").
- ➔ The partners generally shared positive feedback about and made use of the resources and activities. However, some of the resources and activities were more highly valued than others. Thus, the outreach team might consider gathering formative feedback about the materials being developed for future projects to get a sense of what may be especially valuable to partners and educators.
- In general, the partners found the giant screen film to be extremely valuable and the DVD and Museum Educator Guide to be very valuable, and also indicated that they used these resources often. The partners thought the least valuable resource was the iPad app/game, which they rated between slightly and moderately valuable, with one partner explaining, "*I don't think there is a need for the app in a school setting, but should be geared more towards the general public.*" If considering the development of an iPad app for another project, future developers might consider gathering formative feedback on the development of future apps and/or reviewing the metadata from the *Mysteries of the Unseen World* app to better understand how these kinds of resources are used by partners and educators (as also noted earlier in this discussion).
- As a group, the partners indicated that they used almost all of the activities in the Museum Educator Guide, with the Careers activity being the only one that wasn't utilized. Electron Microscope Image Scavenger Hunt, which was used by 9 of the 11 partners, was the most-used activity, followed by Zoom and Too Slow, which were each used by 5 of the partners. Though the reasons for their preferences are unknown, and are beyond the scope of this evaluation, the outreach team might consider gathering formative informal feedback about activities they develop around future giant screen films.



- ➔ The outreach team might consider gathering informal feedback from Museum Educator National Workshop attendees whose organizations declined the outreach award. Additionally, they may want to request more detailed outreach plans from potential partners in order to minimize the likelihood that a partner would not be able to use the funding, as happened with one of the 11 *Mysteries of the Unseen World* partners.
  - Of the 17 organizations that attended the Museum Educators National Workshop, 11 went on to activate the outreach award. Though the reasons why six potential partners declined the award are unknown, the project team might consider gathering informal feedback from these organizations with the goal of creating a program that appeals to (and is feasible for) as many museums and science centers as possible.
  - Additionally, one of the partners that accepted the outreach award explained that they were unable to use the funding because of internal issues. Depending on future project priorities, a similar outreach grant might benefit from a more detailed screening of potential partners, for example requesting more fully developed outreach plans, and/or working with each partner to identify ways that the outreach grant could be of use to their organizations and to the students in their communities.
  
- ➔ Some of the partners indicated that they had difficulty registering educators for their local workshops and gathering surveys from Workshop and Film only attendees. To the first point, future outreach teams may want to set personalized educator attendance goals for each partner, based on the size of their educator network and their experience hosting professional development programs. To the second point, one partner suggested that future outreach teams provide incentives for local educators.
  - Though the partners that activated the outreach award generally found the award requirements reasonable, a few explained that they had trouble registering educators for their local workshop (as in, “*We found it difficult to get educators to register for dedicated workshops for the movie and the associated educational material*”). Future outreach teams, therefore, might want to set different goals for each partner, so that every organization can strive to use the resources to the best of their ability (as in, “*It would be great to have something geared towards museums that are new to teacher/professional development and may not be able to meet the numbers you’ve requested for educators, but could complement those numbers with outreach to the public*”).
  - Some of the partners indicated that they found it difficult to produce enough educator surveys, both from Workshop attendees (as in, “*We had to have them fill out the survey onsite- which can be difficult to convince people to stay and do- or we had to trust that teachers would fill them out offsite, which was not possible for us to track.*”) and from Film only attendees (as in, “*It is difficult to make educators that are just coming to see the movie participate in the evaluation piece in the end*”). One partner suggested that National Geographic provide incentives for educators (for example, “*bags, caps, classroom resources*”), in order to increase the likelihood of a higher response rate to these surveys.

- ➔ Finally, future outreach teams might take into account that projects like *Mysteries of the Unseen World* are likely to continue to foster the development of the partners' educational networks, and in some cases help to establish these networks.
  - Though many of the partners seem to have gone into the project with established educator networks, this was not the case for all of the organizations. As one partner noted, *Mysteries of the Unseen World's* impact was larger than the project itself, as in, “*Our biggest challenge was that we don't have an established educator base of our own yet and are working to develop that...However, having the opportunity to host a dedicated Mysteries workshop has really helped us to jumpstart that and we've made some very important steps in developing our educator network that would not have happened otherwise.*” At the same time, another partner pointed to the larger benefits for educators (and, tangentially, students), saying, “*We'll need to 'teach' our educational community what to do with these opportunities but it is well worth the effort.*”



## **Impact of the giant screen film with a general audience**

**(Summative evaluation study 1 of 3)**

*Knight Williams Inc.*

Valerie Knight-Williams, Ed.D.

Divan Williams Jr., J.D.

Rachael Teel, MEd

Gabriel Simmons

Sauleh Rahbari

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# Table of Contents

<b>Introduction</b>	<b>4</b>
<b>Evaluation goals</b>	<b>5</b>
<b>Report outline</b>	<b>7</b>
<b>Phase 1: On-site theater evaluation of the film's immediate appeal and learning value</b>	<b>9</b>
Method	9
Questionnaire development	10
Data analysis and reporting	10
Sample information	12
Group comparability	12
Participation by site	12
Response rate and missing data	13
Findings	14
Question 1: How appealing and engaging did Viewers find the film?	14
1.1 How did Viewers rate the film in terms of overall likeability, visual excitement, impact on curiosity, interest in the story, and likelihood of recommending the film?	14
1.2 What did Viewers liked most about the film?	16
1.3 What did Viewers not like about the film?	20
Question 2: Did Viewers find the film content to be clearly presented?	24
2.1 How did Viewers feel about the film's overall clarity and the ease or difficulty of following the film visually?	24
2.2 How did Viewers feel about the film's pacing, amount of information and science, and level of scientific explanations?	25
Question 3: What did Viewers learn from the film?	27
3.1 How much did Viewers think they learned from the film?	27
3.2 What was the impact of the film on Viewers' self-perceived knowledge of the unseen world?	28
3.3 What did Viewers think were the most interesting things they learned from the film?	29
3.4 How much did Viewers think they learned from the film about science and technology topics?	33
3.5 What was the film's impact on Viewers'knowledge of unseen worlds?	35
Question 4: How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?	45
4.1 What was the film's impact on Viewers' interest in the unseen world?	45
4.2 Did Viewers think they would "see" the world differently after watching the film?	46
<b>Phase 2: Discussion group explorations of Viewers' connections with the film</b>	<b>51</b>
Method	52
Recruitment	52
Procedure	52
Analysis	52
	2

Sample information	53
Findings	54
Question 1: Who in the family drove the decision to see the film and why?	54
Question 2: How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?	58
Question 3: What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?	65
Question 4: How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?	68
Question 5: How did Viewers feel about the film’s use of the human characters (family/friends) that appeared throughout the film?	70
Question 6: Did Viewers have any other feedback on the film that they would like to share?	72
<b>Phase 3: Follow-up evaluation of extended impact</b>	<b>75</b>
Method	75
Recruitment	75
Procedure	75
Analysis	77
Sample information	77
Findings	78
Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?	78
Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?	80
Question 3: Did the film change how Viewers think or feel about science or technology?	82
Question 4: Did Viewers “see” the world differently a few weeks after watching the film?	84
Question 5: What activities did Viewers do within a few weeks of watching the film?	86
Question 6: What additional feedback did Viewers share a few weeks after watching the film?	90
<b>Phase 4: Site documentation</b>	<b>91</b>
Recruiting process	91
Lawrence Hall of Science in Berkeley, CA	91
Discovery Place in Charlotte, NC	95
<b>Summary of findings</b>	<b>98</b>
<b>Discussion</b>	<b>109</b>
<b>Acknowledgements</b>	<b>116</b>

# Introduction

*Mysteries of the Unseen World* is a National Geographic project centered on a giant screen film that highlights the sciences used to illuminate the amazing worlds around us, invisible to the naked eye.<sup>1</sup> As described on the National Geographic project website:

*Mysteries of the Unseen World* reveals phenomena that can't be seen with the naked eye, taking audiences into earthly worlds secreted away in different dimensions of time and scale.

Experience events that unfold too slowly for human perception; "see" the beauty, drama, and even humor of phenomena that occur in the flash of a microsecond; enter a microscopic world once reserved for scientists, but now made accessible to the rest of us; and begin to understand that what we actually see is only a fraction of what there is to see on Earth.

High-speed and time-lapse photography, electron microscopy, and nanotechnology are just a few of the advancements in science that allow us to see a universe of things, events, creatures, and processes we never even knew existed. These technologies give us new "superpowers" to see beyond what's in front of us.

Visually stunning and rooted in cutting-edge research, *Mysteries of the Unseen World* will leave audiences in thrall as they begin to understand the enormity of the world they can't see—a world that exists in the air they breathe, on their bodies, and in all of the events that occur around them minute by minute and nanosecond by nanosecond. And with this understanding comes a new appreciation of the wonder and possibilities of science.

<http://movies.nationalgeographic.com/movies/mysteries-of-the-unseen-world/about-the-film/>

In 2009 National Geographic was awarded a grant from the National Science Foundation (NSF) which provided funding for the film, related educational programming and outreach, and independent formative and summative evaluation. Beginning in 2013 the film debuted in science center theaters within and beyond the U.S., with some of these theaters also booking a hands-on kiosk developed by National Geographic for use in theater lobbies or surrounding museum spaces to help extend viewers' interest in and learning from the film. The project further included an outreach program involving educators from 17 partner museums who were invited to attend the Museum Educator National Workshop and participate in an awardee program designed to promote the film, related events, and education resources among local and underserved audiences. These educational resources included: a Museum Educator Guide, videos and classroom activities accessible from the project website, an iPad app, and a customized package of materials for use in the Engineer in the Classroom program.

As part of the NSF funding for the project, the independent evaluation firm, Knight Williams Inc. conducted the project's summative evaluation in the form of four separate studies. The first study, the subject of this report, focused on the immediate and longer-term impact of the film on a general audience that viewed the film in a local science center theater context on their own accord. The second study focused on the immediate and longer-term impact of the film on middle school students who viewed the film at their local science center as part of a school field trip. The third study examined the implementation, effectiveness, and longer-term impact of the Museum Educator National Workshop, focusing on the educators who participated in the workshop and

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<sup>1</sup> Text in this Introduction in italics, other than titles, is borrowed from the project description section of the NSF proposal.

those they respectively trained in their local settings, as well as educators who didn't attend the training but saw the film and used or planned to use the educational resources. The fourth study explored the use and effectiveness of a set of educational materials implemented within the context of the Engineers in the Classroom middle school program, as experienced by the engineers that implemented them and the students and teachers that participated in their sessions.

## Evaluation goals

The Study 1 summative evaluation examined general audience members' experience with *Mysteries of the Unseen World* when they self-selected to view the film in a giant screen theater located in a U.S. science center. The evaluation centered on five key questions based on direction provided by National Geographic relating to the film's goals and consultation of the following materials for context and further specification: the film and script, the project's original NSF proposal, the evaluation team's original and revised summative evaluation plan, the project's Impact and Indicator statements submitted to the NSF, the formative evaluation reports on the film's rough cuts completed by Multimedia Research in 2012, and Knight Williams' prior summative evaluations focused on general audiences' learning from giant screen films produced by National Geographic. The five key questions were:

- 1) How appealing and engaging did Viewers find the film?
- 2) Did Viewers find the film content to be clearly presented?
- 3) What did Viewers learn from viewing the film?
- 4) Did viewing the film impact Viewers' STEM interests and perceptions?
- 5) What was the film's motivational impact on Viewers within a few weeks of viewing?

These 5 questions were in turn operationalized into 5 impact areas, each with a corresponding set of indicators. Both the impacts and indicators are listed in the table on the following page.

## Study 1 *Mysteries of the Unseen World* general audience evaluation Impact areas and indicators

### 1) Appeal and engagement

- overall liking of film storytelling
- visual excitement
- content/topic appeal
- personal learning value
- likelihood to recommend

### 2) Clarity of presentation

- overall clarity of presentation
- pacing
- ease of following visually
- density of information and science
- level of science explanations

### 3) Knowledge acquisition

- personal learning value/what is salient for Viewers
- knowledge of the types of light waves that humans and other animals see
- knowledge of the technologies used to see and study things that humans can't see with normal vision
- knowledge of the discoveries scientists have been able to make about nature through new technologies
- knowledge of the things scientists can learn from nature to make innovative materials and devices
- knowledge of the properties and possibilities of the nanoscale

### 4) STEM interest and perceptions

- interest in film's STEM topics
- perceptions of the unseen world

### 5) Motivational impact

- motivation to follow-up on something related to the film or to try some exploration
- motivation to look into the STEM areas covered in the film

To assess the five areas of impact, the evaluation was conducted in four phases, as follows:

#### ▪ **Phase 1: On-site theater evaluation of the film's immediate appeal and learning value**

The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by Viewer performance on a post-viewing questionnaire, compared to the performance of a separate sample of Viewers asked to complete the same knowledge questions prior to seeing the film.

#### ▪ **Phase 2: Discussion group explorations of Viewers' connections with the film**

Immediately following four separate showings of the film, Knight Williams facilitated group discussions with Viewers who completed a post-viewing questionnaire in Phase 1 to allow for a more in-depth exploration of the film's immediate impact among family audiences.

#### ▪ **Phase 3: Follow-up evaluation of extended impact**

To understand the longer-term impact of the film on Viewers and whether and how they took actions related to the film a few weeks within viewing, a follow-up online questionnaire was sent via email to the Viewers who had indicated that they were willing to be contacted approximately 15-20 days after they viewed *Mysteries of the Unseen World*.

#### ▪ **Phase 4: Site documentation**

To provide context for the evaluation work conducted in Phases 1-3, the evaluation team worked collaboratively with staff from the two participating science centers to document the ways in which the film was promoted and exhibited. The team used secondary data (e.g., program flyers, event pictures, and promotional plans) made available by the science centers/theaters.



# Report outline

The Study 1 findings are presented in four sections, based on the four phases of the evaluation. Each section addresses a series of questions relating to the respective phase of the evaluation. Phase 1 addresses four questions, Phase 2 addresses six questions, Phase 3 addresses six questions, and Phase 4 addresses two sections (rather than questions), as follows:

## **Phase 1: On-site theater evaluation of the film's immediate appeal and learning value**

- Question 1: How appealing and engaging did Viewers find the film?
- Question 2: Did Viewers find the film content to be clearly presented?
- Question 3: What did Viewers learn from the film?
- Question 4: How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?

## **Phase 2: Discussion group explorations of Viewers' connections with the film**

- Question 1: Who in the family drove the decision to see the film and why?
- Question 2: How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?
- Question 3: What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?
- Question 4: How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?
- Question 5: How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film?
- Question 6: Did Viewers have any other feedback on the film that they would like to share?

## **Phase 3: Follow-up evaluation of extended impact**

- Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?
- Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?
- Question 3: Did the film change how Viewers think or feel about science or technology?
- Question 4: Did Viewers "see" the world differently a few weeks after watching the film?
- Question 5: What activities did Viewers do within a few weeks of watching the film?
- Question 6: What additional feedback did Viewers share a few weeks after watching the film?

## **Phase 4: Site documentation**

- Lawrence Hall of Science in Berkeley, CA
- Discovery Place in Charlotte, NC

## Labels used in reporting on film sections

In *Mysteries of the Unseen World*'s opening sequence, narrator Forrest Whitaker describes the four main sections of the film, saying: "Imagine if for one day we could see what [the family and their friends] can't... all that's too slow, too fast, too small, or simply invisible." Replicating the structure of *Mysteries of the Unseen World*, which also used animated title cards to highlight the four main sections of the film, the following four labels are used throughout this evaluation:

- *Invisible*: The part of the film focused on the electromagnetic spectrum and other animals' ways of seeing, among other topics.
- *Too Slow*: The part of the film focused on things that happen too slowly for us to see, such as decomposition and plant growth, among other topics.
- *Too Fast*: The part of the film focused on things that happen too quickly for us to see, such as lightning strikes and dragonfly flight patterns, among other topics.
- *Too Small*: The part of the film focused on things that are too small for us to see, including butterfly scales, spider silk, and the nanoworld, among other topics.

# Phase 1: On-site theater evaluation of the film's immediate appeal and learning value

## Method

The evaluation focused on adult and youth who self-selected to view *Mysteries of the Unseen World* at the Lawrence Hall of Science during the last week of May 2015 and Discovery Place during the first week of August 2015. The evaluation team conducted the Phase 1 portion of the evaluation at the theater site during weekday and weekend showings of the film to help ensure the evaluation recruited a balance of participants who visited the theater at different days and times. The questionnaire portion of the evaluation was based on a separate-sample pre-test/post-test design and occurred at the theater site as follows:<sup>2</sup>

- i. Evaluators approached all eligible adult and family theater visitors about the evaluation opportunity as they stood in line to view the film.<sup>3</sup> Approximately half of these visitors were asked to complete a pre-viewing questionnaire before seeing the film, and half were asked to complete a post-viewing questionnaire following the film.<sup>4</sup> <sup>5</sup> Parent/guardian permission was obtained prior to youths completing questionnaires. Evaluators directed participants to the instructions at the top of the questionnaire which asked them to complete all questions and to do so without the help of others. They were reminded that participation in the evaluation was voluntary, informed that their responses were confidential, and thanked for their feedback.
- ii. Visitors who completed a pre-viewing questionnaire served as a comparison group for the evaluation. These visitors (hereafter called “Pre-Viewers”) typically completed the questionnaire using a clipboard provided by the evaluators while standing in line, although some participants chose to complete the questionnaire sitting on a bench or chairs situated near the theater entrance. The pre-viewing questionnaire included demographic and background questions about

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<sup>2</sup> A brief explanation of the rationale for choosing this quasi-experimental design for evaluating giant screen films in a theater setting design choice follows: First, when selecting among possible evaluation designs, it is important to ask: To what population do we want to generalize? Giant screen films such as *Mysteries of the Unseen World* represent an informal science education and entertainment media currently featured in science centers and commercial theaters possessing giant screen format capacity. The population to which we want to generalize is self-selected visitors who choose to view such a film. Therefore, this evaluation focuses on visitors who choose to view *Mysteries of the Unseen World* on their own accord (naturalistic Viewers). Since it is essentially impossible to locate an equivalent control group of visitors from whom the film is withheld, the most appropriate control group is a sample of visitors who intend to view the film but have yet to do so. Administering a pretest and posttest to the same group of visitors may seem like an attractive alternative, but this is neither a) practical given the challenges of obtaining visitor cooperation, nor b) desirable as the pretest would sensitize visitors to the film's content, and hence affect their posttest performance. Typically, the shortcomings with the separate-sample pretest/posttest design involve its failure to control for history, maturation, mortality and their interaction. However, in the case of the giant screen film treatment, where the viewing audience is essentially stationary for close to forty minutes, group changes of this nature are unlikely. The separate-sample design controls for the main and interactive effects of testing and, is overall, an effective approach for evaluating giant screen films in a natural theater setting.

<sup>3</sup> Individuals who weren't eligible included: unaccompanied children, adults accompanied by children below the age of 5, and individuals that were part of a tour or organized trip.

<sup>4</sup> The evaluators over-sampled the number of Viewers recruited to complete a post-viewing questionnaire to ensure a sufficient number of participants in the viewing group given the uncertain attendance rate of each show and the possibility of family groups having to opt out of the evaluation after viewing the film due to unforeseen factors that might arise (e.g., children in need of food, naps, or other caretaking, having to meet up with other members of a group).

<sup>5</sup> Completion time varied roughly between 5-10 minutes for the pre-viewing questionnaire and 8-15 minutes for the post-questionnaire depending on respondents' thoroughness.

visitors' age, gender, ethnicity/race, educational level, number of giant screen films seen, and included a short knowledge assessment of content covered in the film.

- iii. Visitors who agreed to complete a post-viewing questionnaire (hereafter called "Viewers") were asked to complete the questionnaire immediately following the film, either in their seats in the theater, outside the theater where benches or chairs were available, or at a table set up near the exit doors of the theater. The post version of the questionnaire included the same demographic, background, and film content questions asked in the pre-viewing questionnaire, as well as questions that asked for Viewers' reactions to the film with respect to appeal, entertainment value, clarity, information and science density, and learning value.
- iv. Upon completion of either survey, evaluation participants were given a \$5 gift certificate to the science center gift store.

The evaluation team identified the above set of evaluation themes and procedures by: reviewing the project proposal submitted to the National Science Foundation, consulting with the project team, reviewing the film script, reviewing the formative evaluation studies on the film, and viewing the film in an IMAX theater setting and on DVD. Pilot testing of the evaluation instruments was conducted prior to the site evaluation with both adult and youth giant screen film Viewers for readability, length, clarity, and level of difficulty.

## **Questionnaire development**

The two questionnaires referenced above (pre-viewing and post-viewing) were developed through an iterative process that involved collaborating with the project team, revisiting the project goals and original NSF proposal, and reviewing the script and film. The evaluation team also relied on piloting the content learning questions with middle school youth and adults since it was not possible to use established or validated measures for the evaluation given the specific nature of the content covered and the lack of prior evaluation work or research on giant screen films, or other films for that matter, on topics covered in the film as experienced by general audiences. The content assessment items were reviewed for readability, length, clarity, and for feedback on the level of difficulty.

Other items in the questionnaires, including those relating to demographic factors, appeal and engagement, clarity of presentation, and motivational impact, have been used in several past evaluations of giant screen films by Knight Williams and also by Multimedia Research. Although items have been modified depending on the needs of the particular evaluation, questions relating to the appeal/engagement and clarity of presentation impact areas have been cooperatively used by Multimedia Research initially, Knight Williams, and Edumetrics in the interest of creating a body of film evaluations that can be compared (Flagg, 2005).<sup>6</sup> Additional information about the questions used for each impact area listed is described within the respective sections under Findings.

## **Data analysis and reporting**

Statistical analyses were conducted on all quantitative data generated from the evaluation. To explore for possible significant differences within and between the Viewer and Pre-Viewer groups, t-tests, Chi-Square,

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<sup>6</sup> Flagg, B. (2005). Beyond entertainment: Educational impact of films and companion materials. *Big Frame*, 22(2), 50-56.

Kruskal-Wallis, and Mann-Whitney tests were applied as appropriate.<sup>7</sup> Statistically significant findings (hereafter referred to as “significant”) at  $p \leq .05$  are reported in the text. All statistical tests were two-tailed unless otherwise indicated.<sup>8</sup> Interquartile range (IQR) is provided in reporting of non-parametric tests.

To help determine whether a significant difference was a difference of practical concern, effect sizes were also computed and reported in the text where appropriate.<sup>9</sup> <sup>10</sup> As noted by Tahlheimer and Cook (2002), “*Whereas statistical tests of significance tell us the likelihood that experimental results differ from chance expectations, effect-size measurements tell us the relative magnitude of the experiment treatment. They tell us the size of the experimental effect.*”<sup>11</sup> Effect sizes are important to report, particularly when sample sizes are sufficiently large, as it is possible to produce statistically significant differences between groups when the size of the effect is in fact very small. The effect size helps us to interpret whether the difference observed is a difference of practical significance, in other words, a difference that matters. To help with this interpretation, effect sizes are reported in the text where appropriate. Following Cohen’s interpretation (Cohen, 1992), .2 is indicative of a small effect, .5 a medium effect, and .8 a large effect.<sup>12</sup> At the same time, while Cohen’s accepted values are used to help gauge the effect sizes computed for the knowledge questions in Phase 1, these values should also be interpreted along with a comparison of the actual difference in raw scores in the context of the topic addressed.

Demographic and background variables used in the subgroup analyses included: gender, number of IMAX films viewed, educational level, and theater/location. For subgroup analyses involving number of IMAX films viewed, the following category divisions were made (0-2 films vs. 3 or more films). Given the relatively small number of participants in each of the separate racial/ethnic groups represented, results related to this demographic factor were not explored. Note, however, that the percentage of minorities participating in the *Mysteries of the Unseen World* evaluation was higher than the percentage of minorities traditionally found among giant screen audiences (see table on the next page for further breakdown). According to a 2004 Taylor Nelson Sofres Intersearch research study sponsored by the Giant Screen Theater Association (GSTA) and conducted at 44 institutional theaters and 5 commercial theaters in 11 countries, less than one-tenth of the typical viewing market is minority.<sup>13</sup>

Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the film’s objectives, and inductive, by looking for overall themes, keywords, and key phrases. The Viewers’ responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder. The analyses on the content learning questions were coded as randomly ordered responses.

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<sup>7</sup> When examining subgroups with two categories (e.g., gender) using the two-independent-samples t-test, Levene’s test was first used to determine whether the separate-variance t-test or pooled-variance t-test was appropriate for testing the means of the measured variables. If the test indicated the variances were significantly different, the separate-variance t-test was used.

<sup>8</sup> Where appropriate, for example, after multiple post-hoc comparisons using Mann-Whitney tests following the use of Kruskal-Wallis, a Bonferroni correction was used to adjust the *P* value.

<sup>9</sup> Following Cohen’s (1992) interpretation, for t-tests  $d = .2$  indicates a small effect, .5 a medium effect, and .8 a large effect. For non-parametric tests,  $r = .10$  indicates a small effect, .3 a medium effect, and .50 a large effect.

<sup>10</sup> Cohen, J. (1992). A Power Primer. *Psychological Bulletin*, 112 (1), 155-159.

<sup>11</sup> Thalheimer, W. and Cook, S. (2002). How to calculate effect sizes from published research: A simplified methodology, *Work-Learning Research*, p. 2.

<sup>12</sup> Cohen, J. (1992). A Power Primer. *Psychological Bulletin*, 112 (1), pps. 155-159.

<sup>13</sup> Kennedy, M.K., (2004), GSTA’s 2003 Worldwide Viewers and Nonviewer Research Programs: Key Results and how to use them, *The Big Frame*, Winter, pps. 40-59.

## Sample information

A total of 450 adults and youth participated in the evaluation. From this total, 229 Viewers and 221 Pre-Viewers completed questionnaires that subsequently formed the basis for this evaluation report. The table below summarizes the demographic and background information for both groups.

<b>Sample demographic and background information (N=450)</b>			
<b>Demographic/ background factor</b>	<b>Categories</b>	<b>Pre-Viewers (n=221)</b>	<b>Viewers (n=229)</b>
<b>Gender</b>	Female	52%	58%
	Male	47%	42%
<b>Age Group</b>	Age range	7-78	8-76
	Mean	32	35
	18 and below	30%	23%
	19 - 40	36%	39%
	41 and above	34%	38%
<b>Racial/Ethnic Group</b>	African-American/Black	13%	11%
	Asian	9%	17%
	Native American Indian or Alaskan Native	1%	1%
	Native Hawaiian or Pacific Islander	0%	0%
	White	70%	58%
	Multiracial	2%	5%
	Other	3%	6%
	Non-response Hispanic	1%	3%
	Hispanic Origin	11%	11%
<b>Highest level of education</b>	Less than high school	29%	18%
	Completed high school or equivalent	6%	5%
	Some college but no degree	17%	15%
	College graduate	24%	28%
	Some graduate school but no degree	1%	4%
	Completed graduate school	24%	28%
<b>Number of giant screen films viewed</b>	0	11%	15%
	1-2	33%	29%
	3-4	19%	20%
	5 or more	36%	35%

### Participation by site

Of the 229 Viewers that completed a post-viewing questionnaire, 72 saw the film at the Lawrence Hall of Science and 157 saw the film at Discovery Place. Among the 221 Pre-Viewers that completed a pre-viewing questionnaire, 73 saw the film at the Lawrence Hall of Science and 148 saw the film at Discovery Place.

### Group comparability

The evaluation gathered demographic and background information to determine whether the two independent samples (Viewers vs. Pre-Viewers) should be evaluated as having come from the same population. Chi-square analyses indicated that the two groups did not differ significantly with respect to 3 of the 5 measured variables, including: gender, age group, and number of giant screen films viewed. Differences were found for race and

education, however, such that the Viewing group included a significantly higher percentage of minority respondents and respondents with a higher level of education than did the Pre-Viewing group.<sup>14</sup> The demographics and background information for the Pre-Viewing group is provided in the table on the previous page. The Viewer portion of the sample included:

- ▶ Somewhat more females (58%) than males (42%).
- ▶ A wide range of ages, spanning 8-76 years, with a mean age of 35.
- ▶ A racial distribution comprising 58% White, 17% Asian, 11% African-American, 1% Native American or Alaskan Native, 5% multiracial, and 6% Other Viewers. About one-tenth of the participants (11%) were of Hispanic Origin.
- ▶ A combination of high school through graduate level educated respondents, including: 23% with a high school education or less (includes youth Viewers), 43% with some college education or a college degree, and 32% with some graduate school education or a graduate degree.
- ▶ A combination of frequent vs. occasional Viewers of giant screen films, including 44% who reported they had seen only 0-2 films prior to seeing *Mysteries of the Unseen World* and 55% who reported they had seen 3 or more films (see table for further breakdown).

## Response rate and missing data

### Response rate

Using the separate sample design, the evaluation team has in some prior evaluations of giant screen films been able to calculate or estimate a response rate by dividing the number of questionnaires accepted for analysis by the number of visitors from whom the evaluators requested to complete a questionnaire, which includes all those who enter the theater and met the eligibility requirements described under Method. In those cases evaluators were able to monitor the number of questionnaire requests at most shows as visitors typically streamed into the theater site over a period of 10-30 minutes prior to the show. However, at Discovery Place in the current evaluation large crowds of visitors arrived at the theater at roughly the same time for some show times, which didn't permit accurate tracking of the number of requests. Where possible evaluators did attempt to record reasons for not completing the questionnaire, which included: not having time, tending to children's needs, lack of interest, wanting to eat lunch, having to meet other members of a group, or having parking meter time restrictions at the science center. Where evaluators encountered blank questions, they asked respondents if they wished to complete those questions. In each case left blank the respondent indicated they didn't know or had no response.

### Missing data

The initial dataset included 456 participants; 221 in the Pre-Viewer group and 235 in the Viewer group. Six questionnaires from the Viewer group were removed for being substantially incomplete (i.e., missing responses to more than one of the categorical variables, for example gender or education, or more than 10% of the remaining variables). Of the final dataset of 221 Pre-Viewers and 229 Viewers, the percentage of missingness on each variable ranged from none to 1.3%. A non-significant Little's MCAR test, (117)  $\chi^2 = 135$ ,  $p = .13$ , indicates that the data are missing completely at random (Little, 1988).<sup>15</sup> As the dataset was assumed to include MCAR data with relatively minimal missing observations (<5%), missing items were imputed using the expectation maximization method.

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<sup>14</sup> Race ( $\chi^2 = 7.78$ ,  $df=1$ ,  $p = .005$ ); Education ( $\chi^2 = 14.28$ ,  $df = 5$ ,  $p = .014$ )

<sup>15</sup> Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83(404), 1198-1202

# Findings

## Question 1: How appealing and engaging did Viewers find the film?

To assess the film's overall appeal, Viewers were asked to rate how much they liked *Mysteries of the Unseen World* and to rate the film's entertainment value with respect to visual excitement and impact on curiosity. They were also asked to rate their engagement with the film's storyline and their likelihood of recommending the film to others. Finally, they were asked to describe what they liked and didn't like about the film. These findings are presented below in 1.1 through 1.3.

### 1.1 How did Viewers rate the film in terms of overall likeability, visual excitement, impact on curiosity, interest in the story, and likelihood of recommending the film?

**Overall, Viewers indicated that they liked *Mysteries of the Unseen World*. They generally found the film visually exciting, reported that it increased their curiosity about things they can't see with their own eyes, and said they found the film's story interesting. Finally, they expected that they were likely to recommend the film to others.**

Viewers were asked to rate *Mysteries of the Unseen World* for the extent to which they liked the film, found it visually exciting or dull, felt it increased or decreased their curiosity about things they can't see with their own eyes, found the film's story boring or interesting, and were likely to recommend the film to others on a scale from 1.0 (rated the lowest) to 7.0 (rated the highest) in each case. The table on the following page presents the percentages of Viewers selecting each rating. Though there were some differences of opinion, as evidenced by each range of ratings in each case, Viewers generally liked *Mysteries of the Unseen World* (median rating 7.0), found it visually exciting (median rating 7.0), indicated that the film increased their curiosity about things they can't see with their own eyes (median rating 7.0), thought the film's story was interesting (median rating 7.0), and said they were likely recommend the film to others (median rating 7.0).

Mann-Whitney tests indicated a few subgroup differences, as follows. Compared to Viewers aged 19-40, Viewers 41 years and older gave significantly higher ratings to their overall liking of the program (median 7.0 IQR = 0 vs. median 7.0 IQR = 1)<sup>16</sup>, the program's storytelling (median 7.0 IQR = 1 vs. median 6.0 IQR = 1),<sup>17</sup> level of visual excitement (median 7.0 IQR = 0 vs. median 7.0 IQR = 1)<sup>18</sup>, their likelihood of recommending the program (median 7.0 IQR = 0 vs. median 7.0 IQR = 1)<sup>19</sup>, and their level of curiosity about things they can't see

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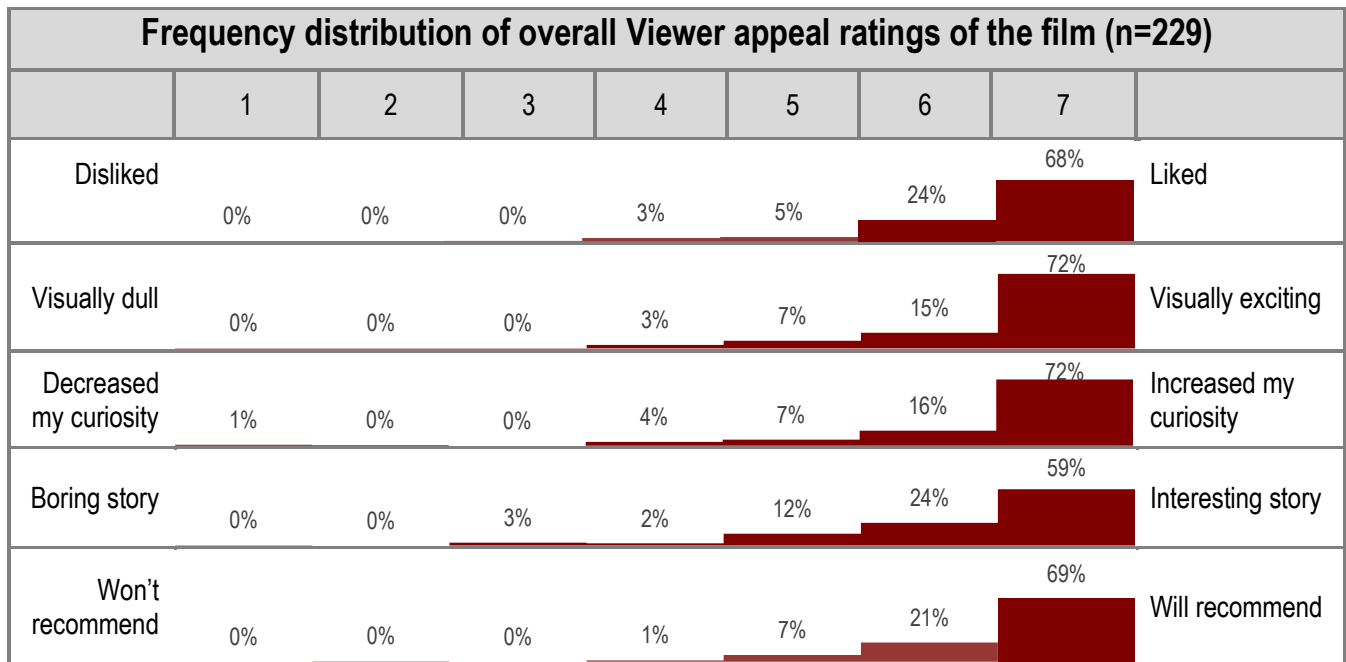
<sup>16</sup> ( $U = 3218, p = .014, r = .18$ )

<sup>17</sup> ( $U = 3040, p = .005, r = .21$ )

<sup>18</sup> ( $U = 3208, p = .011, r = .19$ )

<sup>19</sup> ( $U = 2940, p = .001, r = .26$ )





with their own eyes (median 7.0 IQR = 0 vs. median 7.0 IQR = 1).<sup>20 21</sup> The effect sizes in each case were considered small effects (see footnotes for r values). Similarly, compared to youth Viewers aged 7-18, Viewers 41 years and older gave significantly higher ratings to two items, their overall liking of the film (median 7.0 IQR = 0 vs. median 7.0 IQR = 1)<sup>22</sup> and the film's overall clarity (median 7.0 IQR = 1 vs. median 7.0 IQR = 1).<sup>23</sup> The effect sizes in each case were again considered small effects. In addition, Mann-Whitney tests found that females rated their curiosity about things they can't see with their own eyes significantly higher than did males (median 7.0 IQR = 0 vs. median 7.0 IQR = 1), though here again, the effect size was small.<sup>24</sup>

When invited to elaborate, a number of Viewers shared additional feedback about their ratings. However, none of the Viewers commented on their interest in the story or the likelihood that they would recommend the film to others. Examples of their comments on the other ratings are shared below:

**Liked or disliked**

- *It was awesome! Beautifully done.*
- *Loved the organization of topics. Small things, big things etc.*
- *It was great captivating film but I would like more in depth information.*

**Visually exciting or dull**

- *Visually stimulating*
- *Great animations and visuals, strengthened by smooth transitions.*

**Increased or decreased curiosity about things I can't see with my own eyes**

- *Increased my curiosity of the unseen world.*
- *It definitely interested me to explore and wondered about God's miracles.*

<sup>20</sup> (U = 3079, p = .003, r = .23)

<sup>21</sup> To address possible increase in Type 1 errors, a Bonferroni correction was made with alpha of  $p \leq .017$

<sup>22</sup> (U = 1685, p = .001, r = .28)

<sup>23</sup> (U = 1670, p = .002, r = .26)

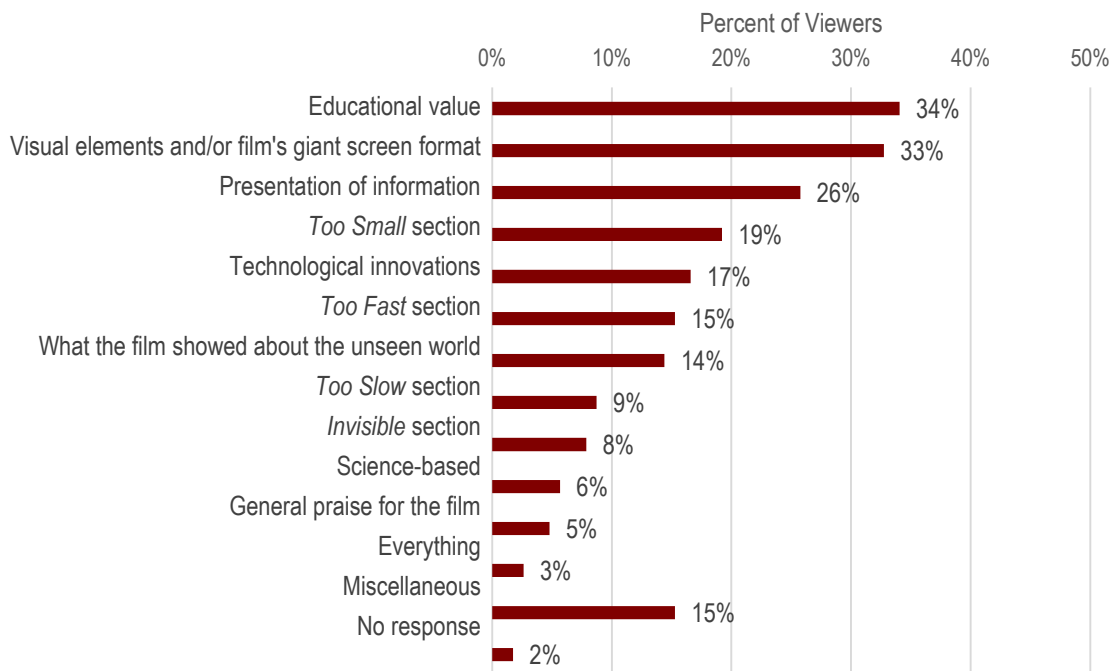
<sup>24</sup> (U = 5118, p = .001, r = .22)

## 1.2 What did Viewers liked most about the film?

Almost all of the Viewers identified at least one aspect of *Mysteries of the Unseen World* that they found appealing, with many mentioning two or more elements. The Viewers were especially enthusiastic about the film's overall educational value, the visual aspects of the giant screen experience, and the film's presentation of information.

When asked to describe what they liked most about *Mysteries of the Unseen World*, almost all (98%) of the Viewers identified at least one thing about the film that they found appealing, with many citing two or more elements. The chart below shows aspects of the film Viewers said they most frequently liked and the percentage of Viewers offering each response.

What Viewers liked about the film (n=229)



As shown in the chart above, about one-third of Viewers commented on the educational value of the film (34%), explaining that they learned a lot, enjoyed learning, and/or found something interesting. At the same time, a third of Viewers shared positive feedback about the film's visual elements (33%) – which some described as “beautiful,” “colorful,” and “incredible” – as well as the film's giant screen format. Around a quarter of Viewers said they liked one or more things about the film's presentation of information (26%), including the pacing, narration, examples provided, and overall structure, among other elements. Just under a fifth most liked something in the *Too Small* section (19%), including the film's discussion of the nanoscale.

Just over one-sixth indicated that they liked something they learned about past and future technological innovations (17%), while less than one-sixth each liked something in the *Too Fast* section (15%) and/or something the film showed them about the unseen world (14%). Less than one-tenth each liked something in

the *Too Slow* section (9%) and/or the *Invisible* section (8%). A slightly smaller group explained that they liked that the film was science-based (6%), and a handful each shared general praise (5%) or indicated that they liked everything about the film (3%). Finally, less than a sixth of Viewers shared miscellaneous responses (15%), and a handful declined to answer the question (2%).

Examples of Viewers' comments on these themes follow below:

**Overall educational value (34%)**

- *Learned so much. Felt like a real scientist! Had so many questions coming out of it.*
- *I liked the film because I am nine years old and it is good for me to learn these skills and the true things about my body.*
- *There were many things I didn't know about, I liked the first part, very interesting for my grandson who is six. He learned a lot of things he had no idea about.*
- *Informative, knowledgeable*
- *Educational; Palatable for all ages*
- *One gains an understanding of the true nature of light.*
- *Learning about the things we can't see.*
- *I learned so many things about my body and the world*
- *Insightful...thought provoking*
- *Ideas...made me want to learn more...*
- *Makes me want to research deeper.*
- *Very interesting, opened my eyes to things I never thought about.*
- *A lot of interesting information that I didn't know before.*
- *Different ages will find subjects of interest in the film.*

**The film's visual elements (33%)**

- *The visuals, color, composition, photography, and macro effects were spectacular.*
- *Colors-especially butterflies, the scene with glass and loved the water drops. Pitcher of milk was beautiful.*
- *I also liked how visually stimulating it was, it made it more interesting how colorful it was.*
- *Cinematography*
- *Visuals...photography amazing*
- *Everything was very well shot. Very beautiful photography! Especially slow and fast motion.*
- *Beautifully made, nice visuals*
- *Incredible images*
- *Visual effects and good quality imagery.*
- *The visuals were amazing...Good incorporation of camera modes and shots and different kinds of photography.*
- *I liked how it was filmed. I like how it's in 3D.*
- *The sensation of movement.*
- *I like when things came out at us.*
- *Visually powerful, IMAX format.*

**Presentation of information (26%)**

- *Perfect timing*
- *It moved along at a good pace*
- *The flow from one topic to the next.*
- *Variety of data. Narration. Multiplicity of examples.*
- *The topics. The narration. The correlation to my personal life.*
- *Clear structure and points*
- *Loved the simple explanations for the eight-year-old daughter.*
- *The way things were explained.*

- *I liked how it categorized things, it made it easier to follow.*
- *Putting everything in context of a clear scene (nice transitions from daily life to other views).*
- *I liked the examples that they used from on everyday. I could relate to them.*
- *I think the most exciting part was that the stories were the things are always around us. For instance it wasn't something that's happening inside forests or deep in the sea. This helps us to pay more attention to around us.*
- *I liked the clear visuals and how for many things it keeps going more deep and deeper...I like how it's examples relate to every one's living.*
- *Shining revelations of everyday experiences.*
- *The film used everyday objects and living things that we can relate to easily to explain the scientific concepts.*
- *I like the overall structure of what we see, than too fast or too slow or too small.*
- *The main topic break up and organization very informational and simple enough for all ages to follow.*

**Too Small section, including the nanoscale (19%)**

- *The nano- "too small to see" section.*
- *Things we see in nano, Tiny insects.*
- *Showing kids about bugs you can't see to reinforce cleaning himself.*
- *Spiders web, mites on eyelashes.*
- *Animals like spiders and their strength of the material*
- *We loved the electron microscopy.*
- *Space matter we breathe in.*
- *Cosmic dust.*

**Technological innovations, past and future (17%)**

- *I saw tech I didn't know existed.*
- *It really uncovered areas that I haven't thought about as being more than sci-fi.*
- *Various types of ways to view the unseen (Camera, microscopes)*
- *Using things in nature for scientific purpose on the future*
- *Use of new technology to mimic natures motions...how nature can be used to advance technology.*
- *I liked how technology can detect different speeds that we are unable to detect. And it shows how the nanoworld and the rest of nature inspires technology.*
- *Future applications (dragonfly-bot and space elevator).*
- *Nanotechnology...dragonfly, gecko and dragonfly robots.*
- *We can move atoms*
- *Being able to learn what nano bots can do...Learn about the things we can create.*
- *Nano science as the new frontier. Advancements in medical science.*
- *Space elevator*

**Too Fast section (15%)**

- *I liked the slow motions.*
- *Everything was very well shot. Very beautiful photography! Especially slow and fast motion.*
- *My favorite was the dragonfly and how its wings can move in different directions.*
- *The wings of the dragonfly.*
- *Slow motion to understand insects*
- *Amazing revelation of the slow motion segment. (ex: water drop etc.)*
- *Water drops bouncing.*
- *Water drops, shattering glass, rattlesnake strike!*
- *Rattlesnake...fast things*
- *I love the lightning*

**Something the film showed them about the unseen world (14%)**

- *Saw things I literally could not imagine.*

- *Appreciated the look into nature of things we don't normally get to see.*
- *I liked that you got to see things that you wouldn't see with your eyes.*
- *It showed all of things that are around us that we can't see, which is fascinating.*
- *It's possible to see the "unseen"*
- *Seeing things move slowly and fast.*
- *Too small, liked the different things they showed.*
- *To see invisible things.*

**Too Slow section (9%)**

- *Time-lapse photography, slow motion.*
- *Everything was very well shot. Very beautiful photography! Especially slow and fast motion.*
- *The flowers that bloomed out.*
- *Flower growth*
- *Loved the flowers blooming.*

**Invisible section (8%)**

- *I liked how when it showed invisible light*
- *The light spectrum in the beginning.*
- *One gains an understanding of the true nature of light.*
- *I particularly enjoyed the section on gamma rays.*
- *Visually diagram of the spectrums (visually and invisible). Gave perception from other organisms.*
- *How bees collect pollen*

**Science-based (6%)**

- *Complex science*
- *Science-based*
- *Whole new view of how science is evolving.*
- *Broke down a lot of the science behind it.*
- *I like anything that is science related.*

**General praise for the film (5%)**

- *Great overall*
- *It is a wow.*
- *Cool, exciting*
- *The production of the film was fantastic.*

**Everything (3%)**

- *Everything was great, perfect timing, interesting all the time.*
- *I liked every single thing about it.*

**Miscellaneous (15%)**

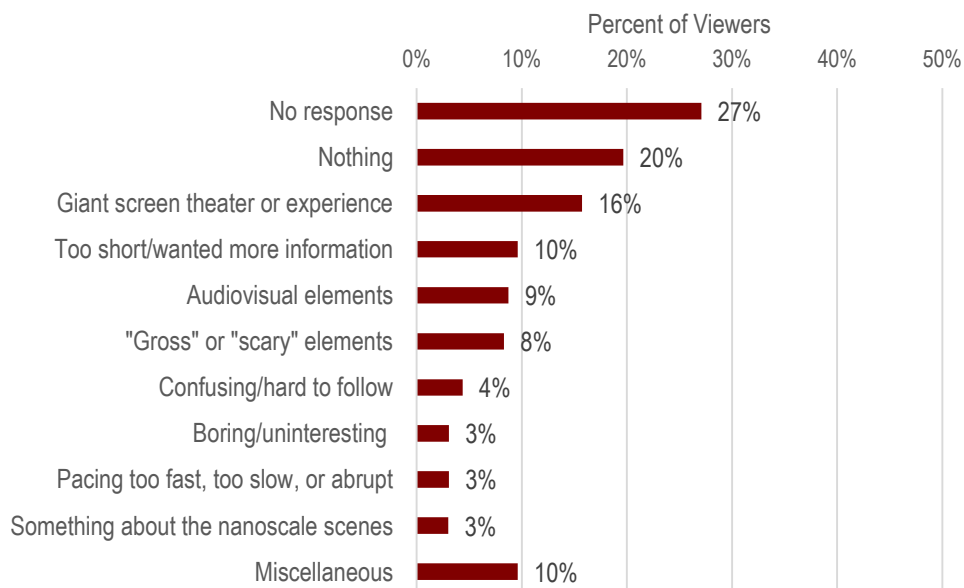
- *Music good*
- *Sound effects*
- *Good length-not too long or too short.*
- *Also, the use of a diverse cast.*
- *Different perspective from school and media.*
- *That lives and culture can change for the better with knowledge of the unknown.*
- *Would like to see more about the human body.*
- *Makes you think and appreciate life.*

### 1.3 What did Viewers not like about the film?

When asked what they disliked about the film, the largest groups of Viewers declined to answer the question or explained that there wasn't anything they disliked. Of those who pointed to aspects they did not like, Viewers most often commented on the giant screen theater or experience, said they thought the film was too short or that they wanted more information, and/or criticized one or more of the film's audiovisual elements.

Viewers were asked to describe what, if anything, they did not like about *Mysteries of the Unseen World*. The chart below shows the aspects of the film Viewers most frequently said they disliked and the percentage of Viewers citing each element.

What Viewers disliked about the film (n=229)



As shown in the chart above, the largest groups of Viewers indicated that they liked everything about the film, with more than one-quarter declining to answer the question (27%) and a fifth explaining that there wasn't anything they disliked (20%). About a sixth disliked something about the giant screen theater or experience (16%), with some criticizing the size or layout of the theater and others explaining that the viewing experience made them "dizzy" or "nauseous." A tenth thought *Mysteries of the Unseen World* was too short and/or said they would have liked more information (10%). Just under a tenth disliked something about the film's audiovisuals elements (9%), including the music, the narrator/narration, and/or the imagery in general. At the same time, a slightly smaller group pointed to "gross" or "scary" elements in the film (8%), such as the decomposing rat, what they learned in the *Too Small* section, and the scenes with the snake and the owl.

Less than a tenth each found something about *Mysteries of the Unseen World* confusing or hard to follow (4%), indicated that the film was boring or uninteresting (3%), noted that they didn't like the pacing (3%), and/or explained that they disliked something about the nanoscale scenes (3%). Finally, a tenth shared miscellaneous

comments (10%), including Viewers who thought the film was too long or contained too much information, thought it was too dramatic, disliked something about the film's focus on technology, and/or were already familiar with the material, among other responses.

Examples of Viewers' comments on these themes follow below:

**Nothing (20%)**

- *There is nothing I disliked.*
- *I liked everything and wanted the movie to continue.*
- *It was amazing.*
- *I completely enjoyed it.*
- *I thought the film was extremely well done.*

**Giant screen theater or experience (16%)**

- *The screen was too big, it looked like it was too close to my face.*
- *Seating arrangement.*
- *The visuals felt nauseating, but I have a weak stomach when it comes to movement and sound.*
- *Motion at time distracting.*
- *Too much "roller coaster" movement made me dizzy.*
- *Larger screen would be nice.*
- *Little dizzy*
- *The motion blur made for a bit of dizziness.*
- *Needs epileptic warning.*
- *The picture moved too quickly at some points for those who have motion sickness.*
- *It took me some time to focus on the screen but that was IMAX not the film itself.*
- *The IMAX concept took me a little while to absorb-at first, I felt a little sick.*
- *The film seemed to be a little out of focus or blurry. Maybe the IMAX film in general. This is the first one I have seen.*

**Too short/wanted more information (10%)**

- *I wanted to hear more about some aspects of the film that were presented. Could be a little longer to do that.*
- *Not deep enough, more like introduction.*
- *Short, some parts too brief.*
- *Too short in some sections. Lots of content to explore (cancer eating machines.)*
- *Could have used this stimulating opportunity to convey more detail and related back to academics for kids.*
- *Somewhat basic, but it's aimed towards kids so I definitely understand.*
- *I wish there was a little more explaining about the nanotechnology they referred to at the end.*
- *Very limited time spent on each subject.*
- *Could have been more in depth and explained more.*
- *Category: Too small/slow/fast was good but would be interesting to have more categories. More items related to plants but need some more items related to humans.*
- *I didn't like the way it didn't answer all of my questions.*

**The film's audiovisual elements (9%)**

- *Music can be better, not good for three-year-old (loud and scary).*
- *Music a little too dramatic.*
- *The narrator was too loud.*
- *It was interesting but I almost went to sleep because of the talking.*
- *The voice was too monotonous, voice needs more life; more excitement.*
- *li didn't like the speaker's sound at the end. I think the speaker at the beginning of the film had a much better voice.*
- *The representation of waves in 2D.*

- Some of the visuals weren't very pleasing.
- Sometimes it is difficult to follow video with audio.
- A little slow near the ending less visually attractive combined with dark room=sleepy.

**“Gross” or “scary” elements (8%)**

- My six year old found the decomposing mouse disturbing enough that he said he "didn't like the movie at all."
- Decomposition of the rat was gross.
- The skeletons
- Looking at insects, but that's just my own phobia.
- I didn't like when it mentioned what we breathe
- Gory details of the microorganisms on my body and in the air, but it generated interest too.
- It was a little scary when it talked about things too small.
- Creepy to see what is on our body
- It told me how there was gross insect in my hair.
- Image of the snake bite.
- Snake. Glad my thirteen year old was not watching with me. That 3D experience with snakes and spiders at age nine has made him 3D movie shy. Although the owl's flight was initially interesting. I became uncomfortable when it approached too close (and it's fiery eyes disturbed me).
- The owl was scary! (In a good way I think.)

**Confusing/hard to follow (4%)**

- I think that the "nano" section may be a little advanced for five and six year olds.
- It could be more understandable for juniors.
- It was easy for me to follow, hard on my son.
- Sometimes some information was not clear enough.
- I got kind of confused at points.
- Minimally, didn't necessarily get the connection between black/white-past-experiment to how it wasn't consistent with all themes.
- The parts about future technology-unclear if the developments are "dreams" or actual ideas.
- Confusing about what are possible future tech and what is currently in use/available.
- Sometimes it is visually hard to follow.

**Boring/uninteresting (3%)**

- The story was a bit boring.
- A little long. Plot slightly boring toward the end.
- Lost a little interest in the nanoworld.
- At times it was boring and need more action.
- It was a bit boring; needs to be more interesting to kids.

**Pacing too fast, too slow, or abrupt (3%)**

- I wish it could be a bit slower in some scenes.
- Felt rushed, wasn't much time to retain the knowledge before moving on.
- It was sometimes a little fast paced, but otherwise it explained a lot very clearly.
- A little slow near the ending less visually attractive combined with dark room=sleepy.
- Sometimes it was a bit abrupt.
- Scene transition

**Something about the nanoscale scenes (3%)**

- The concept of humans playing with nanotechnology makes me nervous because we don't really fully understand it and the room for error is great.
- Some of the topics went a bit too much like nanoworld level including music, too much drama.



- *Nanoworld point of view*
- *I think that the "nano" section may be a little advanced for five and six year olds.*
- *I wish there was a little more explaining about the nanotechnology they referred to at the end.*
- *Lost a little interest in the nanoworld.*
- *A little slow near the ending less visually attractive combined with dark room=sleepy.*
- *"Balls" in the nano section were less interesting than other parts*

**Miscellaneous (10%)**

- *I didn't like the too small portion of the film. It went into too much detail.*
- *A little long.*
- *Too technical.*
- *Not a matter of not liking as much as too much to take in.*
- *Some of the topics went a bit too much like nanoworld level including music, too much drama.*
- *Attempt to freak the audience out a bit.*
- *Propaganda that technology will save the world.*
- *Wasn't crazy about all of the robotic animal ideas.*
- *The parts about future technology-unclear if the developments are "dreams" or actual ideas.*
- *Incorporation of history, projections of future advancements*
- *Some of the information was known to me.*
- *Mostly stuff I already knew.*
- *Not great for kids under eight.*
- *There was not a lot of extra imagery that would explain the film.*
- *I think there could have been better organization than just the "too small" "too slow" etc.*
- *A little too Hollywood.*

## Question 2: Did Viewers find the film content to be clearly presented?

Viewers were asked to rate how successful they found the film in terms of overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations. These findings are presented below in 2.1 through 2.2.

### 2.1 How did Viewers feel about the film's overall clarity and the ease or difficulty of following the film visually?

In general, Viewers thought the film was clear and visually easy to follow.

Viewers rated *Mysteries of the Unseen World* for how they felt about the clarity of the film and for whether they found the film's visuals easy or hard to follow on a scale from 1.0 (lowest rating) to 7.0 (highest rating) in each case. The table below presents the percentages of Viewers selecting each rating.

Frequency distribution of Viewers' ratings of the film's overall clarity and visual clarity (n=229)								
	1	2	3	4	5	6	7	
Confusing	1%	0%	1%	3%	9%	29%	55%	Clear
Visually hard to follow	1%	1%	3%	3%	11%	24%	58%	Visually easy to follow

Though there were some differences of opinion, as evidenced by each range of ratings in the table above, Viewers generally found the film clear (median rating 7.0) and thought the visuals were easy to follow (median rating 7.0). Mann-Whitney tests did indicate one subgroup difference, as follows. More frequent viewers of IMAX films indicated that the film was visually easier to follow than did less frequent viewers (median 7.0, IQR = 1 vs. median 6.0, IQR = 1), though the effect size was small.<sup>25</sup>

A few Viewers shared additional feedback about their ratings, as follows.

#### **Found the film clear or confusing**

- *Informative; but not overly complex given the audience and time limitation.*

#### **Found the film's visuals easy or hard to follow**

- *Having never seen an IMAX, I had a hard time getting used to the visuals.*
- *Lower setting on visual clearness because movement was a bit uncomfortable at times. Probably a result of vision problems.*

<sup>25</sup> ( $U = 5397, p = .015, r = .16$ )

## 2.2 How did Viewers feel about the film’s pacing, amount of information and science, and level of scientific explanations?

Overall, Viewers thought *Mysteries of the Unseen World* was well paced and that the amount of information was about right. They also generally indicated that the amount of science and the level of scientific explanations were about right.

Viewers rated *Mysteries of the Unseen World* for how they felt about the pacing of the film, the amount of information in the film, and the amount of science and level of scientific explanations on a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being “just right” in each case. The table below presents the percentages of Viewers selecting each rating.

Frequency distribution of Viewers’ ratings of the film’s pacing, amount of information and science, and level of science explanations (n=229)								
	1	2	3	4	5	6	7	
Pace was too slow	0%	1%	4%	57%	26%	10%	1%	Pace was too fast
Too little information	0%	1%	11%	59%	17%	8%	3%	Too much information
Too little science	0%	3%	11%	62%	14%	7%	3%	Too much science
Scientific explanations too basic	0%	4%	14%	60%	16%	3%	2%	Scientific explanations too advanced

Though there were some differences of opinion, as evidenced by each range of ratings in the table above, Viewers generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were all about right (median rating 4.0 each).

Mann-Whitney tests also revealed a few subgroup differences, as follows. First, less frequent viewers of IMAX films rated the film’s amount of information, amount of science, and level of scientific explanations significantly higher than did more frequent viewers, though the effect sizes in each case were small (amount of information median 4.0, IQR = 1 vs. median 4.0, IQR = 0; amount of science median 4.0 IQR = 1 vs. median 4.0 IQR = 0; level of scientific explanations median 4.0 IQR = 1 vs. median 5.0 IQR = 0).<sup>26</sup> In addition, Mann-Whitney tests determined that females found the film’s scientific explanations significantly more advanced than did males (median 4.0 IQR = 0 vs. median 4.0 IQR = 1), although here again the effect size was small.<sup>27</sup>

<sup>26</sup> (amount of information:  $U = 5564$ ,  $p = .037$ ,  $r = .14$ ; amount of science  $U = 5391$ ,  $p = .012$ ,  $r = .17$ ; level of scientific explanations ( $U = 5363$ ,  $p = .011$ ,  $r = .17$ ))

<sup>27</sup> ( $U = 5428$ ,  $p = .025$ ,  $r = .15$ )

A number of Viewers shared additional feedback about their ratings, as follows.

***Pacing too fast or too slow***

- *This film pace seemed right.*
- *The video jumped around to lots of things but it was easy to follow.*
- *Pace too fast*
- *Visual sometimes too fast.*
- *Some frames (or type of image to another) too quick.*
- *Too visually moving, gave me dizzy feeling.*

***Too much or too little information***

- *Lots of info, could have watched entire one on one category.*
- *For a general overview to an audiences just right. More in depth for next film of each aspect.*
- *Hard to imagine that there are so many films out there using/featuring these science topics. Would love to see more.*
- *More in depth info*
- *Had to determine right amount but I could have used a bit more detail.*
- *This topic should be more in detail to comprehend.*
- *I wanted to know more!*
- *More information, follow up films or web-links, etc. after could provide more info.*

***Too little or too much science***

- *Would have enjoyed more of the science but the picture with the small amount of narration told the story. Maybe take it farther-talk about what scientist are doing currently with information learned from slow motion photography.*
- *Would have liked to have gotten more in-depth science info on the nano info.*
- *At times it felt too scientific or too over-explained.*

***Scientific explanations too basic or too advanced***

- *I feel the explanations were pretty much spot on. Just right.*
- *At times it felt too scientific or too over-explained.*
- *Some things I wanted more explanation but that [is] what it is meant to elicit though.*
- *Need time to comprehend what we see so a little explanation would help.*
- *Limited time to explain phenomenal physics.*
- *Could've been a bit longer to elaborate more.*
- *Would have likes some more scientific explanations in depth.*
- *Over the head of my years in many parts.*

## Question 3: What did Viewers learn from the film?

The learning value of *Mysteries of the Unseen World* was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, Viewers were asked to rate how much they thought they learned from *Mysteries of the Unseen World*. Second, they were invited to comment on the most interesting things they learned from the film. Third, they were asked to rate how much they thought they learned from the film about science and technology topics. Fourth, in order to assess knowledge gains relating to the content of the film, Viewers and Pre-Viewers both completed a 35 point “quiz” type assessment that included true/false, multiple choice, and short answer questions. These findings are presented below in 3.1 through 3.5.

### 3.1 How much did Viewers think they learned from the film?

**Overall, Viewers indicated that they thought they learned a lot from *Mysteries of the Unseen World*.**

Viewers rated *Mysteries of the Unseen World* for how much they thought they learned from the film on a scale of 1.0 (learned nothing) to 7.0 (learned a lot). The table below presents the percentage of Viewers selecting each rating.

Frequency distribution of Viewers' ratings of how much they thought they learned from the film (n=229)								
	1	2	3	4	5	6	7	
Learned nothing	0%	0%	1%	4%	13%	23%	59%	Learned a lot

Though there were some differences of opinion, as evidenced by the range of ratings in the table above, Viewers generally indicated that they thought they learned a lot from the film (median rating 7.0). Mann-Whitney tests did indicate one subgroup difference, as females rated their learning from the film significantly higher than did males (median 7.0 IQR = 1 vs. median 7.0 IQR = 2), though the effect size was small.<sup>28</sup> A few Viewers shared comments on their learning as follows.

- *The film was very informative and got a lot to learn from it.*
- *I got a lot out of it.*
- *I had my nine year old with me and I felt it was good education.*
- *I didn't realize so much was happening in front of me.*
- *Now it makes me look at things differently.*
- *It was great captivating film but I would like more in depth information.*
- *I knew some of the info in the film already as I am an avid Nat Geo fan.*

<sup>28</sup> ( $U = 5443, p = .028, r = .15$ )

### 3.2 What was the impact of the film on Viewers' self-perceived knowledge of the unseen world?

**Viewers who watched the film rated their knowledge of the unseen world significantly higher than Pre-Viewers who had not yet seen it.**

Viewers and Pre-Viewers were asked to estimate how much they knew about the unseen world on a scale of 1 (know nothing) to 7 (know a lot). The table below shows the median ratings for this simplified self-report measure, which specifically asked: *On a scale of 1 to 7, how much do you feel you know about the unseen world around you (e.g., things that are too small or happen too fast or slow for our human eyes to naturally see?)*. Viewers who had just seen the film rated their knowledge significantly higher than did Pre-Viewers (medians 5.0 vs. 3.0), and the effect size was large.<sup>29</sup>

<b>Median Viewer and Pre-Viewer ratings of how much they felt they knew about the unseen world (Pre-Viewers n=221; Viewers=229)</b>							
	1	2	3	4	5	6	7
Know nothing			3.0 (Pre-Viewers)		5.0 (Viewers)		Know a lot

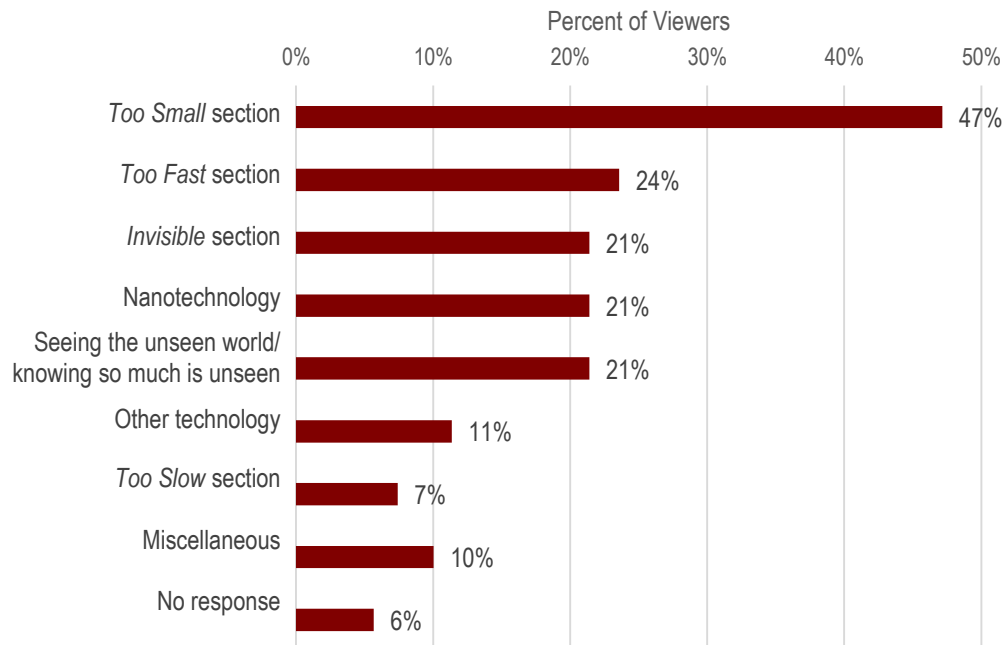
<sup>29</sup> ( $U=13559, p=.001, r=.40$ )

### 3.3 What did Viewers think were the most interesting things they learned from the film?

The majority of Viewers identified at least one thing they learned of interest from the film. The largest groups pointed to something from the *Too Small* section, the *Too Fast* section, the *Invisible* section, or something they learned about nanotechnology. Smaller groups noted that they were interested in seeing the unseen world/knowing that so much is unseen, said they were interested in learning about technology other than nanotech, and/or pointed to something in the *Too Slow* section of the film.

When asked to describe the most interesting things they learned from watching *Mysteries of the Unseen World*, more than nine-tenths (94%) of Viewers identified one or more new subjects they learned about. The chart below shows the general categories Viewers most frequently identified, by film section or topic, and the percentage of Viewers citing each topic.

**Most interesting things Viewers felt they learned from the film  
(by film section or topic) (n=229)**



As shown in the chart above, nearly half of Viewers commented on something interesting they learned from the *Too Small* section of the film (47%), including the topics of microscopic things on our bodies and in the air, as well as the existence of the nanoworld and what they learned about butterfly scales, geckos, and spider silk, among other subjects. About a quarter of Viewers pointed to something in the *Too Fast* section (24%), with a number mentioning what they learned about water drops, dragonflies, and/or lightning strikes, among other topics. Just over one-fifth each pointed to the following: something from the *Invisible* section (21%), with some Viewers commenting on the existence of the electromagnetic spectrum and/or how insects like bees and mosquitoes see the world, among other topics; nanotechnology (21%), including the subjects of cancer

treatments, graphene, and the construction of an elevator to space; and seeing the unseen world and/or knowing that so much is unseen (21%).

Just over a tenth were most interested in technology other than nanotech (11%), including microscopes, X-rays, time-lapse and high-speed photography, and technology based on what we can learn from nature. Less than a tenth were most interested in something in the *Too Slow* section (7%), such as time-lapse photography, plant growth, and air traffic maps. Finally, a tenth of Viewers shared miscellaneous responses (10%), including those who said they were interested in “everything,” and less than a tenth declined to answer the question (6%).

Examples of Viewers’ comments on each theme follow below:

**Too Small section (47%)**

- *The small things we can't see*
- *The wonders of unseen smallness.*
- *...the wonder of what all the different subjects look like when magnified.*
- *I think knowing what little tiny bugs look like is very interesting. Also they showed things getting smaller and smaller.*
- *The things living on us that we can't see*
- *Showing kids about bugs you can't see to reinforce cleaning himself*
- *What we breathe, what's on our skin, how geckos walk, what bugs etc. look like, what spider webs are made of.*
- *Space dust, mites on my eye*
- *Things we breathe in, what different things look like up close.*
- *I'm around things from space all the time.*
- *We breathe in many things we can't see.*
- *The nanoworld, what's in the air.*
- *Going down to the nano level was something I haven't seen before.*
- *Definitely nano worlds! Organisms living on human skin.*
- *Butterfly wings (microscopic).*
- *Geckos walking up glass.*
- *Spider's silk is pound for pound stronger than steel.*

**Too Fast section (24%)**

- *Fast things that we can't normally see.*
- *The too fast was interesting to see how things progress.*
- *How there's slow and superfast things moving around us*
- *High-speed camera*
- *One of the most interesting things I learned in this film is that water droplets bounce back*
- *How drops of water bounce before they disappear*
- *Why a single drop makes the multiple circles.*
- *Raindrops bouncing, dragonflies pattern*
- *About water drop. Dragonfly's wings.*
- *The dragonfly was the most interesting fly in the world, can go front, back, side to side.*
- *Dragonfly being the best flyer in the world.*
- *The lightning and how it not only comes from the sky, but from the ground.*
- *In the film, the most interesting things was how lightning can shoot up.*

**Invisible section (21%)**

- *The array of light that we cannot see; I know some, but they had more than I thought.*
- *The explanation of wave lengths. (Learned it in school, but it was much easier to understand in the film.)*
- *"Waves" and "lights."*



- Different types of rays
- The different wave lengths we use to see objects.
- The radio waves go all around you.
- How many different light spectrums there are. More info. On gamma rays.
- Insects see other wavelengths of light that humans can't see.
- How animals see the world.
- Bumblebees' abilities to see ultraviolet.
- Bees' vision, light rays.

### **Nanotechnology (21%)**

- Future of nanotechnology very cool and Interesting.
- Nanotechnology, how it [works] and how it helps.
- Ability to move cells with nanotechnology to create new nanotechnologies.
- Nano microscope can see all the levels of the atom. Idea of gold atoms cleaning out cancer and idea of repairing DNA.
- Strength of carbon particle in cylindrical form. Cancer cells can be destroyed with gold atom. Repairing DNA.
- Use of gold
- Cancer treatment technology.
- The many uses of carbon atoms. The ability to move carbon atoms. The applications of nanotechnology to medical science- cure cancer/reprogram DNA with bacteria.
- The ability to move atoms
- Carbon nanotubes
- That [graphene] is actually stronger than diamonds.
- They wanted the one thing harder than diamond and flexible as rubber. I know they made one strong as steel.
- Nano carbon fibers for space elevator.
- Nanotechnology helped us build a composition that is flexible yet so strong. Envisioning buildup a space bridge.

### **Seeing the unseen world/knowing so much is unseen (21%)**

- To see all the little creatures we can't see with our eyes.
- That we can see things down to a molecular level.
- Speed and slow idea for what we can and can't see with our naked eye, just the wonder of what all the different subjects look like when magnified.
- The ability to see extremely small particles.
- What we can see of an insect on [a] microscope.
- Showing kids about bugs you can't see to reinforce cleaning himself
- The things living on us that we can't see
- The array of light that we cannot see; I know some, but they had more than I thought.
- Insects see other wavelengths of light that humans can't see.
- That there are way more things than I thought that I can't see.
- All of the fascinating characteristics which encompass the "unseen" world.
- All the degrees that we cannot see.
- What's in our world that we can't see.
- To be aware of the invisible world around us.
- The wonders of unseen smallness.

### **Other technology (11%)**

- Scientific potential of things in nature
- Use of technology to mimic nature's motions.
- I did not know how much science has progressed in the way it's using what we learn from nature to create new technology.
- How we copy nature to recreate robots etc.

- *Robots climbing the glass (learned from the gecko).*
- *How the technology of seeing close up may be able to create things useful like airplane device.*
- *The ability to see how we will help ice on plane.*
- *Cutting edge technology.*
- *The current applications of the observations at those scales.*
- *How the world has evolved to create things to help us in the future.*

**Too Slow section (7%)**

- *Time-lapse/photography and how it allows observations.*
- *Time-lapse- flowers, slime molds*
- *Watching plants take root*
- *How vines use their little fingers to climb up surfaces to reach more sunlight.*
- *Air traffic maps*
- *The airplanes in the air at one time. The time-lapse photography.*
- *Slow things*
- *How there's slow and superfast things moving around us*

**Miscellaneous (10%)**

- *Too many things to list*
- *The most interesting things for me were learning more about things that I thought I already know.*
- *The thorough build up from "too -" to a specific example was great; No gaps in subject transition.*
- *I loved the fact that it connected these discoveries to technology and other real world example to give a purpose to the film.*
- *About... the different forms of liquid.*
- *Practical, life lessons.*
- *Wonders of nature; mechanisms of reproduction.*
- *The process of insects; the life of an insect.*

### 3.4 How much did Viewers think they learned from the film about science and technology topics?

In general, Viewers thought they learned a lot from the film about *the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and the properties and possibilities of the nanoworld. They also thought they learned a fair amount about the kinds of light waves humans and other animals see.*

After watching *Mysteries of the Unseen World*, Viewers were asked to rate how much they learned about 5 science and technology topics on a scale of 1.0 (learned nothing) to 4.0 (learned a lot). The table below presents the percentages of Viewers selecting each rating.

Frequency distribution of Viewers' ratings of how much they thought they learned about science and technology topics (n=229)				
	Learned nothing 1	Learned a little 2	Learned a fair amount 3	Learned a lot 4
The kinds of light waves humans and other animals see	1%	16%	39%	42%
The kinds of discoveries we can make about nature using new technologies	1%	7%	36%	56%
The kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature	0%	11%	35%	53%
The kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)	1%	11%	34%	54%
The properties and possibilities of the nanoworld	1%	11%	29%	57%

While there were some differences in opinion, as evidenced by the range of ratings in each case, Viewers generally indicated that they learned a lot (median rating 4.0 each) from the film about: *the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and the properties and possibilities of the nanoworld. They*

also thought they learned a fair amount (median rating 3.0) about *the kinds of light waves humans and other animals see*.

When invited to elaborate on their ratings, a number of Viewers shared general comments about what they liked about the film, what they learned, and what they thought could have been improved, among other responses. At the same time, a handful explained that they had a background in science and were knowledgeable prior to seeing the film. Examples of Viewers' responses are shared below:

- *Totally opened my eyes.*
- *Excellent material.*
- *Nanotech is so fascinating-would like to have learned more.*
- *I want to know more about graphene.*
- *Basic middle school science taught me about types of electromagnetic waves but not the amazing technology we could make with it.*
- *I came in with a foundational knowledge for some of this because of my college studies.*
- *I know about it, I know some from photography and other subjects.*
- *Ability to make super small and super strong materials for medical treatment.*
- *Some words were very scientific and a little hard to follow.*
- *I don't completely get this...I wanted more!*
- *I've been repeating this a lot but I learned a lot from the Internet.*
- *I had some knowledge coming in so not much new for me, but good explanations, lots of graphics, made my five year old interested. Went over the head of my three year old in many ways.*
- *Assuming "learning" is the same as "being reminded of."*
- *I have an advanced degree in science.*
- *Scientist – already aware of most.*
- *Awesome! It...rekindles the scientist in me.*

### 3.5 What was the film's impact on Viewers' knowledge of unseen worlds?

Overall Viewers significantly outperformed Pre-Viewers on a content assessment designed to assess learning from the film in five topic areas. Out of a total possible score of 35, Viewers averaged 28.4 correct responses, while Pre-Viewers averaged 16.0 correct responses. In addition to this higher overall total score, Viewers also significantly outperformed Pre-Viewers for each of the five main topic areas assessed, including: *The types of light waves that humans and other animals see*, *The technologies used to see and study things that humans can't see with normal vision*, *Discoveries scientists have been able to make about nature through new technologies*, *Things scientists can learn from nature to make innovative materials and devices*, and *Properties and possibilities of the nanoscale*. The effect sizes in all cases, overall, and for each topic area, were large effects.

To evaluate the impact of *Mysteries of the Unseen World* on Viewers' knowledge of content covered in the film, both Viewers and Pre-Viewers were asked to complete a 35 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for a general audience.

The 35 point assessment consisted of five sets of questions covering the major informal science and technology topic areas covered in the film, as follows:

3.5a *Types of light waves that humans and other animals see*

3.5b *Technologies used to see and study things that humans can't see with normal vision*

3.5c *Discoveries scientists have been able to make about nature through new technologies*

3.5d *Things scientists can learn from nature to make innovative materials and devices*

3.5e *Properties and possibilities of the nanoscale*

#### Overall findings

Overall Viewers outperformed Pre-Viewers on the content assessment designed to assess learning gains from the film related to the five topic areas listed above. An independent samples t-test showed that Viewers scored significantly higher than Pre-Viewers, and the effect size was large.<sup>30</sup> Out of a total possible score of 35, Viewers averaged 28.4 correct responses, while Pre-Viewers averaged 16.0 correct responses.

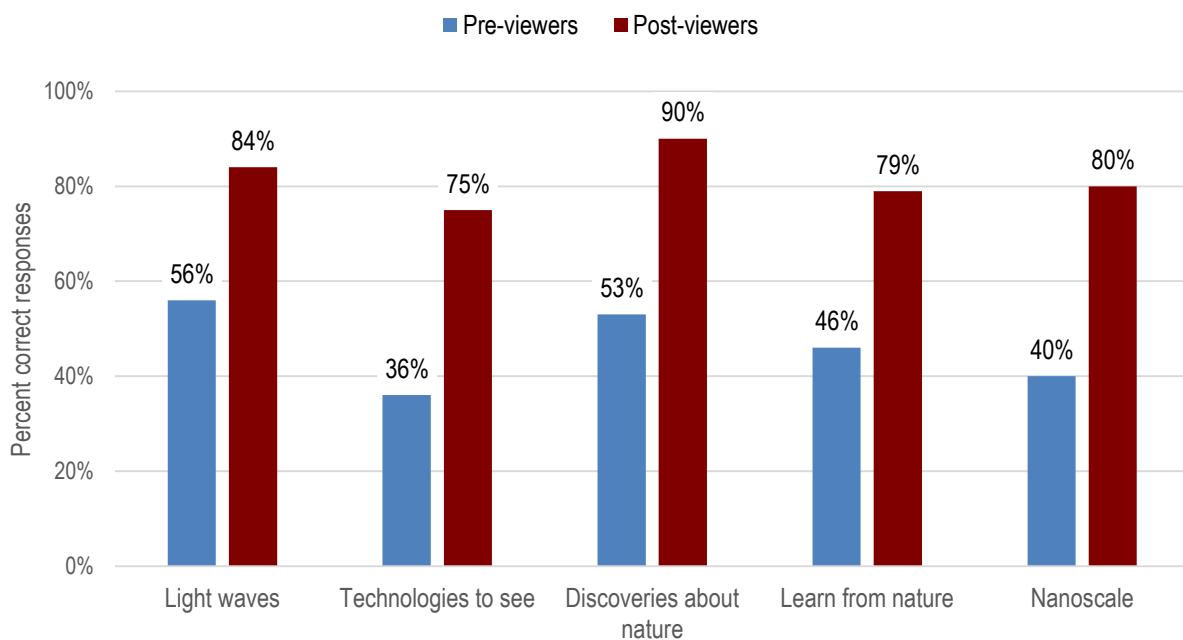
In addition to this higher overall score, Viewers also significantly outperformed Pre-Viewers for each of the five main topic areas assessed, as follows: For *The types of light waves that humans and other animals see*, out of

<sup>30</sup>  $t(384) = 19.5, p < .001, d = 1.84, 95\% CI [11.1, 13.5]$

a total possible score of 6, Viewers averaged 5.1 correct responses while Pre-Viewers averaged 3.4.<sup>31</sup> For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 8, Viewers averaged 6 correct responses while Pre-Viewers averaged 2.8.<sup>32</sup> For the *Discoveries scientists have been able to make about nature through new technologies*, out of a total possible score of 6, Viewers averaged 5.4 correct responses while Pre-Viewers averaged 3.2.<sup>33</sup> For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, Viewers averaged 9.5 correct responses while Pre-Viewers averaged 5.5.<sup>34</sup> Finally, for *Properties and possibilities of the nanoscale*, out of a total possible score of 3, Viewers averaged 2.4 correct responses while Pre-Viewers averaged 1.2.<sup>35</sup> The effect sizes in all instances were large effects.

The graph below compares the scores of Viewers and Pre-Viewers for each of the 5 question sets. Results are presented in terms of the percentage of correct answers. As with the overall assessment, the evaluation found that Viewers outperformed Pre-Viewers on each individual question set.

**Comparison of Viewer (N=229) and Pre-Viewer (N=221) scores  
(performance across 5 question sets)**



Sections 3.5a through 3.5e below summarize the findings for each set of questions.

<sup>31</sup>  $t(431) = 9.93, p < .001, d = 0.94, 95\% CI [1.4, 2.0]$

<sup>32</sup>  $t(430) = 16.3, p < .001, d = 1.54, 95\% CI [2.8, 3.5]$

<sup>33</sup>  $t(347) = 14.7, p < .001, d = 1.39, 95\% CI [1.9, 2.5]$

<sup>34</sup>  $t(424) = 10.7, p < .001, d = 1.01, 95\% CI [3.3, 4.8]$

<sup>35</sup>  $t(422) = 13.5, p < .001, d = 1.27, 95\% CI [1.0, 1.4]$

### 3.5a Types of light waves that humans and other animals see

To assess Viewer learning about the types of light waves humans and other animals see, content featured in the *Invisible* section of the film, Viewers and Pre-viewers were asked to complete three fill in the blank questions in response to the prompt: *For each animal below, please check the ONE type of light wave it naturally uses to see the world.* The table below shows the percentage of Viewers and Pre-Viewers that answered each question correctly.

Percentage of Pre-Viewer and Viewer correct answers to fill in the blank questions about light waves humans and other animals naturally use to see the world						
Pre-Viewers (n=221) Viewers (n=229)		Infrared	Radio	Ultraviolet	Visible	X-ray
Bees see the world using ____ waves.	Pre-Viewers			39%		
	Viewers			79%		
Mosquitoes see the world using ____ waves.	Pre-Viewers	43%				
	Viewers	79%				
Humans see the world using ____ waves.	Pre-Viewers				86%	
	Viewers				95%	

#### Overall results

Out of a total possible score of 6<sup>36</sup> for this subset of questions, Viewers averaged 5.1 correct responses while Pre-Viewers averaged 3.4.<sup>37</sup> The effect size in this case was considered a large effect.

#### Item results

About four-fifths (79%) of Viewers compared to two-fifths of Pre-Viewers (39%) correctly answered that bees see the world using *ultraviolet light*. Similarly, about four-fifths of Viewers (79%) of Viewers compared to just over two-fifths of Pre-Viewers (43%) correctly answered that mosquitoes see the world using *infrared waves*. Unlike with the two previous questions where a minority of Viewers knew the correct answer prior to seeing the film, 95% of Viewers compared to 86% of Pre-Viewers correctly answer that humans see the world using *visible light waves*.

<sup>36</sup> Each question was worth 2 points for a total of 6 possible points.

<sup>37</sup>  $t(431) = 9.93, p < .001, d = 0.94, 95\% CI [1.4, 2.0]$

### 3.5b Technologies used to see and study things that humans can't see with normal vision

To assess Viewer learning about the technologies used to see and study things that humans can't see with normal vision, content featured in the *Invisible*, *Too Small*, *Too Fast*, and *Too Slow* sections of the film, Viewers and Pre-Viewers were asked to complete two two-part open-ended questions about time-lapse photography and high-speed photography, and two true/false questions about gamma ray and electron microscopy content covered in the film.

#### Overall results

Out of a total possible score of 8 for this set of questions, Viewers averaged 6 correct responses while Pre-Viewers averaged 2.8.<sup>38</sup> The effect size in this case was considered a large effect.

#### Item results

##### i. Time-lapse photography

To assess Viewer learning about what time-lapse photography reveals about nature that we can't see with our human eyes, content featured in the *Too Slow* section of the film, Viewers and Pre-Viewers were asked to answer a two-part question. The first part asked: *What does TIME-LAPSE photography (pictures taken over a long time period) allow us to see about nature that we wouldn't otherwise be able to see with our own human eyes?* The second part asked *Please give an example.*<sup>39</sup> The table below shows the percentage of Viewers and Pre-Viewers that answered each part of the question with incorrect, partial, and full explanations and examples, respectively. The table also includes examples of responses that were coded under each category.

Percentage of Pre-Viewer and Viewer correct and incorrect explanations and examples for time-lapse photography question		
Pre-Viewers (n=221)	Part a: What time-lapse reveals about nature we can't see with our own eyes	Viewers (n=229)
41%	Incorrect or no explanation Examples: 1) <i>No clue</i> ; 2) <i>Can see things you can't see with regular eyes</i> ; 3) <i>The human eye isn't capable of catching every motion at high-speed but time lase allows humans to see more</i>	7%
19%	Partial explanation Examples: 1) <i>Change</i> ; 2) <i>Movement</i> ; 3) <i>Processes</i>	9%
39%	Full explanation Examples: 1) <i>How things change over a long period of time that we normally wouldn't notice</i> ; 2) <i>It allows us to see slow movements or changes it time in the 24 picture/second speed we can</i> ; 3) <i>Time-lapse photography allows us to see how flowers unfold or how plants grow (or things that are too slow for our eyes)</i>	84%
Part b: Example		
47%	Incorrect or no example Examples: 1) <i>I don't know</i> ; 2) <i>Hummingbird wings flapping</i> ; 3) <i>Microorganisms, things too small to see</i>	14%
4%	Partial example Examples: 1) <i>Filming a storm</i> ; 2) <i>Watching a plant</i> ; 3) <i>Growing</i>	4%
49%	Full example Examples: 1) <i>People use time-lapse to see flowers growing</i> ; 2) <i>The process of how a leaf develops or how a dead rat decomposes</i> ; 3) <i>A flower blooming. A vine crawling up a tree. Smile mold growing and spreading</i>	83%

<sup>38</sup> $t(430) = 16.3, p < .001, d = 1.54, 95\% CI [2.8, 3.5]$

<sup>39</sup> The first part of the question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of the question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.



As the table on the previous page shows, in both cases a higher percentage of Viewers provided partial or full explanations for Part a (93% Viewers vs. 58% Pre-Viewers) and examples for Part b (87% Viewers vs. 53% Pre-Viewers).

## ii. High-speed photography

To assess Viewer learning about what high-speed photography reveals about nature that we can't see with our human eyes, content featured in the *Too Fast* section of the film, Viewers and Pre-Viewers were asked to answer a two-part question. The first part asked: *What does HIGH-SPEED photography (pictures taken over a short time period) allow us to see about nature that we wouldn't otherwise be able to see with our own human eyes?* The second part asked *Please give an example.*<sup>40</sup> The table below shows the percentage of Viewers and Pre-Viewers that answered each part of the question with incorrect, partial, and full explanations and examples, respectively. The table also includes examples of responses that were coded under each category. As the table shows, in both cases a substantially higher percentage of Viewers provided partial or full explanations for Part a (83% Viewers vs. 32% Pre-Viewers) and examples for Part b (78% Viewers vs. 35% Pre-Viewers).

Percentage of Pre-Viewer and Viewer correct and incorrect explanations and examples for high-speed photography question		
Pre-Viewers (n=221)	Part a: What high-speed reveals about nature we can't see with our own eyes	Viewers (n=229)
14%	Incorrect or no explanation Examples: 1) <i>Not sure</i> ; 2) <i>What you can't see with your normal vision</i> ; 3) <i>Allows us to see development over time</i>	17%
13%	Partial explanation Examples: 1) <i>It goes fast</i> ; 2) <i>Fast moving events</i> ; 3) <i>How quick something moves</i>	14%
19%	Full explanation Examples: 1) <i>It lets people see things that are too fast for the human eye</i> ; 2) <i>We are able to see things work and function by "slowing" the picture down and studying what would normally be impossible to see</i> ; 3) <i>The opposite of time lapse; allows us to see things that happen too fast for us to process</i>	69%
Part b: Example		
65%	Incorrect or no example Examples: 1) <i>Don't know</i> ; 2) <i>Flowers changing shape</i> ; 3) <i>Growing plants</i>	22%
7%	Partial example Examples: 1) <i>Slow motion things</i> ; 2) <i>Bullet</i> ; 3) <i>Hummingbird wings</i>	4%
28%	Full example Examples: 1) <i>Water drops bouncing when they hit water</i> ; 2) <i>Bullet hitting a lightbulb</i> ; 3) <i>Hummingbird wings flapping</i>	74%

<sup>40</sup> This question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of the question asked Viewers to "Please give an example." This question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

### iii. Other technologies (gamma rays and electron vs. compound microscope)

To assess Viewer learning about other technologies used to study things that humans can't see with normal vision, specifically the use of gamma rays and the use of electron vs. compound microscopes, topics featured in the *Invisible* and *Too Small* sections of the film, Viewers and Pre-Viewers were asked to answer two true/false questions that read: *A compound microscope lets us see down into the scales of a butterfly* (False) and *Gamma rays can show what is going on inside a person's body* (True).<sup>41</sup>

The table below shows the percentage of Viewers and Pre-Viewers that answered each question correctly. Four-fifths (80%) of Viewers compared to just over two-fifths of Pre-Viewers (45%) correctly answered true to the statement that *Gamma rays can show what is going on inside a person's body*. Meanwhile one-third (32%) of Viewers compared to less than one-tenth (4%) of Pre-Viewers correctly answered false to the statement that *A compound microscope lets us see down in the scales of a butterfly wing*.

Percentage of Pre-Viewer and Viewer correct answers to true/false question about electron microscopy/compound microscopes and gamma rays		
Pre-Viewer (n=221)	True/false questions	Viewer (n=229)
4%	A compound microscope lets us see down into the scales of a butterfly (F)	32%
45%	Gamma rays can show what is going on inside a person's body (T)	80%

<sup>41</sup> Each T/F question earned a total possible score of 1.

### 3.5c Discoveries scientists have been able to make about nature through new technologies

To assess Viewer learning about the kinds of discoveries scientists have been able to make about nature through new technologies, content presented in the *Too Fast* and *Too Small* sections of the film, Viewers and Pre-Viewers were asked a multiple choice question and three true/false questions about how lightning bolts move and other discoveries facilitated through the use of new technologies.

#### Overall findings

Out of a total possible score of 6, Viewers averaged 5.4 correct responses while Pre-Viewers averaged 3.2.<sup>42</sup> The effect size in this case was considered a large effect.

#### Item results

##### i. How lightning bolts move

To assess Viewer learning about what scientists have discovered about how lightning moves using high-speed photography, content featured in the *Too Fast* section of the film, Viewers and Pre-Viewers were asked the following multiple choice question: *Do lightning bolts move from the sky to the ground, the ground to the sky, both ways, or neither way?*<sup>43</sup> The table above shows the percentage of Viewers and Pre-Viewers that answered the question correctly. Nearly nine-tenths (87%) of Viewers compared to just over two-fifths of Pre-Viewers (43%) correctly answered that lightning strikes both ways.

Percentage of Pre-Viewer and Viewer correct answers to multiple choice question about how lightning strikes				
Pre-Viewers (n=221) Viewers (n=229)	Sky to ground	Ground to sky	Both ways	Neither way
Pre-Viewers			43%	
Viewers			87%	

##### ii. Other discoveries facilitated through the use of new technologies

To assess Viewer learning about other discoveries that new technologies have helped facilitate, Viewers and Pre-Viewers were asked three true/false questions about content featured in the *Too Fast* and *Too Small* sections of the film. The three statements were: *There are more organisms living on you than there are people on Earth* (True), *When a raindrop hits a puddle, it bounces* (True), and *Steel is stronger than spider silk of equal weight (pound for pound)* (False).<sup>44</sup> The table below shows the percentage of Viewers and Pre-Viewers that answered each question correctly.

Percentage of Pre-Viewer and Viewer correct answers to true/false questions about other discoveries facilitated by the use of new technologies		
Pre-Viewer (n=221)	True/false questions	Viewer (n=229)
72%	There are more organisms living on you than there are people on Earth (T)	95%
59%	When a raindrop hits a puddle, it bounces (T)	97%
56%	Steel is stronger than spider silk of equal weight (pound for pound) (F)	85%

<sup>42</sup>  $t(347) = 14.7, p < .001, d = 1.39, 95\% CI [1.9, 2.5]$

<sup>43</sup> This question was worth 3 points

<sup>44</sup> Each T/F question earned a total possible score of 1.

### 3.5d Things scientists can learn from nature to make innovative materials and devices

To assess Viewer learning about the things scientists can learn from nature to make innovative materials and devices, content featured in the *Too Fast* and *Too Small* sections of the film, Viewers and Pre-Viewers were asked four two-part questions that asked them to list features or characteristics of four animals and plants (gecko, dragonfly, spider web, and lotus leaf/lily pad) that scientists could imitate to make a new invention and an example of what scientists could invent from this. The question was presented as outlined in the table below, though adapted for use in this report. Responses were coded as incorrect, partially correct, or fully correct.<sup>45</sup> The table also includes examples of responses that were coded under each category. The relevant film references to each question part are also briefly summarized in each case.

Coding examples		
Scientists can imitate the features or characteristics of plants and animals to make new inventions. For each animal and plant below, briefly describe a feature or characteristic scientists could imitate and then give an example of what they could invent from this. An example is included for you to follow.		
Examples from nature	a) What feature or characteristic could scientists imitate?	b) What could scientists invent from this?
<i>Example:</i> <i>Burr</i>	<i>Burrs – has hooks that easily attach to loops in clothing, animal fur, hair</i>	<i>Velcro with hooks and loops that stick together</i>
Gecko	<u>Incorrect:</u> 1) A lizard; 2) The way they can sell insurance <u>Partial correct:</u> 1) Feet; 2) Walking on glass <u>Fully correct:</u> 1) Has suction cup like feet that allow it to scale vertical surfaces; 2) The pads of its feet, more specifically the tiny hairs that form electromagnetic connections to walk up sheer surfaces.  <b>Film reference:</b> Feet covered with tiny bristles that build up electrical charge to attract to surface	<u>Incorrect:</u> 1) Maybe purses? I don't know; 2) 15 min could save you 15% or more on car insurance <u>Partial correct:</u> 1) Material of similar texture; 2) Climbing <u>Fully correct:</u> 1) A kind of robot or some sort of gear that can adhere to surfaces or climb; 2) They can design new technology which allows humans to camouflage and walk on water easier for rescues.  <b>Film reference:</b> Climbing robots
Dragonfly	<u>Incorrect:</u> 1) Looks; 2) Bug eyes <u>Partial correct:</u> 1) Flight; 2) Wings <u>Fully correct:</u> 1) Can move wings all four, in different directions at the same time, can fly in any direction; 2) The best flying capabilities in nature-fly upside down, front/back.  <b>Film reference:</b> Wings that can move in all directions	<u>Incorrect:</u> 1) Feed animals; 2) Ant-man <u>Partial correct:</u> 1) Wings; 2) Can go any directions <u>Fully correct:</u> 1) Helicopter wings that can easily avoid missiles 2) Create drones that can easily hover go backwards  <b>Film reference:</b> Robotic flyers
Spider web	<u>Incorrect:</u> 1) Where spiders live; 2) Making a spider web <u>Partial correct:</u> 1) Webs, crawls up walls; 2) Silk <u>Fully correct:</u> 1) Thin strong flexible web that's better than steel; 2) Strength and flexibility  <b>Film reference:</b> Strong yet elastic silk	<u>Incorrect:</u> 1) Nice clothes; 2) Entertainment <u>Partial correct:</u> 1) Can stick one thing to another; 2) Strong <u>Fully correct:</u> 1) Create synthetic material that is stronger/lightweight; 2) Use carbon atoms to create the world's thinnest and most flexible material.  <b>Film reference:</b> synthetic version
Lotus leaf/ lily pad	<u>Incorrect:</u> 1) The leaf; 2) plant found in water <u>Partial correct:</u> 1) Fibers in the leaf; 2) Material of the leaf/pad <u>Fully correct:</u> 1) Little hairs on the surface that resist water absorption; 2) The ability to resist water.  <b>Film reference:</b> Surface repels almost any liquid; tiny hair like bumps that cause drops to roll off	<u>Incorrect:</u> 1) Lily pads and stuff; 2) Similar material <u>Partial correct:</u> 1) Airplanes; 2) Clothes <u>Fully correct:</u> 1) Aircraft coating to avoid moisture/freeze; 2) Could create new water resistant clothing.  <b>Film reference:</b> Coating to shield airplanes from ice build up

<sup>45</sup> The first part of each question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of each question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

## Overall findings

Out of a total possible score of 12, Viewers averaged 9.5 correct responses while Pre-Viewers averaged 5.5.<sup>46</sup> The effect size in this case was considered a large effect.

The table below shows the percentage of Viewers and Pre-Viewers that answered each part of the question with incorrect, partial, and full answers.

Percentage of Pre-Viewer and Viewer correct and incorrect responses to question about nature features and inventions						
Scientists can imitate the features or characteristics of plants and animals to make new inventions. For each animal and plant below, briefly describe a feature or characteristic scientists could imitate and then give an example of what they could invent from this. An example is included for you to follow.						
Examples from nature	a) What feature or characteristic could scientists imitate?			b) What could scientists invent from this?		
Pre-Viewers (n=221) Viewers (n=229)	Score	Pre-Viewer	Viewer	Score	Pre-Viewer	Viewer
Gecko	Incorrect	45%	14%	Incorrect	59%	25%
	Partial	5%	1%	Partial	5%	1%
	Full	49%	85%	Full	36%	74%
Dragonfly	Incorrect	51%	14%	Incorrect	61%	25%
	Partial	21%	2%	Partial	16%	4%
	Full	28%	84%	Full	23%	71%
Spider web	Incorrect	37%	16%	Incorrect	47%	31%
	Partial	11%	1%	Partial	5%	3%
	Full	52%	83%	Full	48%	67%
Lotus leaf/ lily pad	Incorrect	52%	19%	Incorrect	62%	31%
	Partial	3%	5%	Partial	1%	1%
	Full	45%	76%	Full	37%	68%

As the table shows, in all cases a substantially higher percentage of Viewers provided partial or full answers than did Pre-Viewers, as summarized below:

- Gecko: feature (86% Viewer vs. 54% Pre-Viewer); invention (75% Viewer vs. 41% Pre-Viewer).
- Dragonfly: feature (86% Viewer, 49% Pre-Viewer); invention (75% Viewer, 39% Pre-Viewer).
- Spider web: feature (84% Viewer, 63% Pre-Viewer); invention (70% Viewer, 53% Pre-Viewer).
- Lotus leaf/lily pad: feature (81% Viewer, 48% Pre-Viewer); invention (69% Viewer, 38% Pre-Viewer).

<sup>46</sup>  $t(424) = 10.73, p < .001, d = 1.01, 95\% CI [3.3, 4.8]$

### 3.5e Properties and possibilities of the nanoscale

To assess Viewer learning about the film's content related to the properties and possibilities of the nanoscale, featured in the *Too Small* section of the film, Viewers and Pre-Viewers were asked three true/false questions including: *Scientists can move atoms using powerful microscopes* (True), *The metal gold can change its color when it is nano-sized* (True), and *The world's thinnest material was created using nanotechnology* (True).<sup>47</sup>

#### Overall findings

Out of a total possible score of 3, Viewers averaged 2.4 correct responses while Pre-Viewers averaged 1.2.<sup>48</sup> The effect size in this case was considered a large effect.

#### Item results

The table below shows the percentage of Viewers and Pre-Viewers that answered each question correctly. More than four-fifths (83%) of Viewers compared to two-fifths (40%) of Pre-Viewers correctly answered true to the statement that *Scientists can move atoms using powerful microscopes*. Four-fifths (79%) of Viewers compared to under two-fifths (37%) of Pre-Viewers correctly answered true to the statement that *The metal gold can change its color when it is nanosized*. Finally, four-fifths (79%) of Viewers compared to just over two-fifths (45%) of Pre-Viewers correctly answered true to the statement that *The world's thinnest material was created using nanotechnology*.

Percentage of correct answers to true/false questions about the properties and possibilities of the nanoscale		
Pre-Viewer (n=221)	True/false questions	Viewer (n=229)
40%	Scientists can move atoms using powerful microscopes (T)	83%
37%	The metal gold can change its color when it is nano-sized (T)	79%
45%	The world's thinnest material was created using nanotechnology (T)	79%

<sup>47</sup> Each T/F question earned a total possible score of 1.

<sup>48</sup>  $t(422) = 13.5, p < .001, d = 1.27, 95\% CI [1.0, 1.4]$

## Question 4: How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?

Question 4 considers the film's immediate impact on Viewers' interest in the unseen world, as well as if and how they thought they would "see" the world differently after watching *Mysteries of the Unseen World*. These findings are presented below in 4.1 through 4.2.

### 4.1 What was the film's impact on Viewers' interest in the unseen world?

Viewers who had just seen the film rated their interest in the unseen world significantly higher than did Pre-Viewers who had yet to do so.

Viewers and Pre-Viewers were asked to rate their interest in the unseen world around them on a scale of 1 (not at all interested) to 7 (very interested). The table below shows the median ratings for this simplified self-report measure, which specifically asked: *On a scale of 1 to 7, how interested are you in the unseen world around you (e.g., things that are too small or happen too fast or slow for our human eyes to naturally see?)*. Viewers rated their interest in the unseen world significantly higher than did Pre-Viewers (medians, 7.0 vs. 6.0), although the effect size was small.<sup>49</sup>

Median Viewer and Pre-Viewer ratings of their interest in the unseen world (Viewers n=229, Pre-viewers n=221)						
1	2	3	4	5	6	7
Not at all interested				6.0 (Pre-Viewers)	7.0 (Viewers)	Very interested

<sup>49</sup> ( $U = 20434, p = .001, r = .18$ )

## 4.2 Did Viewers think they would “see” the world differently after watching the film?

After seeing the film, most Viewers thought they would “see” the world around them differently. Those who thought they wouldn’t “see” the world differently or were unsure if this would be the case most frequently indicated that this was because they were already knowledgeable of the information in the film.

Viewers were asked if, as a result of seeing the film, they thought they would “see” the world around them differently. The table to the right shows the percentages of Viewers saying *Yes*, *No*, and *Unsure*, followed by their reasons in each case.

The majority of Viewers (85%) thought they would “see” the world around them differently as a result of watching the film. When asked how they would “see” the world differently, more than a quarter of Viewers explained that they would generally be more aware, knowledgeable, or conscious of the world around them and the things they cannot see (26%). Less than a fifth of Viewers indicated that they would think about something from the *Too Small* section (17%), including the knowledge they gained about what is on our bodies and in the air. Less than a tenth each said they would feel awe, respect, or appreciation for nature and the world around them (8%), noted that they would wonder, be more curious, or imagine more (7%), explained that they would think about man’s place in nature and the complexity of life (7%), and described how they would think about something from the *Invisible*, *Too Fast*, and/or *Too Slow* sections of the film (7%). A slightly smaller group said they would observe or study the world more carefully (6%). Finally, less than a tenth of Viewers shared miscellaneous responses (9%), including those who explained that they would have a greater appreciation for science and/or scientists.

Less than a tenth of Viewers indicated that they did not think they would “see” the world around them differently as a result of viewing the film (8%). When asked why not, the largest group explained that they were already knowledgeable about the topics in the film (5%), while a handful each said they were limited by (human) sight and experience (1%) or shared miscellaneous responses (1%).

<b>Whether Viewers thought they would “see” the world differently after watching the film (n=229)</b>	
<b>Yes, I will “see” the world around me differently</b>	<b>85%</b>
Will generally be more aware, knowledgeable, or conscious of what’s around me/the things I can’t see	26%
Will think about the <i>Too Small</i> section	17%
Will feel awe, respect, or appreciation for nature and the world around me	8%
Will wonder, be more curious, or imagine more	7%
Will think about man’s place in nature and the complexity of life	7%
Will think about the <i>Invisible</i> , <i>Too Fast</i> , and/or <i>Too Slow</i> sections	7%
Will observe or study the world more carefully	6%
Miscellaneous	9%
<b>No, I will not “see” the world around me differently</b>	<b>8%</b>
Already knowledgeable	5%
Limited by (human) sight and experience	1%
Miscellaneous	1%
<b>Not sure if I will “see” the world around me differently</b>	<b>6%</b>
Already knowledgeable	1%
It won’t be on my mind	1%
Miscellaneous	2%



And finally, less than a tenth of Viewers explained that they were unsure whether they would “see” the world around them differently as a result of viewing the film (6%). When asked why this was the case, some said they were already knowledgeable of the topics in the film (1%), others said the film wouldn’t be on their minds (1%), and a handful shared miscellaneous responses (2%), including a few who explained that they would be limited by (human) sight and experience.

Examples of Viewers’ comments on each theme follow below:

- **Yes, I will “see” the world about me differently (85%)**

***Will generally be more aware, knowledgeable, or conscious of what’s around me and the things I can’t see (26%)***

- *I'll take more time to smell flowers (be more aware of things).*
- *I will be aware of what's around me.*
- *I will now know that things are not how it seems.*
- *Think about invisible world more.*
- *Makes me think more about what is around us.*
- *Because I am very much conscious about the things around me.*
- *Because of knowledge lots of things we can't see.*
- *Think about everything going on.*
- *I will understand and acknowledge the unseen world.*
- *I will "think" more about how complex something I can't see might actually be.*
- *Awareness of life itself.*
- *I won't visually "see" it but, I will be more aware and conscious.*
- *Will always know it's more to see than I can see with naked eyes.*
- *I'll look around and imagine that there's much more I could be seeing.*
- *I'll make sure to remember that I learned that in the film.*
- *Will think about the things I saw in the film in my everyday life all around me.*

***Will think about Too Small section (17%)***

- *Think more about what is in air.*
- *Air we breathe (what's in it).*
- *Know all the micro things in the air.*
- *I will think about the air we breathe and the bacteria on the skin.*
- *Wash hands*
- *Millions of tiny things moving around me!*
- *I will think about all the tiny things going on around me.*
- *DNA we can truly "see."*
- *I will see that everything is an atom. (Pointed to brother and this is an atom, that bee in an atom.)*
- *All the extra small parts of nature.*
- *The microscopic world is very interesting.*

***Will feel awe, respect, or a sense of appreciation for the nature and the world around me (8%)***

- *A sense of awe*
- *A wonder in itself.*
- *More respect to the intricacies of nature and how it is orchestrated.*
- *More open minded, less judgmental.*
- *Won't look down upon the other creatures.*
- *More careful, respectful of environment.*
- *I will have a better understanding of the things of nature that we take for granted.*
- *I will pay closer attention to my surroundings with newfound appreciation.*
- *Appreciation for the unknown...*

- *Appreciate the depth and layers of life and how many living things there are.*
- *I appreciate so much of my world after watching this film.*
- *Maybe it helps me to appreciate all we have as humans. The fact that we are healthy and everything works perfectly inside our body is the result of working millions and millions of molecules perfectly at the cell level.*
- *Makes me think more about what is around us. I appreciate it more.*
- *How God created so much complex stuff so easily. Start looking with idea of somebody in watching all the time.*
- *I appreciate the things we see/interact with more. Draws me closer to my creator Jehovah.*

**Will wonder, be more curious, or imagine more (7%)**

- *I wonder about everything I touch, feel and see.*
- *I will wonder more...*
- *Having a more curious mind when looking at simple things or everyday things.*
- *Because my curiosity will spread to the smallest of details.*
- *I have a new interest in science.*
- *Ask more "questions" like how is that dragonfly able to fly as it does?*
- *I'll start imagining the things I use differently.*
- *I will imagine the things I saw everywhere.*
- *I'll look around and imagine that there's much more I could be seeing.*

**Will think about man's place in nature and the complexity of life (7%)**

- *It's crazy how big we care and don't even realize. How much it takes to make up this pen for example, it's surreal!*
- *Small part in a very large world.*
- *Realize how insignificant a human is.*
- *Keep in mind that there are more layers to life than I can see.*
- *More respect to the intricacies of nature and how it is orchestrated.*
- *I will see the world as a huge living thing.*
- *How complex nature is!*
- *I will "think" more about how complex something I can't see might actually be.*
- *Appreciate the depth and layers of life and how many living things there are.*
- *Maybe it helps me to appreciate all we have as humans. The fact that we are healthy and everything works perfectly inside our body is the result of working millions and millions of molecules perfectly at the cell level.*
- *How God created so much complex stuff so easily. Start looking with idea of somebody in watching all the time.*

**Will think about the Invisible, Too Fast, and/or Too Slow sections (7%)**

- *Visible light is only part of light very slow and very fast actions could be captured by camera*
- *Because we only see a rather narrow spectrum of light.*
- *I am aware about the different spectrums of light.*
- *I will see it differently because when I see a bee, I'll know it has a vision advantage over me.*
- *To think of the process that maybe too fast or too slow to actually see.*
- *Blooming flowers. Lightning (where it comes from).*
- *Buy a time lapse camera to show my kids beauty around them.*

**Will observe or study the world more carefully (6%)**

- *Watch for all the miracles around me.*
- *I will probably pay closer attention to what I am doing.*
- *I will pay closer attention to my surroundings with newfound appreciation.*
- *Pay more attention*
- *I will...look at the mundane carefully.*
- *I will look at things closer.*
- *Because now I am going to use my eyes better not just glance at stuff but to study things if I see a dog I am going to study its fur and stuff.*
- *Will look more carefully at bugs and water.*

- *Will be looking for things I saw.*
- *I will be looking closer at things to see if I can see them with the naked eye.*
- *I will look at things differently and try to see the differences.*
- *Observing spills, showers, flowers opening.*

**Miscellaneous (9%)**

- *Makes me think about future of privacy and drones, as well as space and medicine possibilities.*
- *Thinking more about ...the possibilities around nature influencing science and technology.*
- *Appreciation for the unknown and what science has discovered.*
- *I have more of an appreciation of what scientists are doing*
- *In a microscope. Maybe I am a scientist.*
- *Will probably make frequent use of microscopes and telescopes.*
- *Nanopotential.*
- *The examples tied to visuals help one better grasp the subject.*
- *Industrially.*
- *I will be more focused on what other organisms do to survive.*
- *Will want to explore some of these new topics with kids.*
- *Discussing with my kids who will have questions.*
- *It gave me topics to talk with my two children seven and nine years old. As parents it is very important to expose science to our children and what a great way to give a child a reference about how the world is in reality.*

• **No, I will not “see” the world around me differently (8%)**

**Already knowledgeable (5%)**

- *Much of it I currently do, or done for living.*
- *As a scientist myself, many of the concepts were familiar to me already.*
- *Knew most of the info presented already. Nothing new that impacts my view of life/the world.*
- *I'm already familiar with the concepts.*
- *I knew most of this already happened around me.*
- *I have been aware of much of the information but not had seen it in this manner.*
- *Already aware, but still loved seeing it.*
- *The most of things well known but enjoyed the show!*
- *I have watched many documentaries about these topics, but enjoyed the IMAX experience and delivery of information.*

**Limited by (human) sight and experience (1%)**

- *Because the movie was about things that you can't see.*
- *Because you can only see plain objects and colors not the tiny microscopic things.*
- *I can't see the different lights and radiations with just my eyes.*

**Miscellaneous (1%)**

- *It is what it is.*
- *I like to keep stuff simple.*
- *Not to be too philosophical, but often, the pace of life is too fast to stop and enjoy wonders such as these.*

• **Not sure if I will “see” the world around me differently (6%)**

**Already knowledgeable (1%)**

- *As a science student I'm already aware of much of the information presented.*
- *I have learned half these things.*
- *I did already know many of the facts mentioned in the film.*

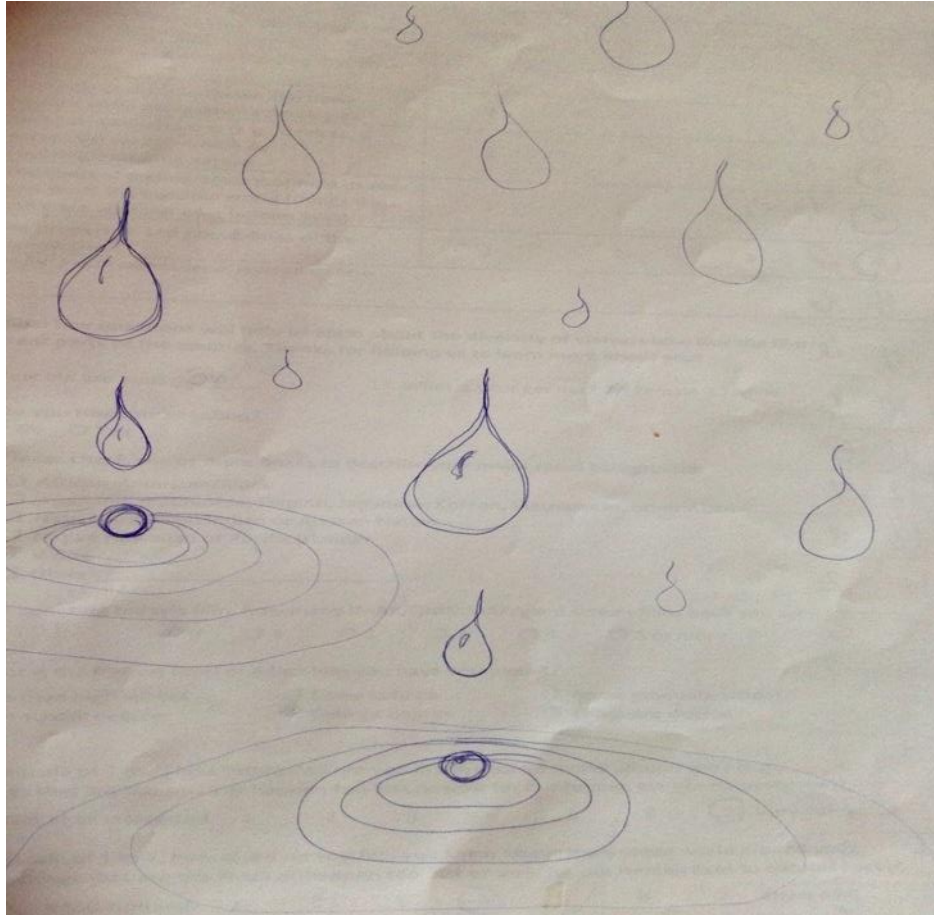
***It won't be on my mind (1%)***

- *I don't think too much of the world but I might start thinking more.*
- *I may or may not remember what I saw today. Although interesting, lots going on in life and this may not resurface.*
- *I don't think it affects my everyday life.*

***Miscellaneous (2%)***

- *Science isn't my thing and the movie didn't really explain.*
- *I don't know.*
- *I don't get the question*
- *Will see things the same mostly.*
- *Basically your eyes can still see some things even though you know stuff is out there.*

## Phase 2: Discussion group explorations of Viewers' connections with the film



***Drawing provided by Viewer when asked to draw a visual that stood out from the film***

Immediately following four separate showings of *Mysteries of the Unseen World*, a trained moderator conducted group discussion sessions with family groups to explore their reactions to the film with respect to the following six questions:

- 1) Who in the family drove the decision to see the film and why?
- 2) How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?
- 3) What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?
- 4) How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?
- 5) How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film?
- 6) Did Viewers have any other feedback on the film that they would like to share?

# Method

## Recruitment

Recruitment for the sessions focused on families because the project team expected that *Mysteries of the Unseen World* would be a particularly appealing and effective learning medium for families. Recruitment occurred as Viewers exited the theater and was purposive, focusing on family groups with youth as opposed to young children.

## Procedure

All 4 sessions were held in an open room located adjacent to the theater exit area and were led by the same moderator. The moderator informed participants: that their participation was voluntary; that only their opinion mattered and there were no right or wrong answers; that their names and identities would be protected in the reporting; and that, as with the questionnaires, the focus groups were made possible with support from the National Science Foundation.

The discussion sessions ran approximately 50-60 minutes, which included time for recruiting and settling participants into the discussion room, introductions, an ice-breaker activity, discussion, wrap-up, and providing an honorarium in the form of a \$25 gift certificate to the science center gift store.

## Analysis

Two evaluators prepared the qualitative analysis by reviewing all available session materials, including: participant drawings, discussion recordings, and post-session notes. The analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Sample information

The table to the right presents basic demographic and background information for the 29 Viewers that participated in the group discussion. This group comprised nearly one-fifth (18%) of the Viewers at Discovery Place who completed a post-viewing questionnaire.

A total of ten families participated in the group discussions. Across the four discussion groups, there were a somewhat higher percentage of females (59%) to males (41%). Nearly three-quarters (72%) of the participants were adults while just over one-quarter (28%) were youth 17 years or younger. The average age of the adults was 38 while the average age of the youth was 11.

As with the Phase 1 questionnaire evaluation, the majority of the participants were White (62%), with 10% Asian, 10% African-American, 3% Native American or Alaskan Native, and 10% reporting Other. One-tenth (10%) of the group identified themselves as Hispanic or Latino.

The majority of participants had a graduate degree or some graduate experience (69%), with 27% having a high school degree or less and 3% having a college degree.

The majority of participants had previously seen 1 or more giant screen films prior to seeing *Mysteries of the Unseen World*, with two-thirds (62%) having seen 3 or more. Overall the group indicated it was very interested in the unseen world (median 7.0) and somewhat knowledgeable (median 5.0).

Group discussion participants' demographic and background information		
Demographic/background factor	Categories	Participants (n=29)
Gender	Female	59%
	Male	41%
Age	Adults (18-above)	72%
	Youth (7-17)	28%
	Age range	8-63
	Average	38 (adults) 11 (youth)
Race and ethnicity	White	62%
	Asian	10%
	Native American or Alaskan Native	3%
	Native Hawaiian or Pacific Islander	0%
	African American	10%
	Other	10%
	Left blank <sup>50</sup>	5%
Number of giant screen films viewed	Hispanic origin	10%
	1	3%
	1-2	35%
	3-4	28%
	5 or more	34%
Highest level of education	Less than high school	24%
	High school degree	3%
	Some college	0%
	College degree	3%
	Some graduate school	38%
	Graduate degree	31%
Interest in unseen world (1 to 7 scale)	Not at all (1)	0%
	2-3	0%
	4-5	17%
	6-7 (very interested)	79%
	Median	7
Knowledge of unseen world (1 to 7 scale)	Know nothing (1)	0%
	2-3	14%
	4-5	65%
	6-7 (know a lot)	17%
	Median	5

<sup>50</sup> The 5% of individuals who left the Race question blank checked "Yes" to the previous question asking them if they were Hispanic or Latino.

## Findings

### Question 1: Who in the family drove the decision to see the film and why?

Most of the families that participated in the group sessions indicated that the children in their families were the key decision makers as to which film they would see, whether it was a matter of the child directly choosing or their choosing based on what they thought was in their child's best interest. Only a couple of families made the decision based on what the parents/guardians wanted to see.

When asked to describe their reasons for seeing the *Mysteries of the Unseen World* film the Viewers most often pointed to the film's: focus on the unseen world or science more broadly, diverse topic areas, and/or the attention given to unusual animals and plants or to time-lapse photography. A couple of families indicated they chose the film through a process of elimination as they didn't want to see the other film playing at Discovery Place at the time.

#### **Youth directly made choice**

Six of the ten families that attended the group sessions said that the children in their families were the direct decision makers, as follows:

- Two families ended up seeing *Mysteries of the Unseen World* as a result of the youth in each family choosing to see the film after researching the film online at home or through a smart phone prior to arriving to Discovery Place. The first family watched the trailers for the two film options featured at the science center at home, with the second option being *Great White Shark: The Truth Behind the Legend*. The daughter in the family preferred the variety of topics shown in *Mysteries of the Unseen World* as well as the focus on learning about new discoveries. As she and her mother explained:
  - *Mother: We watched the trailers for both movies at home before we came and she picked this one. And tell her why you picked this one.*
  - *Daughter: Because the shark movie was only about learning about sharks and this one was about learning about things that you never discovered before, about many things.*

The second family followed the lead of its 16-year-old niece who looked up the film options on her phone, and then chose it over sharks. The aunt explained, "I have family staying from out of town. A 10 year old nephew and a 16 year old niece and the 16 year old is the one that looked up Discovery Place and IMAX on her phone this morning and said, 'let's go to this one.'" When asked why her niece picked this film over the other the aunt elaborated, "When watching the film, it occurred to me that her grandfather on the other side of the family is a chemist that she probably does have a science gene in there, but maybe not, I don't know...it could have been the visuals she saw online, I don't know, we really didn't talk about it."



- One family decided to see the film at the science center after the son and daughter noticed and interacted with the *Mysteries of the Unseen World* kiosk (see image to right). Though the family didn't plan to see an IMAX film at the theater that day, the kiosk piqued their interest to learn more about the film which prompted them to walk to the nearby lobby area where the film tickets were being sold (see image below right). Here they in turn noticed the film poster and brochures which further increased their interest in seeing the film and ultimately help confirm their decision. The mother and daughter both described what they noticed as they looked at the poster and brochure:



*Mysteries of the Unseen World* interactive kiosk  
Photo by Knight Williams Inc.

- *Mother: Yeah, we didn't know we were going to see an IMAX, but we were like, yeah, this looks really cool. And especially the pictures on the poster where you see the images that you know are going to be in the film.*
- *Daughter: When I first saw it, me and my friend saw how it said *Mysteries of the Unseen World* and it kind of had me thinking: Is it animals and insects that we don't know about that are going to be discovered or is it about bacteria and stuff that is on us? And then to find out that there are animals and insects that we don't know of kind of has me wanting to research stuff instead of using my spare time to play, use my spare time to learn about these things.*
- *Mother: I really wanted to see the *Great White Shark* movie, but they really wanted to see this one and I'm kinda glad we did, because it's just like, oh wow, I am so clueless. She (her daughter) said, "This is a creature that we don't even know exists." It was actually the tick that you saw on the dog, it was on the brochure. I was like OMG what kind of creature is that?*



*Mysteries of the Unseen World* admissions desk signage  
Photo by Knight Williams Inc.

A copy of the film brochure the family referred to from Discovery Place is provided on the next page.

**DISCOVERY PLACE**

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**MYSTERIES OF THE UNSEEN WORLD**

PRESENTED BY LOCKHEED MARTIN

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# MYSTERIES OF THE UNSEEN WORLD



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Both sides of brochure from Discovery Place

- In listening to the discussion about the kiosk another set of parents asked their daughter to remember why she chose the film over the shark film and they referred back to the kiosk, noting that their daughter stayed at the kiosk for about 40 minutes "holding the iPads and using the microscopes to zoom in on stuff." The daughter agreed that the kiosk increased her interest in the film but didn't elaborate.
- For the final two families whose children directed them to the film, the families didn't describe the process they went through to determine which film to see but simply stated that their children made the choice based on the film content, with one mother explaining: "There were two and my son is very curious and I let him chose. He is much into science and we come from a family of attorneys and accountants. Every time

we go on a trip, we try to do one educational thing and I figured he would love this, and he did. He'll have questions when we leave." A son from the other family spoke on his own behalf, observing that the unseen world intrigued him: "I was the one with the movie idea. It was my option to watch it or not. I thought it would be interesting to see what I wouldn't normally see in just everyday life."

### Parent made choice

For the remaining five families, the parents, most often the mother, indicated they made the decision for the family, in each case factoring in what they thought was in their children's best interest or the family at large.

- The mothers of two families indicated they chose to see the *Mysteries* film through a process of elimination because they didn't want to see the *Great White Shark* film and elaborated about their thought process. One mother reasoned that her family could see the shark film during Shark Week, and that the *Mysteries* film seemed "unique." The other mother indicated her decision was made in light of a series of recent shark attacks off the North Carolina coast. The headline in the article to the right shows the types of headlines appearing in the news over the summer. Referring to her daughter she said, "I chose this over the great white because I didn't think the movie would be something that we...because we live near the beach...we've had a lot of shark issues on the beach this summer and I didn't want to see that because she would never get back in the water." She further added that the broad appeal of the *Mysteries of the Unseen World* film contributed to her decision as well, noting, "But I did want to do this because I felt it would range the whole age differences."



Example of an article on shark attacks that appeared in local Charlotte news station [WBTV](#) during the summer months

- In another family, a mother expressed that her son's interest in the unseen world was the deciding factor in her mind, such that: "I got the tickets, but my 6 year old is fascinated with all this germs and what is the unseen world and what you can't see with your eyes. Dust mites. And he would recognize so many of them. That's his favorite book. He will read it over again, and again, and again. He is fascinated with all that, and my daughter is getting into that too. We just had a summer camp in Discovery where she dissected so many animals, all organs, to see how it works and what happens and all that. So that's what I thought would interest them...when you say "unseen" it is automatic, like what is there that we haven't see? The title itself is very...it attracts you to it. It kinda makes you want to know more about...what is there? When you draw the curtain, people want to look behind."
- Finally, a couple of parents said they made the decision for the family to see the film because they personally wanted to see it, with the time-lapse material in the film being a draw in both cases. In one case a spouse preferred to see the film because the description of the time-lapse sections of the film on the film website captured his interest. His spouse explained her reaction to her husband's interest in seeing the film as she was concerned that *Mysteries of the Unseen World* would not be as pretty and photographically

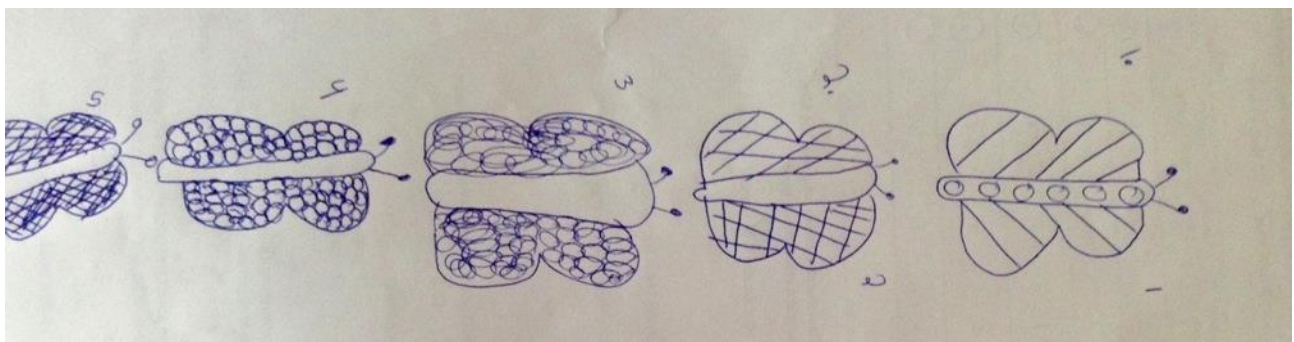
stunning as other IMAX films she had seen, though she was pleasantly surprised: *“One of the things I appreciated, so why I like IMAX, is visually because it’s pretty and the photography is stunning and the animals, and so that’s what I like and so when he suggested that we see this, I was like...hmmm...I don’t know if I’m going to get the experience that I like with all the pretty pictures, but it did a really good job and I was really impressed and really stunned at how artistic it was in addition to being scientific.”* In the other case the parents reasoned they could see a film on sharks in other places and were intrigued by the *Mysteries of the Unseen World* time-lapse content which a Discovery Place staff member praised while they were in line to buy tickets debating which film to see. The father explained, *“Partly because I felt I could see sharks other places, but when they mentioned time-lapse photography, I’m really into that. The girl selling tickets told us that.”*

## Question 2: How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?

To help break the ice and explore what Viewers noticed about the film’s visuals, the moderator asked Viewers to draw any visuals from the film that stood out for them. They were encouraged: to enjoy the drawing activity, to not worry about creating works of art, and to view the activity as an informal “ice breaker” exercise that would also give the producers some sense of Viewers’ visual impressions from the film. To accommodate anyone who might be uncomfortable drawing, the moderator also offered the option of using words or labeling their pictures for ease of interpretation. To this suggestion, a couple of Viewers qualified, while laughing, that they would draw pictures of visuals that they personally could figure out how to draw, as some of the film’s visuals were complex.

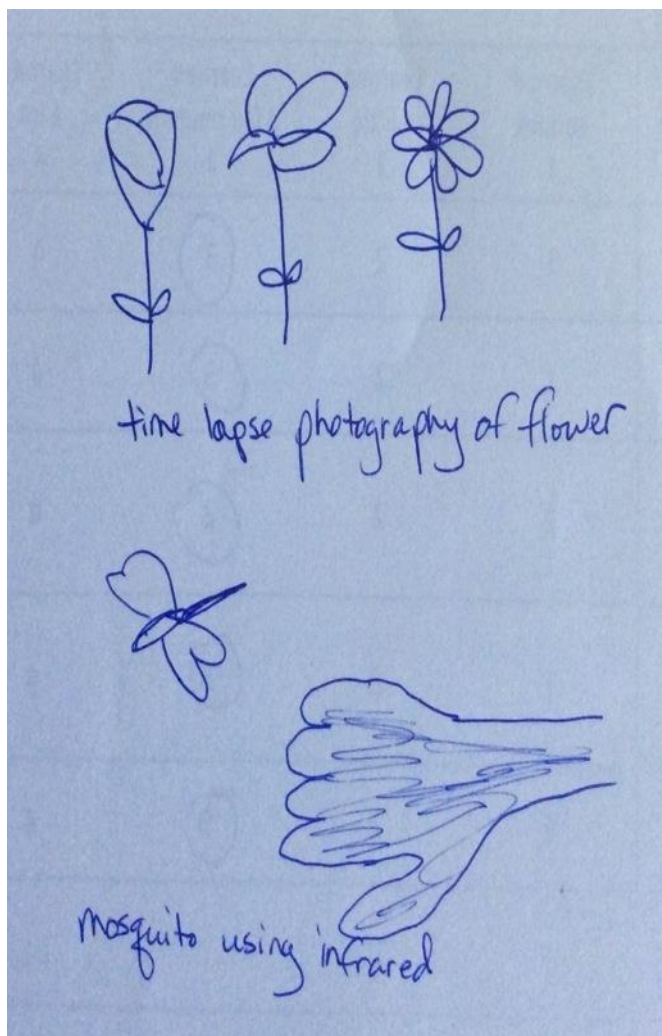
Both adult and youth Viewers seemed engaged in the drawing activity, with most commenting that they found it to be a “fun,” “creative,” “personal,” or “interesting” way to reflect on the film. While they were drawing their pictures, many Viewers observed that the film left a “strong,” “lasting,” or “powerful” visual impression on them and/or that the film’s visuals “sparked” new “curiosities” or “questions.”

To illustrate the range of drawings produced, sample youth and adult drawings are included throughout this section of the report, as in the drawing below by an 11-year-old who said she drew what the film showed her about: *“how electron microscopy could look deep deep inside the scales of a butterfly wing.”*

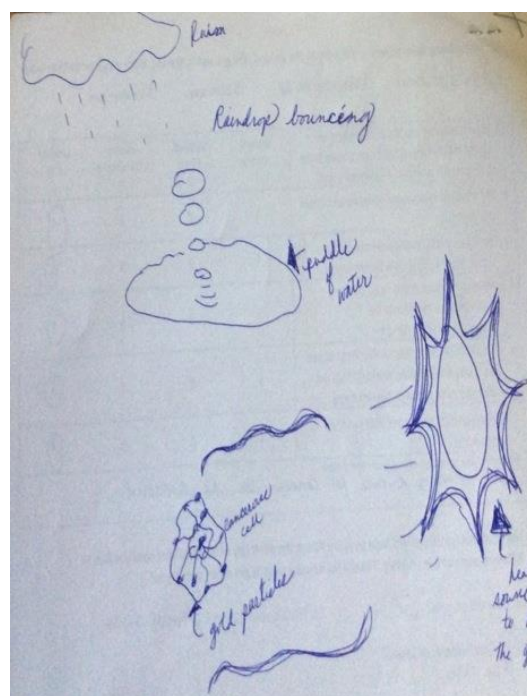


### Visuals that Viewers most frequently drew

The table to the right shows the 16 different visuals that one or more of the Viewers drew leading into the group discussion. No one particular visual stood out for a majority of the 29 Viewers; instead, Viewers choose a wide range of different visuals with 8 of these visuals being drawn by 10% or more of the group. Nearly one-third of the Viewers (31%) drew a picture of a raindrop hitting/bouncing in a puddle. A few Viewers each (14%) drew a picture of: a dragonfly, details of butterfly wings/scales, gold particles attacking cancer cells, an elevator to space, and/or a graphene/carbon tube. A couple of Viewers each (10%) drew a picture of: light waves and a time-lapse of flower blooming. One Viewer each (3%) drew a picture of: a lizard looking at a robot lizard, a balloon bursting from a push pin, a lightning strike, a strawberry decomposing, a spider climbing on spider web, a bee pollinating a flower, a mosquito using infrared vision, and hummingbird wings.



Visuals that Viewers drew from the film	
	(n=29)
Raindrop hitting/bouncing in a puddle	31%
Dragonfly	14%
Details of butterfly wings/scales	14%
Gold particles attacking cancer	14%
Elevator to space	14%
Graphene/carbon tube	14%
Light waves	10%
Time-lapse of flower blooming	10%
Lizard looking at robot lizard	3%
Balloon bursting from push pin	3%
Lightning strike	3%
Strawberry decomposing	3%
Spider climbing on spider web	3%
Bee pollinating flower	3%
Mosquito using infrared vision	3%
Hummingbird wings	3%

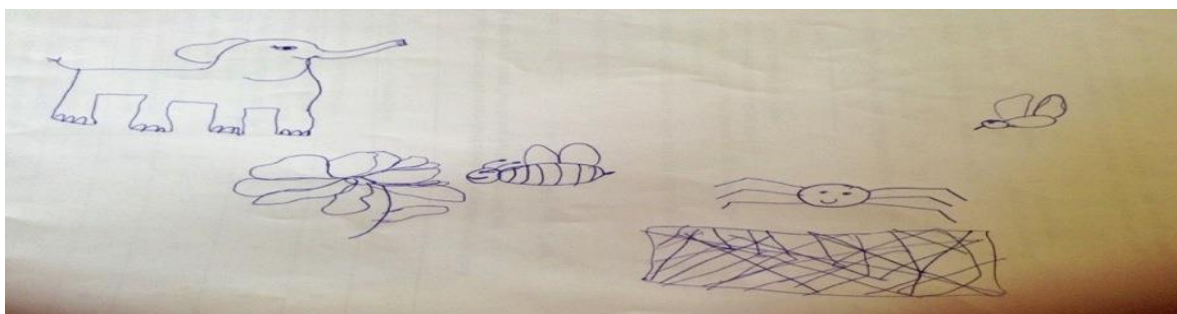
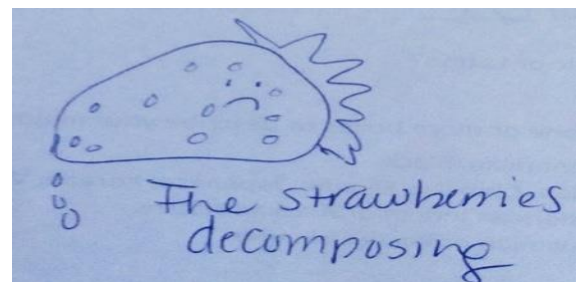
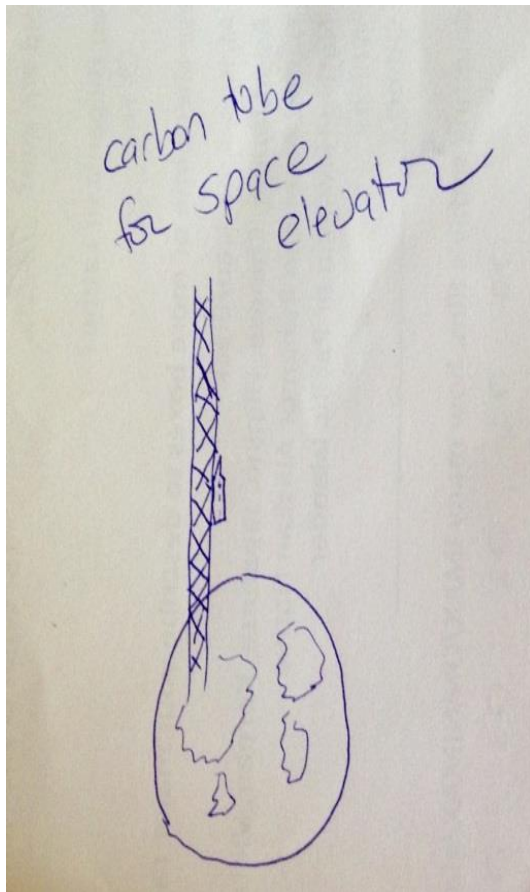


### Film sections to which Viewer drawings related

Each of the film's four sections was represented across the Viewers' drawings, but some sections were represented more than others. Two-thirds of the drawings related to visuals shown in the *Too Small* section of the film (62%), including the scenes about the nanoworld, compared to a slightly smaller group (58%) that related to the *Too Fast* section of the film (58%). One-seventh of the drawings related to visuals from the *Too Slow* section (14%) and one-tenth to the *Invisible* section (10%).<sup>51</sup>

### The film sections to which Viewers' drawings most frequently related

	(n=29)
<b>Invisible</b>	14%
Light waves (3)	
Mosquito using infrared (1)	
<b>Too Slow</b>	14%
Strawberry decomposing (1)	
Time-lapse of flower blooming (3)	
<b>Too Fast</b>	58%
Raindrop hitting/bouncing in a puddle (9)	
Dragonfly (4)	
Lightning striking (1)	
Balloon bursting with push pin (1)	
Hummingbird wings (1)	
Bee pollinating flower (1)	
<b>Too Small/nano</b>	62%
Gold particles attacking cancer cells (4)	
Elevator to space (4)	
Graphene/carbon tube (4)	
Details of butterfly wings/scales (4)	
Lizard looking at robot lizard (1)	
Spider climbing on spider web (1)	



<sup>51</sup> Note that some Viewers drew more than one picture, resulting in the percentages adding up to more than 100%

## **Overall visual impressions**

Most of the adults and youth indicated that the film as a whole impressed them visually. They variously described the film's visuals as: "to the point," "clear to understand," "stunning," "artistic," "scientific," "broadly appealing to all ages," and "unique." The Viewers also described their reactions to the film's visuals in diverse ways, ranging from experiencing an "emotional rush" to feeling like the visuals were "easy to follow," to liking how the film showed the "inner workings or movements" of everyday phenomena, to appreciating that the visuals weren't "scary," although a few youth and adults alike observed some images like the germs and eyelash mites were "gross" or "creepy." Others observed that the visuals offered them "a change of perspective" or allowed them to more easily "relate" to what was being shown or reflected that some images lingered and/or "stuck in their minds." A sampling of the Viewers' comments included:

- *Female adult: The visuals were very, very to the point. It was great, it was very clear to understand with the story that was being told. It was easy to follow.*
- *Female adult: It made me a little bit motion sick and thank you for not making this scary. My little guy said, "It wasn't scary at all." We were a little bit nervous about that.*
- *Female adult: I did think it was cool that it does appeal to a lot of ages. I got a lot of it, he got a lot of it, and I imagine she, at a younger age, got a lot of it. It definitely appeals across the board.*
- *Female adult: You're surrounded by it (the giant screen), and it enables you to get almost an emotional rush. Like with the very quick movement of the dog. Okay, I see a dog and I can relate to that and I have a context for it and then the quick zoom in. It's almost like a shock value point of view that makes it stick in your mind a little bit more than just showing it before you see the dog and have that quick zoom.*
- *Female adult: (Referring to water drop and balloon popping) That was one of the few parts of the movie that was actually really slow and focused on one thing for a long period of time. If you think about it, it was just one image over one period of time*
- *Male adult: One of the words that I put in there was that I liked the change of perspective. That we get so stuck in what we can see and so changing that and all the different lens that they provided in the film was really eye opening.*
- *Male adult: I thought that even if you didn't learn anything, you didn't find anything interesting; I thought it was visually stimulating enough. That you could just enjoy the visuals alone and that adding the science on top of it was better. They (the visuals) are very unique and they seem very high quality. You are seeing something you don't see every day.*
- *Male adult: I really liked the slowness of everything. Like the dragonfly, I think I caught a glimpse of some of that. It kind of increases your curiosity with everything else. I always like to see how things function, but you can't see everything function when it is so fast. You can't grasp it. So that was nice.*

## **Experience of viewing on the giant screen**

Several adults discussed the experience of watching the film on the giant screen, which at Discovery Place was in a dome theater. Some Viewers raised negative experiences, although no one issue stood out as a problem among the Viewers as a whole. These issues, raised by a few Viewers, included that the film seemed "out of focus," "blurry," "dark," "overstimulating," or "motion sickness" producing. Other Viewers, meanwhile, felt the giant screen experience was bearable for them, with one Viewer describing her viewing experience as "tolerable" compared to other giant screen films that often "throw things" at the audience. More often though, Viewers felt the giant screen experience "maximized" and was "central" to their enjoyment of the film's visuals. One Viewer described that she felt like she was "there and that she was moving the whole time" while another observed that he appreciated the long "lingering" moments that allowed Viewers to "experience" and even "study" what was happening, as in the high-speed photographic examples of the rain drops bouncing on water and the balloon popping. A number of Viewers similarly pointed to appreciating that the images "zoomed in" or

“surrounded” them which gave them a real sense of “detail,” “context” and/or “scale” and even an “emotional rush.” The range of Viewers’ comments on these themes included;

- *Female adult: Felt the picture could have been a little brighter, seemed dark to her.*
- *Female adult: It definitely took me awhile to get used to it. I think people try to be overstimulating and I’m much more of a fan. I’d rather be peacefully stimulated than images constantly. I can do it, but it’s hard and I worry about my kids and they’re constantly getting this from everywhere, even though they may process this kind of movie better.*
- *Female adult: Yeah, but I have to say comparatively to some of this stuff that I can’t even see today, like there is some things that I can’t even watch because, to your point, they just try to throw stuff at you. But this I found at least there were several lingering moments, they were big too. Like that bee thing, I have horrible eyesight, so I just assume it’s me, so it was hard to focus. And at one point I told my 5 year old, look at the bee, focus on that, because she was...we were all getting used to it initially. There were a few things just constantly coming at you so they just think...the more being thrown at you visually. And to me, it’s painful. Like I can’t even see it. This was better than some I’ve seen.*
- *Female adult: I think this means of disseminating the information, you couldn’t understand the same thing if you were reading a book or at least not nearly as easily or with listening to someone talk about it. You can hear someone say over and over again that there are microscopic organisms and try to explain in great detail what they look like, but actually being able to see that is very valuable.*
- *Female adult: I think for me, it’s like [someone else in the group] said, when they show the dog and then you go down to the flea, it kind of shows you that you have this big concept and they make you break this big concept down into the complexities by going into the tip and you see the flea. The next part about a cake. It’s not just that you’re eating a cake...Hey, you have a cake...Oh, a dog’s there, sweet, but then it goes down into...oh wow, that’s my kind of cake. And then you just see all this other stuff and you think, oh wow. There is just so much that you didn’t understand that was there before you. So when it shows this big picture and then it gets to this idea underneath it, it kind of opens your eyes a lot more.*
- *Female adult: I felt like I was moving the entire time. I think it was the dome, but it made you feel like you were in an airplane and you are looking over the city every time it showed you where everything was. And it was pretty cool. It was a bit of a combination (dome/film), but I felt it was more the movie this time, which was pretty cool. It kind of put you more in the film. Instead of watching a movie you were more interacting with the movie, it was cool.*
- *Female adult: I felt like the picture could have been a little brighter, and maybe that’s part of the blurriness of it. I felt it was kind of dark to me.*
- *Male adult: It was my first IMAX, but I felt it was out of focus—blurry. Like the “blurry bee” flying down to flower.*



## ***Images that stood out***

Across the groups, the Viewers pointed to a wide range of different visual images or sequences that stood out for them, some of which were the same as those depicted in the pictures they chose to draw, though many Viewers also described other visuals. The air traffic/flight patterns, dragonfly, and elevator to space visuals were each mentioned by several Viewers. A few Viewers mentioned visual sequences that showed how animals use light waves, the flea in the dog's coat, or the use of nano gold in nanotechnology. Individual Viewers pointed to the following additional visuals: the balloon popping from the push pin, seeing microorganisms in action, the animation of nano gold used to treat cancer cells, the water droplet bouncing in a puddle, the strawberry decomposing, the animation of atoms moving, and the gecko robots.

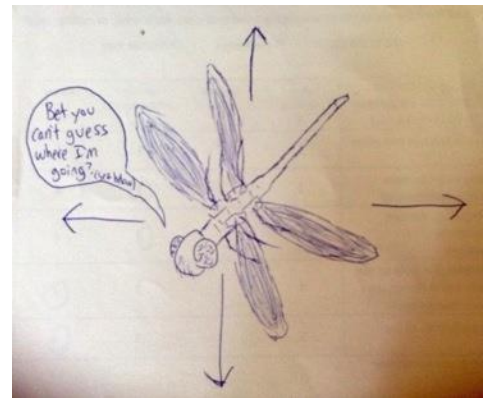
Examples of how Viewers spoke about each visual are provided below:

### Air traffic patterns

- *Female adult: I visually really appreciated the flight plans over the US as they drew back and showed you how they looked from a high level. That made a huge impression on me.*
- *Male adult: I really liked the map of the US and Europe where they were showing the patterns of ships and flight patterns.*
- *Male adult: The trajectory of the US and the planes, that was amazing.*

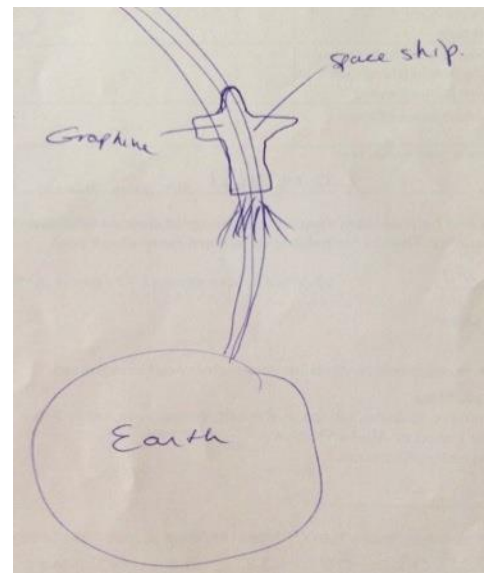
### Dragonfly

- *Male adult: I drew the dragonfly.*
- *Male adult: To dovetail off of the dragonfly thing, that's the one I ended up drawing too, that along with some of the subsequent images they showed, showing the air patterns around the various wing types. I thought it was really useful.*
- *Male adult: I really liked the slowness of everything. Like the dragonfly, I think I caught a glimpse of some of that. It kind of increases your curiosity with everything else. I always like to see how things function, but you can't see everything function when it is so fast. You can't grasp it. So that was nice.) And I didn't know that a dragonfly uses two wings and how they were incorporating that into the other thing.*



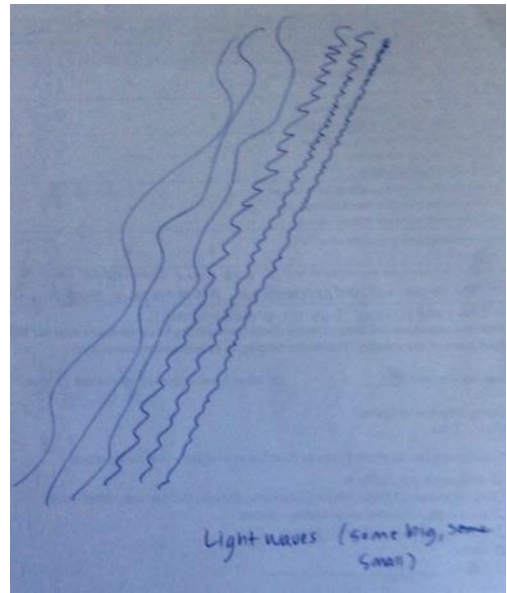
### Elevator to space

- *Female adult: For me it was the elevator to space. It was fascinating. And I kept wondering, are we going to see it in our lifetime? It was just fascinating to know that we are just living in an age where humans are already talking about that. That was something different.*
- *Female adult: I drew the space elevator, probably because it was one of the last images I saw and it was in my head.*
- *Male adult: I thought it was awesome. I want to ride the elevator to space.*



### Light waves

- Female adult: Sitting there with the kids, I love the first thing they started with, what you visualize, the visible lights then how it goes into the brain and the nerves and all that. Being in the medical field, I'm like, okay, wow, I'm getting that but the kids are now seeing it. This part was easiest for all ages to understand. Maybe my 5 year old got lost, he had motion sickness, but it was fascinating for him too. I told him to close his eyes, but he wouldn't.
- Female youth: It kind of showed me that you can use...your eyes are basically...you can use your eyes in different ways. How bees use their eyes to see is it hot or is it too cold and mosquitos do the same thing. If it's very, very hot then there is more blood. If it's cold then it doesn't have much blood. So basically in the video it showed that they are going to try to find a way where you can see, like there's scales and stuff, very, very, very closely. Because when you go very close now, it starts to blur up.

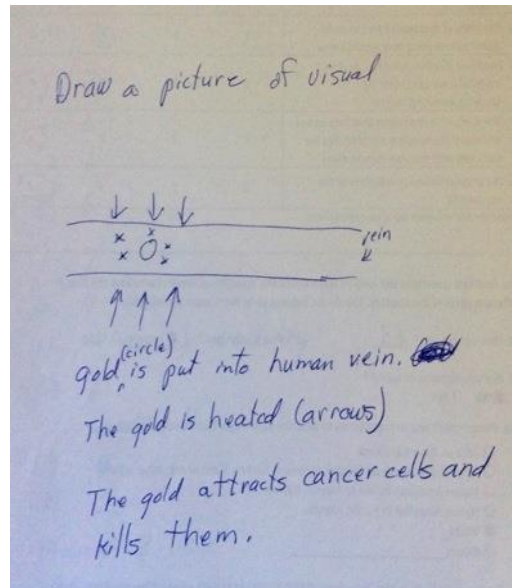


#### Flea in dog's coat

- Female adult: Dog. Value of showing big picture then going in deeper to the idea underneath it opens your eyes a lot more.
- Male adult: I like the way it went from the dog all the way down to its skin, hair or the flea with real quick movement. That was pretty cool. The way it was done.

#### Nano gold

- Female adult: I drew something easy. The gold that is inserted into veins then heated that kills cancer cells. So in terms of oh, this is something that can impact my life or a family member's life in the immediate future. There were some other visuals, like the small stuff that was really interesting, but that one was easy to draw and I could see it would have an immediate impact because I've lost parents. And as you can kind of tell by the gray hair, that I'm approaching the age where I hear more and more that people my age with cancer.
- Male adult: And I like the concept of using gold. I mean all we know about gold is that it is a precious metal, but you can change it into different things. Like with nanotechnology and use it for treatment and stuff, so that was nice. So, I learned a lot.



#### Other

- Female adult: I think for me, it was as simple as a strawberry decomposing. We buy strawberries 3 or 4 times a week and you buy it one day and the next day it ripens.
- Male adult: Mine was the fact that we can move atoms physically. That seems like it is a never ending, limitless opportunity, that you can do things with that. Just that they are able to do that and that we were able to watch them do that.
- Male adult: That water bubble was cool. I remember that, that was one of my favorites.
- Male youth: The Gecko looking at the robot. It was kind of the way they showed it and I didn't know technology could do that.
- Female youth: I liked the part where they popped the balloon in the water. I liked how the water was still in the shape of the balloon. I liked the part where they popped the balloon in/over the water with the tack.

## Question 3: What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?

About two-thirds of the Viewers eagerly identified new questions or curiosities they had about the world around them as a result of watching the film, while the remaining Viewers most often suggested that the film needed to “settle in” a little longer. Those who shared new questions or curiosities most often pointed to an area of nanotechnology applications, particularly involving: the overall possibilities and precautions, the use of gold at the nano level for developing medical treatments, and moving or splitting atoms. A few Viewers pointed to other areas of interest relating to electron microscopy or making or using animal robots.

### ***Nanotechnology applications***

More than half of the Viewers indicated they had new questions or curiosities related to content in the nanoworld section of the film. Their comments most often focused on the possibilities of using nanotechnology, including the use of gold at the nano level for medical treatments, the composition and uses of graphene and carbon tubes, the applications for space travel, and what is currently possible in terms of moving and splitting atoms. Several adults also raised concerns about the ethics of nanotechnology and the relative benefits to humanity. A few individuals also commented on wanting to know more about other topics such as the types of colleges that offer nanotechnology coursework. A sampling of the Viewers’ comments on these themes follows.

#### *Possibilities vs. precautions of nanotechnology*

- *Female adult: A sense of accountability. The more we know about what we can do with technology, then knowing how we are using it and making sure we are using it in the right way to benefit humanity. Which is something, I think, which is a takeaway for me. Still, watching the film prompted that kind of response.*
- *Male adult: I think they could have made the video a little longer and explained things a little bit more. I wanted more of the nano. Let me see more of the stuff we may never see again. Explain a little more of that.*
- *Male adult: I don't know if this is so much a question, but tagging onto that, but from a non I have a kid going to college perspective, not that it's not extremely valuable. I'm a technologist as well, but for the average adult, who sees this film, how do I come to appreciate more of each of these various scientific application areas, nanotechnology, the obvious one, but the other ones as well? To appreciate better where our investments in science can pay off for us even if it's not necessarily just education, but other application areas as well, because I feel like that's one of the things that suffers from a funding perspective, not just with education, but even investments we're making in R & D. A good example that popped into my head was when we started to pull back a little on our Space & Exploration fund. These are other areas that might potentially be at risk and so by enhancing that understanding people can raise those concerns to whoever their representatives are hopefully, and make sure they are not on the cutting block.*
- *Male adult: The Nanotechnology, in general, and the different uses it can have and I think we're just on the brink of it, touching the very basics of it right now. Where can we go with that and what have they done with that so far? Nanotechnology and the different uses it can have and wondering how far we have gotten.*
- *Male adult: With stuff like this, things I want to look for are things that I can learn more about that just inspire incredible change. The way we do it, the world, and I'm beyond how we would go about that, but this is what is really resonating with me. Gosh, look at the possibilities. Cancer, medically, clogged arteries, all that wonderful stuff, but also space, and travel and energy and strength, and materials. Look at all we can do, why are we spending trillions on weapons?*
- *Male adult: We love the potential of what we can do. That's where I would almost want to chart the dreams of the future. The dreamers are the ones that can change the future for you. That would motivate me more, more, more. Whether it was the bugs, or the waves, or how I can do this, or how I can cure cancer. Those things are phenomenal.*

### Use of gold at nano level to develop medical treatments

- *Male adult: I like the concept of using gold. I mean all we know about gold is that it is a precious metal, but you can change it into different things. Like with nanotechnology and use it for treatment and stuff, so that was nice. So, I learned a lot.*
- *Female adult: With the gold part of medicine, I'd like to know how far they are, have they started to do trials, etc.? That's where I would be at a dead end. I'd probably start with Google, to find out where to go, find the next step. Maybe make a couple of calls. My mom, she went through the cancer, and my sister has Cerebral Palsy and this is something I always debate with everyone, with all this technology there has to be...you know how with the gold it can attract the cancer cells? There might be a future possibility that science can come up with that can connect all the brain, because that's what it is about, Cerebral Palsy. The brain connections are not there. And it can be fixed, so I've been always curious about that.*
- *Female youth: We're studying nano gold in Chemistry (high school). I like the Iodine 131, to treat thyroid problems. It's a non-invasive way to identify and destroy cancer cells. I want to know more on infrared technology and gamma radiation. Only a small part of film was dedicated to this, and we learn about these now in chemistry, so I would like to see how that could be adapted to the real world.*

### Moving/splitting atoms

- *Female adult: Makes me want to stay more up to date a little more than I have been with a lot of things regarding science in general. Especially when you talk about splitting an atom and even splitting open electrons and how minute it is. Going further than, I guess what people have thought possible before.*
- *Female adult: That's exactly what I thought when they showed moving that atom. Why do we not have a cure for cancer just yet? Is this what they are trying to do with beginning to move the atoms around and the gold particles? Wow, we're more advanced than I realized. I didn't know we could do these things to this level.*

### Graphene/carbon tubes

- *Male adult: Graphene, I want to know more about Graphene.*
- *Male youth: I was wondering how they made the carbon tubes? I don't really see how they can make them as strong as steel, but still have them rubbery. I would probably Google it to begin.*

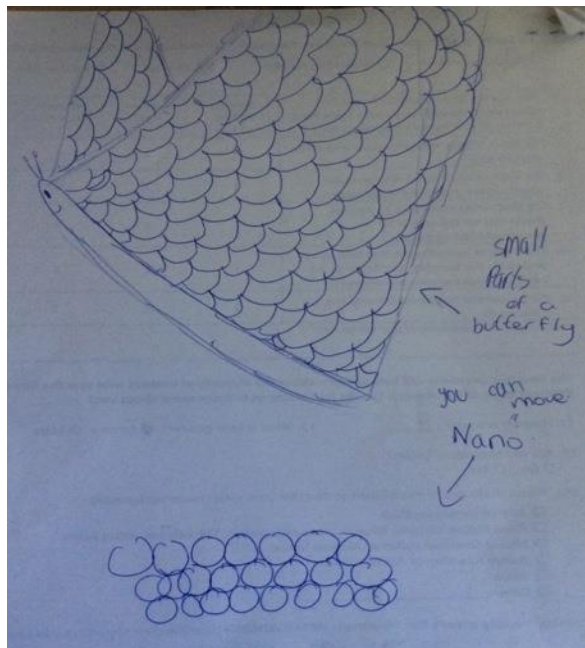
### Other

- *Female adult: I'm helping her try to figure out college, so that immediately set up in my mind to look that (nano gold) up to see if I can find out more information. Trying to figure out colleges and who offers the type of education you'll need to do that type of job.*

## **Electron microscopy**

A couple of Viewers, one adult and one youth, raised curiosities or questions related to the *Too Small* section of the film, with the youth wanting to know more about seeing deep inside the scales of butterflies and the adult wanting to know about how electron microscopy works.

- *Male adult: And they even went into electron microscope. They said it fires electrons. Well, how does that work? It went right into showing pictures, and I'm good with that, because I wanted to see what the electron microscope sees, but I'm the type of person...I want to know how it works. A little more detail. Make the video a little longer and put more detail or more explanation on the different parts.*
- *Female youth: Butterflies. I want to see about what they look like inside, deeper inside the scales. I would do a bunch of research. I would get all that I already know and then try to find out more about it on different websites then gather it all together*

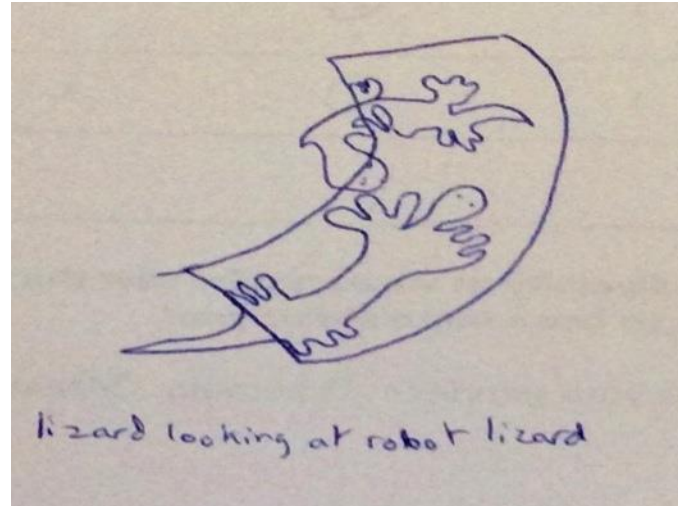


## **Making or using robots based on animal designs**

Two youth focused on the idea of wanting to know more about making or using animal robots.

➤ *Female youth: So now I realize that some kids don't like to learn, but this is like a fun way of learning, but kids think they're not learning, but at the end of the day they realize they learned something new without learning, with learning during the movie when they think they weren't. So when I go home, I want to see, like research this, to see if we can make this, or how to do that because one of my (friends) he made a computer, just by making parts and now, since you can do that it makes me want to make this just by looking at that. Like robots, and animals. Like making robotic animals, like how they said they want to do with the gecko. How they want to make a robot gecko that can climb on anything. So I think I might want to start making stuff like that compared to animals.*

➤ *Male youth: When I was watching the movie, I was thinking about all those robotic stuff they made and I was wondering about the animals and I was thinking about some stuff. Not just using them for other stuff, which is really good, but I was thinking about using them in fun ways, such as making gecko gloves and boots to go rock climbing. Using robotic dragonfly wings as a jet pack or some sort of way to travel.*



## **Other**

- *Male adult: I was intrigued by the light rays, especially by the gamma rays and how they can see through the walls and see what you're doing. I'm sure there are people in there right now. I'd probably Google that.*
- *Female adult: I think for me it was just more inspiring about things I probably wouldn't have, topics I wouldn't have, thought about introducing to my 3 and 5 yr. olds, but that they picked up on and had questions about so now I might be more apt to go look for other things to kind of help teach, feed their interests on it.*

## Question 4: How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?

Viewers mentioned a variety of different ways they would go about seeking information on new questions or curiosities the film raised for them. Most were able to come up with at least a starting point, although a few Viewers said they weren't sure how they would frame or direct their search. Those who listed a starting point most often described turning to: online searching, Google searches, National Geographic resources, science-based publications or websites, video or film resources, and/or their local library.

### **Online searching/Google**

Most often the Viewers, both adults and youth, indicated they would go online, as in *"I would get all that I know and then try to find out more about it through different websites (online) then gather (information) together"* or *"Could be resources online to delve deeper."* Several Viewers specifically suggested they would "Google" their question as in *"Would probably Google it"* and *"That's where I would be at a dead end. Start with Google, to find the next step."* One high school student further elaborated that her classmates *"would Google the hashtag before they Google the actual movie title."* A male adult indicated he would also conduct a hashtag search.

### **National Geographic resources**

Several adults pointed to National Geographic-based resources, both online and print based. A few specified the film *"may"* or *"should"* have additional information online, as in: *"They may even have that information if you go onto the NatGeo website"* or *"The film should have provided information as to where they can find more information, links."* Another wondered if the film had something *"on the website to share on Facebook."* A couple of adults pointed to print-based options, including the *National Geographic* magazine or *"a handout."* One female adult reflected about the magazine: *"I've always said I would subscribe to National Geographic magazine when I retired. And it was like, yeah, this is why I keep saying this is why I'm going to subscribe to National Geographic when I retire. So much to know."*

Related to the National Geographic online resources, a Viewer in one group noted that she did visit the film's website and suggested that it would be even more appealing with greater interactivity, as in: *"Especially if they plug it with, not necessarily experiments you can do, but I think people like manipulating, so if you can click a zoom button so you can control what you are seeing to some extent. Stuff that's fun and hands on, especially for kids. Like maybe they have the microscope and they get to move the atoms, stuff like that would be pretty cool."* A Viewer in another group noted that he wouldn't have thought to go to the website, reflecting: *"I've always assumed National Geographic, to be more of a, I guess that was from childhood. In the magazines you look at, all the animals and things in different parts of the world, not necessarily scientific oriented."*

Although the discussion was not geared specifically to a consideration of the website, a few Viewers in each group added to the conversation that they hadn't thought about searching out the film website on their own accord, but might have if the film or ancillary materials (e.g., signage, brochures, kiosk) drew their attention to it. In one group, the discussion moved toward the use of social media to promote or extend the film's impact through tagging, as the follow exchange reveals:

- *Male adult: That was one of the comments I put was that they should have provided stuff on where you can look for more of this stuff. I appreciate the fact that it was quick and maybe it couldn't go into details because maybe*

our knowledge level, it would take too long to explain, has to keep it interesting, but it would be nice if you had links or some other area you could go and look.

- *Female adult: Like a handout.*
- *Male adult: I think especially with what media can do today. I think that anything that can supplement that experience, to his point, if I want to dive off into nanotechnology or into the dragonfly wings or whatever. There could be resources online that could go into those that are probably at a lower cost of production, but pieces that will allow you to dive in a little bit more would be extremely valuable.*
- *Female adult: And they may even have that information if you go onto the National Geographic website, since they're the ones that produced it.*
- *Female adult: But they don't really tag it?*
- *Male adult: And even from a social media perspective to tell people that hey, I just saw a great documentary, go see it. Is there a hashtag?*
- *Female adult: Or maybe they have something on their website to share on your Facebook.*
- *Female adult: Most people probably know, but if they're going to put the money into it, put the tag on it.*
- *Female youth: That's how everybody at my school finds it. They Google the hashtag before they Google the actual movie title.*

### **Science based publications or websites**

A few adults suggested they would turn to one of the following science based publications or websites: "Scientific research website or facility," the "Discovery Website" or "Popular Science" magazine.

### **Video/film resources**

A few adults pointed to video film options they would check out including: "Netflix documentaries," "TED Talks," or "YouTube videos."

### **Local library**

Finally, one mother mentioned that hearing her daughter's comments about making robots made her think about taking her kids to the library to continue the learning process, to which other parents in that group agreed this was a good idea.

## Question 5: How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film?

In three of the four groups, there was time for a final question about the film's use of human characters. Overall, some Viewers appreciated that the characters added context and relevance to the film's focus on the unseen world, others suggested that the film might have leveraged the characters further or strengthened their relevance to specific scenes, and a few Viewers generally observed that they personally didn't experience a connection with the featured characters.

### **Characters added context and relevance**

Several adult and youth Viewers reflected that the human characters provided "context" and/or "relevance" for the content that was featured and that it helped to promote the idea that they were watching a story unfold. Some of their comments included:

- *Adult male: I think in certain instances it helped set the context for what you were looking at...okay, this helps me understand better what the setting is.*
- *Adult male: I thought there was a lot of information given to you, a great amount, but it was grouped together well and segmented everything. There was one that was "too fast", "too slow", "too small" and I thought it was grouped together very well. You were given a good wealth of information, but it wasn't thrown at you too much, it was kind of weaved into you very simplistically. There was the story with the whole apartment building people and them moving around and doing that. I thought it was just grouped very well together as far as the delivery of the information."*
- *Female youth: It kind of made it more of a storyline rather than a documentary. By the scene changing, it kind of gave you something new to look at instead of this plain documentary.*
- *Female youth: Yes, there was enough relevance without making it overly about the people.*
- *Female youth: It was more to make the storyline relevant, then it's more to say that's mom, dad, brother. It made it feel actually relevant because if it's with them, then it is obviously going to be with me. Kind of like the mysterious world.*
- *Male youth: I thought the boy and the fire truck was funny.*

### **Could have leveraged characters further or strengthened relevance**

Several Viewers reflected that they felt that the film could have gone further in leveraging the human characters or at least strengthening the "relevance" of the human characters in specific scenes. Some Viewers didn't see the role that the characters played in demonstrating or transitioning the film content's about the unseen world. Specific scenes they commented on involved the skateboarding scenes, the boy nearly hit by the fire truck, the picture of head lice, and the transition from showing the slime mold. Some of their comments and suggestions included:

- *Adult male: They could have leveraged the characters more. I really liked the African American gentleman. I felt I would have been more engaged had they been more involved in the story. I learn better that way. I like stories.*
- *Female adult: I agree. Felt like it was a forced element. I remember the family, woman and the mother making cake or doing something earlier in the film, and then they brought it together at the end with everyone sitting at the table, but I just felt like it was forced and it really didn't teach me anything, so I felt like it was losing valuable time.*
- *Female adult: Maybe a bug on the skate and you know how they talked about bacteria on your eyelashes...zoom into the eyelash...to start off and then one of them falls. They might do something like that. Or*



- a scrape and then goes into the skin. I think because we were so engrossed with all the other stuff that was going on, I don't even think that people related as much to those actors as they did to the subject matter.
- *Male youth: I didn't think they needed to be in it, because I only saw one thing that helped go with the story, which was when the skateboard kid almost got hit by the fire truck. So the scene part. Other than that I didn't really see why they would need to be in that.*
  - *Female adult: I didn't think they were that relevant to what was going on. I thought more was going to come of it—like you were going to show me something cool with the skateboard.*
  - *Female adult: The kid who almost got hit by the fire truck got a reaction from my 3-year-old. We're in the middle of teaching him how to cross the street, so for him it was highly relevant material.*
  - *Female adult: I think they were talking about head lice, or something. I think they had a really zoomed in picture, which is really awesome, but if they wanted to connect it to the people, then zoom out and have it on someone's head. Like they did that with the dog, I think. The dog walked on something that was super magnified and then they zoomed out to give it relevance to everyday life.*
  - *Female adult: They were talking about the slime mold and then it showed a woman walking her dog but it never really, like for her age, I don't know if she would have made the connection that by the dog or the human walking over those, that they took it somewhere else at a 7 year old age.*

### **Didn't feel connection to characters:**

While recognizing the role that the human characters played in the film a few adults qualified they personally didn't feel a "connection" to them, as follows:

- *Female adult: I didn't feel connected. I felt like an outsider looking in on their experience, which wasn't bad. But, if interaction was what the film was going for, I didn't get that.*
- *Male adult: There wasn't a connection to the individuals.*
- *Male adult: I didn't really feel any connection to the people. I thought, for example I think there was a scene where they were skipping a rock. I was like, oh, that's an example of them slowing something down. Like it was a way to give examples of what they were talking about. It wasn't so much connecting with the characters.*

One group debated about the relevance of connecting with the characters, as one Viewer suggested that connecting with Viewers wasn't their role and instead the focus was on the unseen world. They exchanged:

- *Female Adult: To be honest, after the first visual stuff, I don't think I really paid that much attention to the people. Like when the kids were skate boarding, I'm thinking where is this taking me? If you're talking about too fast, is it where the wheels are going to go with the ground or, what is happening? The kids just didn't...I'm not even paying any attention...I'm thinking about the clothes they're wearing. Are they taking you into the fabric? That was my visual. It's like where are they taking me next. The kids, yeah you came and they were just gone. It was more like, my head was going, what's next. They were people, it was more the surroundings where I'm like, okay, something is going to happen somewhere. Yeah, they were just there.*
- *Male Adult: You could have done without it.*
- *Female adult: If they are trying to make the characters significant for this film, no.*
- *Female adult: But they shouldn't have been.*
- *Female adult: Right, because it's the concept of the unseen world. To us, people are seen. It's everything else that is minute that we are not seeing on a daily basis. We all see, we have eyes, different colors, different hairstyles, this that, clothing, we ignore that stuff, right? That's what we are taught to do a little bit too. And then you look at the little things and when you see the title, that's where you want to go to see something else.*

## Question 6: Did Viewers have any other feedback on the film that they would like to share?

When offered the chance to provide any other feedback on the film, the Viewers most often focused on two issues: 1) their wishing the film was longer or 2) their feeling that the pace was too fast in places. A few Viewers also mentioned something relating to: the introduction being too long or unclear, the film being useful to youth looking into different careers, and/or the film having relevance even to young children.

### ***Wished film was longer***

Viewers in three of the four groups made comments about wanting the film to be longer. Most often they elaborated that they felt they wanted additional depth on specific topics rather than an overview of many different topics. One group had the following exchange:

- *Male adult: I liked it. And I agree, I think they could have made the video a little longer and explained things a little bit more. A little more detail. Make the video a little longer and put more detail or more explanation on the different parts.*
- *Female Adult: But you could run 4 different movies. One on the too small, one on the too fast, one on the too slow. And I would almost think to stay to watch all three of them and maybe take a break between one or two of them, but if you had them all at the same museum I would come and see those parts.*
- *Male Adult: Or a different medium, or you would have web episodes, or you would have TV episodes or other ways of doing it, because the whole goal of this is to get the general public to see and exposed to things you weren't familiar with. Nanotechnology. Oh look, that's kind of cool, let me go figure out a little more about that.*

Another group had a similar exchange:

- *Male adult: I thought there was a lot of really good concepts that they had presented there and it's a forty minute film, so you're not going to go into details of a whole lot, but it would be very cool how they always look at tie ins from hashtags, or twitter, or whatever that they would say, oh, wouldn't it be great if we got enough feedback from people that would say, hey, I'd love to learn more about ultraviolet light with the animals. Let's do a 30-minute show on that topic. Whatever came back from the high results from whatever they were.*
- *Male adult: I think it was great, but I think it lacked depth for certain things. I think it was great for the bits and pieces of what you can do. It was a basic overview, a brief summary of what unseen things there are. I would love to go into more depth. There are so many topics in there.*
- *Female adult: I agree. That's what it is. There were so many deep topics together, but each topic has so much depth and for us, as humans, we have so much to learn. It's like we are barely scratching the surface. So, it would have been so fascinating if they would take each topic and make movies on each, just that topic alone. So this was a good taste. It was more like a trailer of what's coming up next.*

Following this exchange most of the group members agreed they would be willing to watch a forty minute version of the film on a specific topic, such as nanotechnology which was suggested by one Viewer in the group.

A few Viewers in other groups elaborated on what more they would have liked the film to cover, as follows:

- *Male adult: I know each frame is expensive, and it wasn't a complaint, but I would love to see more. There were so many little areas where I felt like if you had dove into that, I don't think the film would have suffered at all and I think it would have enriched it. I get that there's a price to that.*

- *Female youth: I would like to see them do more on infrared technology and gamma radiation, that sort of thing. Only a small part, portion, but we even learn this in chemistry now, so I would like to see how that could be adapted to the real world. Cause otherwise it's just there.*

### **Pace seemed fast**

A few Viewers across the groups commented that the pace seemed too fast in places, as the following comments reveal:

- *Female adult: For me, I thought the pacing was a little too fast. I thought it was a lot of great information. But I think even as an adult, and I was familiar with the concepts so it wasn't new material for me, but I still thought it was, from concept to concept, a little fast to kind of get it and reinforce it and then move on. I still picked up way more than I thought, or knew more than I thought I did.*
- *Female adult: It continuously moved, so you couldn't get bored with it. It had a good pace. Some of it was too fast when they were talking about different ideas or information, by the time, or maybe because I'm older, by the time you'd let that sink in, they'd already moved on to the next thing, so I don't know if it was the dome. You're trying to look here and there and everywhere and just to kinda absorb it. Keep?*
- *Male adult: I thought that one that particularly stuck out in my mind, was when they were discussing the nanotechnology capabilities and creating cancer-eating machines. It was like as soon as I was beginning to process, it was like okay, moving on.*

### **Introduction unclear or too long**

A couple of Viewers felt that the introduction was unclear, unfocused, or went on for too long, as in:

- *Male Adult: I think the introduction, in the beginning took too much time. We could have used that to enforce the material that we learned at that time, almost kind of save time at the beginning and paced out the rest of the movie, the rest of the information. That would have been better that way, because at one time I was kind of zoned out and that was just the beginning, it was too long.*
- *Female adult: I couldn't tell from the beginning where we were going with it, and then you get into the pace of it and you're like, oh, we're going to learn about these different things. So I think the setup could be half the time with a lot more clarity around it and say, okay, we're going to go into these areas and then we could say okay, so I think that's a good point. I think the setup could have some more clarity and brevity. I was unable to see where it was going. The intro could be half the time with more clarity and more brevity.*

### **Career possibilities for youth**

A few mothers noted that the film caused them to think about careers for their children based on the film content.

- *Female adult: I like the movie from the standpoint of a parent. I have one getting ready to go to college and one is in elementary. And the possibilities from that movie, because of the possible careers, this exposes them to new views and new ideas. So it opens their world up to know that there are other things out there that they can start dreaming and exploring and figure out where they want to be when they are in a job.*
- *Female Adult: Especially for younger, because when I was Emerson's age I didn't realize I could get a job in microbiology until I ended up in my 2<sup>nd</sup> semester in high school. So if they are younger (other female adult finishes the sentence) and exposed to this information now, then when they are ready to go to college there are jobs that don't even exist now, that due to that technology will exist.*
- *Female Adult: I'm helping her try to figure out college, so that immediately set up in my mind to look that (nano gold) up to see if I can find out more information. Trying to figure out colleges and who offers the type of education you'll need to do that type of job.*

### ***Has relevance for young children***

Finally, a couple of mothers explained that the film was relevant to their young children, with both noting that they talked to their children throughout the film about what was on the screen. They reflected:

- *Female adult: I was narrating with two 5-year-olds. Remember when we do this? And what is she eating there? She's eating a popsicle...tell the cold vs...So asking questions throughout. Is the water hot right now? It's hot because, why? It was the infrared part. What's the water temperature now? So they could learn, not just so they could see it, but so they could connect it with something.*
- *Female adult: Even with my 3-year-old, it was clearly above his head, but he picked up on pieces of it. And he would say, "what's that" and so Kaitlyn was sitting on one side and I was sitting on the other side and we were kind of explaining to him because he had a lot of cool questions along the way. But it almost moved a little too fast for him to get the information he needed before it moved onto the next point.*

## Phase 3: Follow-up evaluation of extended impact

The follow-up evaluation considers how much Viewers continued to think about *Mysteries of the Unseen World* after viewing, as well as the extent to which they looked into various topics from the film. It also reports on if and how *Mysteries of the Unseen World* changed Viewers' feelings about science and technology, if and how Viewers reported "seeing" the world differently after viewing, the activities they did after watching the film, and additional feedback they opted to share at the end of the follow-up questionnaire. These findings are presented below, addressing the following 6 questions:

*Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?*

*Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?*

*Question 3: Did the film change how Viewers think or feel about science or technology?*

*Question 4: Did Viewers "see" the world differently a few weeks after watching the film?*

*Question 5: What activities did Viewers do within a few weeks of watching the film?*

*Question 6: What additional feedback did Viewers share a few weeks after watching the film?*

## Method

### Recruitment

To explore the longer-term impact of the *Mysteries of the Unseen World* film, a follow-up online questionnaire was sent to Viewers who: a) completed a post-viewing questionnaire, b) but did not participate in a discussion group, and who c) indicated that they were willing to be contacted via email and an online questionnaire to provide feedback on the film within 15-20 days. These Viewers were informed of the opportunity to provide feedback via a small piece of paper stapled to the post-viewing questionnaire, which was subsequently removed and separated from the questionnaire. The invitation requested that respondents share their name and email address if they were interested in participating in the brief online questionnaire, and informed them they would be provided a \$10 gift certificate to amazon.com as a thank you for their participation.

### Procedure

An email with a link to the online questionnaire was sent to Viewers who provided contact information within 15-20 days of their seeing the film. The email was sent via the independent evaluation firm's [Constant Contact](#) account. A screenshot of this email invitation is shown on the next page. The table below shows the number of post-viewing respondents at each science center and the number that agreed to be contacted for follow-up, followed by the email bounces, spam reports, opt-outs, opens, and questionnaire completions. A total of 72 out of 136 respondents opened the email request within the one-week evaluation period, and 25 of these 72 recipients completed the online evaluation request, resulting in a completion rate of 35%.

Follow-up questionnaire completion rates							
Science center	# of post-viewing respondents	# agreeing to be contacted for follow-up	Bounces	Spam reports	Opt-outs	Opens	Questionnaire completions
Lawrence Hall of Science	72	37	4	0	1	20	10
Discovery Place	157	99	33	0	1	52	15
<b>Total</b>	<b>229</b>	<b>136</b>	<b>37</b>	<b>0</b>	<b>2</b>	<b>72</b>	<b>25</b>



Dear viewer,

Thank you for participating in our independent evaluation of the *Mysteries of the Unseen World* film, which you viewed at Discovery Place a few weeks ago. Since you expressed interest in providing some longer term reflections on your experience, we wanted to give you an opportunity to complete this brief online survey which should take about 7-10 minutes of your time.

**If you choose to complete the survey, please be sure to do so this week so that we are capturing all viewers' feedback within the same general time frame.**

**We will email you the \$10 gift certificate to [amazon.com](http://amazon.com) within one week of your completing the survey.**

When you are ready to begin, please click on the link below. If you have trouble clicking on the link, you can copy the link into your browser window.

<http://www.knightwilliams.com/ngm//muwfollow.aspx>

If you have any questions or comments about this online survey, please feel free to contact us at [muw@knightwilliams.com](mailto:muw@knightwilliams.com) or by calling toll free [\(888\) 204-3939](tel:8882043939).

Thanks very much for taking the time to provide further feedback on the film. We greatly appreciate your input!

Dr. Valerie Knight-Williams  
Divan Williams Jr., J.D.  
Co-Directors, Mysteries of the Unseen World evaluation  
Knight Williams Inc.

## About Us

Knight Williams Research Communications ("Knight Williams Inc. ") specializes in the development and evaluation of health and science media-based programs targeting diverse audiences. The projects we collaborate on are frequently national or regional in scope, incorporate outreach programs in a wide range of settings, and feature one or more of the following media: television or radio programs, giant screen films, museum exhibits, websites, interactive multimedia, and curricula or other print materials.

## Analysis

Basic descriptive statistics were conducted on the quantitative data gathered from participants' ratings and background information. Two evaluators prepared the qualitative analysis of open-ended responses. The analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

## Sample information

The table to the right presents basic demographic and background information for the 25 Viewers that participated in the follow-up evaluation.

There was a higher percentage of females (72%) to males (28%). Nearly all (92%) of the participants were adults while just under one-tenth (8%) were youth 17 years or younger. The average age of the adults was 43 while the average age of youth was 14.

As with the Phase 1 questionnaire, the majority of the participants were White (56%), with 24% Asian, 4% African-American, and 12% Other, including 2 Viewers who noted that they were Dominican. Just over one-tenth (12%) of the group identified themselves as Hispanic or Latino.

The largest group of participants indicated that they had a graduate degree (36%), with 4% having attended some graduate school, 16% having a college degree, 28% having attended some college, 8% having a high school degree, and 8% having attended some high school.

The largest group of participants indicated that they had seen 3 or 4 giant screen films prior to seeing *Mysteries of the Unseen World* (40%), with 20% having seen 1 or 2, 28% having seen 5 or more, and 12% having seen none.

Follow-up Viewer demographic and background information		
Demographic/ background factor	Categories	Participants (n=25)
<b>Gender</b>	Female	72%
	Male	28%
<b>Age</b>	Adults (18-above)	92%
	Youth (7-17)	8%
	Age range	14-69
	Average age of adults	43
<b>Race and ethnicity</b>	White	56%
	Asian	24%
	African-American	4%
	Other	12%
	Hispanic origin	12%
<b>Highest level of education</b>	Less than high school	8%
	High school degree	8%
	Some college	28%
	College degree	16%
	Some graduate school	4%
	Graduate degree	36%
<b>Number of giant screen films viewed</b>	0	12%
	1-2	20%
	3-4	40%
	5 or more	28%

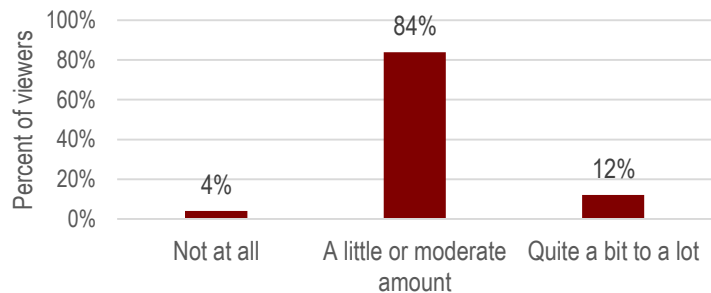
# Findings

## Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?

The majority of Viewers indicated that they thought about *Mysteries of the Unseen World* at least a little in the weeks since watching the film. Of those who described what they thought about, the largest group pointed to topics from the *Too Small* section.

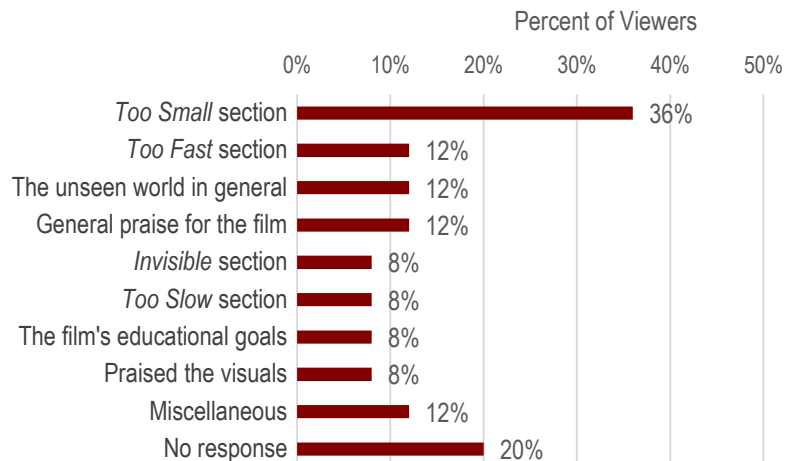
Nearly all of the Viewers indicated that they thought about the film in the weeks since viewing (96%). When asked to rate the extent to which they thought about the film, the Viewers' ratings ranged from 1.0 (not at all) to 7.0 (a lot), with a median rating of 3.0. The chart to the right shows the percentage of Viewers who indicated that they hadn't thought about the film (4%), thought about the film a little or a moderate amount (84%), or thought about the film quite a bit to a lot (12%).

How much Viewers thought about the film in weeks after viewing (n=25)



Next, Viewers were asked to describe what they thought about from the film in the weeks since watching. As shown in the chart to the right, more than a third of Viewers mentioned that they thought about something from the *Too Small* section (36%), including a few who thought about the nanoworld. More than one-tenth each explained that they thought about the *Too Fast* section (12%), the unseen world in general (12%), and/or what they liked about the film (12%), with some calling it “cool” and “entertaining,” for example. Slightly less than a tenth each described having thought about the *Invisible* section (8%), the *Too Slow* section (8%), the film’s educational goals (8%), and/or what they liked about the film’s visuals (8%). Finally, just over a tenth of Viewers shared miscellaneous responses (12%), including one viewer who explained that s/he hadn’t thought about the film much, and a fifth declined to answer the question (20%). Examples of Viewers’ responses in each case are shared on the following page:

What did Viewers think about from the film in the weeks after viewing (n=25)





**Too Small section (36%)**

- *Bugs on eyebrows*
- *The amount of germs around*
- *Very small things on people's skin etc.*
- *I have thought about how small matter can be.*
- *When I see mold or bacteria in some form with the naked eye, I think what it must look like by the equipment used to film Unseen World.*
- *The incredible things viewable through an electron microscope.*
- *The Nano vision*
- *Since I've seen the film I've mostly thought about the endless possibilities if we are able to harness the types of things we see in the nanoworld.*

**Too Fast section (12%)**

- *The dragonfly's abilities.*
- *Water splashing in ever decreasing globules.*
- *How you use cameras to slow down the speed of a hummingbird, honey bees, etc... and how a rain drop falls as a ball and bounces and it keeps doing that until it's nothing left*

**The unseen world (12%)**

- *It forces you think about certain things that may have gone unnoticed before.*
- *I have thought of what is in our lives, (living things) that we can not see.*
- *How much unseen world is there which we do not know and which is very fascinating.*

**General praise for the film (12%)**

- *Amazing*
- *How a film can be educational as well as entertaining, especially for younger people.*
- *Oh that was cool. Maybe I should bring my roommate up to see it.*

**Invisible section (8%)**

- *I really liked the representation and explanation of the different wavelengths in the EM spectrum, and tumbled that around in my head (scientifically, and how "non-science" Viewers might experience it).*
- *The bees and their vision*

**Too Slow section (8%)**

- *...you use cameras to speed up the growth of flowers...*
- *I am seeing the flowers and the other living organisms in a different way after seeing the movie.*

**The film's educational goals (8%)**

- *Generally thought about how people with a smaller science background might have experienced the movie, and how the movie approached the different aspects to reach out to them.*
- *How a film can be educational as well as entertaining, especially for younger people.*

**Praised the visuals (8%)**

- *Its vivid images and detail.*
- *The beautiful colors and photography.*

**Miscellaneous (12%)**

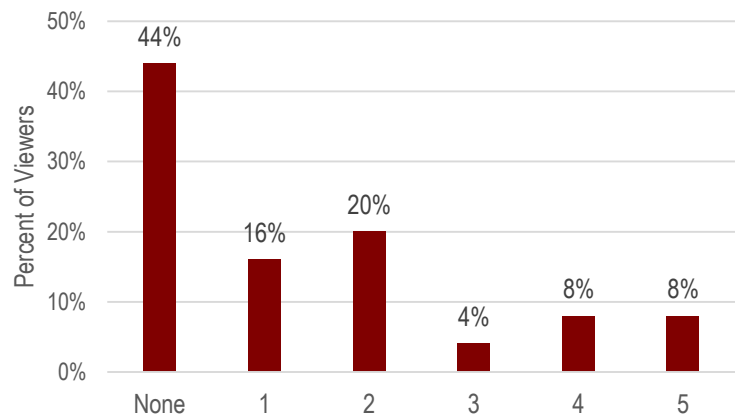
- *It has not really been on my mind much.*
- *The experience.*
- *Wondering what future films will be coming to this location. Wondering how I did on the survey and if I got some of the answers correct!*

## Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?

More than half of Viewers indicated that they looked into 1 or more topics from the film in the weeks since viewing (56%). The topic of *the invisible world/things you can't see* was looked into by the largest group of Viewers (44%).

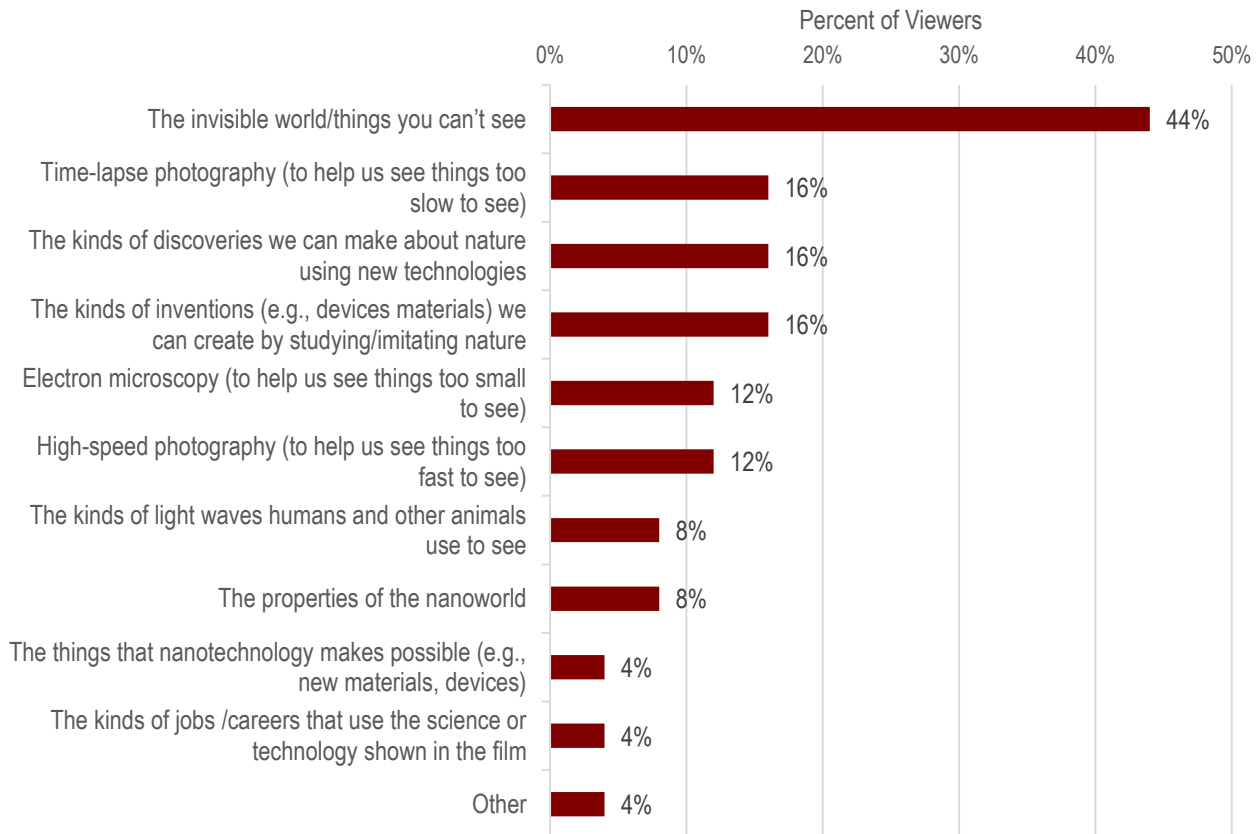
Viewers were asked which topics from the film they looked into (e.g., talked to someone about, read about, watched videos, or researched online) since viewing *Mysteries of the Unseen World* a few weeks earlier. As shown in the chart to the right, more than half of Viewers looked into one or more of the topics from the film (56%). About a sixth of Viewers looked into 1 topic (16%) and a fifth looked into 2 topics (20%). Less than one-tenth each looked into 3 (4%), 4 (8%), or 5 topics (8%). None of the Viewers looked into more than 5 topics, and more than two-fifths didn't look into any topics (44%).

How many topics Viewers looked into within a few weeks of viewing the film (n=25)



As shown in the chart on the following page, the largest group of Viewers noted that they looked into *the invisible world/things you can't see* (44%). About one-sixth each looked into *time-lapse photography (to help us see things too slow to see)* (16%), *the kinds of discoveries we can make about nature using new technologies* (16%), and *the kinds of inventions (e.g., devices materials) we can create by studying/imitating nature* (16%). At the same time, just over one-tenth each looked into *electron microscopy (to help us see things too small to see)* (12%) and *high-speed photography (to help us see things too fast to see)* (12%). Less than a tenth each looked into: *the kinds of light waves humans and other animals use to see* (8%), *the properties of the nanoworld* (8%), *the things that nanotechnology makes possible (e.g., new materials, devices)* (4%), and *the kinds of jobs /careers that use the science or technology shown in the film* (4%). Finally, although none of the Viewers checked a box on the follow-up questionnaire to indicate that they looked into \*other topics from the film, one Viewer (4%) wrote in that s/he looked into "Pluto."

## What topics Viewers looked into within a few weeks of viewing the film (n=25)



When asked to explain what they looked into, more than a tenth of Viewers shared feedback about who they talked to (12%), rather than what they discussed (for example, “*Talked to my husband about these amazing things*” and “*Conversation with friends and family about the topics have been interesting*”). A group of the same size mentioned having looked into topics from the film (12%), as in, “*I watched the film ‘Gratitude’ with time-lapsed photography,*” “*I began to look into the kinds of technology we can create by imitating nature, such as dragonfly wings, while being able to use nanotechnology to make them super efficient,*” and “*Drones,*” which likely referred to an animation of dragonfly drones. Just under a tenth described having viewed other films (8%), as in, “*I looked more into other documentaries with similar themes.*”

## Question 3: Did the film change how Viewers think or feel about science or technology?

The majority of Viewers indicated that the film changed how they think or feel about science or technology. The largest groups of Viewers pointed to changed feelings about the world around them and/or changed feelings about science, technology, and what the future holds. Those who said *Mysteries of the Unseen World* didn't change how they think or feel about science or technology most often explained that they were knowledgeable of or interested in the unseen world prior to seeing the film.

Next, Viewers were asked if seeing the film changed how they think or feel about science or technology. As shown in the table to the right, around two-thirds of Viewers indicated that this was the case (64%). Just over a third explained that the film did not change how they think or feel about science or technology (36%).

Those who said Yes were asked how seeing the film changed how they think or feel. As shown in the table to the right, more than a quarter described having a greater awareness or appreciation of the world around them (28%), while just under a quarter said they thought about science, technology, and what the future holds (24%). More than a tenth of Viewers shared miscellaneous responses (12%).

As noted above, more than a third of Viewers indicated that seeing the film did not change how they think or feel about science or technology (36%). When asked why they didn't think or feel differently, more than a quarter explained that they were knowledgeable of or interested in the unseen world prior to seeing the film (28%). One Viewer shared a miscellaneous response (4%) and one Viewer didn't answer the question (4%).

<b>Whether seeing the film changed how Viewers thought or felt about science or technology a few weeks after viewing (n=25)</b>	
<b>Yes, it has changed how I think or feel about science or technology</b>	<b>64%</b>
I have a greater awareness or appreciation of the world around us	28%
I have thought about science, technology, and what the future holds	24%
Miscellaneous	12%
<b>No, it has not changed how I think or feel about science or technology</b>	<b>36%</b>
Already knowledgeable or interested	28%
Miscellaneous	4%

Examples of Viewers' comments on each theme follow below:

- **Yes, it has changed how I think or feel about science or technology (64%)**

*I have a greater awareness or appreciation of the world around us (28%)*

- *I've been looking at things differently than I did before.*
- *It just made me more aware of my surroundings and what impact science has in the realm of our everyday lives.*
- *Inspirational, tells you there's always scope!*
- *Appreciate nature and science more*

- *I have greater appreciation for the beauty in nature.*
- *Made it seem even more incredible!*
- *While I may have already known about how tiny matter can be, I never knew about it on a level that was explained in the film.*

*I have thought about science, technology, and what the future holds (24%)*

- *Appreciate nature and science more*
- *The possibilities that science and tech provide for making life easier.*
- *It just made me more aware of my surroundings and what impact science has in the realm of our everyday lives.*
- *It powerfully reminded me how MUCH there's still left to discover and study!*
- *The film made me realize how close scientists have come to being able to make use of elements and substances we would normally never see.*
- *It has made me realize the amazing capabilities of man and science as far as creating and discovery of more and more that will enhance life in many ways. For example, the discovery of the camera that made the film, how they can "uncover" "things" that don't need to be there, diseases, tumors, etc. just to name a few examples.*

*Miscellaneous (12%)*

- *As we have a 2 year old granddaughter, we think how it must be for her to see things for the very first time. She notices everything, especially small and in detail.*
- *More interesting*
- *I can't really think of a specific example*

- **No, it has not changed how I think or feel about science or technology (36%)**

*Already knowledgeable or interested (28%)*

- *I was already aware of most of the issues mentioned.*
- *I knew it before*
- *Most of the stuff covered in the film was something I have heard about in the past.*
- *It all fit in with my previous understanding of science and technology.*
- *It offered nothing new.*
- *I am still fascinated by technology; the film just reinforced the feeling.*
- *I know that the science and technology do and show wonders. This is not of any surprise to me. But I was very excited and fascinated to see those things*

*Miscellaneous (4%)*

- *I just don't*

## Question 4: Did Viewers “see” the world differently a few weeks after watching the film?

The majority of Viewers said they “saw” the world differently in the weeks since viewing the film, explaining that they watched things differently or paid closer attention to the world around them, had a different perspective, and/or thought about the things they couldn’t see. Those who indicated that they hadn’t “seen” the world differently most often noted that they were knowledgeable about the unseen world prior to viewing the film.

When asked if they had seen the world around them differently after watching *Mysteries of the Unseen World*, more than four-fifths of Viewers indicated that they *did* see the world differently (84%), while about one-sixth said they did not (16%).

Those who said Yes were asked to provide an example of how they had seen the world differently since viewing the film. As shown in the table to the right, the largest group – nearly half of Viewers – explained that they watched things, paid closer attention, or observed the world more carefully (48%). A fifth noted that they had a different perspective or looked at things differently since viewing the film (20%), and about a sixth reported thinking about the things they can’t see (16%).

As noted above, about a sixth of Viewers said they did not “see” the world differently after viewing the film (16%). When asked why not, a few explained that they were already knowledgeable (8%), and one each said they hadn’t thought about the film (4%) or were too busy (4%).

Whether Viewers “saw” the world differently a few weeks after watching the film (n=25)	
<b>Yes, I have “seen” the world about me differently</b>	<b>84%</b>
Watched things/paid closer attention/observed the world more carefully	48%
Have a different perspective/look at things differently	20%
Thought about the things they can’t see	16%
<b>No, I have not “seen” the world around me differently</b>	<b>16%</b>
Already knowledgeable	8%
Haven’t thought about the film	4%
Too busy	4%

Examples of Viewers’ comments on each theme follow below:

- **Yes, I have “seen” the world about me differently (84%)**

- 

- ***Watched things/paid closer attention/observed the world more carefully (48%)***

- *Watching things fly*
- *I watched my flower blooming.*
- *I now pay more attention to bugs that are attracted to infrared light.*
- *When I was in Seattle recently, I would watch the waves in Puget Sound and think about how the bubbles gradually disappear.*
- *Watching a hawk in our backyard has made me think about the film - wish I could watch him fly in slow motion!*

- *I've been paying more attention to the hummingbirds and also to the rain as it falls.*
- *When I see the droplets of water or the flowers blooming, I could remember the scenes of the movie where you have shown in minute details about them*
- *Looked more closely at nature's phenomenon - flowers, water droplets, rain, etc.*
- *More sensitivity to color and sound. I also try to observe smaller objects and processes that occur on a grand scale (mainly space).*
- *Since the film, we visited Bryce Canyon, Zion and Monument Valley. We noticed more about the environment and natural aspects of the parks as well as people's influence of the environment and how we need to take care of what natural resources we have and conserve.*
- *I see the world at a much "smaller" level, knowing that some of the materials and substance that we use are formed on a microscopic level and we can make better materials by going even smaller.*

**Have a different perspective/look at things differently (20%)**

- *I just feel like I have additional knowledge which always changes your perspective.*
- *My kids and I look at things differently*
- *Since the film, we visited Bryce Canyon, Zion and Monument Valley. We noticed more about the environment and natural aspects of the parks as well as people's influence of the environment and how we need to take care of what natural resources we have and conserve.*
- *The film made me realize that the "naked eye" perhaps wasn't intended to see all that there is to see in nature and other places. This creating a need to look further into every aspect of our lives.*
- *More conscience about the possibilities*

**Thought about the things they can't see (16%)**

- *The film showed me all the different kinds of substances and living things that exist at such a small level, even though I never knew, there were billions of things around me that I didn't know existed because I never saw them.*
- *The film made me realize that the "naked eye" perhaps wasn't intended to see all that there is to see in nature and other places. This creating a need to look further into every aspect of our lives.*
- *Thinking about all the organisms that I can't see*

• **No, I have not "seen" the world about me differently (16%)**

**Already knowledgeable (8%)**

- *It simply didn't offer me anything drastically different from what I already knew.*
- *I was already aware of most of the issues mentioned.*

**Haven't thought about the film (4%)**

- *I have a bad memory, so things like this film don't really stick in my brain enough to inspire me to look at things differently.*

**Too busy (4%)**

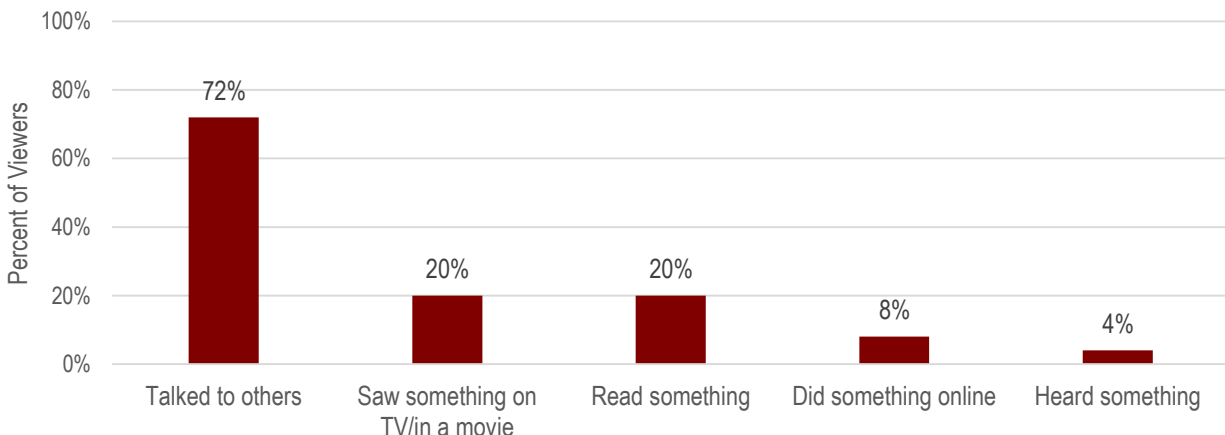
- *I guess I got too busy with my day to day activities.*

## Question 5: What activities did Viewers do within a few weeks of watching the film?

The majority of Viewers engaged in one or more activities in the weeks after viewing *Mysteries of the Unseen World*. The largest groups explained that they *talked to others* about the film, *saw something* on TV or in a movie that made them think of the film, and/or *read something* that made them think of the film.

Next, Viewers were asked which, if any, of the following activities they did after watching *Mysteries of the Unseen World*: 1) *talked to others about the film*; 2) *saw something on television or in a movie that made them think of the film*; 3) *heard something on the radio or while listening to music that made them think of the film*; 4) *read something (e.g., in a book, magazine, newspaper) that made them think of the film*; or 5) *did something online related to the film*.

What activities Viewers did within a few weeks of viewing (n=25)



As shown in the chart above, the largest group of Viewers, nearly three-quarters, *talked to others* about the film (72%). At the same about, one-fifth each explained that they *saw something* on TV or in a movie that made them think of the film (20%) and/or *read something* that made them think of the film (20%). Less than one-tenth each *did something online* related to the film (8%) and/or *heard something* that made them think of the film (4%). More information about the activities done by Viewers is presented below, from highest frequency to lowest frequency among Viewers.

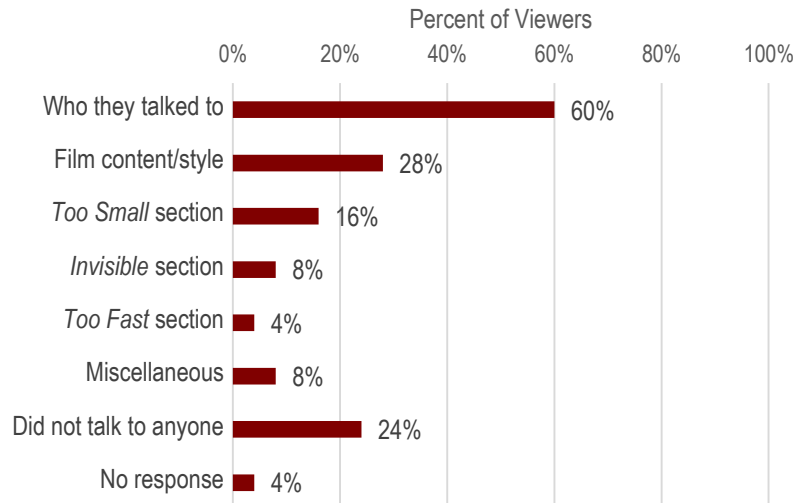


## Talked to others about the film (72%)

Nearly three-quarters of Viewers who completed the follow-up questionnaire indicated that they discussed *Mysteries of the Unseen World* with others in the weeks after viewing the film (72%). When asked who they talked to and what they talked about, the Viewers shared a range of responses. As shown in the chart to the right, nearly two-thirds of Viewers described who they talked to (60%), including friends and family members who saw the film with them and people who did not. More than a quarter of Viewers described having talked about the general content or style of the film (28%), including a few Viewers who recommended the film to others. A sixth talked about the *Too Small*

section (16%), and less than one-tenth each talked about the *Invisible* section (8%) and/or the *Too Fast* section (4%). About a tenth talked about miscellaneous topics (8%), just under a quarter said they didn't talk to anyone (24%), and one Viewer declined to answer the question (4%).

### What Viewers talked about and who they talked to after viewing the film (n=25)



Examples of Viewers' responses on each of these subjects are shared below:

#### **Described who they talked to (60%)**

- *Friends and family*
- *Only those I watched the film with, and only on the day I watched it. We talked about what cool things were covered in the film and what we already knew.*
- *I talked to my family about the hummingbirds, bees, and the raindrops.*
- *Yes, I have discussed it with my fiancée and my friends. I have told them what has been shown in the movie, how the world is which we can't see from our naked eye.*
- *Yes, I explained as best I could to my husband and friends the amazing abilities of the cameras to capture what was seen in the movie. The conversation made each of them want to see the film.*
- *Yes, I checked in Columbus, Ohio to see if it was showing so my husband would have a chance to watch it. My husband and I talked about the radio waves.*
- *Yes I told my husband all about the film.*
- *Told my partner about it. But not in great detail.*
- *Just my husband as we both had seen it together and he works as a volunteer at Lawrence Hall of Science.*
- *I spoke with my son about the germs also to try to get him to wash his hands more (I swear I'm not a crazy germ person btw :)*
- *My daughter about the film, some of its general ideas.*
- *I talked to my daughter about the wonders going around us.*
- *I talked about it once with my mother. We talked about the millions of tiny creatures that live everywhere without our knowledge.*
- *Yes, other volunteers and friends especially in relation to the Lawrence Hall of Science. I recommended the film to them.*

**Talked about the general content or style of the film (28%)**

- *I talked to my daughter about the wonders going around us.*
- *Only those I watched the film with, and only on the day I watched it. We talked about what cool things were covered in the film and what we already knew.*
- *Yes I told my husband all about the film.*
- *Yes, I have discussed it with my fiancée and my friends. I have told them what has been shown in the movie, how the world is which we can't see from our naked eye.*
- *My daughter about the film, some of its general ideas.*
- *Yes, I explained as best I could to my husband and friends the amazing abilities of the cameras to capture what was seen in the movie. The conversation made each of them want to see the film.*
- *Yes, other volunteers and friends especially in relation to the Lawrence Hall of Science. I recommended the film to them.*

**Talked about Too Small section (16%)**

- *All the bugs around us that we don't see*
- *I spoke with my son about the germs also to try to get him to wash his hands more (I swear I'm not a crazy germ person btw :)*
- *I talked about it once with my mother. We talked about the millions of tiny creatures that live everywhere without our knowledge.*
- *The microscopic pictures.*

**Talked about Invisible section (8%)**

- *My husband and I talked about the radio waves.*
- *I talked to my family about the...bees.*

**Talked about Too Fast section (4%)**

- *I talked to my family about the hummingbirds...and the raindrops.*

**Miscellaneous (8%)**

- *Yes, I checked in Columbus, Ohio to see if it was showing so my husband would have a chance to watch it.*
- *Yes; discussed how scientists should be the ones who most believe in God.*

**Didn't talk to anyone (24%)**

- *I have not talked to anyone about the film.*
- *No I have not spoken to anybody about it.*
- *No. But I took a friend to watch it.*

**Saw something on television or in a movie that made them think of the film (20%)**

A fifth of Viewers explained that they saw something on TV or in a movie that made them think of *Mysteries of the Unseen World* (20%). When asked what they saw that reminded them of the film, the Viewers pointed to a variety of topics and a range of platforms, including TV shows, online videos, and computer screensavers. For example:

- *Yes, I watched a TED talk called "Gratitude" that the filmmaker presented.*
- *Seeing some TV shows about sharks reminded me of the film*
- *Watching videos with my granddaughter a little more carefully*
- *I recently watched [something] about almond farming.*
- *There are wallpapers on my laptop which keeps on changing with different pictures like droplets of water or the flowers. This constantly make me think about the unseen things in the world.*

### **Read something that made them think of the film (20%)**

One-fifth of Viewers explained that they read something (e.g., in a book, magazine, newspaper) that made them think of *Mysteries of the Unseen World* (20%). When asked what they read that reminded them of the film, most Viewers pointed to nonfiction books, including two Viewers who were reminded of the film by the same book, *Insiders Extreme Weather*, for readers in grades 3-7. One Viewer pointed to *National Geographic* articles. Viewers' responses are shared below:

- *Yes, when I read Stephen Hawking's A Brief History of Time.*
- *I like to see books that show in detail, colors and how things impact other things, especially during the drought and lack of water.*
- *I read Insiders Extreme Weather, a book that explains different types of natural disasters and weather patterns. The book reminded me of the film because it made me think of how these kind of conditions might affect the substances mentioned in the film.*
- *I recently read a book, Insiders: Extreme Weather, that talks about weather patterns and natural disasters. I thought of the film because I wondered how certain weather patterns might affect the nanomaterials or how we can make buildings and entire cities resistant to natural disasters using the strength of nanomaterials.*
- *Some National Geographical articles about science.*

### **Did something online related to the film (8%)**

Less than one-tenth of Viewers indicated that they did anything online related to *Mysteries of the Unseen World* since viewing the film (8%). Both Viewers who did something online indicated that they looked for more information about the film on social media (8%) and that they visited the film's website (8%), with one Viewer noting, "I was checking where it was currently showing." One of the Viewers also searched something from the film online (4%), saying, "Just tried to learn more about the film and its development process, particularly the type of exposure and photography used to shoot it."

None of the Viewers indicated that they downloaded the *Mysteries of the Unseen World* app from iTunes, "liked" the film's Facebook page, posted the film's trailer on their Facebook page, tweeted or blogged or used Facebook to discuss the film with others, or did another online activity. Finally, one Viewer explained that s/he intended to visit the film's website in the future, saying, "I will eventually look at the website."

### **Heard something on the radio or while listening to music that made them think of the film (4%)**

Less than a tenth of Viewers said they heard something on the radio or while listening to music that made them think of *Mysteries of the Unseen World* (4%). When asked what they heard that reminded them of the film, one Viewer explained, "I have music from the Navajo people and listening to it reminds me of nature---how Native Americans view nature and how they are part of a larger world."

## Question 6: What additional feedback did Viewers share a few weeks after watching the film?

Viewers who opted to share additional feedback about their experience with the film since viewing said they enjoyed it, thought it could be longer, and/or that they shared it with their children, among other responses.

After completing the follow-up questionnaire, more than a quarter of Viewers opted to share additional feedback about their experience with the film since viewing (28%). A fifth of Viewers commented on *Mysteries of the Unseen World* (20%), saying they enjoyed it, thought it could be longer, and/or that they shared it with their children, among other responses, as in:

- *Thinking about the film I remember how much I enjoyed it and how mesmerizing was the photography.*
- *I enjoyed and appreciate the film very much.*
- *It was extremely pleasant - wish it was longer!*
- *I really enjoyed the film and felt like I learned quite a bit I didn't know about the world that I've used in discussions with my children. But I'm a busy mom so I don't have as much time to look up information, watch TV etc. so that's why I haven't seen anything that reminded me of the film. But it was great, nice job!*
- *My daughter and I watched the film twice on two different trips to Charlotte, NC, and I would like to see it one more time. There is so much information to learn. I didn't watch the snake striking.*

Finally, a couple of Viewers shared miscellaneous comments about their experience with the film since viewing (8%), commenting on their personal interests and their thoughts about the follow-up questionnaire, as in:

- *I have become increasingly interested in Materials Science and MEMS research.*
- *Survey is good follow up reminder to go online*

## Phase 4: Site documentation

### Recruiting process

Beginning in the spring of 2015, Knight Williams and National Geographic staff collaborated to locate two science centers that: 1) were showing *Mysteries of the Unseen World* between May and August 2015, 2) participated as a partner science center in the NSF grant, and 3) were willing to host the theater evaluation and had the facility to do so. Phase 4 provides information about the two sites that hosted the Study 1 evaluation: Lawrence Hall of Science in Berkeley, CA and Discovery Place in Charlotte, NC.

### Lawrence Hall of Science in Berkeley, CA

Located in Berkeley, CA, the Lawrence Hall of Science is UC Berkeley's public science center. In addition to their exhibit spaces, live demonstrations, and special events, Lawrence Hall is also the site of the National Geographic 3D Theater. As noted on their website:

#### **Our Mission**

To inspire and foster learning of science and mathematics for all, especially those who have limited access to science.

#### **What We Do**

We investigate, create, and evaluate educational materials and methods, professional development programs, and hands-on learning experiences for our science center, schools, communities, and homes. We develop programs that engage across the learning continuum — from simple curiosity to deep understanding. And our programs are proven effective in any environment — from informal to afterschool to formal K-12 classrooms.

#### **Increasing Opportunities to Learn**

Since the Hall opened to the public in 1968, learning by doing has been core to all of our programs. We emphasize science inquiry as well as science content. We know that children learn more effectively and develop stronger interests in science and math if they engage with the subject through hands-on investigations. To address the challenges in science, technology, engineering and mathematics (STEM) education today, we've created a comprehensive set of programs to help increase the quality and quantity of great science learning that kids get both in and out of school.

<http://www.lawrencehallofscience.org/about/mission>

The Lawrence Hall of Science promoted the film in numerous ways including through announcements posted on the [UC Berkeley Events Calendar](#) and [The Daily Californian](#), an online publication for the UC Berkeley campus and community. The film was also cross-promoted with other exhibits and hands-on activities that were being hosted at the science center in various Bay Area family resources such as [Red Tricycle](#). The film was further promoted through various social media platforms such as [Facebook](#), [Twitter](#) and [Instagram](#). Sample promotions are shown below from Instagram (left), Twitter (upper right), and Red Tricycle (lower right).



@berkeleyscience

@natgeo uses cutting edge technology to bring you "Mysteries of the Unseen World 3D." Explore nano particles and otherwise invisible phenomena in this amazing 3D film. Shows daily at the Lawrence Hall of Science. Tickets are \$4 plus admission.



Berkeley Science  
@berkeleyscience

Follow

Explore science in a larger-than-life way with *Mysteries of the Unseen World 3D* now at the Hall's [@NatGeo 3D Theater](#).  
[ow.ly/JJV9l](http://ow.ly/JJV9l)



RED TRICYCLE



EVENTS



EAT

WHAT'S ON: [NEW >> Family Vacation Guide](#) [Classes & Camps](#) [Storybook Destinations](#) [Local S](#)

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photo by: Lawrence Hall of Science

### build a marble machine at the lawrence hall

**WHEN:** Jan 2, 2015 - Jan 4, 2015 at 10 a.m. to 5 p.m.

**WHERE:** UC Berkeley, Lawrence Hall of Science, 1 Centennial Dr., Berkeley, Ca

**COST:** \$12/adult; \$10/child 3-18; children 2 and under are free

**AGES:** All Ages

**ADD TO CALENDAR:** [Google](#) [iCal/Outlook](#)  
[add to my play list](#)

#### THE SCOOP:

The last weekend of Winter Weeks at the Hall, kids can create stop-motion animation and harness the wind with wind turbines at the Design Quest exhibit, try their hand at feats of marble engineering, and watch science on the big screen with our two 3-D films, *Meerkats 3-D* and *Mysteries of the Unseen World*, then search for new planets in our NASA-inspired Planetarium programs.

#### MORE INFO:

[visit website](#)  
RT.647.5127





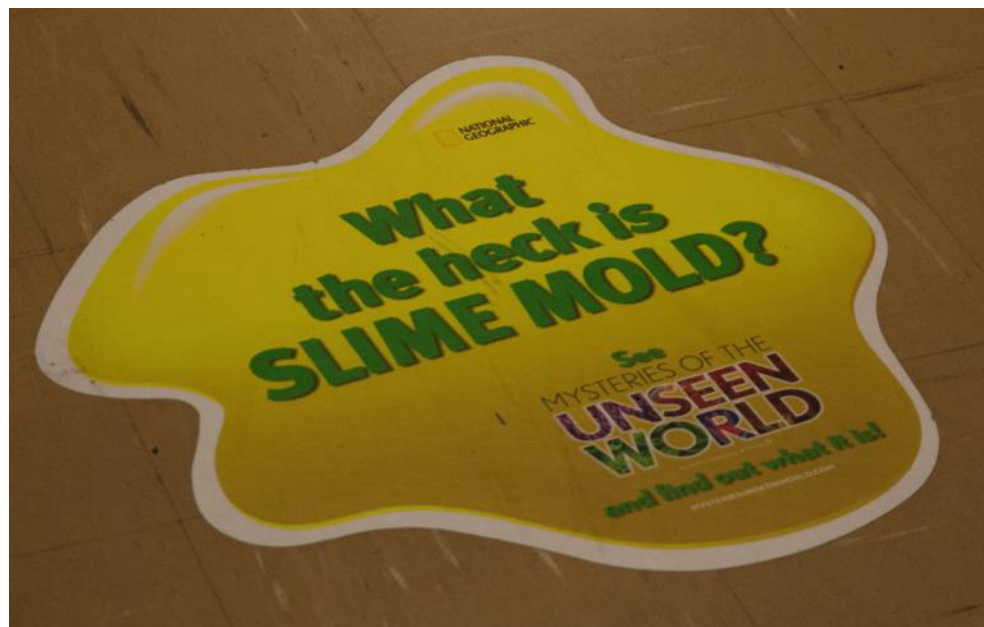
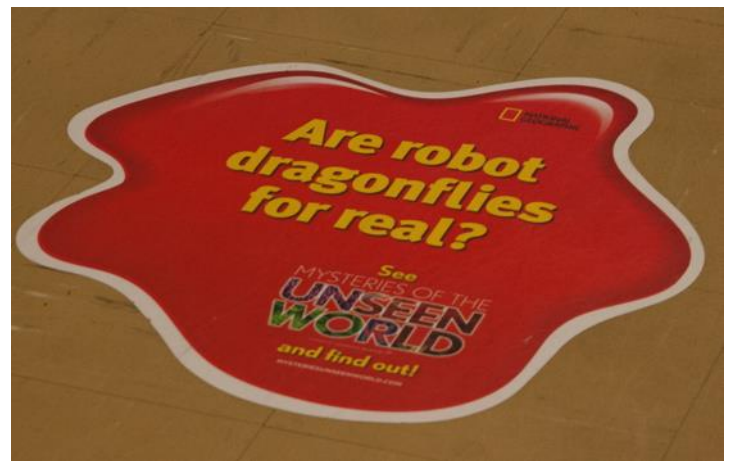
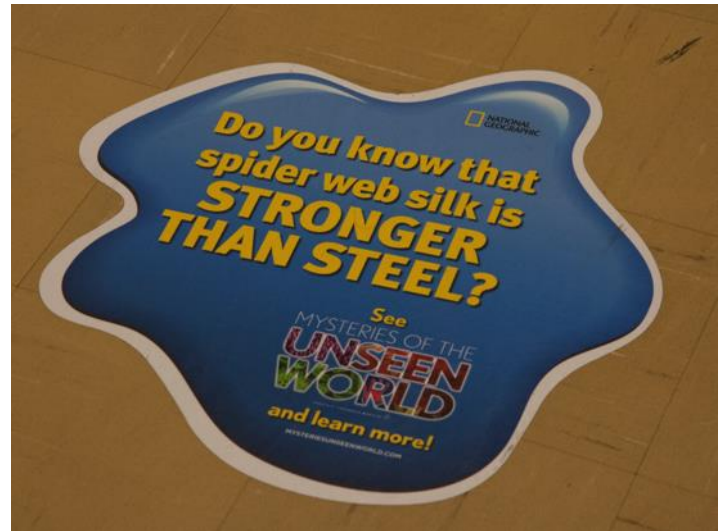
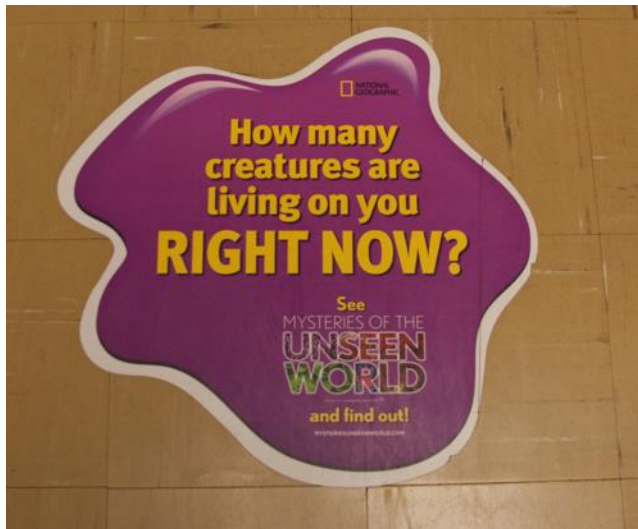
Exterior of the Lawrence Hall of Science  
Image courtesy of [http://www.lawrencehallofscience.org/about/advisory\\_council](http://www.lawrencehallofscience.org/about/advisory_council)



Entrance to the National Geographic  
3D Theater at the Lawrence Hall of Science  
Photo by Knight Williams Inc.



Interior of the National Geographic 3D Theater at the Lawrence Hall of Science  
Photo by Knight Williams Inc.



Mysteries of the Unseen World floor pads at the Lawrence Hall of Science  
Photo by Knight Williams Inc.



## Discovery Place in Charlotte, NC

Located in uptown Charlotte, NC, Discovery Place encompasses over 160,000 square feet of educational, exhibition, meeting, and support spaces, including the Charlotte Observer IMAX Dome Theatre, the exterior and interior of which are shown in the images below.<sup>52</sup> As noted on their website:

Discovery Place, Inc. is a private 501c(3) not-for-profit education organization dedicated to inspiring exploration of the natural and social world through extraordinary exhibitions and educational programs that inform, challenge and engage audiences of all ages.

As one of the leading hands-on science centers in the country, Discovery Place offers visitors the opportunity to gain a greater understanding of science, technology, engineering and mathematics in a fun, interactive and informal setting. Located in one of the nation's fastest growing metropolitan areas, Charlotte, N.C., Discovery Place offers a family-friendly experience surrounded by the excitement of a bustling urban community.

<http://www.discoveryplace.org/about/>

Staff at Discovery Place described promoting the film in a number of ways. They took out print ads and shared movie listing in a local newspaper, *The Charlotte Observer*, and ran 30-second television ads on the Discovery Channel and Animal Planet. Online, they promoted the film through their Facebook and Twitter accounts, shared movie listings with relevant websites, advertised *Mysteries of the Unseen World* on their homepage banner and landing page, did an AdWords search, and coordinated display and video pre-roll advertising. Staff also organized an adults-only, after hours event called *Science on the Rocks* that featured the film and was promoted with flyers, web listings, and museum signage.



Charlotte Observer IMAX Dome Theatre  
Image courtesy of <http://charlottecentercity.org>



Interior of the Charlotte Observer IMAX® Dome Theatre  
Photo by Knight Williams Inc.



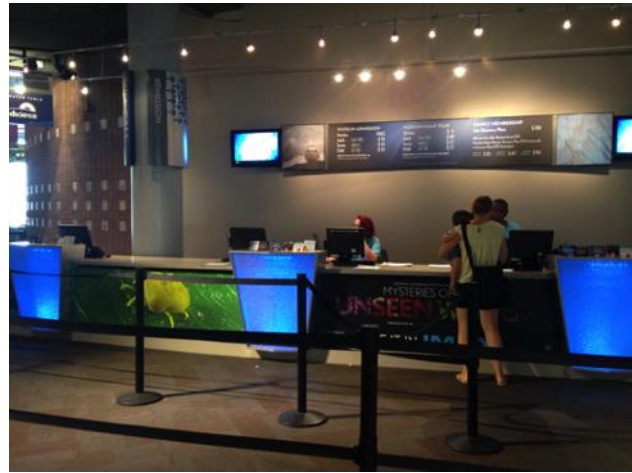
Interior of the Charlotte Observer IMAX® Dome Theatre  
Image courtesy of <http://www.discoveryplace.org/about/>

<sup>52</sup> Information about Discovery Place's history may be found at <http://www.discoveryplace.org/about/history/>

As shown in the images below and on the following page, Discovery Place also promoted the film through on-site signage, including wraps at the admissions desks at both entrances, placement of the project's interactive kiosk near their 6<sup>th</sup> Street admissions entrance, brochures, and other museum signage throughout the building.



*Mysteries of the Unseen World* admissions desk signage at the Tryon Street entrance. Photo by Knight Williams Inc.



*Mysteries of the Unseen World* admissions desk signage at the 6<sup>th</sup> Street entrance. Photo by Knight Williams Inc.



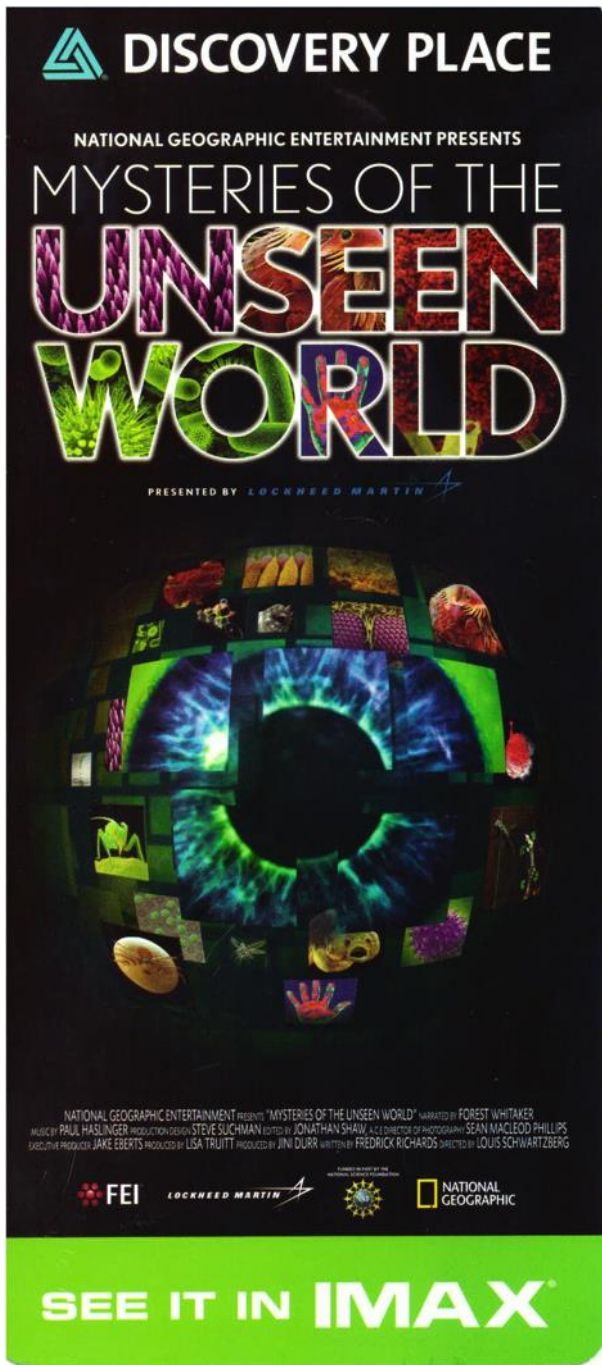
Additional admissions desk signage near the 6<sup>th</sup> Street entrance. Photo by Knight Williams Inc.



Close-up of the interactive kiosk at the 6<sup>th</sup> Street entrance. Photo by Knight Williams, Inc.



*Mysteries of the Unseen World* interactive kiosk near the 6<sup>th</sup> Street admission entrance. Photo by Knight Williams Inc.



# MYSTERIES OF THE UNSEEN WORLD



## SEEING IS BELIEVING.

High-speed and time-lapse photography, electron microscopy and nanotechnology are just a few of the advancements in science that allow us to see a universe of things, events, creatures and processes we never even knew existed.

These technologies give us new "superpowers" to look beyond what's in front of us.

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Front and back of Discovery Place's  
*Mysteries of the Unseen World* brochure

# Summary of findings

## Phase 1: On-site theater evaluation of the film's immediate appeal and learning value

Phase 1 of the Study 1 summative evaluation focused on 450 adult and youth who self-selected to view *Mysteries of the Unseen World* at the Lawrence Hall of Science during the last week of May 2015 and Discovery Place during the first week of August 2015. The evaluation team conducted the evaluation at the theater sites during weekday and weekend showings of the film to help ensure the evaluation recruited a balance of participants who visited the theater at different days and times. The evaluation was based on a separate-sample pre-test/post-test design which examined the appeal and immediate educational impact of the film as assessed by adult and youth performance on a post-viewing questionnaire completed within minutes of seeing the film (Viewers), as compared to the performance of a separate sample of viewers who completed the same set of content questions prior to seeing the film (Pre-Viewers).

This section summarizes the Phase 1 evaluation findings relating to the following four questions: 1) How appealing and engaging did Viewers find the film? 2) Did Viewers find the film content to be clearly presented? 3) What did Viewers learn from the film? 4) How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?

### Question 1: How appealing and engaging did Viewers find the film?

**1.1 How did Viewers rate the film in terms of overall likeability, visual excitement, impact on curiosity, interest in the story, and likelihood of recommending the film?** When asked to rate *Mysteries of the Unseen World* for overall appeal and engagement using a scale from 1.0 (rated the lowest) to 7.0 (rated the highest), Viewers generally liked the film (median rating 7.0), found it visually exciting (median rating 7.0), indicated that the film increased their curiosity about things they can't see with their own eyes (median rating 7.0), thought the film's story was interesting (median rating 7.0), and said they were likely recommend the film to others (median rating 7.0).

Mann-Whitney tests indicated a few subgroup differences, as follows. Compared to Viewers aged 19-40, Viewers 41 years and older gave significantly higher ratings to their overall liking of the program ( $U = 3218$ ,  $p = .014$ ,  $r = .18$ ), the program's storytelling ( $U = 3040$ ,  $p = .005$ ,  $r = .21$ ), level of visual excitement ( $U = 3208$ ,  $p = .011$ ,  $r = .19$ ), their likelihood of recommending the program ( $U = 2940$ ,  $p = .001$ ,  $r = .26$ ), and their level of curiosity about things they can't see with their own eyes ( $U = 3079$ ,  $p = .003$ ,  $r = .23$ ). The effect sizes in each case were considered small effects. Similarly, compared to youth Viewers aged 7-18, Viewers 41 years and older gave significantly higher ratings to two items, their overall liking of the program ( $U = 1685$ ,  $p = .001$ ,  $r = .28$ ) and the film's overall clarity ( $U = 1670$ ,  $p = .002$ ,  $r = .26$ ). The effect sizes in each case were again considered small effects. Finally, Mann-Whitney tests also found that females rated their curiosity about things they can't see with their own eyes significantly higher than did males ( $U = 5118$ ,  $p = .001$ ,  $r = .22$ ), though here again, the effect size was small.

**1.2 What did Viewers like most about the film?** When asked to describe what they liked most about *Mysteries of the Unseen World*, almost all (98%) of the Viewers identified at least one thing about the film that they found appealing, with many citing two or more elements. About one-third of Viewers commented on the educational value of the film (34%), explaining that they learned a lot, enjoyed learning, and/or found something interesting. At the same time, a third of Viewers shared positive feedback about the film's visual

elements (33%) – which some described as “beautiful,” “colorful,” and “incredible” – as well as the film’s giant screen format. Around a quarter of Viewers said they liked one or more things about the film’s presentation of information (26%), including the pacing, narration, examples provided, and overall structure, among other elements. Just under a fifth most liked something in the *Too Small* section (19%), including the film’s discussion of the nanoscale. Just over one-sixth indicated that they liked something they learned about past and future technological innovations (17%), while less than one-sixth each liked something in the *Too Fast* section (15%) and/or something the film showed them about the unseen world (14%). Less than one-tenth each liked something in the *Too Slow* section (9%) and/or the *Invisible* section (8%). A slightly smaller group explained that they liked that the film was science-based (6%), and a handful each shared general praise (5%) or indicated that they liked everything about the film (3%). Just under a sixth of Viewers shared miscellaneous responses (15%), and a handful declined to answer the question (2%).

**1.3 What did Viewers not like about the film?** When asked what they did not like about the film, the largest groups of Viewers indicated that they liked everything, with more than one-quarter declining to answer the question (27%) and a fifth explaining that there wasn’t anything they disliked (20%). About a sixth disliked something about the giant screen theater or experience (16%), with some criticizing the size or layout of the theater and others explaining that the viewing experience made them “dizzy” or “nauseous.” A tenth thought *Mysteries of the Unseen World* was too short and/or said they would have liked more information (10%). Just under a tenth disliked something about the film’s audiovisuals elements (9%), including the music, the narrator/narration, and/or the imagery in general. At the same time, a slightly smaller group pointed to “gross” or “scary” elements in the film (8%), such as the decomposing rat, what they learned in the *Too Small* section, and the scenes with the snake and the owl. Less than a tenth each found something about *Mysteries of the Unseen World* confusing or hard to follow (4%), indicated that the film was boring or uninteresting (3%), noted that they didn’t like the pacing (3%), and/or explained that they disliked something about the nanoscale scenes (3%). Finally, a tenth shared miscellaneous comments (10%).

## Question 2: Did Viewers find the film content to be clearly presented?

**2.1 How did Viewers feel about the film’s overall clarity and the ease or difficulty of following the film visually?** Using a scale from 1 (confusing) to 7 (clear), Viewers generally indicated they found the film clear (median rating 7.0). Similarly, using a scale from 1 (visually hard to follow) to 7 (visually easy to follow) Viewers also generally indicated they found the film visually easy to follow (median rating 7.0). A Mann-Whitney test found one subgroup difference for the latter question in that more frequent viewers of IMAX films rated the film to be visually easier to follow than did less frequent viewers though the effect size was small ( $U = 5397, p = .015, r = .16$ ).

**2.2 How did Viewers feel about the film’s pacing, amount of information and science, and level of scientific explanations?** Viewers rated the film for how they felt about the pacing, the amount of information and science, and the level of scientific explanations, using a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being “just right” in each case. Overall, Viewers generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were all about right (median rating 4.0 each). Mann-Whitney tests further indicated a few subgroup differences, as follows. First, less frequent viewers of IMAX films rated the film’s amount of information ( $U = 5564, p = .037, r = .14$ ), amount of science ( $U = 5391, p = .012, r = .17$ ), and level of scientific explanations ( $U = 5363, p = .011, r = .17$ ) significantly higher than did more frequent viewers, though the effect sizes in each case were small. In addition, Mann-Whitney tests revealed that females found the film’s level of scientific explanations to be significantly more advanced than did males ( $U = 5428, p = .025, r = .15$ ), although here again the effect size was small.

### Question 3: What did Viewers learn from the film?

**3.1 How much did Viewers think they learned from the film?** Overall, Viewers indicated that they thought they learned a lot from *Mysteries of the Unseen World*. On a scale from 1 (learned nothing) to 7 (learned a lot) the median rating was 7.0. Mann-Whitney tests did indicate one subgroup difference, as females rated their overall learning from the film significantly higher than did males, though the effect size was small ( $U = 5443$ ,  $p = .028$ ,  $r = .15$ ). The median ratings in each case were 7.0.

**3.2 What was the impact of the film on Viewers' self-perceived knowledge of the unseen world?**

Viewers who had just seen the film rated their knowledge of the unseen world significantly higher than did Pre-Viewers, and the effect size was large ( $U = 13559$ ,  $p = .001$ ,  $r = .40$ ). On a scale from 1 (know nothing) to 7 (know a lot) the median rating for Viewers was 5.0 compared to 3.0 for Pre-Viewers.

**3.3 What did Viewers think were the most interesting things they learned from the film?**

When asked to describe the most interesting things they learned from watching *Mysteries of the Unseen World*, more than nine-tenths (94%) of Viewers identified one or more new subjects of interest. Nearly half of Viewers commented on something interesting in the *Too Small* section of the film (47%), while about a quarter pointed to something in the *Too Fast* section (24%). Just over one-fifth each pointed to the following: something from the *Invisible* section (21%), nanotechnology (21%), and seeing the unseen world and/or knowing that so much is unseen (21%). Just over a tenth were most interested in technology other than nanotech (11%), and less than a tenth were most interested in something in the *Too Slow* section (7%). Finally, a tenth of Viewers shared miscellaneous responses (10%), and less than a tenth declined to answer the question (6%).

**3.4 How much did Viewers think they learned from the film about science and technology topics?**

Using a scale from 1 (learned nothing) to 4 (learned a lot), Viewers generally indicated that they learned a lot (median rating 4.0 each) from the film about four of the film's five main topic areas, including: 1) the kinds of discoveries we can make about nature using new technologies, 2) the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, 3) the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and 4) the properties and possibilities of the nanoworld. They also thought they learned a fair amount (median rating 3.0) about the kinds of light waves humans and other animals see.

**3.5 What was the film's impact on Viewers' knowledge of the unseen world?**

To evaluate the impact of *Mysteries of the Unseen World* on Viewers' knowledge of content covered in the film, both Viewers and Pre-Viewers were asked to complete a 35 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for a general audience. Overall Viewers outperformed Pre-Viewers on the content assessment designed to assess learning gains from the film. An independent samples t-test showed that Viewers scored significantly higher than Pre-Viewers, and the effect size was large ( $t(384) = 19.5$ ,  $p < .001$ ,  $d = 1.84$ , 95% CI [11.1, 13.5]). Out of a total possible score of 35, Viewers averaged 28.4 correct responses, while Pre-Viewers averaged 16.0 correct responses.

In addition to this higher overall score, Viewers also significantly outperformed Pre-Viewers for each of the five main topic areas assessed, as follows: For *The types of light waves that humans and other animals see*, out of a total possible score of 6, Viewers averaged 5.1 correct responses while Pre-Viewers averaged 3.4 ( $t(431) = 9.93$ ,  $p < .001$ ,  $d = .94$ , 95% CI [1.4, 2.0]). For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 8, Viewers averaged 6 correct responses while Pre-Viewers averaged 2.8 ( $t(430) = 16.3$ ,  $p < .001$ ,  $d = 1.54$ , 95% CI [2.8, 3.5]). For the *Discoveries scientists have*

been able to make about nature through new technologies, out of a total possible score of 6, Viewers averaged 5.4 correct responses while Pre-Viewers averaged 3.2 ( $t(347) = 14.7, p < .001, d = 1.39, 95\% CI [1.9, 2.5]$ ). For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, Viewers averaged 9.5 correct responses while Pre-Viewers averaged 5.5 ( $t(424) = 10.73, p < .001, d = 1.01, 95\% CI [3.3, 4.8]$ ). Finally, for *Properties and possibilities of the nanoscale*, out of a total possible score of 3, Viewers averaged 2.4 correct responses while Pre-Viewers averaged 1.2 ( $t(422) = 13.5, p < .001, d = 1.27, 95\% CI [1.0, 1.4]$ ). The effect sizes in all instances were large effects.

#### **Question 4: How did watching the film impact Viewers' interest in the unseen world and the way they "see" the world?**

**4.1 What was the film's impact on Viewers' interest in the unseen world?** Viewers who had just seen the film rated their interest in the unseen world significantly higher than did Pre-Viewers who had yet to do so, although the effect size was small ( $U = 20434, p = .001, r = .18$ ). Using a scale of 1 (not at all interested) from 7 (very interested) there was a point difference in the median ratings between the two groups (7.0 vs. 6.0 respectively).

**4.2 Did Viewers think they would "see" the world differently after watching the film?** When asked if they thought they would "see" the world around them differently as a result of watching the film, the majority of Viewers said *Yes* (85%), while just under a tenth each said *No* (8%) or identified as *Unsure* (6%). Those who said *Yes* were asked how they would "see" the world differently. More than a quarter of Viewers explained that they would generally be more aware, knowledgeable, or conscious of the world around them and the things they cannot see (26%), and less than a fifth of Viewers indicated that they would think about something from the *Too Small* section (17%). Less than a tenth each said they would feel awe, respect, or appreciation for nature and the world around them (8%), noted that they would wonder, be more curious, or imagine more (7%), explained that they would think about man's place in nature and the complexity of life (7%), and described how they would think about something from the *Invisible*, *Too Fast*, and/or *Too Slow* sections of the film (7%). A slightly smaller group said they would observe or study the world more carefully (6%). Finally, less than a tenth of Viewers shared miscellaneous responses (9%).

Those who said *No* were asked why not. The largest group explained that they were already knowledgeable about the topics in the film (5%), while a handful each said they were limited by (human) sight and experience (1%) or shared miscellaneous responses (1%). And finally, those who were *Unsure* were asked why this was the case. A handful each said they were already knowledgeable of the topics in the film (1%), explained that the film wouldn't be on their minds (1%), or shared miscellaneous responses (2%).

### **Phase 2: Discussion group explorations of Viewers' connections with the film**

Immediately following four separate showings of *Mysteries of the Unseen World*, a trained moderator conducted four group discussion sessions with family groups to explore their reactions to the film. Recruitment for the sessions focused on families because the project team expected that *Mysteries of the Unseen World* would be a particularly appealing and effective learning medium for families. Recruitment occurred as Viewers exited the theater and was purposive, focusing on family groups with youth as opposed to young children.

All four sessions were held in an open room located adjacent to the theater exit area and were led by the same moderator. The sessions ran approximately 50-60 minutes, which included time for recruiting and settling

participants into the discussion room, introductions, an ice-breaker activity, discussion, wrap-up, and providing an honorarium in the form of a \$25 gift certificate to the science center gift store.

Twenty-nine (29) Viewers participated in the group discussion. This group comprised nearly one-fifth (18%) of the Viewers at Discovery Place who completed a post-viewing questionnaire. A total of ten families participated in the group discussions. Across the four discussion groups, there were a somewhat higher percentage of females (59%) to males (41%). Nearly three-quarters (72%) of the participants were adults while just over one-quarter (28%) were youth 17 years or younger. The average age of the adults was 38 while the average age of the youth was 11. As with the Phase 1 questionnaire evaluation, the majority of the participants were White (62%), with 10% Asian, 10% African-American, 3% Native American or Alaskan Native, and 10% reporting Other. One-tenth (10%) of the group identified themselves as Hispanic or Latino. The majority of participants had a graduate degree or some graduate experience (69%), with 27% having a high school degree or less and 3% having a college degree. The majority of participants had previously seen 1 or more giant screen films prior to seeing *Mysteries of the Unseen World*, with two-thirds (62%) having seen 3 or more. Overall the group indicated it was very interested in the unseen world (median 7.0) and somewhat knowledgeable (median 5.0).

This section presents the Phase 2 evaluation findings relating to the following six questions: 1) Who in the family drove the decision to see the film and why? 2) How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them? 3) What new questions or curiosities did Viewers have about the world around them as a result of seeing the film? 4) How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do? 5) How did Viewers feel about the film's use of the human characters (family/friends) that appeared throughout the film? 6) Did Viewers have any other feedback on the film that they would like to share?

### **Question 1: Who in the family drove the decision to see the film and why?**

Most of the families that participated in the group sessions indicated that the children in their families were the key decision makers as to which film they would see, whether it was a matter of the child directly choosing or their choosing based on what they thought was in their child's best interest. Only a couple of families made the decision based on what the parents/guardians wanted to see. For these families, the parents, most often the mother, indicated they made the decision for the family, in each case factoring in what they thought was in their children's best interest or the family at large.

When asked to describe their reasons for seeing the *Mysteries of the Unseen World* film the Viewers most often pointed to the film's: focus on the unseen world or science more broadly, diverse topic areas, and/or the attention given to unusual animals and plants or to time-lapse photography. A couple of families indicated they chose the film through a process of elimination as they didn't want to see the other film playing at Discovery Place at the time.

### **Question 2: How did Viewers respond to the film on a visual level and which visual images or sequences stood out for them?**

To help break the ice and explore what Viewers noticed about the film's visuals, the moderator asked Viewers to draw any visuals from the film that stood out for them. They were encouraged: to enjoy the drawing activity, to not worry about creating works of art, and to view the activity as an informal "ice breaker" exercise that would also give the producers some sense of Viewers' visual impressions from the film. To accommodate anyone who might be uncomfortable drawing, the moderator also offered the option of using words or labeling their



pictures for ease of interpretation. To this suggestion, a couple of Viewers qualified, while laughing, that they would draw pictures of visuals that they personally could figure out how to draw, as some of the film's visuals were complex.

Both adult and youth Viewers seemed engaged in the drawing activity, with most commenting that they found it to be a “fun,” “creative,” “personal,” or “interesting” way to reflect on the film. While they were drawing their pictures, many Viewers observed that the film left a “strong,” “lasting,” or “powerful” visual impression on them and/or that the film's visuals “sparked” new “curiosities” or “questions.”

No one particular visual stood out for a majority of the 29 Viewers; instead, Viewers choose a wide range of different visuals with 8 of these visuals being drawn by 10% or more of the group. Nearly one-third of the Viewers (31%) drew a picture of a raindrop hitting/bouncing in a puddle. A few Viewers each (14%) drew a picture of: a dragonfly, details of butterfly wings/scales, gold particles attacking cancer cells, an elevator to space, and/or a graphene/carbon tube. A couple of Viewers each (10%) drew a picture of: light waves and a time-lapse of flower blooming. One Viewer each (3%) drew a picture of: a lizard looking at a robot lizard, a balloon bursting from a push pin, a lightning strike, a strawberry decomposing, a spider climbing on spider web, a bee pollinating a flower, and hummingbird wings.

Each of the film's four sections was represented across the Viewers' drawings, but some sections were represented more than others. Two-thirds of the drawings related to visuals shown in the *Too Small* section of the film (62%), including the scenes about the nanoworld, compared to a slightly smaller group (58%) that related to the *Too Fast* section of the film (58%). One-seventh of the drawings related to visuals from the *Too Slow* section (14%) and one-tenth to the *Invisible* section (10%).<sup>53</sup>

Most of the adults and youth indicated that the film as a whole impressed them visually. They variously described the film's visuals as: “to the point,” “clear to understand,” “stunning,” “artistic,” “scientific,” “broadly appealing to all ages,” and “unique.” The Viewers also described their reactions to the film's visuals in diverse ways, ranging from experiencing an “emotional rush” to feeling like the visuals were “easy to follow,” to liking how the film showed the “inner workings or movements” of everyday phenomena, to appreciating that the visuals weren't “scary,” although a few youth and adults alike observed some images like the germs and eyelash mites were “gross” or “creepy.” Others observed that the visuals offered them “a change of perspective” or allowed them to more easily “relate” to what was being shown or reflected that some images lingered and/or “stuck in their minds.”

Several adults discussed the experience of watching the film on the giant screen, which at Discovery Place was in a dome theater. Some Viewers raised negative experiences, although no one issue stood out as a problem among the Viewers as a whole. These issues, raised by a few Viewers, included that the film seemed “out of focus,” “blurry,” “dark,” “overstimulating,” or “motion sickness” producing. Other Viewers, meanwhile, felt the giant screen experience was bearable for them, with one Viewer describing her viewing experience as “tolerable” compared to other giant screen films that often “throw things” at the audience. More often though, Viewers felt the giant screen experience “maximized” and was “central” to their enjoyment of the film's visuals. One Viewer described that she felt like she was “there and that she was moving the whole time” while another observed that he appreciated the long “lingering” moments that allowed Viewers to “experience” and even “study” what was happening, as in the high-speed photographic examples of the rain drops bouncing on water and the balloon popping. A number of Viewers similarly pointed to appreciating that the images “zoomed in” or

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<sup>53</sup> Note that some Viewers drew more than one picture, resulting in the percentages adding up to more than 100%

“surrounded” them which gave them a real sense of “detail,” “context” and/or “scale” and even an “emotional rush.”

Across the groups, the Viewers pointed to a wide range of different visual images or sequences that stood out for them, some of which were the same as those depicted in the pictures they chose to draw, though many Viewers also described other visuals. The air traffic/flight patterns, dragonfly, and elevator to space visuals were each mentioned by several Viewers. A few Viewers mentioned visual sequences that showed how animals use light waves, the flea in the dog’s coat, or the use of nano gold in nanotechnology. Individual Viewers pointed to the following additional visuals: the balloon popping from the push pin, seeing microorganisms in action, the animation of nano gold used to treat cancer cells, the water droplet bouncing in a puddle, the strawberry decomposing, the animation of atoms moving, and the gecko robots.

### **Question 3: What new questions or curiosities did Viewers have about the world around them as a result of seeing the film?**

More than half of the Viewers indicated they had new questions or curiosities related to content in the nanoworld section of the film. Their comments most often focused on the possibilities of using nanotechnology, including the use of gold at the nano level for medical treatments, the composition and uses of graphene and carbon tubes, the applications for space travel, and what is currently possible in terms of moving and splitting atoms. Several adults also raised concerns about the ethics of nanotechnology and the relative benefits to humanity. A few individuals also commented on wanting to know more about other topics such as the types of colleges that offer nanotechnology coursework. At the same time, a couple of Viewers, one adult and one youth, raised curiosities or questions related to the *Too Small* section of the film, with the youth wanting to know more about seeing deep inside the scales of butterflies and the adult wanting to know about how electron microscopy works, and two youth focused on the idea of wanting to know more about making or using animal robots.

### **Question 4: How might Viewers go about searching out more information about their new questions and curiosities? Where might they go, what might they do?**

Viewers mentioned a variety of different ways they would go about seeking information on new questions or curiosities the film raised for them. Most were able to come up with at least a starting point, although a few Viewers said they weren’t sure how they would frame or direct their search. Those who listed a starting point most often described turning to: online searching, Google searches, National Geographic resources, science-based publications or websites, video or film resources, and/or their local library.

### **Question 5: How did Viewers feel about the film’s use of the human characters (family/friends) that appeared throughout the film?**

In three of the four groups, there was time for a final question about the film’s use of human characters. Several adult and youth Viewers reflected that the human characters provided “context” and/or “relevance” for the content that was featured and that it helped to promote the idea that they were watching a story unfold. At the same time, several Viewers reflected that they felt that the film could have gone further in leveraging the human characters or at least strengthening the “relevance” of the human characters in specific scenes. Some Viewers didn’t see the role that the characters played in demonstrating or transitioning the film content’s about the unseen world. Specific scenes they commented on involved the skateboarding scenes, the boy nearly hit

by the fire truck, the picture of head lice, and the transition from showing the slime mold. Finally, while recognizing the role that the human characters played in the film a few adults qualified they personally didn't feel a "connection" to them.

### **Question 6: Did Viewers have any other feedback on the film that they would like to share?**

When offered the chance to provide any other feedback on the film, Viewers in three of the four groups made comments about wanting the film to be longer. Most often they elaborated that they felt they wanted additional depth on specific topics rather than an overview of many different topics. Additionally, a few Viewers across the groups commented that the pace seemed too fast in places. Finally, a few mothers noted that the film caused them to think about careers for their children based on the film content, and a couple of mothers explained that the film was relevant to their young children, with both noting that they talked to their children throughout the film about what was on the screen.

## **Phase 3: Follow-up evaluation of extended impact**

To explore the longer-term impact of the *Mysteries of the Unseen World* film, a follow-up online questionnaire was sent to Viewers who: a) completed a post-viewing questionnaire, b) but did not participate in a discussion group, and who c) indicated that they were willing to be contacted via email and an online questionnaire to provide feedback on the film within 15-20 days. These Viewers were informed of the opportunity to provide feedback via a small piece of paper stapled to the post-viewing questionnaire, which was subsequently removed and separated from the questionnaire. The invitation requested that respondents share their name and email address if they were interested in participating in the brief online questionnaire, and informed them they would be provided a \$10 gift certificate to amazon.com as a thank you for their participation.

An email with a link to the online questionnaire was sent to Viewers who provided contact information within 15-20 days of their seeing the film. The email was sent via the independent evaluation firm's [Constant Contact](#) account. A total of 72 out of 136 respondents opened the email request within the one-week evaluation period, and 25 of these 72 recipients completed the online evaluation request, resulting in a completion rate of 35%.

Twenty-five (25) Viewers completed the follow-up questionnaire. There was a higher percentage of females (72%) to males (28%). Nearly all (92%) of the participants were adults while just under one-tenth (8%) were youth 17 years or younger. The average age of the adults was 43 while the average age of youth was 14. As with the Phase 1 questionnaire evaluation, the majority of the participants were White (56%), with 24% Asian, 4% African-American, and 12% Other, including 2 Viewers who noted that they were Dominican. Just over one-tenth (12%) of the group identified themselves as Hispanic or Latino. The largest group of participants indicated that they had a graduate degree (36%), with 4% having attended some graduate school, 16% having a college degree, 28% having attended some college, 8% having a high school degree, and 8% having attended some high school. Additionally, the largest group of participants indicated that they had seen 3 or 4 giant screen films prior to seeing *Mysteries of the Unseen World* (40%), with 20% having seen 1 or 2, 28% having seen 5 or more, and 12% having seen none.

This section presents the Phase 3 evaluation findings relating to the following six questions: 1) How much did Viewers continue to think about the film within a few weeks of viewing? 2) How much did Viewers look into topics from the film within a few weeks of viewing? 3) Did the film change how Viewers think or feel about science or technology? 4) Did Viewers "see" the world differently a few weeks after watching the film? 5) What

activities did Viewers do within a few weeks of watching the film? 6) What additional feedback did Viewers share a few weeks after watching the film?

### **Question 1: How much did Viewers continue to think about the film within a few weeks of viewing?**

Nearly all of the Viewers indicated that they thought about the film in the weeks since viewing (96%). More than four-fifths thought about the film a little or moderate amount (84%), and just over a tenth thought about the film quite a bit to a lot (12%). Less than one-tenth didn't think about the film at all (4%).

When asked to describe what they thought about from the film in the weeks since watching, more than a third of Viewers pointed to something from the *Too Small* section (36%), including a few who thought about the nanoworld. More than one-tenth each explained that they thought about the *Too Fast* section (12%), the unseen world in general (12%), and/or what they liked about the film (12%), with some calling it “cool” and “entertaining,” for example. Slightly less than a tenth each described having thought about the *Invisible* section (8%), the *Too Slow* section (8%), the film's educational goals (8%), and/or what they liked about the film's visuals (8%). Finally, just over a tenth of Viewers shared miscellaneous responses (12%), and a fifth declined to answer the question (20%).

### **Question 2: How much did Viewers look into topics from the film within a few weeks of viewing?**

Viewers were asked if they looked into (e.g., talked to someone about, read about, watched videos, or researched online) topics from the film since viewing *Mysteries of the Unseen World* a few weeks earlier. More than half of Viewers looked into one or more of the topics from the film (56%). About a sixth of Viewers looked into 1 topic (16%) and a fifth looked into 2 topics (20%). Less than one-tenth each looked into 3 (4%), 4 (8%), or 5 topics (8%). None of the Viewers looked into more than 5 topics, and more than two-fifths didn't look into any topics (44%)

The largest group of Viewers noted that they looked into *the invisible world/things you can't see* (44%). About one-sixth each looked into *time-lapse photography (to help us see things too slow to see)* (16%), *the kinds of discoveries we can make about nature using new technologies* (16%), and *the kinds of inventions (e.g., devices materials) we can create by studying/imitating nature* (16%). At the same time, just over one-tenth each looked into *electron microscopy (to help us see things too small to see)* (12%) and *high-speed photography (to help us see things too fast to see)* (12%). Less than a tenth each looked into: *the kinds of light waves humans and other animals use to see* (8%), *the properties of the nanoworld* (8%), *the things that nanotechnology makes possible (e.g., new materials, devices)* (4%), and *the kinds of jobs /careers that use the science or technology shown in the film* (4%). Finally, although none of the Viewers checked a box on the follow-up questionnaire to indicate that they looked into *other* topics from the film, one Viewer (4%) wrote in that s/he looked into “Pluto.”

When asked to explain what they looked into, more than a tenth of Viewers shared feedback about who they talked to (12%), rather than what they discussed (for example, “Talked to my husband about these amazing things” and “Conversation with friends and family about the topics have been interesting”). A group of the same size mentioned having looked into topics from the film (12%), as in, “I watched the film ‘Gratitude’ with time-lapsed photography,” “I began to look into the kinds of technology we can create by imitating nature, such as dragonfly wings, while being able to use nanotechnology to make them super efficient,” and “Drones,” which

likely referred to an animation of dragonfly drones. Just under a tenth described having viewed other films (8%), as in, “*I looked more into other documentaries with similar themes.*”

### **Question 3: Did the film change how Viewers think or feel about science or technology?**

Nearly two-thirds of Viewers thought seeing the film changed how they think or feel about science or technology (64%), while more than a third said it did not (36%). Those who said *Yes* were asked how seeing the film changed how they think or feel. More than a quarter described having a greater awareness or appreciation of the world around them (28%), while just under a quarter said they thought about science, technology, and what the future holds (24%). More than a tenth of Viewers shared miscellaneous responses (12%).

Those who said *No* were asked why they didn’t think or feel differently. More than a quarter explained that they were knowledgeable of or interested in the unseen world prior to seeing the film (28%), one Viewer shared a miscellaneous response (4%), and one declined to answer the question (4%).

### **Question 4: Did Viewers “see” the world differently a few weeks after watching the film?**

Next, Viewers were asked if they had seen the world around them differently since watching *Mysteries of the Unseen World*. More than four-fifths of Viewers indicated that they *did see* the world differently (84%), while one-sixth said they did not (16%). Those who said *Yes* were asked to provide one or more examples of how they had seen the world differently since viewing the film. The largest group – nearly half of Viewers – explained that they watched things, paid closer attention, or observed the world more carefully (48%). A fifth noted that they had a different perspective or looked at things differently since viewing the film (20%), and about a sixth reported thinking about the things they can’t see (16%).

Those who indicated that they *did not* see the world differently were asked why this was the case. A few explained that they were already knowledgeable (8%), and one each said they hadn’t thought about the film (4%) or were too busy (4%).

### **Question 5: What activities did Viewers do within a few weeks of watching the film?**

When asked what activities they did related to the film within a few weeks of viewing, the largest group of Viewers, nearly three-quarters, reported they *talked to others* about the film (72%). At the same about, one-fifth each explained that they *saw something* on TV or in a movie that made them think of the film (20%) and/or *read something* that made them think of the film (20%). Less than one-tenth each *did something online* related to the film (8%) and/or *heard something* that made them think of the film (4%). More information about each of these activities is shared below.

- Talked to others about the film (72%)

When asked who they talked to and what they talked about, the Viewers shared a range of responses. Nearly two-thirds of Viewers described who they talked to (60%), including friends and family members who saw the film with them and people who did not. More than a quarter of Viewers described having talked about the general content or style of the film (28%), including a few Viewers who recommended the

film to others. A sixth talked about the *Too Small* section (16%), and less than one-tenth each talked about the *Invisible* section (8%) and/or the *Too Fast* section (4%). About a tenth talked about miscellaneous topics (8%), just under a quarter said they didn't talk to anyone (24%), and one Viewer declined to answer the question (4%).

- Saw something on television or in a movie that made them think of the film (20%)  
When asked what they saw that reminded them of the film, Viewers pointed to a variety of topics and a range of platforms, including TV shows, online videos, and computer screensavers.
- Read something that made them think of the film (20%)  
When asked what they read that reminded them of the film, Viewers pointed to nonfiction books – including two Viewers who were reminded of the film by the same book, *Insiders Extreme Weather*, for readers in grades 3-7 – and *National Geographic* articles.
- Did something online related to the film (8%)  
Both Viewers who did something online indicated that they looked for more information about the film on social media (8%) and that they visited the film's website (8%), with one Viewer noting, "I was checking where it was currently showing." One of the Viewers also searched something from the film online (4%), saying, "Just tried to learn more about the film and its development process, particularly the type of exposure and photography used to shoot it." None of the Viewers indicated that they downloaded the *Mysteries of the Unseen World* app from iTunes, "liked" the film's Facebook page, posted the film's trailer on their Facebook page, tweeted or blogged or used Facebook to discuss the film with others, or did another online activity. Finally, one Viewer explained that s/he intended to visit the film's website in the future, saying, "I will eventually look at the website."
- Heard something on the radio or while listening to music that made them think of the film (4%). When asked what they heard that reminded them of the film, one Viewer explained, "I have music from the Navajo people and listening to it reminds me of nature---how Native Americans view nature and how they are part of a larger world."

### **Question 6: What additional feedback did Viewers share a few weeks after watching the film?**

After completing the follow-up questionnaire, more than a quarter of Viewers opted to share additional feedback about their experience with the film since viewing (28%). A fifth commented on *Mysteries of the Unseen World* (20%), saying they enjoyed it, thought it could be longer, and/or that they shared it with their children, among other responses. Additionally, a handful of Viewers shared miscellaneous comments about their experience with the film since viewing (8%), commenting on their personal interests and their thoughts about the follow-up questionnaire.

## **Phase 4: Site documentation**

Beginning in the spring of 2015, Knight Williams and National Geographic staff collaborated to locate two science centers that: 1) were showing *Mysteries of the Unseen World* between May and August 2015, 2) participated as a partner science center in the NSF grant, and 3) were willing to host the theater evaluation and had the facility to do so. This section provides information about the two sites that hosted the Study 1 evaluation: Lawrence Hall of Science in Berkeley, CA and Discovery Place in Charlotte, NC.

### Lawrence Hall of Science in Berkeley, CA

Located in Berkeley, CA, the Lawrence Hall of Science is UC Berkeley's public science center. In addition to their exhibit spaces, live demonstrations, and special events, Lawrence Hall is also the site of the National Geographic 3D Theater. The Lawrence Hall of Science promoted the film in numerous ways including through announcements posted on the UC Berkeley Events Calendar and The Daily Californian, an online publication for the UC Berkeley campus and community. The film was also cross-promoted with other exhibits and hands-on activities that were being hosted at the science center in various Bay Area family resources such as Red Tricycle. The film was further promoted through various social media platforms such as Facebook, Twitter and Instagram.

### Discovery Place in Charlotte, NC

Located in uptown Charlotte, NC, Discovery Place encompasses over 160,000 square feet of educational, exhibition, meeting, and support spaces, including the Charlotte Observer IMAX Dome Theatre. Staff at Discovery Place described promoting the film in a number of ways. They took out print ads and shared movie listing in a local newspaper, *The Charlotte Observer*, and ran 30-second television ads on the Discovery Channel and Animal Planet. Online, they promoted the film through their Facebook and Twitter accounts, shared movie listings with relevant websites, advertised *Mysteries of the Unseen World* on their homepage banner and landing page, did an AdWords search, and coordinated display and video pre-roll advertising. Staff also organized an adults-only, after hours event called Science on the Rocks that featured the film and was promoted with flyers, web listings, and museum signage. Discovery Place also promoted the film through on-site signage, including wraps at the admissions desks at both entrances, placement of the project's interactive kiosk near their 6<sup>th</sup> Street admissions entrance, brochures, and other museum signage throughout the building.

## Discussion

The evaluation results indicate that the *Mysteries of the Unseen World* film was a successful informal science learning initiative with the audience recruited for Study 1 of the summative evaluation, meeting the project's goals in each of the five impact areas detailed in the introduction of this evaluation: 1) appeal and engagement, 2) clarity of presentation, 3) knowledge acquisition, 4) STEM interest and perceptions, and 5) motivational impact.

The findings in this report show that *Mysteries of the Unseen World* appealed to and engaged Viewers recruited for the evaluation. Overall, Viewers liked the film, found it visually exciting, thought the story was interesting, and expected to recommend the film to others. In general, they also found it well paced, clear, and visually easy to follow. Additionally, Viewers generally indicated that the film increased their curiosity about things they can't see with their own eyes and that it struck the right balance in terms of the amount of information, amount of science, and level of scientific explanations provided. Furthermore, *Mysteries of the Unseen World* had a significant impact on Viewers' knowledge of the content covered in the film, increased their interest in the film's STEM content, and increased their interest in and awareness of the unseen world. Finally, the majority of Viewers who completed the follow-up questionnaire indicated that they had done one or more activities related to the film in the weeks since viewing.

It is notable that relatively few subgroup differences were found across the evaluation. The few that were found involved older Viewers (41 years and older) tending to rate some individual aspects of the film higher than younger Viewers, including, in the case of Viewers aged 19-40, the program's storytelling, level of visual excitement, their likelihood of recommending the program, and their level of curiosity about things they can't

see with their own eyes. Similarly, compared to youth Viewers aged 7-18, Viewers 41 years and older tended to give significantly higher ratings to their overall liking of the program and the film's overall clarity. A few gender differences were also found, as females tended to rate their learning from the film significantly higher than did males, as well as their own level of curiosity about the unseen world after viewing. Meanwhile, females also tended to find the scientific explanations in the film significantly more advanced than did males. Finally, more frequent viewers of IMAX films tended to rate the film as visually easier to follow than did less frequent viewers, while less frequent viewers tended to rate the film's amount of information and science significantly higher and find the film's level of scientific explanations significantly more advanced.

In each of these cases though, it is important to bear in mind that the effect sizes were small, and Viewers ratings were very positive across all subgroups. Therefore, taken together with the film's overall lack of other major subgroup differences, the findings indicate that *Mysteries of the Unseen World* was well received by and successful with both males and females, as well as with individuals of varying ages, educational levels, and number of IMAX films viewed.

It is also important to note that, although this evaluation wasn't designed to consider format differences, as other giant screen studies have done<sup>54</sup>, *Mysteries of the Unseen World* showed in many different theater types (including IMAX, IMAX Dome, and 3D). For this report, the film was evaluated in two different theater types, with one being a giant screen dome theater and the other a National Geographic 3D theater with a smaller screen. Recognizing that the evaluation was not designed to assess the role of theater or screen type on Viewers' experience with the film, the evaluation found no significant differences in Viewers' ratings of the film at the two theaters/locations. Thus, *Mysteries of the Unseen World* was well received by and successful with Viewers who saw the film in a dome theater and in a 3D theater with a smaller screen.

Below, we briefly summarize aspects of the film that stood out for Viewers in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions. Reflecting on the findings that stood out from this vantage point, we highlight 11 themes, each of which we briefly discuss below with sample comments that capture the spirit of the theme:

➤ ***I liked the educational value/learned a lot from the film:*** When asked what they liked most about *Mysteries of the Unseen World*, the largest group of Viewers pointed to the film's educational value (as in, "*Learned so much. Felt like a real scientist!*" and "*A lot of interesting information that I didn't know before*"). In addition to appreciating the film's educational value, Viewers generally thought that they learned a lot from the film overall and that they learned a lot about specific STEM topics, including: *the kinds of discoveries we can make about nature using new technologies; the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature; the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes); and the properties and possibilities of the nanoworld.* As a group, they also thought they learned a fair amount about *the kinds of light waves humans and other animals see.*

The evaluation of the film's impact on Viewers' knowledge indicates that Viewers' perceptions of these personal knowledge gains were generally accurate. As detailed in this report, the Viewer group significantly outperformed the Pre-Viewer group overall *and* on each of the following five topics: *Types of light waves that humans and other animals see, Technologies used to see and study things that humans can't see with normal vision, Discoveries scientists have been able to make about nature*

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<sup>54</sup> Heimlich, J. E., Sickler, J., Yocco, V., & Storcksdieck, M. (2010). Influence of immersion on visitor learning: Maya skies research report. Edgewater, MD: Institute for Learning Innovation.



through new technologies, Things scientists can learn from nature to make innovative materials and devices, and Properties and possibilities of the nanoscale.

- **I like that the film showed me and enabled me to see the unseen world:** Throughout their responses, many Viewers indicated that they liked being able to see the unseen world (as in, “Saw things I literally could not imagine” and “It showed all of things that are around us that we can’t see, which is fascinating”). Viewers often pointed to the specific things the film showed them about the unseen world as being what they liked most about the film (as in, “seeing things move slowly and fast” and “too small, liked the things they showed”). Some Viewers also appreciated how seeing the unseen would or did provide a new perspective on their surroundings, as in, “The film made me realize that the ‘naked eye’ perhaps wasn’t intended to see all that there is to see in nature and other places” and “When I see the droplets of water or the flowers blooming, I could remember the scenes of the movie where you have shown in minute details about them.” Additionally, one of the Viewers who participated in a group discussion explained that the film’s title and the idea of being able to see the unseen world were what attracted her family to the theater in the first place, saying: “I got the tickets, but my 6 year old is fascinated with all this germs and what is the unseen world and what you can’t see with your eyes...He is fascinated with all that, and my daughter is getting into that too...So that’s what I thought would interest them...when you say “unseen” it is automatic, like what is there that we haven’t see? The title itself is very...it attracts you to it. It kinda makes you want to know more about...what is there? When you draw the curtain, people want to look behind.”
- **The film increased interest in and curiosity about the unseen world:** Viewers who had just seen the film rated their interest in the unseen world significantly higher than did Pre-Viewers, and throughout their questionnaires a number of Viewers noted that the film increased their curiosity about the unseen world around them (as in, “Ask more ‘questions’ like how is that dragonfly able to fly as it does?”). Additionally, the majority of discussion group Viewers eagerly identified new questions or curiosities they had about the world around them as a result of watching the film, with the largest group pointing to questions about nanotechnology, considered below.
- **The nanotechnology section inspired new questions for me:** In the discussion sessions and post-viewing questionnaires, a number of Viewers indicated they had questions or curiosities related to content in the nanoworld section of the film. Their comments focused on the possibilities of using nanotechnology, including the use of gold at the nano level for medical treatments, the composition and uses of graphene and carbon tubes, the applications for space travel, and what is currently possible in terms of moving and splitting atoms (for example, “I wish there was a little more explaining about the nanotechnology they referred to at the end” and “With the gold part of medicine, I’d like to know how far they are, have they started to do trials, etc.?”). Some Viewers also raised concerns about the ethics of nanotechnology and the relative benefits to humanity, as in, “The concept of humans playing with nanotechnology makes me nervous because we don’t really fully understand it and the room for error is great.”
- **I was particularly interested in the content of the Too Small section:** In comparison with the *Too Fast*, *Too Slow*, and *Invisible* sections of the film, Viewers more often pointed to content from the *Too Small* section when asked questions about the film, including: what they liked most, what they found most interesting, if and how they thought they would “see” the world differently after viewing, and what they thought about in the weeks since seeing the film in the theater. Additionally, when discussion group Viewers were asked to draw visuals from the film that stood out to them, the majority of their drawings depicted content and scenes from the *Too Small* section.

Though these findings indicate that Viewers were particularly interested in the content of the *Too Small* section, further research would be needed to determine the extent to which this content stood out because the *Too Small* section was the final section of the film (as one discussion group participant noted, “*I drew the space elevator, probably because it was one of the last images I saw and it was in my head*”) and/or because the *Too Small* section was the longest of the four sections (approximately 14 minutes long) and likely contained more visuals, information, and ideas that might “stick” with Viewers.

- ***I wanted even more information:*** Throughout the post-viewing and follow-up questionnaires, a number of Viewers expressed an interest in learning more, either wishing the film had provided more information (as in, “*I could have used a bit more detail*” and “*this topic should be more in detail to comprehend*”) or that the film had been longer (as in, “*It was extremely pleasant - wish it was longer!*”). When offered the chance to provide additional feedback at the end of the group discussions, Viewers in three of the four groups also shared comments about wanting the film to be longer. Most often they elaborated that they wanted additional depth on specific topics rather than an overview of many different topics (for example, “*Make the video a little longer and put more detail or more explanation on the different parts*”), and in one of the groups the majority of discussion participants agreed they would be willing to watch a forty minute version of the film on a specific topic, such as nanotechnology, suggested by one Viewer in the session.
- ***I could relate to the everyday examples in the film:*** Though they weren’t specifically asked for feedback on the choice of examples shared throughout the film, some Viewers explained that they liked the film’s use of “*everyday objects*” and “*experiences*” because they “*could relate to them*.” One Viewer elaborated, saying, “*For instance it wasn’t something that’s happening inside forests or deep in the sea. This helps us to pay more attention to around us*.” One Viewer noted that s/he like how the exploration of the everyday gave these objects and experiences greater “*relevance*,” while another explained that s/he thought the everyday examples would spark more curiosity in his or her daily life (as in, “*Having a more curious mind when looking at simple things or everyday things*”).
- ***I thought the visuals were beautiful:*** Viewers generally shared positive feedback about the film’s visuals, describing them as “*beautiful*,” “*colorful*,” and “*amazing*.” For many Viewers, the visuals were what they said they liked most about the film, as in “*Colors—especially butterflies, the scene with glass and loved the water drops. Pitcher of milk was beautiful. I also liked how visually stimulating it was, it made it more interesting how colorful it was*.”

In the questionnaires and discussion group sessions, Viewers variously described the visuals as: “*to the point*,” “*clear to understand*,” “*stunning*,” “*artistic*,” “*stimulating*,” “*scientific*,” “*broadly appealing to all ages*,” and “*unique*.” Viewers also described their reactions to the film’s visuals in diverse ways, ranging from experiencing an “*emotional rush*,” to appreciating that the visuals were “*easy to follow*,” to liking how the film showed the “*inner workings or movements*” of everyday phenomena. Others observed that the visuals offered them “*a change of perspective*,” allowed them to more easily “*relate*” to what was being shown, “*stuck in their minds*,” or helped them “*better grasp the subject*.”

Finally, in one of the discussion groups, an adult woman explained her reaction to her husband’s interest in seeing the film as she was concerned that *Mysteries of the Unseen World* would not be as pretty and photographically stunning as other IMAX films she had seen, though she was pleasantly surprised: “*One of the things I appreciated, so why I like IMAX, is visually because it’s pretty and the photography is stunning and the animals, and so that’s what I like and so when her (her husband) suggested that we see this, I was like...hmmm...I don’t know if I’m going to get the experience that I like*

*with all the pretty pictures, but it did a really good job and I was really impressed and really stunned at how artistic it was in addition to being scientific.”*

- **The film was well suited to the giant screen format:** Some Viewers commented on the experience of watching the film on the giant screen, as experienced at Discovery Place on a dome theater. Most often, these Viewers felt the giant screen experience maximized and was central to their enjoyment of the film’s visuals, as in *“Visually powerful, IMAX format”* and *“I...enjoyed the IMAX experience and delivery of information.”* Additionally, one discussion group participant described that she felt like she was *“there and that she was moving the whole time,”* while another shared an appreciation for the long *“lingering”* moments that allowed Viewers to *“experience”* and even *“study”* what was happening, as in the high-speed photographic examples of the rain drops bouncing on water and the balloon popping, among other responses.

Meanwhile some Viewers raised negative experiences about their viewing the film on the giant screen, although no one issue stood out as a problem among the Viewers as a whole and few comments related specifically to the film itself. These issues, raised by a handful of Viewers, included that the film seemed *“out of focus or blurry”* and that it made them *“dizzy”* or *“nauseous.”* Other Viewers, meanwhile, felt the giant screen experience was bearable, with some Viewers noting that they adjusted to the experience (as in, *“It took me some time to focus on the screen but that was IMAX not the film itself”*) and one discussion group Viewer describing her experience as *“tolerable”* compared to other giant screen films that often *“throw things”* at the audience.

- **Since viewing the film, I will see (or have seen) the world differently:** Nearly nine-tenths of Viewers reported immediately after viewing that they thought they would *“see”* the world differently as a result of watching the film (85%). A few weeks later, roughly the same proportion of Viewers who completed a follow-up survey indicated that they *had* seen the world differently in the weeks since viewing (84%). In both cases their comments included examples like, *“I will understand and acknowledge the unseen world”* and *“I see the world at a much ‘smaller’ level, knowing that some of the materials and substance that we use are formed on a microscopic level and we can make better materials by going even smaller.”*

Just under one-tenth of Viewers leaving the theater thought they would not *“see”* the world differently (8%), and a slightly smaller group of Viewers were unsure (6%), compared to the one-sixth of follow-up Viewers who indicated that they had not *“seen”* the world differently in the weeks since viewing the film (16%). In both groups of Viewers, those who thought they would not or did not *“see”* the world differently most often explained that this was because they were already knowledgeable of the unseen world (as in, *“Already aware, but still loved seeing [the film].”*)

- **I would be interested in learning more about the film’s online resources, but I might need encouragement:** Viewers who participated in the group discussion sessions and indicated that they had new questions or curiosities after viewing most often said they thought they would go online for more information (with several noting that they would *“Google”* their question) and/or that they would turn to online or print-based resources from National Geographic, suggesting that Viewers were generally open to extending their learning and engagement with the film beyond the theater experience.

Furthermore, when asked about the activities they had done in the weeks since viewing *Mysteries of the Unseen World*, the majority of Viewers indicated that they had talked to others about the film. Smaller groups explained that they saw something on TV/in a movie or read something that reminded them of the film. However, relatively few of the follow-up Viewers explained that they did an online activity related to the

film in the weeks after viewing. A handful each noted that they had looked for more information about the film on social media and/or had visited the film's website. None of the Viewers indicated that they downloaded the *Mysteries of the Unseen World* app from iTunes, "liked" the film's Facebook page, posted the film's trailer on their Facebook page, tweeted or blogged or used Facebook to discuss the film with others, or did another online activity. Additionally, although the discussion sessions were not geared specifically to a consideration of the website, a few Viewers in each group added to the conversation that they hadn't thought about searching out the film website on their own accord, but might have if the film or ancillary materials (e.g., signage, brochures, kiosk) had drawn their attention to it. In one group, the discussion moved toward the use of social media to promote or extend the film's impact through the use of hashtags. Future giant screen evaluations might look at the role that social media can play not only in promoting a film but also in directing audience members to additional information and resources. As noted by one group discussion Viewer, "*I think especially with what media can do today. I think that anything that can supplement that experience... if I want to dive off into nanotechnology or into the dragonfly wings or whatever. There could be resources online that could go into those that are probably at a lower cost of production, but pieces that will allow you to dive in a little bit more would be extremely valuable.*"

The above list of 11 themes are ones that we found to be most pertinent to the goals of the current evaluation, and with possible implications for future work produced by National Geographic and other groups focused on producing giant screen films funded by the NSF. As always, caution should be taken in drawing broad implications from any one evaluation. In this case, *Mysteries of the Unseen World* is a multi-faceted giant screen media project, which presented many alternative ways to evaluate the project's success in meeting its informal science learning goals.

The findings from *Mysteries of the Unseen World* offer broader implications for other giant screen film projects aiming to informally educate the public about science facts, concepts, or research. Although the evaluation was conducted at only two theater sites due to scheduling/availability and to allow for in-depth group discussions, the findings add further support to a conclusion reached in a review of 10 giant screen films funded by the NSF (Flagg, 2005):<sup>55</sup>

*Summative evaluations of 10 giant screen films indicate that the NSF's grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers' understanding of what scientists do; and positively impacts viewers' actions after a museum visit.*

This evaluation assessed Viewers' scientific knowledge of the unseen world, their interest in and attitude toward the unseen world, their understanding of the kind of work scientists do, and the extent to which a subgroup of Viewers ultimately pursued actions subsequent to their theater visit. In each of these areas, the film was found to be successful.

## Final remarks

Beyond confirming that the film met the project's goals in each of the 5 impact areas, and in addition to the issues raised in the discussion above, this evaluation also raises new issues for consideration around three aspects of the giant screen viewing experience that have received little or no evaluation attention to date: the use of human characters in a fictional storyline; the use of a cross-promotional project kiosk; and the impact of

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<sup>55</sup> Flagg, B. (2005). Beyond entertainment: Educational impact of films and companion materials. *Big Frame*, 22(2), 50-56.

immersive visualizations on Viewers' imaginations.

First, *Mysteries of the Unseen World's* narrative was structured by a fictional story about a family and their friends. Though these human characters were a topic of consideration in the group discussion sessions, Viewers were not asked to share their thoughts about the characters in the post-viewing or follow-up questionnaires. Given that discussion group participants generally provided diverse feedback about the characters (for example, "*I think in certain instances it helped set the context for what you were looking at,*" "*I didn't think they were that relevant to what was going on,*" and "*There wasn't a connection to the individuals*") and given the lack of research on fictional human characters in educational giant screen films, this is a subject that might be considered in future research.

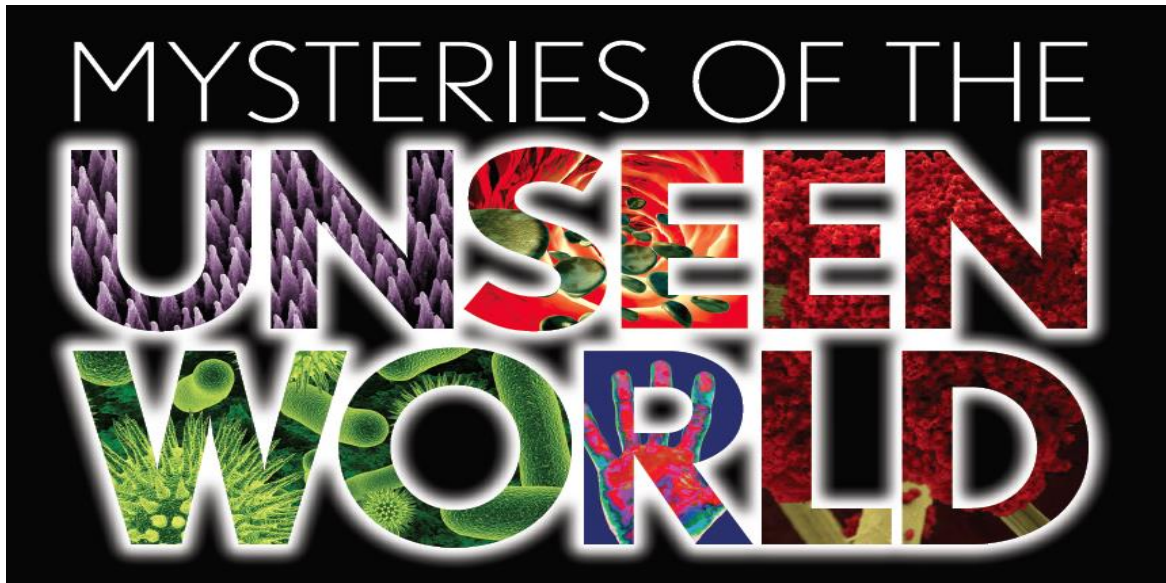
Second, though Viewers were not asked about their interest in or interaction with the *Mysteries of the Unseen World* kiosk at the evaluation site that hosted the kiosk in their lobby, one family in a group discussion session explained that they decided to see the film after the son and daughter noticed and interacted with the kiosk. Though the family didn't plan to see an IMAX film at the theater that day, the kiosk piqued their interest to learn more about the film which prompted them to walk to the nearby lobby area where the film tickets were being sold. Here they in turn noticed the film poster and brochures, which further increased their interest in seeing the film and ultimately help confirm their decision. Future research might explore the use of similar kiosks across a variety of theater sites, considering their impact on film ticket sales and Viewer engagement with film content, among other topics.

Finally, though it was not directly addressed in the questionnaires and discussion group sessions, a number of Viewers indicated that seeing things that are too fast, too slow, too small, and invisible to the naked eye inspired them to imagine the unseen world around them (as in, "*I'll look around and imagine that there's much more I could be seeing*"). Further research might examine the extent to which the immersive qualities of the giant screen format impact Viewers' imaginations across audience members of various ages and backgrounds, and the influence of imagination on knowledge gains, among other topics.

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We would like to thank the following individuals for their invaluable assistance in facilitating the Study 1 summative evaluation:

- Joanie Vandenberg Philipp, Mary Beth Ausman, Brian Hester, and Joe McGuire for helping to coordinate and host the Study 1 summative evaluation at the Discovery Place in Charlotte, North Carolina. A special thanks to Mary Beth Ausman for reviewing and providing feedback on evaluation procedures, providing on-site support, and sharing information about the various ways Discovery Place promoted the film.
- Sue Guevara, Megan Gray Banes, Emily Arnold, and Seth Harthun for helping to coordinate and host the Study 1 summative evaluation at the Lawrence Hall of Science in Berkeley, California.
- Dr. Barbara Flagg of Multimedia Research for sharing and discussing the formative evaluation findings on the rough cut version of the film and for reviewing and providing input on evaluation procedures and questions.



## **Impact of the giant screen film with a student audience**

**(Summative evaluation study 2 of 3)**

*Knight Williams Inc.*

Valerie Knight-Williams, Ed.D.  
Divan Williams Jr., J.D.  
Rachael Teel, MEd  
Gabriel Simmons  
Sauleh Rahbari

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# Table of Contents

<b>Introduction</b>	<b>3</b>
<b>Evaluation goals</b>	<b>4</b>
<b>Method</b>	<b>5</b>
<b>Sample</b>	<b>7</b>
<b>Report outline</b>	<b>9</b>
<b>Phase 1: Pre-post assessment of the film's immediate appeal and learning value</b>	<b>11</b>
Findings	11
Question 1: How appealing and engaging did students find the film?	11
1.1 How did students rate the film in terms of overall likeability, visual excitement, impact on curiosity, engagement with the storyline, and likelihood of recommending the film?	11
1.2 What did students like most about the film?	14
1.3 What did students not like about the film?	17
Question 2: How successful did students find the film in terms of: overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations?	20
2.1 How did students feel about the film's overall clarity and the ease or difficulty of following the film visually?	20
2.2 How did students feel about the film's pacing, amount of information and science, and level of scientific explanations?	21
Question 3: What did students learn from the film?	23
3.1 How much did students think they learned from the film?	23
3.2 What did students think were the most interesting things they learned from the film?	24
3.3 How successful did students think the film was in communicating specific themes about science and technology?	27
3.4 How much did students think they learned from the film about science and technology topics?	28
3.5 What was the film's impact on students' knowledge of unseen worlds?	29
Question 4: How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?	42
4.1 What was the film's impact on students' interest in science and technology topics?	42
4.2 What was the film's impact on students' interest in a job/career involving science or technology?	43
4.3 Did students think they would "see" the world differently after watching the film?	46
<b>Phase 2: Follow-up evaluation of extended impact</b>	<b>49</b>
Findings	49
Question 1: How much did students continue to think about the film within a few weeks of viewing?	49
Question 2: How much did students look into topics from the film within a few weeks of viewing?	52
Question 3: Did the film change how students think or feel about science or technology?	54
Question 4: Did students "see" the world differently a few weeks after viewing the film?	57
Question 5: What activities did students do within a few weeks of viewing the film?	60
<b>Summary of findings</b>	<b>66</b>
<b>Discussion</b>	<b>75</b>
<b>Acknowledgements</b>	<b>81</b>



# Introduction

*Mysteries of the Unseen World* is a National Geographic project centered on a giant screen film that highlights the sciences used to illuminate the amazing worlds around us, invisible to the naked eye.<sup>1</sup> As described on the National Geographic project website:

*Mysteries of the Unseen World* reveals phenomena that can't be seen with the naked eye, taking audiences into earthly worlds secreted away in different dimensions of time and scale.

Experience events that unfold too slowly for human perception; "see" the beauty, drama, and even humor of phenomena that occur in the flash of a microsecond; enter a microscopic world once reserved for scientists, but now made accessible to the rest of us; and begin to understand that what we actually see is only a fraction of what there is to see on Earth.

High-speed and time-lapse photography, electron microscopy, and nanotechnology are just a few of the advancements in science that allow us to see a universe of things, events, creatures, and processes we never even knew existed. These technologies give us new "superpowers" to see beyond what's in front of us.

Visually stunning and rooted in cutting-edge research, *Mysteries of the Unseen World* will leave audiences in thrall as they begin to understand the enormity of the world they can't see—a world that exists in the air they breathe, on their bodies, and in all of the events that occur around them minute by minute and nanosecond by nanosecond. And with this understanding comes a new appreciation of the wonder and possibilities of science.

<http://movies.nationalgeographic.com/movies/mysteries-of-the-unseen-world/about-the-film/>

In 2009 National Geographic was awarded a grant from the National Science Foundation (NSF) which provided funding for the film, related educational programming and outreach, and independent formative and summative evaluation. Beginning in 2013 the film debuted in science center theaters within and beyond the U.S., with some of these theaters also booking a hands-on kiosk developed by National Geographic for use in theater lobbies or surrounding museum spaces to help extend viewers' interest in and learning from the film. The project further included an outreach program involving educators from 17 partner museums who were invited to attend the Museum Educator National Workshop and participate in an awardee program designed to promote the film, related events, and education resources among local and underserved audiences. These educational resources included: a Museum Educator Guide, videos and classroom activities accessible from the project website, an iPad app, and a customized package of materials for use in the Engineer in the Classroom program.

As part of the NSF funding for the project, the independent evaluation firm, Knight Williams Inc. conducted the project's summative evaluation in the form of four separate studies. The first study focused on the immediate and longer-term impact of the film on a general audience that viewed the film in a local science center theater context on their own accord. The second study, the subject of this report, focused on the immediate and longer-term impact of the film on middle school students who viewed the film at their local science center as part of a school field trip. The third study examined the implementation, effectiveness, and longer-term impact of the Museum Educator National Workshop, focusing on the educators who participated in the workshop and those they respectively trained in their local settings, as well as educators who didn't attend the training but

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<sup>1</sup> Text in this Introduction in italics, other than titles, is borrowed from the project description section of the NSF proposal.

saw the film and used or planned to use the educational resources. The fourth study explored the use and effectiveness of a set of educational materials implemented within the context of the Engineers in the Classroom middle school program, as experienced by the engineers that implemented them and the students and teachers that participated in their sessions.

## Evaluation goals

The Study 2 summative evaluation examined middle school students' experience with *Mysteries of the Unseen World* when the film was viewed at their local science center during part of a school field trip. The evaluation centered on five key questions based on direction provided by National Geographic relating to the film's goals and consultation of the following materials for context and further specification: the film and script, the project's original NSF proposal, the evaluation team's original and revised summative evaluation plan, the project's Impact and Indicator statements submitted to the NSF, the formative evaluation reports on the film's rough cuts completed by Multimedia Research in 2012, and Knight Williams' prior summative evaluations focused on middle school students' learning from giant screen films produced by National Geographic. The five key questions were:

- 1) How appealing and engaging did students find the film?
- 2) Did students find the film content to be clearly presented?
- 3) What did students learn from viewing the film?
- 4) Did viewing the film impact students' STEM interests and perceptions?
- 5) What was the film's motivational impact on students within a few weeks of viewing?

These five questions were in turn operationalized into five impact areas, each with a corresponding set of indicators. Both the impacts and indicators are listed in the table on the following page.

To assess the five areas of impact, the evaluation was conducted in two phases, as follows:

- **Phase 1: Pre-post questionnaire assessment of the film's immediate appeal and learning value**  
The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by student performance on a post-viewing questionnaire, as compared to the students' performance on the same set of content questions prior to seeing the film.
- **Phase 2: Follow-up evaluation of extended impact**  
Approximately 15-20 days after students viewed the film they were asked to complete a brief questionnaire exploring the film's longer-term impact.

Additional details about each phase of the evaluation are provided under Method.

## Study 2 *Mysteries of the Unseen World* student evaluation Impact areas and indicators

### **1) Appeal and engagement**

- overall liking of film storytelling
- visual excitement
- content/topic appeal
- personal learning value
- likelihood to recommend

### **2) Clarity of presentation**

- overall clarity of presentation
- pacing
- ease of following visually
- density of information and science
- level of science explanations

### **3) Knowledge acquisition**

- personal learning value/what is salient for students
- knowledge of the types of light waves that humans and other animals see
- knowledge of the technologies used to see and study things that humans can't see with normal vision
- knowledge of the discoveries scientists have been able to make about nature through new technologies
- knowledge of the things scientists can learn from nature to make innovative materials and devices
- knowledge of the properties and possibilities of the nanoscale

### **4) STEM interest and perceptions**

- interest in film's STEM topics
- interest in STEM careers
- perceptions of the unseen world

### **5) Motivational impact**

- motivation to follow-up on something related to the film or to try some exploration
- motivation to look into the STEM areas covered in the film

## Method

### Study design

The evaluation used a quasi-experimental one group pretest/posttest design and follow-up, with the evaluation procedure occurring in two phases as follows:

#### **Phase 1: Pre-post questionnaire assessment of the film's immediate appeal and learning value**

The Phase 1 evaluation included two steps, as follows:

- 1) Pre-viewing/pretest questionnaire: One week prior to seeing the film, students in eight middle school classes completed a pre-viewing/pretest questionnaire that included demographic and background questions about students' gender, ethnicity/race, number of IMAX films seen, and interest in and knowledge of the film's main topic areas. The questionnaire also included a short knowledge quiz of content covered in the film relating to the indicators listed under knowledge acquisition in the table above.

- 2) Post-viewing/posttest questionnaire: One day after seeing the film, all eight classes completed a post-viewing/posttest questionnaire. The questionnaires collectively addressed the impact areas 1-4 listed in the table on the previous page.

The evaluation design involved a pre-post design which raises an external validity issue of not being able to ascertain whether the process of pre-testing students influenced the findings given the lack of an available comparison against students that did not see the film. The evaluation attempted to help minimize this sensitization issue by having students complete the pre-viewing questionnaire a week before seeing the film and the post-viewing questionnaire a day after viewing. However, future evaluations might look to evaluating the film with control or comparison groups in order to examine differences between students on short and longer-term outcomes. Although the preferred design for the Study 2 evaluation was a separate-sample pre-test/post-test design as was used in Study 1, this design was not feasible at the participating schools given that all of the classes in each participating grade level were signed up to see the film and the schools did not have time during their fieldtrips to have students divided into groups to complete the pre or post-viewing questionnaires respectively on-site.

### **Phase 2: Follow-up evaluation of extended impact**

Approximately 15-20 days after seeing the film students completed a follow-up questionnaire designed to explore impact area 5 in the table on the previous page.

## **Questionnaire development**

The three student questionnaires referenced above (pre, post, and follow-up) were developed through an iterative process that involved collaborating with the project team, revisiting the project goals and original NSF proposal, and reviewing the script and film with middle school youth advisors. The evaluation team also relied on piloting the questions with middle school youth since it was not possible, in most cases, to use established or validated measures for the evaluation given the specific nature of the content covered and the lack of prior evaluation work or research on giant screen films, or other films for that matter, on topics covered in the film as experienced by middle school youth. The content assessment items in particular were reviewed for readability, length, clarity, and for feedback on the level of difficulty.

Additional information about the questions used for each impact area listed in the table under Evaluation Goals is provided under the respective sections of the report.

## **Data analysis and reporting**

Statistical analyses were conducted on all quantitative data generated from the evaluation. Differences in student ratings and scores from pre to posttest as well as subgroup differences are noted where significant differences of less than .05 were found. To explore for significant differences, the analyses used t-tests and Mann-Whitney test as appropriate.<sup>2 3</sup> Demographic and background variables used in the subgroup analyses

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<sup>2</sup> When analyzing for differences between the means of subgroups within the same group, paired t-tests were used. When analyzing for differences between the means of two groups or subgroups, Levene's test was used to determine whether 2-sample t-tests or pooled t-tests were appropriate for testing the means of the measured variables. If Levene's test showed there was not a significant difference among the variances of the two groups or subgroups, a pooled t-test was used to determine if there were significant differences among the means. If Levene's test showed there was a significant difference among the variances, a 2 sample t-test was used to determine if there were significant differences among the means.

included: gender, location/grade level, and number of IMAX films viewed. Number of IMAX films viewed was divided into categories (0-2 films vs. 3 or more films).

Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases. The students' responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder. The analyses on the pre and posttest content learning questions were coded as randomly ordered responses.

## Sample

### Recruiting process

Beginning in January 2015, Knight Williams and National Geographic staff collaborated to locate middle school teacher representatives whose classes were scheduled to see or expressed an interest in seeing *Mysteries of the Unseen World* during the spring of the 2014-2015 school year at a partner science center. Working from a list of four partner sites that were showing *Mysteries of the Unseen World* in the spring and had middle school classes booked to see the film, the team then used the following four criteria to help select schools to participate in the evaluation: 1) The schools' scheduled viewing had to occur one month before the end of the school year to ensure time for completion of the Phase 2 follow-up, and during a timeframe that did not include school holidays to ensure no disruptions to the evaluation process; 2) The schools had to have a minimum of two classes scheduled to see the film; 3) The schools were public schools; and 4) The schools served a diverse cross-section of students from different backgrounds and metropolitan areas.

In March and April of 2015, the evaluation team located two middle schools that fit the above evaluation criteria. The two participating schools were respectively located in the Alabaster, Alabama and San Jose, California metropolitan areas. The supervising teachers in each case confirmed they were interested in and able to complete all of the required evaluation activities within the requested evaluation timeframe, from the initial pretesting of students one week prior to seeing the film through to the follow-up questionnaire 15-20 days later. To ease the burden of the evaluator requests for the above set of activities, both schools that participated in the evaluation were provided honoraria.

During the month of May 2015, a total of four classes from each school attended a field trip to either the McWane Science Center in Birmingham, Alabama or the Tech Museum of Innovation in San Jose, California, respectively. In both cases students viewed the film on a dome screen as both science centers host an IMAX dome theater.

Additional information about the student sample from these eight classes can be found under Sample demographic and background information, on the next page.

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<sup>3</sup> Note, the original standard deviations of the scores was used to compute the effect size. In correlated designs, to reduce the distortion in estimating the effect size,  $d$ , the original standard deviations of the scores is preferable to either the paired  $t$ -test value or the within subject's  $F$  value as each may overestimate the actual effect size. See: Dunlap, W. P., Cortina, J. M., Vaslow, J. B., & Burke, M. J. (1996). Meta-analysis of experiments with matched groups or repeated measures designs. *Psychological Methods*, 1(2), 170.

## Sample demographic and background information

A total of 194 students from 8 classrooms completed both the pre-viewing and post-viewing questionnaires, of which 90% (n=174) also completed a follow-up questionnaire 15-20 days later.<sup>4</sup> The table below summarizes demographic and background information for the student sample, including: gender, race/ethnicity, age, number of IMAX films viewed, interest in a science or technology career, and interest in and knowledge of the film's STEM topics. This information was gathered both for use in describing the student sample and for exploring subgroup differences.

The sample included:

- A balance of boys and girls (50% each).
- An age range that spanned 11-14 years, with a mean and median age of 12.
- A racial/ethnic distribution comprising 55% White, 10% Asian, 4% African-American, 13% mixed-race, and 14% Other. Sixteen percent (16%) of the students were of Hispanic origin.
- A comparable number of students from each of the two participating schools in California (54%) and Alabama (46%).
- A combination of frequent vs. occasional viewers of giant screen films, including 45% who reported they had seen only 0-2 films prior to seeing *Mysteries of the Unseen World* and 55% who reported they had seen 3 or more films.
- A majority of students who felt they knew a little about the five main topics featured in the film (median ratings 2.0 across).
- A majority of students who felt they were a little knowledgeable (median rating 2.0) and a little or fairly interested in the film's topics, with the discoveries about nature, inventions by studying nature, and technologies to see the unseen world being rated somewhat higher overall (median ratings 3.0) than the light waves or nanoworld properties and possibilities (median ratings 2.0).
- A combination of students that indicated they were not at all or slightly interested (35%) somewhat interested (33%) or very or extremely interested (32%) in a future job/career involving science.

Student demographic and background information			
Demographic/ background factor	Categories	Students (N=194)	
<b>Gender</b>	Female	50%	
	Male	50%	
<b>Age Group</b>	Age range	11-14	
	Mean	12	
<b>Racial/ethnic background</b>	African-American/Black	4%	
	Asian	10%	
	White	55%	
	Multiracial	13%	
	Other	14%	
	Hispanic Origin	16%	
<b>State of residence</b>	California	54%	
	Alabama	46%	
<b>Number of giant screen films viewed</b>	0	13%	
	1-2	32%	
	3-4	30%	
	5 or more	25%	
<b>Knowledge of film topics</b>	Median ratings		
	Light waves	1 (nothing) – 4 (a lot)	2.0
	Discoveries about nature		2.0
	Inventions by studying nature		2.0
	Technologies to see unseen world		2.0
	Nanoworld properties/possibilities		2.0
<b>Interest in film topics</b>	Median ratings		
	Light waves	1 (not at all) - 4 (very)	2.0
	Discoveries about nature		3.0
	Inventions by studying nature		3.0
	Technologies to see unseen world		3.0
	Nanoworld properties/possibilities		2.0
<b>Interest in future job/career involving science or technology</b>	Not at all interested	13%	
	Slightly interested	22%	
	Somewhat interested	33%	
	Very interested	19%	
	Extremely interested	13%	

<sup>4</sup> A total of 20 students across the 8 classrooms were sick or otherwise absent on the day the follow-up questionnaire was administered to students.

## Missing data

The initial dataset included 219 students; providing 218 pre-viewing questionnaires and 201 post-viewing questionnaires. After deleting 18 students who had only pre-viewing questionnaires and one student who had only a post-viewing questionnaire, six additional students were removed from the dataset as their questionnaires were substantially incomplete (i.e., missing responses to more than one of the categorical variables, for example gender or number of IMAX films viewed, or more than 10% of the remaining variables). Of the final dataset of 194 students, the percentage of missingness on each variable ranged from none to 4.6%. A non-significant Little's MCAR test,  $\chi^2(659) = 689, p = .20$ , indicates that the data were missing completely at random (Little, 1988).<sup>5</sup> As the dataset was assumed to include MCAR data with relatively minimal missing observations (<5%), missing items were imputed using the expectation maximization method.

## Report outline

The Study 2 findings are presented in 2 phases. Phase 1 contains 4 questions and Phase 2 contains 5 questions, as follows:

### Phase 1: Pre-post assessment of the film's immediate appeal and learning value

Question 1: How appealing and engaging did students find the film?

Question 2: How successful did students find the film in terms of: overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations?

Question 3: What did students learn from the film?

Question 4: How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?

### Phase 2: Follow-up evaluation of extended impact

Question 1: How much did students continue to think about the film within a few weeks of viewing?

Question 2: How much did students look into topics from the film within a few weeks of viewing?

Question 3: Did the film change how students think or feel about science or technology?

Question 4: Did students "see" the world differently a few weeks after viewing the film?

Question 5: What activities did students do within a few weeks of viewing the film?

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<sup>5</sup>Little, R. J. (1988). A test of missing completely at random for multivariate data with missing values. *Journal of the American Statistical Association*, 83(404), 1198-1202

## Labels used in reporting on film sections

In *Mysteries of the Unseen World*'s opening sequence, narrator Forrest Whitaker describes the four main sections of the film, saying: "Imagine if for one day we could see what [the family and their friends] can't... all that's too slow, too fast, too small, or simply invisible." Replicating the structure of the film, which also used animated title cards to highlight the four main sections of the film, the following four labels are used throughout this evaluation:

- *Invisible*: The part of the film focused on the electromagnetic spectrum and other animals' ways of seeing, among other topics.
- *Too Slow*: The part of the film focused on things that happen too slowly for us to see, such as decomposition and plant growth, among other topics.
- *Too Fast*: The part of the film focused on things that happen too quickly for us to see, such as lightning strikes and dragonfly flight patterns, among other topics.
- *Too Small*: The part of the film focused on things that are too small for us to see, including butterfly scales, spider silk, and the nanoworld, among other topics.



## Phase 1: Pre-post assessment of the film's immediate appeal and learning value

### Findings

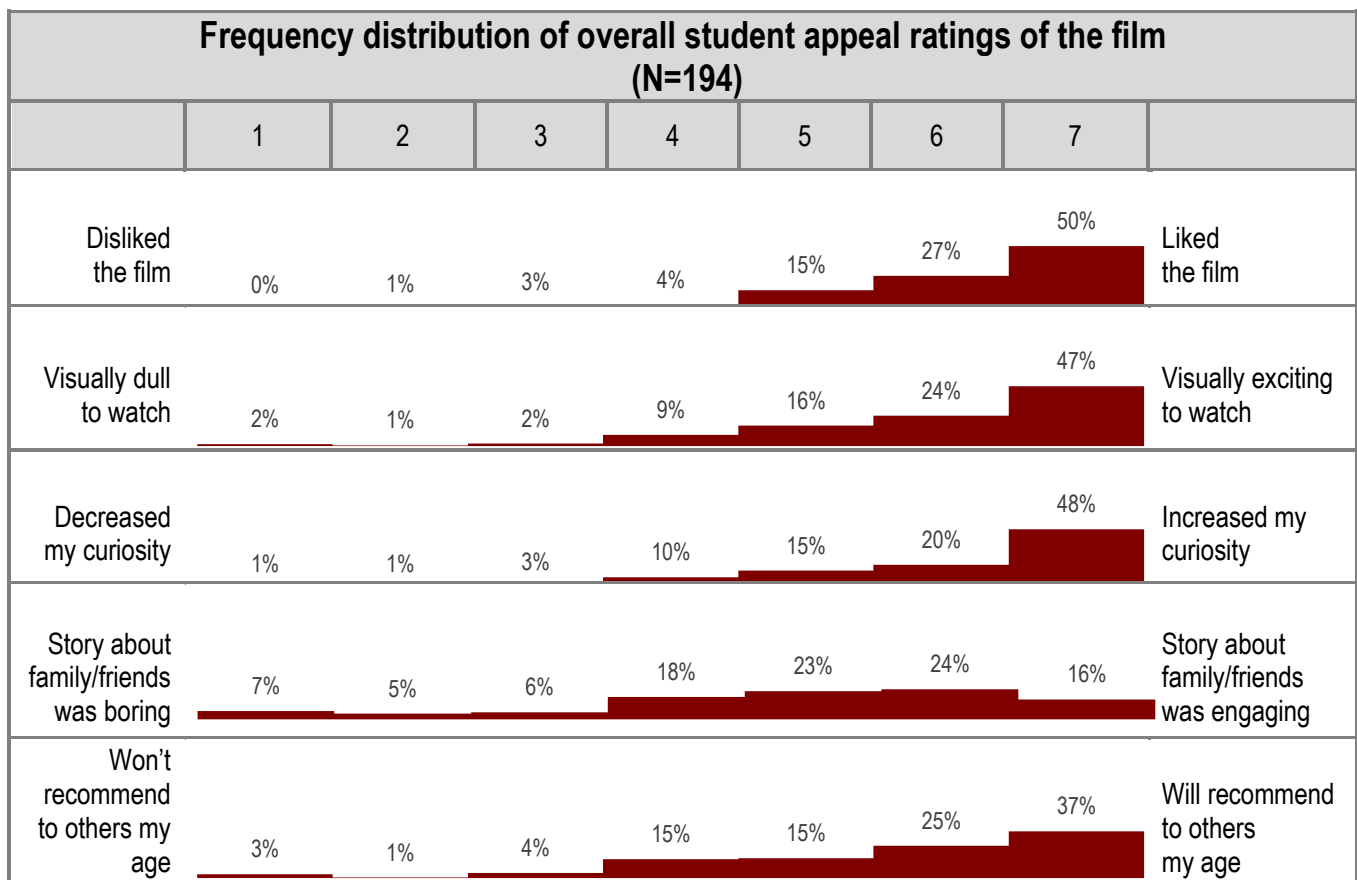
#### Question 1: How appealing and engaging did students find the film?

To assess the film's overall appeal, students were asked to rate how much they liked *Mysteries of the Unseen World* and to rate the film's entertainment value with respect to visual excitement and impact on curiosity. They were also asked to rate their engagement with the film's storyline and their likelihood of recommending the film to others their age. Finally, they were asked to describe what they liked and didn't like about the film. These findings are presented below in 1.1 through 1.3.

#### 1.1 How did students rate the film in terms of overall likeability, visual excitement, impact on curiosity, engagement with the storyline, and likelihood of recommending the film?

Overall, students indicated that they liked *Mysteries of the Unseen World*, with some explaining that it was “cool,” “fun,” and “interesting.” They generally found the film visually exciting, reported that it increased their curiosity, and said that they thought the film's story about the family and their friends was somewhat engaging. Finally, they noted that they were likely to recommend the film to others their age.

Students were asked to rate *Mysteries of the Unseen World* for the extent to which they liked the film, found it visually exciting or dull, felt it increased or decreased their curiosity, felt the film's storyline about the family and their friends was boring or engaging, and were likely to recommend the film to others their age on a scale from 1.0 (rated the lowest) to 7.0 (rated the highest) in each case. The table on the following page presents the percentages of students selecting each rating.



Though there were some differences of opinion, as evidenced by each range of ratings in the table above, students generally liked *Mysteries of the Unseen World* (median rating 6.5), found it visually exciting (median rating 6.0), indicated that the film increased their curiosity (median rating 6.0), and thought they would recommend the film to others their age (median rating 6.0). They also generally found the film's story about the family and their friends somewhat engaging (median rating 5.0).

Mann-Whitney tests determined a few subgroup differences for this set of questions. First, boys indicated that watching the film increased their curiosity significantly more than did girls (median 7.0 IQR = 2 vs. median 6.0 IQR = 2), though the effect size was small.<sup>6</sup> Second, 6th graders in California found the film's story about the family/friends significantly more engaging than did the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama (median 5.0 IQR = 2 vs. median 5.0 IQR = 2), though the effect size was small.<sup>7</sup> Third and finally, the 6<sup>th</sup> graders also indicated they were more significantly more likely to recommend the film than did the 7<sup>th</sup> and 8<sup>th</sup> graders (median 6.0 IQR = 2 vs. median 6.0 IQR = 3), though here again, the effect size was small.<sup>8</sup>

Students were then invited to explain their ratings. Examples of their comments are shared below:

**Liked or disliked**

- Great film
- It was bright, exciting, fun and interesting.
- It was cool, and also very understandable! Thanks!
- I loved EVERYTHING about the film and I do recommend watching it.

<sup>6</sup> ( $U = 3929, p = .045, r = .14$ )

<sup>7</sup> ( $U = 3642, p = .008, r = .19$ )

<sup>8</sup> ( $U = 3775, p = .017, r = .17$ )

- *It was an interesting film and helped me learn new things.*
- *Liking to disliking the film was a 6 out 7 because it didn't really talk nanotechnology.*
- *PICTURE: (drawing of 5 stars) It was a good film.*
- *It was okay*
- *I am not interested in those types of things*

**Found the film visually exciting or dull**

- *Lots of detail and color, which helped bring everything together.*
- *The 5 was because it got kinda boring to watch on some parts.*
- *The 6 was because of the decomposing mouse and strawberries.*
- *Too big of screen*

**Increased or decreased curiosity**

- *I thought the film was very interesting & educational*
- *It was an interesting film and helped me learn new things.*
- *It made me think about how [much] scientific knowledge there is to discover*
- *I was able to visualize lots of the scenes and definitely wanted to learn [more].*
- *Well the film made me more curious to know more about visibility and things like that.*
- *Not so many gross facts*

**Found the film's story engaging or boring**

- *Caught my attention*
- *An interesting way of doing it.*
- *It was a nice idea to show a family for daily life explanation.*
- *The family had a normal life, making you think what is going on in your everyday life.*
- *It was engaging most of the times but some-what boring.*
- *I think it did not relate, but kept the film moving.*
- *Didn't realize it was a story. Was just kinda there to me*
- *The normal people were really boring*
- *It was boring to see how it was with the family.*
- *That was what I disliked about the film*
- *I don't remember the story about the family and their friends.*
- *I thought the family was not needed in the film*
- *The film should be all about the nano tech.*
- *Because they kind of distract us from the real important stuff*
- *We learned more by just giving examples; the family didn't do much to help the concept*
- *It was cool but didn't really benefit from them being in it.*
- *I just thought it was kinda pointless, but I have nothing against it.*

**Will or won't recommend to others their age**

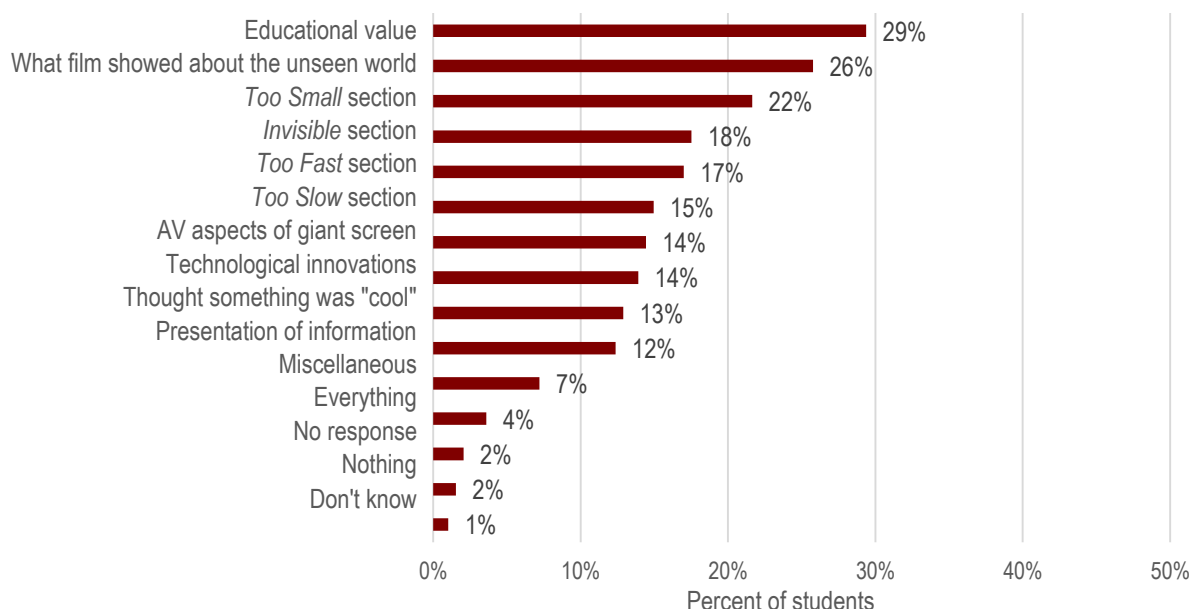
- *The film was very appropriate for kids our age...*
- *I think this is good for all ages.*
- *I loved EVERYTHING about the film and I do recommend watching it.*
- *I don't really talk to my friends about a science movie.*
- *Not appealing to middle schoolers*

## 1.2 What did students like most about the film?

Almost all of the students identified at least one aspect of *Mysteries of the Unseen World* that they found appealing, with many mentioning two or more elements. The students were especially enthusiastic about the educational value of the film and what the film showed them about the unseen world.

When asked to describe what they liked most about *Mysteries of the Unseen World*, the majority (95%) of students identified at least one thing about the film that they found appealing, with many citing two or more elements. The chart below shows aspects of the film students said they most frequently liked and the percentage of students offering each response.

What students liked most about the film (N=194)



As shown in the chart above, nearly three-tenths of students commented on the educational value of the film (29%), explaining that they learned a lot, enjoyed learning, and/or found something interesting. At the same time, just over one-quarter of students explained that they most liked something the film showed them about the unseen world (26%). More than one-fifth of students indicated that they most liked something in the *Too Small* section, including the film's discussion of the nanoscale (22%). About one-sixth each explained that they most liked something in the *Invisible* section (18%) and/or something *Too Fast* section (17%). Slightly less than one-sixth most liked something in the *Too Slow* section (15%). About one-seventh each pointed to something they learned about past and future technological innovations (14%) and/or something to do with the audiovisual aspects of giant screen filmmaking (14%), including the film's IMAX presentation, animation, and music. Slightly smaller groups specifically described something about the film as "cool" (13%) and/or explained that they most liked an aspect of the presentation of information (12%), including the structure of the film and the examples and explanations that were given. Finally, less than one-tenth each indicated that they liked everything in the film (4%), explained that they liked nothing (2%), noted that they did not know what they liked most about the film (1%), or declined to provide a response (2%). A handful shared miscellaneous responses

(7%), including 2 students who indicated that they most liked something in the trailer for another IMAX film, *Humpback Whales*.

Examples of students' comments on these themes follow below:

**Overall educational value (29%)**

- *I liked all of the information and details given because I did not know most of it.*
- *I liked how it was very educational. It told us all the different topics there are*
- *I enjoyed learning about the things that are too fast, slow for us to see and the invisible stuff we can't see*
- *I loved all of the things in the film! I was just so interested to see how other animals see the world and stuff like that.*
- *I liked the different ways each insect sees things the most. It was very interesting how each bug knows what it wants.*

**Something the film showed them about the unseen world (26%)**

- *It showed us up close at the objects around us. Now I know what it looks like and how they work.*
- *I liked watching and learning about the smaller organisms the most because I don't get to experience and see things like that on a daily basis.*
- *Showing things that are too fast or too slow in nature we couldn't see with our eyes*
- *I liked watching things 'to slow' because being able to see things I'll never see again is amazing.*
- *I liked the way it showed how other bugs see because well you don't get to see through your eyes like that every day.*
- *One thing I liked the most was when it tells you stuff that you can't see. Like, when you breathe in air, the air has dry skin and bug pieces that you can't see. They are too little for our eyes.*

**Too Small section, including the nanoscale (22%)**

- *Knowing that there are more organisms living on you than there are people in the world. Because it was cool to know that there were new species we didn't even know of because we can't see them*
- *I liked the part where it showed the butterfly wings up close. It was very interesting because I never knew they reflected the color blue.*
- *When the narrator told the audience that there are creatures on your eyebrows and everyone started scratching their eyebrows. I also liked how I learned a lot of new things like the lotus leaf is repellent to any liquid.*
- *The part where they could look onto one butterfly scale and beyond*
- *I liked the part about the nano/small things. This made me interested in learning more about really small things. I liked it because it showed many thing[s] in a nanoscale.*

**Invisible section (18%)**

- *I liked seeing things invisible to the naked eye because it was interesting seeing what you usually wouldn't see.*
- *I liked how they told us about all the different types of rays that we can't see. I really learned a lot from it!*
- *I liked when it showed us how we would see the world if we used more than visible light waves*
- *I think I liked learning about the gamma rays the most because I think it's cool to be able to see the bones of an animal or person.*
- *When it showed the warmth in people and it showed that when mosquitos see warmth which are the humans they bite you and drink the blood*
- *What I liked most about the film was how mosquitos can see wear the most amount o blood is. I liked that because it seemed really cool to look at, but not cool to feel that.*

**Too Fast section (17%)**

- *High-speed photography part. I never knew how interesting the world really was until you slow down time*
- *I liked, especially for the fast speed, how they showed real-life lapse photography and high-speed.*
- *I like most how dragonflies can fly backwards, upside down, and move it's wings in a different way*

- *I liked when it showed us the things that are too fast for us to see. I thought it was really cool to know that droplets float.*

#### **Too Slow section (15%)**

- *The time-lapse camera – I liked seeing things that we can't usually see happen.*
- *I liked watching things 'too slow' because being able to see things I'll never see again is amazing.*
- *The part when they were testing all of the time-lapse films. I was able to see how flowers grew invisible to human eye form.*
- *I liked the part when they were talking about the things too slow and there was the doctor who had fun with the plants.*

#### **Audiovisual aspects of giant screen filmmaking (14%)**

- *I liked how it made you have the feeling that you were there every step of the way. It was very realistic*
- *It felt like we were inside of the film.*
- *The animations really helped visualize places hard to comprehend.*
- *When the geographic features showed up, because I loved the scenery*
- *I enjoyed its balance of entertaining visuals and information, as it made the topic more interesting to hear about.*

#### **Technological innovations, past and future (14%)**

- *I liked it when they were using the electronscope because it me wonder what other things we can see.*
- *I also liked about how scientists can imitate the features of characteristics of plants and animals to make new inventions*
- *I really LOVED learning about that certain microscope that shows you each little texture inside of another texture. It was just SO interesting that it's like that.*
- *The nano carbon atoms. I like how they could make a material stronger than diamond but flexible as rubber*
- *The atom moving. It was cool!*
- *I liked the part about the elevator to space. I would love to go into space.*
- *What new things are being invented with nano technology because it is fascinating what can be done with it.*
- *I liked how it said they could kill cancer cells because I know a lot of people w/ cancer and it sucks.*
- *The potentialness and possibilities it told.*

#### **Something in or about the film was “cool” (13%)**

- *The high-speed and time-lapse shots because they were really cool.*
- *I liked how they presented information in a way we could understand and it was cool to watch*
- *I liked when it showed us the things that are too fast for us to see. I thought it was really cool to know that droplets float.*
- *What I liked most about the film was how mosquitos can see wear the most amount of blood is. I liked that because it seemed really cool to look at, but not cool to feel that.*

#### **Presentation of information (12%)**

- *How the categories fit with the little story.*
- *I liked how you added different backgrounds/theme of the family because it adds that everything is around you.*
- *I liked how they presented information in a way we could understand and it was cool to watch*
- *I liked how it teaches us about things and making it so it is easy to understand by using examples we can relate to.*
- *It gave very descriptive details that could allow us to understand what it wanted us to know*
- *I also really liked the way the narrator explained things because it was easy to understand.*

#### **Everything (4%)**

- *All of it, it showed me new things and things I can use someday.*
- *I liked everything about the film. I liked it since I like science and I also thought it was interesting and I learned a lot.*

### 1.3 What did students not like about the film?

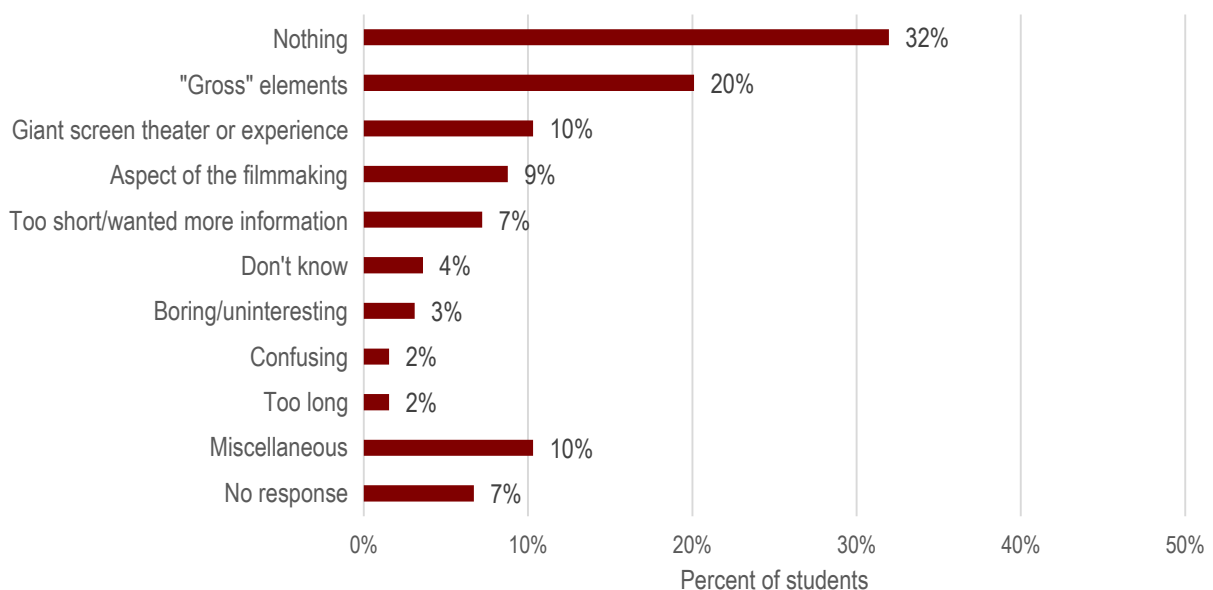
The largest group of students indicated that there was nothing they disliked about the film. Of those who pointed to aspects they didn't like, students most often commented on the film's "gross" elements, explained that they were physically uncomfortable during the screening, and/or shared feedback about an aspect of the filmmaking.

Students were asked to describe what, if anything, they did not like about *Mysteries of the Unseen World*. The chart below shows the aspects of the film students most frequently said they disliked and the percentage of students citing each element. Nearly a third of students indicated that there was *nothing* they disliked about the film (32%). One-fifth of students pointed to elements they considered "gross" (20%), including scenes focused on the mites on our eyelashes, particles in the air we breathe, decomposition, and close-ups of small organisms.

One-tenth of students explained that they were physically uncomfortable during the screening (10%), with most explaining that the film gave them "a headache," made them "dizzy," or "hurt their eyes." Of this group, students generally indicated that their discomfort was due to the giant screen experience, with only 2 students noting that the theater's shape played a role. Additionally, 2 students indicated that the sound was too loud and 1 said s/he experienced back pain caused by the theater's seats.

Just under a tenth of students indicated that they didn't like an aspect of the filmmaking (9%), including the film's audiovisual elements and storytelling devices. A slightly smaller group noted that they thought the film was too short and/or wanted more information (7%). A handful each said they didn't know what they did not like about *Mysteries of the Unseen World* (4%), found the film boring or uninteresting (3%), thought parts were confusing (2%), and/or thought the film was too long (2%). Finally, a tenth shared miscellaneous responses (10%), and just under a tenth declined to answer the question (7%).

What students disliked about the film (N=194)



Examples of students' comments on these themes follow below:

**Nothing (32%)**

- *NONE. I liked it all. It was very interesting.*
- *I enjoyed the whole thing, it was a great film to watch.*
- *Nothing it was great*
- *I didn't dislike anything. I thought it was nice and cool and mostly very educational.*
- *I'm not sure I didn't like anything about the video. It was so amazing and awesome, even the dome/theater was awesome. Every thing was planned right and awesome.*
- *I liked the video. It was one of the best videos I have seen in the Imax theatre.*
- *I liked everything about the film, I learned a lot.*

**"Gross" elements (20%)**

- *The mites on the eye lashes, because it was disturbing.*
- *The part where they were telling about your skin. It was very interesting but I felt uncomfortable the rest of the movie!*
- *The part where they talk about the bacteria and the dead skin that we breath. (adds a drawing)*
- *I didn't like when it explained the things that are in the air we breath. I mean nobody wants to know that dead skin is in the things they inhale.*
- *I didn't like watching the dead mouse decompose. That was disgusting.*
- *I didn't like when you had the huge spider and head lice and anything really with bugs because it creeps me out.*
- *I didn't like the part where the spider appeared because I have a fear of spiders*
- *I disliked that they gave vivid pictures of the different bugs. I like learning about them, but not seeing them. I heard people groaning due to the pictures.*
- *I did not like seeing the parasites and organisms up close because it is gross to me.*

**Giant screen theater or experience (10%)**

- *The film was constantly moving, making my eyes hurt (loved it though)*
- *I can't really watch IMAX or some 3D movies because get really bad headaches. So, during the film, I was really dizzy and I had a headache*
- *What I didn't like about the film was at some parts my eyes would hurt I would feel a bit dizzy.*
- *I didn't like that it was in IMAX because it gives me headaches*
- *The sound was too loud and it hurt my ears. The screen was really big so I couldn't see the whole screen or display*

**Aspects of the filmmaking (9%)**

- *The unneeded complex graphics*
- *The spinning. Do fade away instead.*
- *The sound during the black and white movie*
- *Too much was going on.*
- *I did not understand the drawing the boy drew, as it didn't really connect to the story.*
- *Not enough humor.*
- *I didn't like the story because the normal people were king of boring.*
- *I didn't like how they had a random scene in the end including a random family, that has nothing to do with science.*

**Too short/wanted more information (7%)**

- *I did not like the shortness. I wanted to see more things in each category.*
- *The film seemed short, but no real complaints otherwise.*
- *It was too short. I wanted to learn more.*
- *I wish it gave more examples.*
- *Learning about mosquitoes was my least favorite part because I feel like I didn't learn enough about them*
- *Not enough talk about Nanotechnology.*



**Boring/uninteresting (3%)**

- *Electrons, was boring to watch*
- *It was kind of boring – I fell asleep*
- *Details about nanotechnology because I'm uninterested.*

**Confusing (2%)**

- *When it talked about nanos you couldn't understand how small it actually was.*
- *Nanoscale, very confusing*
- *Confusing: Explain each thing more*

**Too long (2%)**

- *A little too long but not that much*
- *I didn't like how long the film was b/c I almost fell asleep. (Or maybe b/c I was tired).*
- *It was too long.*

**Miscellaneous (10%)**

- *I didn't like what scientist[s] are doing with what they learn like the little robots and the whole elevator to space is unrealistic, even for science.*
- *I didn't like that people are inventing things with nano-technology that are just luxuries when there are kids starving in Africa. They should spend their money on that and not on an elevator to space!!!*
- *When they talked about what's in nano [gold].*
- *The dragon fly robot and gecko robot.*
- *The spider silk part of the film was the part I did not like. The information wasn't so good.*
- *I did not like how the film before it started it took about 10 mins for the actual film to start.*

## Question 2: How successful did students find the film in terms of: overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations?

Students were asked to rate how successful they found the film in terms of overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations. These findings are presented below in 2.1 through 2.2.

### 2.1 How did students feel about the film's overall clarity and the ease or difficulty of following the film visually?

In general, students thought the film was fairly clear and visually easy to follow.

Students rated *Mysteries of the Unseen World* for how they felt about the clarity of the film and for whether they found the film's visuals easy or hard to follow on a scale from 1.0 (lowest rating) to 7.0 (highest rating) in each case. The table below presents the percentages of students selecting each rating.

Frequency distribution of students' ratings of the film's overall clarity and visual clarity (N=194)								
	1	2	3	4	5	6	7	
Confusing	1%	2%	2%	19%	16%	26%	34%	Clear
Visually hard to follow	2%	0%	6%	16%	18%	26%	30%	Visually easy to follow

Though there were some differences of opinion, as evidenced by each range of ratings in the table above, students generally found the film fairly clear (median rating 6.0) and thought the visuals were fairly easy to follow (median rating 6.0). A handful of students shared additional feedback about their ratings, as in:

#### **Found the film clear or confusing**

- *Well mostly why I picked those is because lots of it was good, clear, lots of science, and awesome.*
- *It wasn't hard to understand and it was worded simple enough to follow.*

#### **Found the film's visuals easy or hard to follow**

- *I picked these ratings because I felt that was clear...*
- *[It] was definitely clear and easy to visualize. I wish the video went into a bit more detail.*

## 2.2 How did students feel about the film’s pacing, amount of information and science, and level of scientific explanations?

Overall, students thought *Mysteries of the Unseen World* was well paced and that the amount of information was about right. Students also generally indicated that the amount of science and the level of scientific explanations were about right.

Students rated *Mysteries of the Unseen World* for how they felt about the pacing of the film, the amount of information in the film, and the amount of science and level of scientific explanations on a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being just right in each case. The table below presents the percentages of students selecting each rating.

Frequency distribution of students’ ratings of the film’s pacing, amount of information and science, and level of science explanations (N=194)								
	1	2	3	4	5	6	7	
Pace was too slow	2%	1%	5%	61%	18%	9%	4%	Pace was too fast
Too little information	1%	1%	4%	54%	22%	11%	6%	Too much information
Too little science	2%	0%	3%	56%	21%	10%	8%	Too much science
Scientific explanations too basic	2%	2%	6%	49%	24%	9%	5%	Scientific explanations too advanced

Although there were some differences of opinion, as evidenced by each range of ratings in the table above, students generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were all about right (median rating 4.0 each). In addition, Mann-Whitney tests found that girls found the film’s level of scientific explanations significantly more advanced than did boys (median 4.0 IQR = 1 vs. median 4.0 IQR = 1), although the effect size was small.<sup>9</sup>

<sup>9</sup> ( $U = 3854, p = .018, r = .17$ )

A number of students shared additional feedback about their ratings, as in:

***Pacing too fast or too slow***

- *The film seemed somewhat rushed*
- *4 = Pace was right*

***Too much or too little information***

- *I picked these ratings because I felt that...there was a lot of info*
- *The film was getting too much info!*
- *I liked all because it wasn't too hard to follow or too much information.*
- *4 = Enough information that it wasn't overwhelming*
- *I wanted to learn MORE!*
- *I wish the video went into a bit more detail.*

***Too little or too much science***

- *Lots of science and it was just at my level.*
- *5. Nobody can have too much science.*
- *I never know that I was able to learn that much of science in just a film.*
- *Not too much science but there was a good bit there*
- *I think the film should describe more about nano-tech because it is a fairly new technology not everyone knows about.*

***Scientific explanations too basic or too advanced***

- *Lots of science and it was just at my level.*
- *It wasn't hard to understand and it was worded simple enough to follow.*
- *I liked the fact that the information was advanced but I still knew what they meant*
- *Used a lot of words I've never heard or learned and didn't explain them*
- *Some things that they talked about I did not understand. For example the big words.*
- *I wanted...better explanations.*

### Question 3: What did students learn from the film?

The learning value of *Mysteries of the Unseen World* was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, students were asked to rate how much they thought they learned from *Mysteries of the Unseen World*. Second, they were invited to comment on the most interesting things they learned from the film. Third, they were asked to rate how successful they thought the film was in communicating science and technology themes, and how much they thought they learned from the film about science and technology topics. Fourth, in order to assess knowledge gains relating to the content of the film, students completed a 40 point “quiz” type assessment that included true/false, multiple choice, and short answer questions before and after viewing the film. These findings are presented below in 3.1 through 3.5.

#### 3.1 How much did students think they learned from the film?

Overall, students indicated that they thought they learned a considerable amount from *Mysteries of the Unseen World*.

Students rated *Mysteries of the Unseen World* for how much they thought they learned from the film on a scale of 1.0 (learned nothing) to 7.0 (learned a lot). The table below presents the percentage of students selecting each rating.

Frequency distribution of students' ratings of how much they thought they learned from the film (N=194)								
	1	2	3	4	5	6	7	
Learned nothing	1%	1%	2%	4%	18%	35%	39%	Learned a lot

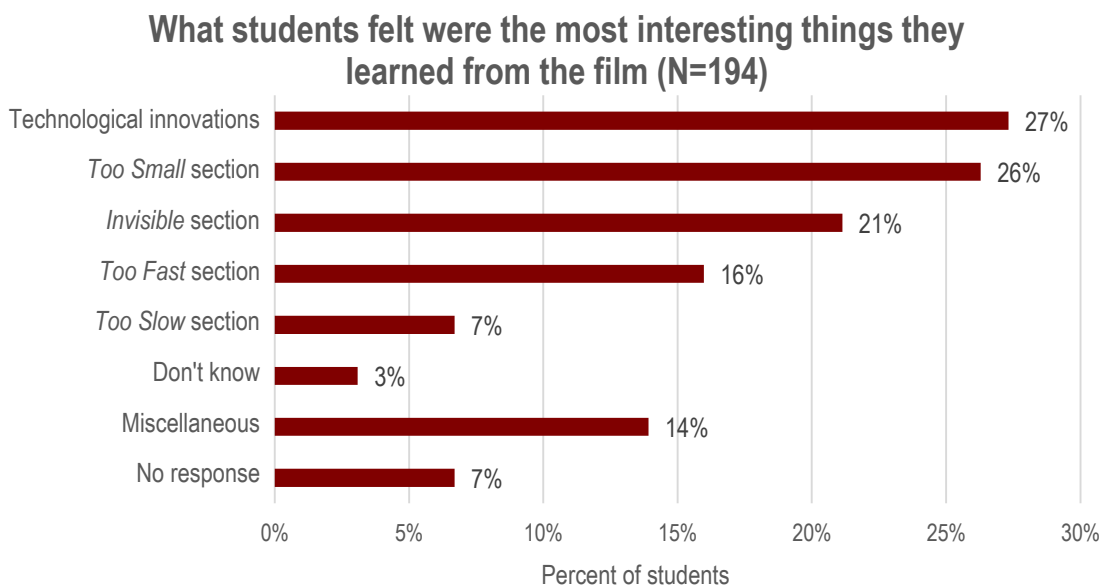
Though there were some differences of opinion, as evidenced by the range of ratings in the table above, students generally indicated that they thought they learned a considerable amount from the film (median rating 6.0). Examples of students' comments on the subject are shared below:

- *Lots of it opened my mind to a new experience.*
- *I learned so much, it was so awesome.*
- *I think I learned a lot because I was surprised for a lot of the film.*
- *Frankly, I learned too much.*
- *Previously said, I kind off already know these things by watching other documentaries (Nova, National Geographic :P, Smithsonian).*
- *I did learn but not a lot because I was distracted by the lights and sound*

### 3.2 What did students think were the most interesting things they learned from the film?

The majority of students identified at least one thing they found interesting in the film. The largest groups pointed to technological innovations, something interesting in the *Too Small* section, and something interesting in the *Invisible* section. Smaller groups of students shared interesting things they learned from the *Too Fast* and/or *Too Slow* sections.

When asked to describe the most interesting things they learned from watching *Mysteries of the Unseen World*, nine-tenths (90%) of students identified one or more new subjects of interest. The chart below shows the general categories students most frequently identified, and the percentage of students citing each topic.



As shown in the chart above, more than a quarter of students pointed to technological innovations (27%), such as nanotechnology, microscopes, and inventions that imitate nature, while a slightly smaller group commented on something interesting in the *Too Small* section (26%), including what they learned about particles in the air, mites on our bodies, butterfly wings, lily pads, the strength of spider silk, the size of the nanoscale, and what small organisms look like up close, among other topics. Just over a fifth of students indicated that they learned something interesting in the *Invisible* section (21%), including how bees and mosquitoes see the world. Slightly less than one-sixth of students pointed to something they learned in the *Too Fast* section (16%) about topics such as dragonfly wings, lightning, and rain drops, while less than a tenth shared something interesting from the *Too Slow* section (7%), including what they learned about how plants move. A handful said they didn't know what they found most interesting in the film (3%), and less than a tenth declined to answer the question (7%). Finally, one-seventh of students shared miscellaneous responses (14%), including comments about whales seen in the trailer for another IMAX film, *Humpback Whales*, and general praise for the film.

Examples of students' comments on each theme follow on the next page:

### **Technological innovations (27%)**

- Nano technology can help us build great things
- Nano technology could help build an elevator to space.
- That nanomaterial + technology are very useful and small.
- That we can make something that is super strong 1 atom thick
- The graphene because it's cool.
- About nanotechnology because it's new and no one knows much about it
- The nanoworld because it was talking about moving atoms to repair DNA
- PICTURE: Everything especially the nano world and going to the space.
- Electroscope, because it cool that you can seeish and move matter
- You can move atoms. Cure cancer and stuff!
- That a microscope can move atoms because I didn't know it was possible.
- The most interesting things were the technology that was used. (Time-lapse, high-speed, microscope). This is because I enjoy learned how things work. (Finding small things, etc).
- That you can see stuff you couldn't see with technology
- The most interesting part was how we can copy nature. This way we can do what the original things do but have control.
- How we can mimic nano things and skills/adaptations from living things
- How there using affects like animals to make robots that help

### **Too Small section (26%)**

- That some things are too small for the human brain to comprehend. It's cool
- The too small part because there are interesting that we don't see with our eyes.
- I liked about when it was telling about the things about "too small"
- When I breathe I breathe in tiny insect parts (thanks for that)
- I think the most interesting is about what we breathe in live skin flakes, something from space, and many other things
- The amount of bacteria on your body
- The things that much applied to me, like organisms on my body
- That there are little bugs living all in your and on you.
- I think the most interesting thing from the movie is that there are a lot of small tings, such as lice on our head, bugs on our eyelashes, and fleas on our dogs.
- About bugs in your eyelashes
- The butterflies' wing because that was really small and we were able to see it.
- How the wings of a butterfly have layers and among those there are even smaller ones
- One most interesting thing was that lily pads are totally repellent to any liquid and would slide right off, so I thought was interesting because I never that lily pads could do that.
- Lotus lily pads are water resistant – seems cool
- That spider silk was very strong, things that [are]...too small, because I never see those things
- I learned that spider silk is one of the most lightest and strongest materials on earth.
- How things are on the nanoscale.
- The nano scale because of how small it was
- How the compound eyes of a fly was shaped and other things at a microscopic level.

### **Invisible section (21%)**

- How many waves are around us – I did not know that.
- Different rays like UV, Gamma, radio waves because I find those interesting
- The most interesting thing that I learned was that there are more rays like ultraviolet gamma rays
- The one thing that sticks out in my mind is when the film was talking about the different types of light waves. Mostly because of the animation, but it definitely caught my attention.
- The different kinds of waves because of the different colors.

- *The ultraviolet light, because it shows where the most heat is.*
- *Mosquitos see infrared waves to see where most blood in human body is*
- *Learning how bugs see because it's cool to think that they see the world differently than us.*
- *Bees and mosquitoes see in ultraviolet and infrared light*
- *The different things that bugs see and we don't*

**Too Fast section (16%)**

- *Things that went too fast...because I never see those things*
- *How fast things go and we can't see it*
- *I liked that we learned about too fast because its interesting how fast things move.*
- *The high-speed camera because it was cool*
- *How dragonflies fly. They can move there wings in different directions.*
- *I learned that dragonflies can fly all sorts of ways/directions*
- *That when a lightning strikes it goes back up. When a water droplets falls into a puddle it floats.*
- *The lightening bolt because I only thought it traveled only down.*
- *Lightning can go up or down, water drops bouncing*
- *Water bounces on the surface of water – It goes too fast for us to see so I thought it was interesting to see it happen*
- *I learned that a water drop floats and bounces back up and gets smaller and smaller. I think that is important because I always thought a water drop sinks into the water.*

**Too Slow section (7%)**

- *The most interesting things that I learned were how they take time-lapse videos...*
- *Things that went...too slow... because I never see those things*
- *Things too fast or slow for our eyes.*
- *How many things are too small, too fast, or too slow for us to see because it is weird to think that we miss that much.*
- *Time-lapse, high-speed*
- *That flowers can dance :)*
- *I...enjoyed how they showed interesting clips from the 1930's*
- *About how plants move, because I always wondered that too*

**Miscellaneous (14%)**

- *How many things we do not notice with our eyes that are all around us!*
- *The things we can't see because I didn't know they existed*
- *The facts because I learned a lot from it.*
- *The most interesting thing I learned was the different discoveries made by studying nature.*
- *I would say the whales because I never new that the can be so cool.*
- *Everything*
- *I don't know, I liked it all!*
- *The video was one of the best films I watched in my life honestly it was great.*
- *It was great and cool to watch*



### 3.3 How successful did students think the film was in communicating specific themes about science and technology?

Students generally thought the film was successful in communicating the following themes about science and technology: that *scientists have invented technology to look at things in nature that we cannot see with our own eyes*, that *technology opens up new frontiers to explore*, that *technology reveals things about nature that could change our understanding of the planet we live on*, that *there is a lot to learn from the invisible worlds that surround us*, and that *when we study nature we discover new things that could improve our lives*.

Next, students were asked how successful they thought the film was in communicating 5 science and technology themes on a scale from 1.0 (not at all successful) to 7.0 (very successful). The table below presents the percentages of students selecting each rating.

Frequency distribution of students' ratings of film's success in communicating science and technology themes (N=194)							
	Not at all successful 1	2	3	4	5	6	Very successful 7
Scientists have invented technology to look at things in nature that we cannot see with our own eyes	1%	0%	1%	14%	22%	17%	34%
Technology opens up new frontiers to explore	1%	1%	2%	15%	15%	19%	36%
Technology reveals things about nature that could change our understanding of the planet we live on	0%	2%	1%	13%	15%	21%	35%
There is a lot to learn from the invisible worlds that surround us	0%	0%	3%	13%	11%	18%	42%
When we study nature we discover new things that could improve our lives	1%	0%	4%	10%	15%	20%	38%

While there were some differences in opinion, as evidenced by each range of ratings in the table above, the students generally thought the film was successful in communicating all 5 themes (median rating 6.0 each): that *scientists have invented technology to look at things in nature that we cannot see with our own eyes*, that *technology opens up new frontiers to explore*, that *technology reveals things about nature that could change our understanding of the planet we live on*, that *there is a lot to learn from the invisible worlds that surround us*, and that *when we study nature we discover new things that could improve our lives*.

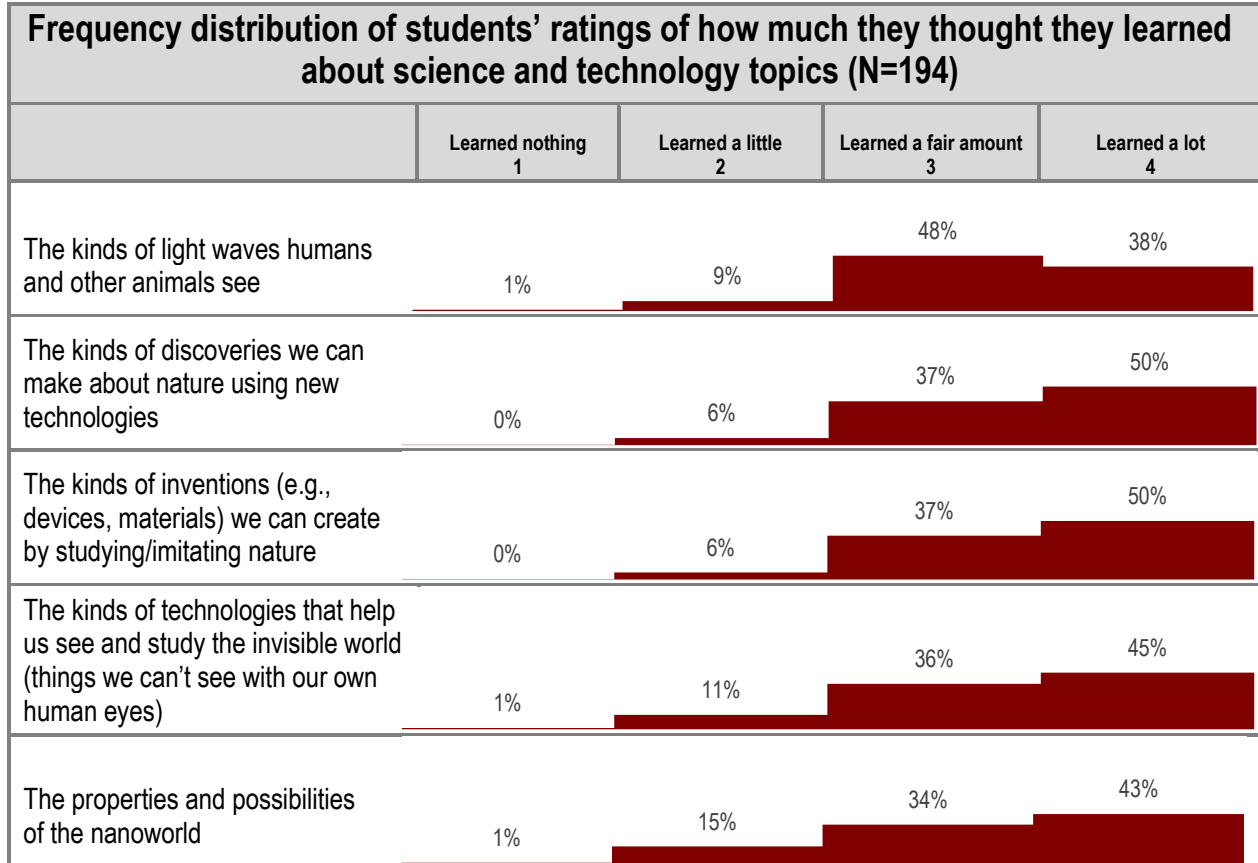
Though the majority of students declined to provide additional feedback about their ratings, 2 students praised the film, 2 raised criticisms, and 1 asked a question. Their responses are shared below:

- They were all successfully communicated.
- Learned so much.
- Some of the themes were shortly explained and not always “complete”
- When the things that were fixing the DNA, why did the DNA fall of as soon as repaired.

### 3.4 How much did students think they learned from the film about science and technology topics?

In general, students thought they learned a lot from the film about *the kinds of discoveries we can make about nature using new technologies and the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature*. They also thought they learned a fair amount about *the kinds of light waves humans and other animals see, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and the properties and possibilities of the nanoworld*.

After viewing *Mysteries of the Unseen World*, students were asked to rate how much they learned about 5 science and technology topics on a scale of 1.0 (learned nothing) to 4.0 (learned a lot). The table below presents the percentages of students selecting each rating.



While there were some differences in opinion, as evidenced by the range of ratings in each case, the students generally indicated that they learned a lot (median rating 4.0 each) from the film about *the kinds of discoveries we can make about nature using new technologies* and *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature*. They also thought they learned a fair amount (median rating 3.0 each) about the following topics: *the kinds of light waves humans and other animals see*, *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)*, and *the properties and possibilities of the nanoworld*.

Mann-Whitney tests determined that the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama rated the amount they learned from the film about the nanoworld significantly higher than did the 6<sup>th</sup> graders in California (median 4.0 IQR = 1 vs. median 3.0 IQR = 1), though the effect size was small.<sup>10</sup>

### 3.5 What was the film's impact on students' knowledge of unseen worlds?

**Overall the evaluation found students made significant gains in their content learning from the film. Out of a total possible score of 40, the students averaged 17 correct answers prior to seeing the film and 31 correct responses after seeing the film. In addition to this higher overall knowledge score, significant overall gains from pre-viewing to post-viewing were found for each of the five main topic areas assessed, including: *The types of light waves that humans and other animals see*, *The technologies used to see and study things that humans can't see with normal vision*, *Discoveries scientists have been able to make about nature through new technologies*, *Things scientists can learn from nature to make innovative materials and devices*, and *Properties and possibilities of the nanoscale*. The effect sizes in all cases, overall and for each topic area, were large effects.**

To evaluate the impact of *Mysteries of the Unseen World* on students' knowledge of content covered in the film, students were asked to complete a 40 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions one week before seeing the film and then one day after viewing. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for middle school students.

The 40 point assessment consisted of 5 sets of questions covering the major informal science and technology themes covered in the film, as follows:

3.5a *The types of light waves that humans and other animals see*

3.5b *The technologies used to see and study things that humans can't see with normal vision*

3.5c *The discoveries scientists have been able to make about nature through new technologies*

3.5d *The things scientists can learn from nature to make innovative materials and devices*

3.5e *The properties and possibilities of the nanoscale*

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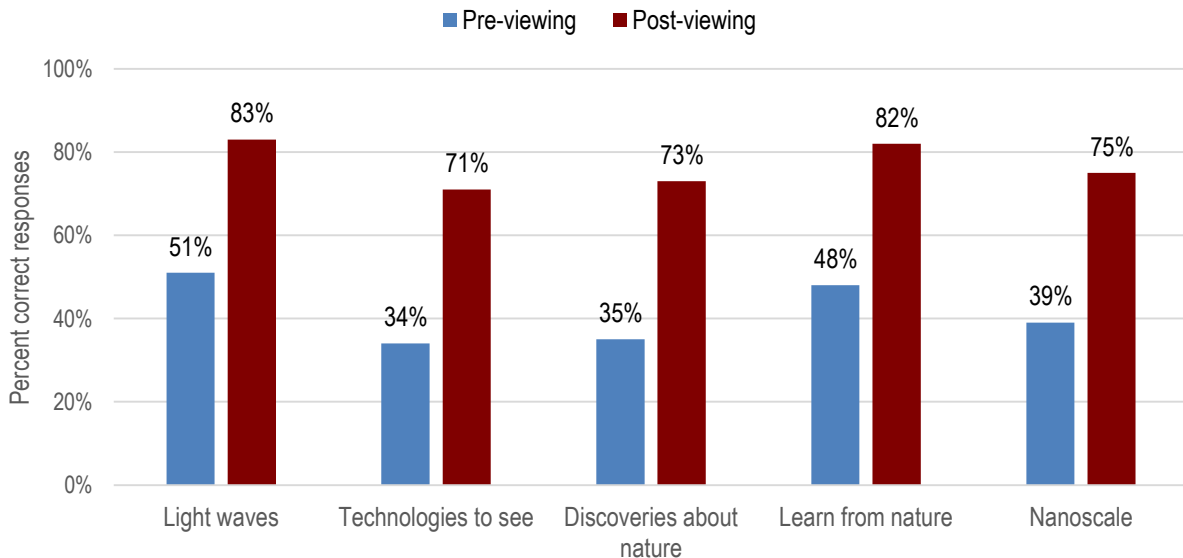
<sup>10</sup> ( $U = 3734, p = .01, r = .19$ )

## Overall findings

Overall the evaluation found students made significant gains in their content learning from *Mysteries of the Unseen World*. A paired sample t-test showed that students' scores were significantly higher after watching the film than before, and the effect size was large.<sup>11</sup> Where students averaged 17 out of 40 correct answers on the pre-viewing questionnaire, they scored 31 correct responses on the post-viewing questionnaire.

In addition to this higher overall score, after watching the film students also scored significantly higher each of the five main topic areas assessed, as follows as follows: For *The types of light waves that humans and other animals see*, out of a total possible score of 6, students averaged 3.1 correct answers before seeing the film and 5.0 correct answers after. For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 10, students averaged 3.4 correct answers before the film and 7.1 after. For the *Discoveries scientists have been able to make about nature through new technologies*, out of a total possible score of 6, students averaged 2.1 correct answers before seeing the film and 4.4 after. For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, students average 6.0 correct answers before seeing the film and 10 after. Finally, for *Properties and possibilities of the nanoscale*, out of a total possible score of 6, students averaged 2.2 correct answers before seeing the film and 4.1 correct answers after. The effect sizes in each case were large.

**Comparison of students' pre- and post-viewing scores across 5 question sets (N=194)**



Sections 3.5a through 3.5e below summarize the findings for each set of questions.

<sup>11</sup>  $t(193)=32.5, p < .001, d = 1.96, 95\% CI [13.2, 15.0]$

### 3.5a The types of light waves that humans and other animals see

To assess students' learning about the types of light waves humans and other animals see, content featured in the *Invisible* section of the film, students were asked to complete three fill in the blank questions in response to the prompt: *For each animal below, please check the ONE type of light wave it naturally uses to see the world.* The table below shows the percentage of students that answered each question correctly before and after seeing the film.

Percentage of correct answers to fill in the blank questions about light waves humans and other animals naturally use to see the world (N=194)						
		Infrared	Radio	Ultraviolet	Visible	X-ray
Bees see the world using ____ waves.	Pre			30%		
	Post			77%		
Mosquitoes see the world using ____ waves.	Pre	38%				
	Post	77%				
Humans see the world using ____ waves.	Pre				86%	
	Post				95%	

#### Overall findings

A paired sample t-test showed that students' scored significantly higher on the 6 point question set<sup>12</sup> after watching the film than before, and the effect size was large.<sup>13</sup> Students averaged 3.1 correct responses on the pre-viewing questionnaire and 5.0 correct responses on the post-viewing questionnaire.

#### Item results

Just under one third (30%) of students correctly answered on the pre-viewing questionnaire that bees see the world using *ultraviolet*, where more than three-quarters (77%) correctly answered the question on the post-viewing questionnaire. Just under two-fifths (38%) correctly answered on the pre-viewing questionnaire that mosquitoes see the world using *infrared waves* while just over three-quarters (77%) correctly answered the question on the post-viewing questionnaire. Unlike with the two previous questions where a minority of students knew the correct answer prior to seeing the film, more than four-fifths (86%) of students correctly answer that humans see the world using *visible light waves* on the pre-viewing questionnaire, although this percentage increased to 95% after viewing the film.

<sup>12</sup> Each question was worth 2 points for a total of 6 possible points.

<sup>13</sup>  $t(193)=11.8, p < .001, d = 1.18, 95\% CI [1.6, 2.2]$

### 3.5b The technologies used to see and study things that humans can't see with normal vision

To assess students' learning about the technologies used to see and study things that humans can't see with normal vision, content featured in the *Invisible*, *Too Small*, *Too Fast*, and *Too Slow* sections of the film, students were asked to complete two two-part open-ended questions about time-lapse photography and high-speed photography, two true/false questions about the use of gamma rays and electron microscopy, and an additional open-ended question about the use of electron microscopy vs. compound microscopes.

#### Overall findings

A paired sample t-test showed that students' scores were significantly higher on the 10 point question set after the film than before, and the effect size was large.<sup>14</sup> Students averaged 3.4 correct responses on the pre-viewing questionnaire and 7.1 correct responses on the post-viewing questionnaire.

#### Item results

##### i. Time-lapse photography

To assess students' learning about what time-lapse photography reveals about nature that we can't see with our human eyes, a topic featured in the *Too Slow* section of the film, students were asked to answer a two-part question. The first part asked: *What does TIME-LAPSE photography (pictures taken over a long time period) allow us to see about nature that we wouldn't otherwise be able to see with our own human eyes?* The second part of the question asked students to *"Please give an example."*<sup>15</sup> The table below shows the percentage of students that answered each part of the question with incorrect, partial, and full explanations and examples,

Percentage of correct and incorrect explanations and examples for time-lapse question (N=194)		
Pre-viewing	Part a: What time-lapse reveals about nature we can't see with our own eyes	Post-viewing
36%	Incorrect or no explanation Examples: 1) Don't know; 2) Allows you to see things human eye can't; 3) Tiny organisms	7%
7%	Partial explanation Examples: 1) Change; 2) Progress 3) Time goes faster	2%
57%	Full explanation Examples: 1) Able to see what happens to nature, organisms over a period of time (how it changes); 2) Time lapse photography shows us what happens over a long period of time, like how weather patterns change in a week; 3) Things grow or deconstitute. Like flowers, vines, or trees. Ants eating rats	91%
Part b: Example		
48%	Incorrect or no example Examples: 1) I don't know; 2) Bullet shooting a bulb; 3) Bugs	10%
5%	Partial example Examples: 1) Seasons; 2) See trees move; 3) Things moving	1%
46%	Full example Examples: 1)Decomposing rat, vines moving; 2) Antarctica is melting, how do we know this? Time lapse images 3) Say you have a rose and you take pictures of it blooming every 10 minutes you will see how it grows.	89%

<sup>14</sup>  $t(193) = 11.8, p < .001, d = 1.53, 95\% CI [1.6, 2.2]$

<sup>15</sup> The first part of the question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of the question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

respectively. The table also includes examples of responses that were coded under each category. As the table shows, after viewing the film substantially higher percentages of students provided partial or full explanations in Part a of the question (64% pre →93% post) and partial or full examples in Part b (51% pre → 90% post).

## ii. High-speed photography

To assess students' learning about what high-speed photography reveals about nature that we can't see with our human eyes, content featured in the *Too Fast* section of the film, students were asked to answer a two-part question. The first part asked: *What does HIGH-SPEED photography (pictures taken over a short time period) allow us to see about nature that we wouldn't otherwise be able to see with our own human eyes?* The second part of the question asked students to *"Please give an example."*<sup>16</sup>

The table below shows the percentage of students that answered each part of the question with incorrect, partial, and full explanations and examples, respectively. The table also includes examples of responses that were coded under each category. As the table shows, after viewing the film more than twice as many students provided partial or full explanations (36% pre →76% post) and nearly three times as many students provided partial or full examples (24% pre →71% post).

Percentage of correct and incorrect explanations and examples for high-speed question (N=194)		
Pre-viewing	Part a: What high speed reveals about nature we can't see with our own eyes	Post-viewing
65%	Incorrect or no explanation Examples: 1) <i>Don't know</i> ; 2) <i>Allows us to see what the human eye can't</i> ; 3) <i>Growth of nature</i>	23%
13%	Partial explanation Examples: 1) <i>Fast stuff</i> ; 2) <i>Sudden movement</i> ; 3) <i>They see things fast, quick</i>	13%
23%	Full explanation Examples: 1) <i>Things that are so fast, human eyes can't keep up</i> ; 2) <i>High speed photography allow us to see things that are too fast for us to see</i> ; 3) <i>It allows us to be able to see things that move too fast for our eyes to see</i>	63%
Part b: Example		
76%	Incorrect or no example Examples: 1) <i>Don't know</i> ; 2) <i>In water there can be bacteria or things like that</i> ; 3) <i>What would happen to food if you left it for three days</i>	29%
7%	Partial example Examples: 1) <i>Slow motion things</i> ; 2) <i>Bullet</i> ; 3) <i>Hummingbird wings</i>	3%
17%	Full example Examples: 1) <i>It allows you to see a raindrop fall on the ground or on a puddle</i> ; 2) <i>A pitcher of milk shattering on the floor is too fast for our eyes to track</i> ; 3) <i>A humming bird flaps it's wings way too fast for us to see them, it's a blur, but when we use high speed photography we could see them in motion</i>	68%

<sup>16</sup> The first part of the question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of the question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

### iii. Other technologies (gamma rays and electron vs. compound microscope)

#### iiia. gamma rays and electron vs. compound microscope

To assess students' learning about other technologies used to study things that humans can't see with normal vision, specifically the use of gamma rays and the use of electron vs. compound microscopes, topics featured in the *Invisible* and *Too Small* sections of the film, students were asked to answer two true/false questions that read: *A compound microscope uses electrons to produce magnified images* (False) and *Gamma rays can show what is going on inside a person's body* (True).<sup>17</sup> The table below shows the percentage of students that answered each question correctly. After seeing the film, four-fifths (80%) of students correctly answered true to the statement that *Gamma rays can show what is going on inside a person's body* compared to two-fifths (46%) before viewing the film. Meanwhile one-quarter (22%) of students correctly answered false to the statement that a compound microscope uses electrons to produce magnified images after viewing the film compared to one-tenth (11%) before viewing the film.

Percentage of correct answers to true/false question about electron microscopy/compound microscopes and gamma rays (N=194)		
Pre-Viewing	True/false questions	Post-viewing
11%	A compound microscope uses electrons to produce magnified images (F)	22%
46%	Gamma rays can show what is going on inside a person's body (T)	80%

<sup>17</sup> Each T/F question earned a total possible score of 1.



## Electron vs. compound microscope elaborated

To further assess students' learning about electron microscopy and compound microscopes, students were also asked a two-part question. The first part asked: *When might a scientist use an electron microscope instead of a compound microscope.* The second part of the question asked students to *Please give an example.*<sup>18</sup>

The table below shows the percentage of students that answered both parts of the question with incorrect, partial, and full explanations and examples, respectively. After viewing the film more than twice as many students provided partial or full explanations (28% pre → 66% post) and more than four times as many students provided partial or full examples (15% pre → 61% post).

Percentage of correct and incorrect explanations and examples for electron vs. compound microscope (N=194)		
Pre-viewing	Part a: When might scientist use an electron microscope instead of a compound microscope	Post-viewing
72%	Incorrect or no explanation Examples: 1) <i>When he needs it</i> ; 2) <i>To see different things</i> ; 3) <i>To see farther into space</i>	33%
9%	Partial explanation Examples: 1) <i>To get a closer image</i> ; 2) <i>To see extremely small organisms</i> ; 3) <i>When stuff is too small</i>	4%
19%	Full explanation Examples: 1) <i>To see even closer into something that a compound microscope cannot do</i> ; 2) <i>A scientist would use an electron microscope over a compound one when finding small areas that would be blurry with a compound microscope</i> ; 3) <i>A scientist might use an electron microscope to look at an atom or possibly move them to a better place.</i>	62%
Part b: Example		
85%	Incorrect or no example Examples: 1) <i>Don't know</i> ; 2) <i>cells</i> ; 3) <i>Looking in a pond</i>	40%
3%	Partial example Examples: 1) <i>Butterfly wings</i> ; 2) <i>Looking at super small organisms</i> ; 3) <i>Mosquito eyes</i>	6%
12%	Full example Examples: 1) <i>Say you want to see a butterfly's wings you use a compound micro, you want to see in to the butterfly's wings use a electron microscope</i> 2) <i>Looking at the scales of a butterfly's wing</i> ; 3) <i>When watching atoms or moving them</i>	55%

<sup>18</sup> The first part of the question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 points for an incorrect response. The second part of the question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response

### 3.5c Discoveries scientists have been able to make about nature through new technologies

To assess students' learning about the kinds of discoveries scientists have been able to make about nature through new technologies, content presented in the *Too Fast* and *Too Small* sections of the film, students were asked a multiple choice question and three true/false questions about how lightning bolts move and other discoveries facilitated through the use of new technologies.

#### Overall findings

A paired sample t-test showed that students' scores were significantly higher on the 6 point question set after the film than before, and the effect size was large.<sup>19</sup> Students averaged 2.1 correct responses on the pre-viewing questionnaire and 4.4 correct responses on the post-viewing questionnaire.

#### Item results

##### i. How lightning bolts move

To assess student learning about what scientists have discovered about how lightning moves using high-speed photography, content featured in the *Too Fast* section of the film, students were asked the following multiple choice question: *Do lightning bolts move from the sky to the ground, the ground to the sky, both ways, or neither way?*<sup>20</sup>

The table below shows the percentage of students that answered the question correctly. More than nine-tenths (92%) of students correctly answered that lightning strikes both ways after seeing the film compared to just under two-fifths (39%) prior to viewing.

Percentage of correct answers to multiple choice question about how lightning strikes (N=194)				
	Sky to ground	Ground to sky	Both ways	Neither way
Pre-viewing			39%	
Post-viewing			92%	

<sup>19</sup>  $t(193) = 21.5, p < .001, d = 2.01, 95\% CI [2.0, 2.4]$

<sup>20</sup> This question was worth 3 points.

## ii. Other discoveries facilitated through the use of new technologies

To assess student learning about other discoveries that new technologies have helped facilitate, students were asked three true/false questions about content featured in the *Too Fast* and *Too Small* sections of the film. The three statements were: *There are more organisms living on you than there are people on Earth* (True), *When a raindrop hits a puddle, it bounces* (True), and *Steel is stronger than spider silk of equal weight (pound for pound)* (False).<sup>21</sup> The table below shows the percentage of students that answered each question correctly.

Percentage of correct answers to true/false questions about other discoveries facilitated by the use of new technologies (N=194)		
Pre-viewing	True/false questions	Post-viewing
70%	There are more organisms living on you than there are people on Earth (T)	97%
20%	When a raindrop hits a puddle, it bounces (T)	88%
45%	Steel is stronger than spider silk of equal weight (pound for pound) (F)	69%

Almost all (97%) students correctly answered true to the statement that *There are more organisms living on you than people on Earth* after seeing the film compared to less than three-quarters (70%) prior to viewing. Nearly nine-tenths (88%) correctly answered true to the statement that *When a raindrop hits a puddle, it bounces* compared to one-fifth (20%) prior to viewing. Finally, nearly three-quarters (69%) of students correctly answered false to the statement that *Steel is stronger than spider silk of equal weight (pound for pound)* after seeing the film compared to less than half (45%) prior to viewing.

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<sup>21</sup> Each T/F question earned a total possible score of 1.

### 3.5d Things scientists can learn from nature to make innovative materials and devices

To assess student learning about the things scientists can learn from nature to make innovative materials and devices, content featured in the *Too Fast* and *Too Small* sections of the film, students were asked four two-part questions that asked them to list features or characteristics of four animals and plants (gecko, dragonfly, spider web, and lotus leaf/lily pad) that scientists could imitate to make a new invention and an example of what scientists could invent from this. The question was presented as outlined in the table below, though adapted for use in this report. Responses were coded as incorrect, partially correct, or fully correct.<sup>22</sup> The table also includes examples of responses that were coded under each category. The relevant film references to each question part are also briefly summarized in each case.

<b>Coding examples</b>		
<b>Scientists can imitate the features or characteristics of plants and animals to make new inventions. For each animal and plant below, briefly describe a feature or characteristic scientists could imitate and then give an example of what they could invent from this. An example is included for you to follow.</b>		
<b>Examples from nature</b>	<b>a) What feature or characteristic could scientists imitate?</b>	<b>b) What could scientists invent from this?</b>
<i>Example: Burr</i>	<i>Burrs – has hooks that easily attach to loops in clothing, animal fur, hair</i>	<i>Velcro with hooks and loops that stick together</i>
<b>Gecko</b>	<u>Incorrect:</u> 1) Don't know; 2) Gecko – type of lizard (animal) <u>Partial correct:</u> 1) The feet; 2) Scales <u>Fully correct:</u> 1) Extremely sticky feet that allows it to climb up a glass surface; 2) In the geckos paws are tubes with split ends that are able to hold on glass without pulling. <b>Film reference:</b> Feet covered with tiny bristles that build up electrical charge to attract to surface	<u>Incorrect:</u> 1) Don't know; 2) Mission Impossible <u>Partial correct:</u> 1) New technology and gear; 2) They could invent a robot <u>Fully correct:</u> 1) Electron suction technology; 2) They can make replica of geckos feet to climb walls and so on. <b>Film reference:</b> Climbing robots
<b>Dragonfly</b>	<u>Incorrect:</u> 1) Don't know; 2) Pretty eyes <u>Partial correct:</u> 1) Wings; 2) It flies around <u>Fully correct:</u> 1) Using 4 wings to create a helicopter like ability; 2) Moves all four wings in different directions <b>Film reference:</b> Wings that can move in all directions	<u>Incorrect:</u> 1) We can create; 2) Keeping us <u>Partial correct:</u> 1) Wings to help; 2) Wings in the imitated corner of the dragonfly <u>Fully correct:</u> 1) Drones using same flying technique as dragonfly and move faster; 2) An airplane that can fly normal directions plus backwards and upside down. <b>Film reference:</b> Robotic flyers
<b>Spider web</b>	<u>Incorrect:</u> 1) Made from spiders; 2) Spider web- what spiders use to do stuff <u>Partial correct:</u> 1) Silk; 2) Silky smooth <u>Fully correct:</u> 1) Extreme strength, in addition to elasticity; 2) Pound by pound, this material is stronger than steel <b>Film reference:</b> Strong yet elastic silk	<u>Incorrect:</u> 1) We can use something like this; 2) Spider man <u>Partial correct:</u> 1) Make a material with the same functions as spider web; 2) a material, strong <u>Fully correct:</u> 1) A small item that is "as hard as diamond but almost as flexible as rubber"; 2) Strongest/ stretchiest/ stickiest material ever <b>Film reference:</b> Synthetic version
<b>Lotus leaf/ lily pad</b>	<u>Incorrect:</u> 1) Lily pad water; 2) A plant <u>Partial correct:</u> 1) A plant that grows on water; 2) Floats <u>Fully correct:</u> 1) Water repellent atom structure; 2) Fibers that allow water to roll off easily <b>Film reference:</b> Surface repels almost any liquid; tiny hair like bumps that cause drops to roll off	<u>Incorrect:</u> 1) You can invent a new flower or leaf; 2) Floats <u>Partial correct:</u> 1) As a plane or clothes; 2) To be able to hold large amounts of water without it soaking in <u>Fully correct:</u> 1) Scientist can build new planes that will stop ice building; 2) Water repellent airplanes and/or ice repellent airplanes. <b>Film reference:</b> Coating to shield airplanes from ice build up

<sup>22</sup> The first part of each question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of each question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

## Overall findings

A paired sample t-test showed that students' scores were significantly higher on the 12 point question set<sup>23</sup> after the film than before, and the effect size was large.<sup>24</sup> Students averaged 6 correct responses on the pre-viewing questionnaire and 10 correct responses on the post-viewing questionnaire.

The table below shows the percentage of students that answered each part of the question with incorrect, partial, and full answers before and after viewing the film.

Percentage of correct and incorrect responses to pre- and post-viewing questions about nature features and inventions (N=194)						
Scientists can imitate the features or characteristics of plants and animals to make new inventions. For each animal and plant below, briefly describe a feature or characteristic scientists could imitate and then give an example of what they could invent from this. An example is included for you to follow.						
Examples from nature	a) What feature or characteristic could scientists imitate?			b) What could scientists invent from this?		
	Score	Pre-viewing	Post-viewing	Score	Pre-viewing	Post-viewing
Gecko	Incorrect Partial Full	46% 2% 52%	11% 1% 89%	Incorrect Partial Full	50% 6% 44%	15% 1% 84%
Dragonfly	Incorrect Partial Full	47% 24% 28%	11% 6% 83%	Incorrect Partial Full	56% 6% 38%	20% 0% 80%
Spider web	Incorrect Partial Full	38% 0% 62%	13% 1% 86%	Incorrect Partial Full	43% 1% 56%	33% 4% 63%
Lotus leaf/ lily pad	Incorrect Partial Full	59% 0% 41%	19% 1% 80%	Incorrect Partial Full	61% 1% 39%	30% 1% 70%

A substantially higher percentage of students provided partial or full answers about the features of each animal and plant that could be studied and the inventions that could result after viewing the film compared to before:

- Gecko: feature (54% pre → 90% post); invention (50% pre → 85% post).
- Dragonfly: feature (52% pre → 89% post); invention (44% pre → 80% post).
- Spider web: feature (62% pre → 87% post); invention (57% pre → 67% post).
- Lotus leaf/lily pad: feature (41% pre → 81% post); invention (40% pre → 71% post)

<sup>23</sup> The first part of each question was scored as worth 2 points: 2 points for a fully correct response, 1 point for a partially correct response, and 0 points for an incorrect response. The second part of each question was scored as worth 1 point: 1 point for a fully correct response, .5 points for a partially correct response, and 0 for an incorrect response.

<sup>24</sup>  $t(193) = 15.2, p < .001, d = 1.13, 95\% CI [3.5, 4.6]$

### 3.5e The properties and possibilities of the nanoscale

To assess students' learning about the film's content related to the properties and possibilities of the nanoscale, featured in the *Too Small* section of the film, students were asked three true/false questions including: *Scientists can move atoms using powerful microscopes* (True), *The metal gold can change its color when it is nano-sized* (True), and *The world's thinnest material was created using nanotechnology* (True). In addition they were asked a two-part open-ended question about their awareness of any benefits of potential benefits of studying things at the nanoscale.

#### Overall findings

A paired sample t-test showed that students' scores were significantly higher on the 6 point question set after the film than before, and the effect size was large.<sup>25</sup> Students averaged 2.2 correct responses on the pre-viewing questionnaire and 4.1 correct responses on the post-viewing questionnaire.

#### Item results

The table below shows the percentage of students that answered each of the three true/false questions correctly.<sup>26</sup> More than nine-tenths (92%) of students correctly answered true to the statement that *Scientists can move atoms using powerful microscopes* after seeing the film compared to less than two-thirds (57%) before seeing the film. Three-quarters (75%) of students correctly answered true to the statement that *The metal gold can change its color when it is nanosized* after seeing the film compared to one-fifth (20%) before seeing the film. Finally, nearly nine-tenths (86%) of post-viewing students compared to just over half (56%) of pre-viewing students correctly answered true to the statement that *The world's thinnest material was created using nanotechnology*.

Percentage of correct answers to true/false questions about the properties and possibilities of the nanoscale (N=194)		
Pre-viewing	True/false questions	Post-viewing
57%	Scientists can move atoms using powerful microscopes (T)	92%
20%	The metal gold can change its color when it is nano-sized (T)	75%
56%	The world's thinnest material was created using nanotechnology (T)	86%

<sup>25</sup>  $t(193) = 15.4, p < .001, d = 1.23, 95\% CI [1.9, 2.5]$

<sup>26</sup> Each T/F question earned a total possible score of 1.

## ii. Benefits of the nanoscale

To assess students' learning about the benefits of studying at the nanoscale, content featured in the *Too Small* section of the film, students were asked to answer a two-part question. The first part asked: *Are you aware of any benefits or potential benefits of studying things at the nanoscale?* The second part of the question asked students to give an example of a benefit if they answered *Yes* or to explain their answer if *No*.<sup>27</sup> As the table below shows, after viewing the film more than twice as many students provided a benefit or potential benefit of studying things at the nanoscale than did so before (36% pre → 67% post).

Percentage of correct and incorrect explanations of the benefits or potential benefits of studying things at the nanoscale (N=194)		
Pre-viewing	Benefits of studying	Post-viewing
64%	Incorrect or no explanation Examples: 1) <i>I don't have one</i> ; 2) <i>science</i> ; 3) <i>bugs</i>	33%
7%	Partial explanation Examples: 1) <i>Extreme detail</i> ; 2) <i>Scientific discovery</i> ; 3) <i>See things thoroughly</i>	1%
29%	Full explanation Examples: 1) <i>Nano technology could be able to cure clogged arteries and even fix DNA</i> ; 2) <i>Making carbon nano tubes thin and strong</i> ; 3) <i>A potential benefit of studying things at the nanoscale may help us create new things by moving the atoms around.</i>	66%

<sup>27</sup> This question was adapted from a question previously used in a naturalistic post-only experiment designed to assess the effectiveness of four *Sci-Tech Today* segments in educating the public to learn more about nanotechnology, among other goals (Source: Multimedia Research (2009) *Impact of Sci-Tech Today Nanotechnology Cable News Segments*). In that study adults' responses were coded for type of application and depth of application knowledge related to the applications emphasized in the media programming. The current evaluation adapted the coding scheme for use in the film evaluation with students. All of the students' responses, whether students answered yes or no, were analyzed for depth of explanation using the following scoring criteria: 3 points for a full explanation, 1.5 point for a partial explanation, and 0 points for an incorrect explanation.

## Question 4: How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?

Question 4 considers the film's immediate impact on students' interest in science and technology, science and technology jobs/careers, and students' thoughts about if and how they thought they would "see" the world differently after viewing *Mysteries of the Unseen World*. These findings are presented below in 4.1 through 4.3.

### 4.1 What was the film's impact on students' interest in science and technology topics?

In general, the film increased students' interest in *the properties and possibilities of the nanoworld*. It also slightly increased their interest in each of the following subjects: *the kinds of light waves humans and other animals see, the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, and the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)*.

After viewing *Mysteries of the Unseen World*, students were asked how much the film increased or decreased their interest in 5 science and technology topics on a scale of 1.0 (decreased strongly) to 7.0 (increased strongly), with 4.0 being "neither increased nor decreased" in each case. The table below presents the percentages of students selecting each rating.

<b>Frequency distribution of students' ratings of the film's impact on their interest in science and technology topics (N=194)</b>							
	Decreased strongly 1	2	3	4	5	6	Increased strongly 7
The kinds of light waves humans and other animals see	0%	1%	3%	28%	30%	18%	12%
The kinds of discoveries we can make about nature using new technologies	0%	1%	2%	20%	25%	22%	22%
The kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature	0%	0%	5%	20%	21%	19%	27%
The kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)	0%	2%	4%	23%	19%	20%	23%
The properties and possibilities of the nanoworld	2%	1%	3%	19%	20%	20%	27%

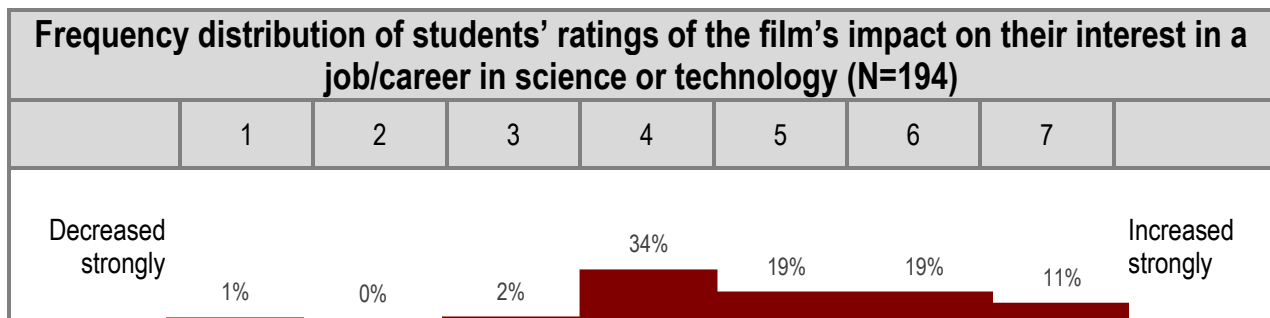


While there were some differences in opinion as evidenced by the range of ratings in each case, the students generally indicated that *Mysteries of the Unseen World* increased their interest in the subject of *the properties and possibilities of the nanoworld* (median rating 6.0) and somewhat increased their interest (median rating 5.0 each) in the following subjects: *the kinds of light waves humans and other animals see, the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, and the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes).*

## 4.2 What was the film's impact on students' interest in a job/career involving science or technology?

**In general, viewing the film slightly increased students' interest in a future job/career involving science or technology. When asked to identify sections of the film that influenced their interest in a job/career in science or technology, students most often commented on the nanotechnology scenes and/or scenes highlighting technology inspired by nature.**

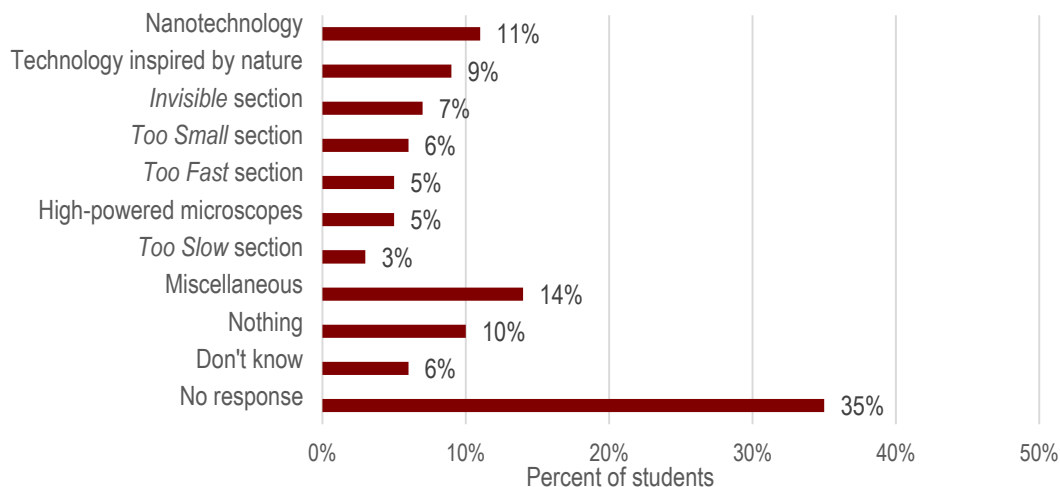
After viewing *Mysteries of the Unseen World*, students were asked to rate how much the film increased or decreased their interest in a future job/career involving science or technology on a scale from 1.0 (decreased strongly) to 7.0 (increased strongly), with 4.0 being neither increased nor decreased. The table below presents the percentage of students selecting each rating.



While there were some differences in opinion, as evidenced by the range of ratings in the table above, the students generally indicated that viewing the film somewhat increased (median rating 5.0) their interest in a future job/career involving science or technology.

Next, students were asked which part(s) of the film, if any, influenced their interest in a science or technology job/career. The chart on the next page shows parts of the film students most frequently cited and the percentage of students offering each response.

## What parts of the film influenced students' interest in a science or technology job/career (N=194)



As shown in the chart above, when asked which part(s) of the film, if any, influenced their interest in a science or technology job/career, more than a tenth of students pointed to something in the nanotechnology section (11%), while just under a tenth commented on a scene highlighting technology inspired by nature (9%). A slightly smaller group of students noted something in the *Invisible* section (7%), while just over one-twentieth pointed to the *Too Small* section (6%). At the same time, a handful each commented on the *Too Fast* section (5%), high-powered microscopes (5%), and/or the *Too Slow* section (3%).

One-seventh of students provided miscellaneous responses (14%), and a tenth said they weren't influenced by any part of *Mysteries of the Unseen World* (10%), including 2 students who noted that they were *already* interested in this career path prior to seeing the film. Finally, less than a tenth said they didn't know which sections of the film influenced their interest in a job/career in science or technology (6%), and more than a third of students declined to answer the question (35%).

Examples of students' responses in each case are shared below:

### **Nanotechnology (11%)**

- *If anything it would be the nano-study part. Considering I want to be a doctor, nanotechnology could be used to create more powerful and effective medicines.*
- *Space elevator, technology + designs for aircrafts*
- *The nanotechnology; I think it would be epic to engineer something like the elevator to space (which I thought was a little unrealistic – we don't necessarily need it)*
- *Nano technology and killing cancer cells*
- *I thought the part where we could make tiny nanobots was cool, and I would like to make or engineer one.*
- *The part about the nano technology interests me in a career based on it*
- *The part about how they programed gold atoms to stick to cancer cells.*

### **Technology inspired by nature (9%)**

- *Creating thing like an animal. Example: The dragonfly's wings.*
- *...Also what WE CAN DO WITH ANIMALS.*
- *I thought that the part where they explained how animals can influence us on our new technologies was really interesting!*
- *That we can imitate animals and use the imitation for good cause, and advances in our world.*

- *The robot gecko and the dragonfly machine*
- *I'm really interested in the discoveries we can make by studying nature.*
- *How we can mimic skills/adaptations from animals and plants.*

**Invisible section (7%)**

- *Learning about the human body with x-rays*
- *About the x-rays/MRI*
- *The part where they talked about wavelengths.*
- *The way bugs and humans and animals see the world.*
- *I really liked the part of the film that showed us how bees and mosquitoes see the world.*

**Too Small section, including the nanoworld (6%)**

- *The part on the bugs/bacteria*
- *The robot gecko...*
- *The part about the nanoscale*
- *The nanoworld*
- *Nano size things*
- *The parts about the nanoworld because it seems cool and interesting.*

**High-powered microscopes (5%)**

- *It increased a little because I liked the part where the film taught us about how they can move atoms and I thought that was cool!*
- *The part that influenced me was the part where they showed how they move atoms.*
- *How they moved atoms*
- *Electronscope*
- *When they used the microscopes to see the world up close*

**Too Fast section (5%)**

- *Photography through high-speed and time-lapse.*
- *I think that the slow and the fast world have inspired me the most.*
- *The part where it showed what we can film and see it in high-speed or slow motion.*
- *Creating thing like an animal. Example: The dragonfly's wings.*

**Too Slow section (3%)**

- *Photography through high-speed and time-lapse.*
- *I think that the slow and the fast world have inspired me the most.*
- *The part where it showed what we can film and see it in high-speed or slow motion.*

**Miscellaneous (14%)**

- *The knowledge that scientists get to do this everyday.*
- *I realized that sometimes scientist only think about robots + elevators to space and not what is more important.*
- *I am fairly interested in it because then I know a lot around me.*
- *Seeing things we can't see with are own eyes.*

**None (10%)**

- *I don't really want a job involving that stuff*
- *They interested me but I still do not want to be a scientist.*

### 4.3 Did students think they would “see” the world differently after watching the film?

After seeing the film, most students thought they would “see” the world around them differently. Those who thought they wouldn’t “see” the world differently or were unsure if this would be the case most frequently indicated that this was because they were limited by (human) sight and experience.

Students were asked if, as a result of seeing the film, they thought they would “see” the world around them differently. The table to the right shows the percentages of students saying *Yes*, *No*, and *Unsure*, followed by their reasons in each case.

The majority of students (72%) thought they would “see” the world around them differently as a result of viewing the film. When asked how they would “see” the world differently, one-fifth of students explained that they would generally have more knowledge and awareness of unseen worlds (20%), just under a fifth said they would think about things from the *Too Small* section (17%), and more than one-seventh said they would think about things from the *Invisible* section (15%). Less than one-tenth each explained that they would observe more (4%), would think about things from the *Too Fast* section (3%), would be inspired to learn more (3%), would think about things from the *Too Slow* section (2%), or provided miscellaneous responses (8%).

A tenth of students indicated that they did not think they would “see” the world around them differently as a result of viewing the film (10%). When asked why not, a handful each explained that they would be limited by (human) sight and experience (3%), that they were already knowledgeable (2%), that they weren’t impacted by the film (2%), or said the world around them would remain the same (1%). A similarly small group shared miscellaneous responses (2%).

And finally, less than a fifth of students explained that they were unsure whether they would “see” the world around them differently as a result of viewing the film (18%). When asked why this was the case, a handful

Whether students thought they would “see” the world differently after viewing the film (N=194)	
<b>Yes, I will “see” the world around me differently</b>	<b>72%</b>
Will have general increase in knowledge and awareness of unseen worlds	20%
Will think about the <i>Too Small</i> section	17%
Will think about the <i>Invisible</i> section	15%
Will observe more	4%
Will think about the <i>Too Fast</i> section	3%
Will be inspired to learn more	3%
Will think about the <i>Too Slow</i> section	2%
Miscellaneous	8%
<b>No, I will not “see” the world around me differently</b>	<b>10%</b>
Limited by (human) sight and experience	3%
Already knowledgeable	2%
Was not impacted by the film	2%
The world around me remains the same	1%
Miscellaneous	2%
<b>Not sure if I will “see” the world around me differently</b>	<b>18%</b>
Limited by (human) sight and experience	4%
Unsure	4%
It won’t be on my mind	3%
Already knowledgeable	2%
I didn’t understand the film/would need to learn more	1%
Miscellaneous	4%

each explained that they would be limited by (human) sight and experience (4%), said they were unsure (4%), noted that the subject of the film wouldn't be on their minds (3%), indicated that they were already knowledgeable (2%), or said they didn't understand something in the film or needed to learn more (1%). A similarly small group provided miscellaneous responses (2%). Examples of students' comments on each theme follow below:

- **Yes, I will "see" the world about me differently (72%)**

*Will have general increase in knowledge and awareness of unseen worlds (20%)*

- *Because no I know what all is out there to know about*
- *I know more things now, so I will watch more and point things out*
- *I will think about what is there that I can't see*
- *I know what's around me*
- *I will understand things more*
- *I'll be more aware of what's happening that I don't see*
- *I will see it differently because I know more than I use to know.*
- *I will "see" the world differently by realizing that there are so many beautiful things that we don't see.*

*Will think about the Too Small section (17%)*

- *I am swallowing tiny insect parts right now :(*
- *I will see the world as kind of gross, cause all of the skin flakes.*
- *To know that there are a ton of tiny world inside ours*
- *Think of things that are on the nanoscale*
- *I know that there are billions of [organisms] living on my body*
- *I will know that I have bacteria on my eyelashes.*

*Will think about the Invisible section (15%)*

- *I'll remember how bees and mosquitos see the world in infrared*
- *I will start to think about all the different light waves*
- *I will imagine I am a bee*
- *Cause now I know why bees pick certain flowers and mosquitos pick certain types of parts on the body.*

*Will observe more (4%)*

- *I know more things now, so I will watch more and point things out*
- *Look at things closer*
- *I think I will look for small details in everyday life more.*

*Will think about the Too Fast section (3%)*

- *Wonder what is to slow and too fast for us to see*
- *Because, now that I know raindrops float in the water when they fall, I will notice that.*
- *I will want to be able to see every little thing slowly now!*

*Will be inspired to learn more (3%)*

- *Makes me think more and more interested in science*
- *I think that I was inspired and also would be more intrigued to learn more about the world and nature.*
- *I will be more curious*
- *The world will get me curious and think more*

*Will think about the Too Slow section (2%)*

- *Wonder what is to slow and too fast for us to see*
- *I will always be thinking of how & why that flower is so pretty.*

*Miscellaneous (8%)*

- *Different than before*
- *Everything will be changed*
- *B/c there are so many things we can achieve greatness with that are all around us*
- *Now I know science can make many new creations to enhance our life experience.*
- *These things still make me think. How is that whiteboard working or the waterless toilet.*

• **No, I will not “see” the world around me differently (10%)**

*Limited by (human) sight and experience (3%)*

- *Because I still see things the same. Unless we invent some new tech*
- *Because I only can see visual waves.*

*Already knowledgeable (2%)*

- *I had previous knowledge about a fair amount of the information.*
- *I am already aware that I am surrounded by radio waves and different waves.*

*Was not impacted by the film (2%)*

- *Just a film, it won't change my life.*
- *I thought it was interesting, but it didn't affect me that much.*

*The world around me remains the same (1%)*

- *Because even though I didn't know about some of that stuff, seeing it doesn't mean it just appeared It's always been there & it always will be.*
- *The world is the same as it always has been*

*Miscellaneous (2%)*

- *I'm a pretty lame person, so my “point of view in life” won't really change in any way.*
- *I'm simple minded*

• **Not sure if I will “see” the world around me differently (18%)**

*Limited by (human) sight and experience (4%)*

- *Because the things I "see" are the same, the movie made me want to actually see things.*
- *Because since I still physically see the same, I don't think about it differently either*
- *Well I can't exactly see the world like that because humans only have one way to see unlike bees or mosquitos.*

*It won't be on my mind (3%)*

- *I will forget and live life normally until something is brought up that reminds me about the film.*
- *I am not thinking about those kind of things*

*Already knowledgeable (2%)*

- *I have always known there were things I couldn't see, so since I don't see them, I don't see the world differently.*
- *My general outlook on the scientific workings of the things around me hasn't changed drastically, but the film did add a bit of extra understanding, so maybe I will notice a change at some point a bit in the future*

*I didn't understand the film/would need to learn more (1%)*

- *I am not sure because I did not completely understand the processes.*

*Miscellaneous (4%)*

- *Nothing has changed on how I see the world so far.*

## Phase 2: Follow-up evaluation of extended impact

Phase 2 examines the longer-term impact of *Mysteries of the Unseen World*. It considers how much students continued to think about the film after viewing, as well as the extent to which they looked into various topics. It also reports on if and how *Mysteries of the Unseen World* changed students' feelings about science and technology, if and how students reported "seeing" the world differently after viewing, and the activities they did after watching the film. These findings are presented below, addressing the following 5 questions:

*Question 1: How much did students continue to think about the film within a few weeks of viewing?*

*Question 2: How much did students look into topics from the film within a few weeks of viewing?*

*Question 3: Did the film change how students think or feel about science or technology?*

*Question 4: Did students "see" the world differently a few weeks after viewing the film?*

*Question 5: What activities did students do within a few weeks of viewing the film?*

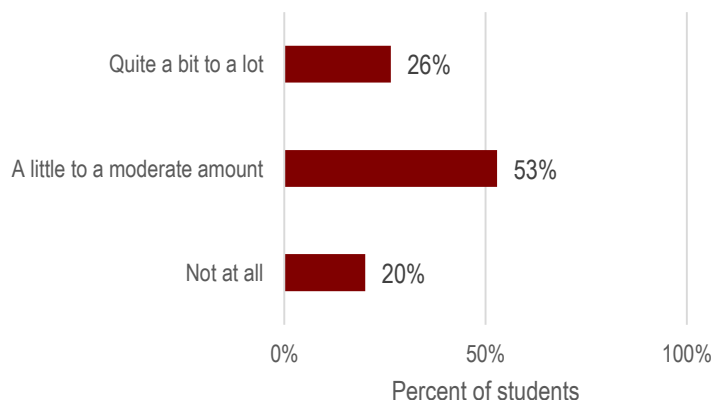
### Findings

#### Question 1: How much did students continue to think about the film within a few weeks of viewing?

The majority of students indicated that they thought about the film at least a little in the weeks since viewing. Of those who described what they thought about, the largest groups pointed to the topics from the *Too Small* and *Invisible* sections.

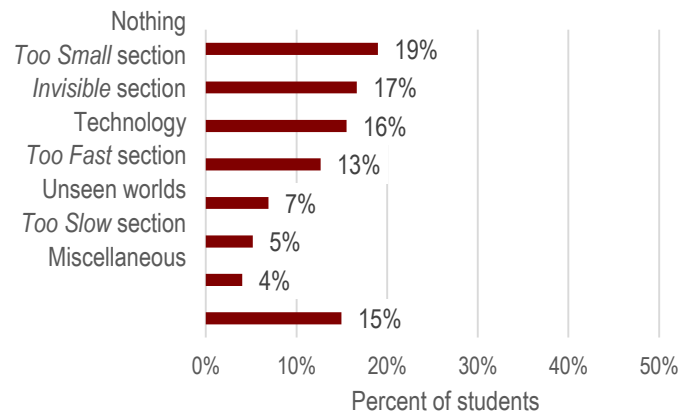
Four-fifths of students indicated that they thought about the film in the weeks since viewing (80%). When asked to rate the extent to which they thought about the film, the students' ratings ranged from 1.0 (not at all) to 7.0 (a lot), with a median rating of 3.0. The chart to the right shows the percentage of students who indicated that they hadn't thought about the film (20%), thought about the film a little or moderate amount (53%), or thought about the film quite a bit to a lot (26%).

How much students thought about the film within a few weeks of viewing (N=174)



Next, students were asked to describe what they thought about from the film in the weeks since viewing. As shown in the chart to the right, nearly a fifth of students said they did not think about the film (19%). About one-sixth explained that they thought about something from *Too Small* section (17%), including things that live on our bodies, particles in the air, and the nanoworld in general. A slightly smaller group thought about something from the *Invisible* section (16%), including light waves and other invisible waves. More than a tenth of students thought about technology, such as microscopes, inventions that mimic nature, and nanotechnology (13%), while less than a tenth thought about something from the *Too Fast* section (7%), such as water drops and dragonflies. A handful each said they thought about something related to unseen worlds (5%) and/or something from the *Too Slow* section (4%). Finally, more than one-seventh shared miscellaneous feedback (15%), including comments from students who indicated that they learned a lot, said they didn't know, or shared feedback about the theater in which they viewed the film, among other responses.

**What students thought about from the film within a few weeks of viewing (N=174)**



Examples of students' responses in each case are shared below:

**Nothing (19%)**

- *I haven't thought about anything*
- *Nothing really, it was pretty cool*

***Too Small* section (17%)**

- *Things eating my eyelashes, things living on me*
- *About the creatures on my eyelashes*
- *Bugs are on me, everywhere*
- *I thought about the bugs that are in our hair, eyelashes and eyebrows. I also thought about the things that we breathe in.*
- *That what I breathe is filled with weird stuff*
- *When I see flies I look at them and I want to know what they actually look like*
- *I thought when they showed about the inside of a butterfly*
- *Is there anything smaller than an atom*
- *Nanoworld*
- *The "too small" section*
- *I have probably thought more about how we can't see some stuff change because it is too small*

***Invisible* section (16%)**

- *Mosquitoes seeing in infrared*
- *How flies and different animals see things in the world*
- *I have thought about [how] bees and mosquitoes see the world*
- *I thought about how bugs saw the world and how useful it would be to see coldness from heat.*
- *Different ways bugs see*
- *I have thought a lot about how there are different types of vision like for example: ultraviolet and visible vision*
- *Ultraviolet lights*



- *About different waves like radio and x-ray*
- *I picture seeing sound waves all around me*

### **Technology (13%)**

- *I have thought about...atoms and how you can move them*
- *How they are creating tiny little robot versions of fireflies. They can also move atom, and they are creating super sensitive microscopes*
- *How we use animals to influence our technology*
- *I have thought about the robotic dragonflies and geckos part of the film*
- *Zooming in on animals and objects and making new tech about them*
- *The possibilities of nanotechnology*
- *I have thought about what material we could make with nanotechnology*
- *What may occur if we come in contact with the nanotechnology on clothes + pans*
- *Thinnest material*
- *The space elevator*
- *I have thought about nanotech can help the world*

### **Too Fast section (7%)**

- *How things go fast and slow*
- *I have thought about the fast motion and how you can't see some things because they are too fast*
- *In the film, it talked about water drops bouncing on water, while they get smaller and smaller. I have tried to observe this at home*
- *The water drops*
- *Water floating...and a bullet being shot*
- *How cool dragon flies are*
- *I have thought about the robotic dragonflies and geckos part of the film*
- *The lightning*

### **Unseen worlds (5%)**

- *All the things we can't see*
- *I have thought about how I will see the world differently*
- *Like how I see everything different*
- *Why can't we see more? How much is there?*
- *How I would like to see the things in my daily life at different speeds*

### **Too Slow section (4%)**

- *How things go fast and slow*
- *The time-lapse feature*
- *Flowers blooming*
- *I thought about why flowers move slowly when blooming*

### **Miscellaneous (15%)**

- *I've thought about most of the things in the movie*
- *I thought about the new things that have been discovered and that there are more things that need to be discovered*
- *The different visuals of life*
- *The different things I learned and how good and interesting it was*
- *I thought about the awesomeness of the movie and the science of the movie*
- *That popcorn would be nice to have while watching it*
- *I just saw it on Netflix + remembered it*

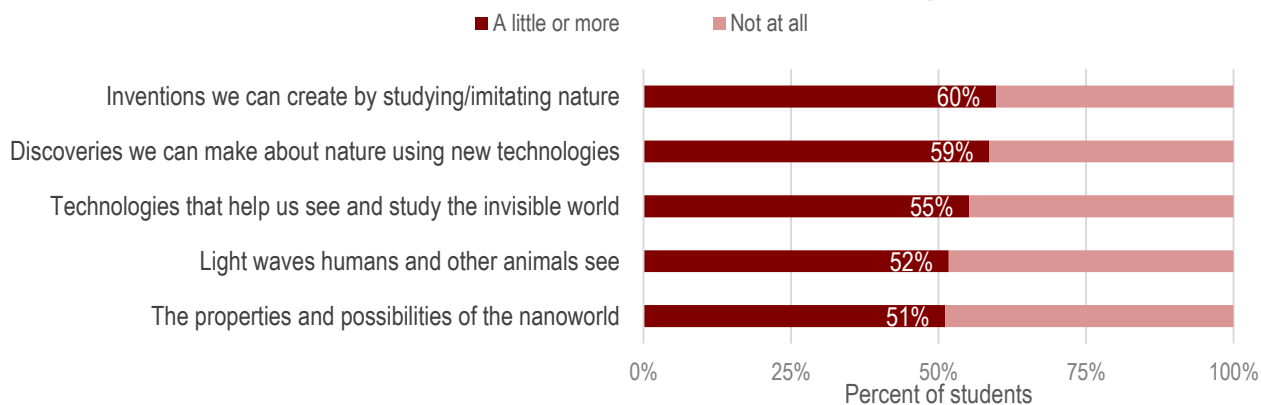
## Question 2: How much did students look into topics from the film within a few weeks of viewing?

When asked to rate the extent to which they looked into 5 science and technology topics within the weeks since viewing the film, more than half each explained that they looked into *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, the kinds of discoveries we can make about nature using new technologies, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), the kinds of light waves humans and other animals see, and the properties and possibilities of the nanoworld.*

Additionally, some students indicated that they looked into the topics of *high-speed photography, time-lapse photography, the invisible world, things nanotechnology makes possible, and electron microscopy*, with nearly three-quarters of students looking into 1 or more of these topics.

Students were asked to rate the extent to which they looked into (e.g., talked to someone about, read about, watched videos, or researched online) 5 science and technology topics since viewing the film a few weeks earlier. The chart below shows the percentage of students who indicated that they looked into each topic.

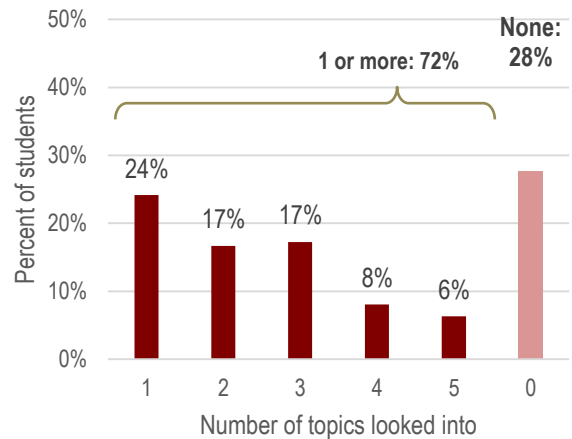
### Percentage of students who looked into science and technology topics from the film within a few weeks of viewing (N=174)



As shown in the chart above, about three-fifth each indicated that they looked into the kinds of *inventions (e.g., devices, materials) we can create by studying/imitating nature* (60%) and the kinds of *discoveries we can make about nature using new technologies* (59%). More than half each explained that they looked into the kinds of *technologies that help us see and study the invisible world (things we can't see with our own human eyes)* (55%), the kinds of *light waves humans and other animals see* (52%), and the *properties and possibilities of the nanoworld* (51%).

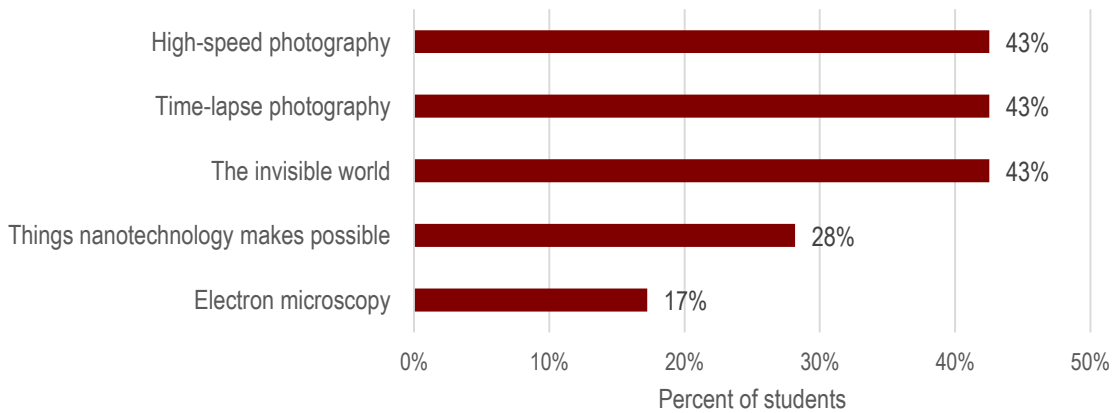
Next, students were asked if they looked into (e.g., talked to someone about, read about, watched videos, or researched online) 5 additional topics from the film: 1) *the invisible world*, 2) *time-lapse photography*, 3) *high-speed photography*, 4) *things nanotechnology makes possible*, and 5) *electron microscopy*. As shown in the chart to the right, nearly three-quarters of students looked into at least of 1 of these 5 topics (72%). Just under one-quarter looked into 1 topic (24%), and about a sixth each looked into 2 (17%) or 3 (17%) topics. Less than a tenth each looked into 4 (8%) or 5 topics (6%). More than a quarter didn't look into any topics (28%).

**How many additional topics students looked into within a few weeks of viewing (N=174)**



As shown in the chart below, more than two-fifths each (43% each) indicated that they looked into: *the invisible world/things you can't see*, *time-lapse photography (to help see things too slow to see)*, and *high-speed photography (to help see things too fast to see)*. More than a quarter said they looked into *the things that nanotechnology makes possible (e.g., new materials, devices)* (28%), while about a sixth noted that they looked into *electron microscopy (to help see things too small to see)* (17%).

**Percentage of students who looked into additional topics within a few weeks of viewing (N=174)**



## Question 3: Did the film change how students think or feel about science or technology?

The majority of students indicated that the film changed how they think or feel about science or technology. The largest groups of students pointing to changed feelings about technology and the nanoworld/nanotechnology, unseen worlds, science, and the world in general. Those who said the film didn't change how they think or feel about science or technology most often explained that they did not care about the film or its subject, or noted that they weren't affected in this way.

Next, students were asked if seeing the film changed how they think or feel about science or technology. As shown in the table to the right, nearly two-thirds of students indicated that this was the case (64%). About a third of students explained that the film did not change how they think or feel about science or technology (35%).

Those who said *Yes* were asked how seeing the film changed how they think or feel. As shown in the table to the right, more than a tenth said they now think or feel differently about technology, including nanotechnology (15%). A slightly smaller group commented on things they learned about unseen worlds (12%), including things from the *Too Small*, *Too Slow*, *Too Fast*, and *Invisible* sections, while a tenth each explained that they think or feel differently about science (10%) and/or the world in general (10%). A handful each described being more interested in a science or technology job/career (5%) and/or commented on observing or imitating nature (4%). A tenth of students shared miscellaneous responses (10%).

<b>Whether seeing the film changed how students thought or felt about science or technology a few weeks of viewing (N=174)</b>	
<b>Yes, it has changed how I think or feel about science or technology</b>	<b>64%</b>
Think/feel differently about technology, including nanotechnology	15%
Commented on unseen worlds	12%
Think/feel differently about science	10%
Think/feel differently about the world in general	10%
More interested in science or technology job/career	5%
Commented on observing or imitating nature	4%
Miscellaneous	10%
<b>No, it has not changed how I think or feel about science or technology</b>	<b>35%</b>
Don't care/don't like science	7%
The film didn't impact me in that way	7%
Haven't thought about it/don't remember	5%
Don't know	3%
Miscellaneous	10%

As noted above, more than a third of students indicated that seeing the film did not change how they think or feel about science or technology (35%). When asked why they didn't think or feel differently, less than a tenth each explained that they didn't care about the film or didn't like science (7%) and/or that the film didn't impact them in that way (7%). A slightly smaller group said they hadn't thought about it or didn't remember (5%), and a handful indicated that they didn't know why they didn't think or feel differently (3%). One-tenth of students

provided miscellaneous feedback (10%), including those who explained that they were already knowledgeable about unseen worlds, among other responses.

Examples of students' comments on each theme follow below:

- **Yes, it has changed how I think or feel about science or technology (64%)**

- Think/feel differently about technology (15%)**

- *Technology can help us see new things*
    - *More excited for technology*
    - *The new technology of small robots is awesome*
    - *It has changed now I think about technology because it is a different type of technology*
    - *I now think science and technology is more interesting*
    - *I think more about new inventions*
    - *I want to use a microscope*
    - *It has changed the way I feel because now I look at things of their atom and how they change*
    - *I started thinking about the nanoworld and its possibilities*
    - *I realized that our abilities in the nanoworld has progressed more than I thought*
    - *Like nanoworld makes creates a new world by learning and inventing one by one*

- Commented on unseen worlds (12%)**

- *I now know there are things that are smaller than I could imagine*
    - *Everything gets smaller and smaller*
    - *Feel, because when I touch my skin I don't notice there are creatures that I can't feel there*
    - *I think about all the bacteria now. I never used to think about it but now I do*
    - *It made me think differently because now I can think of how germ are everywhere*
    - *It's changed the way I think about things that move too quickly or slowly for us to see*
    - *Makes me think about raindrops + lightning*
    - *Now I know how many things happen in just one second*
    - *Animal vision*
    - *It's cool to see how other animals see the world*
    - *I pretended to think like a bee, I can see pollen*

- Think/feel differently about science (10%)**

- *It made me think that science is very significant*
    - *I now think science and technology is more interesting*
    - *It made me wonder if there are more things to discover*
    - *I feel that science is even more interesting to learn new discoveries*
    - *Science can be used everywhere*
    - *I'm interested in science more*
    - *I now appreciate scientists more of the science they do all day*
    - *I think science is more interesting*
    - *It showed me different types of science that amazed me and made something a little more about it*
    - *Science is more fun to me*
    - *I feel like science is the best thing in the world because it help the people understand more the world*

- Think/feel differently about the world in general (10%)**

- *It changed how I think because I learned more*
    - *I feel different because I know much more now*
    - *It has me to think more deeply about it*
    - *It made me realize how complex the simplest things can be*
    - *Now I think more about what is going on around me*
    - *I know my surroundings better*

- *It has changed how I think because I saw the world in different visions*
- *I could see, what I couldn't see before*
- *For example now I think differently because I know what is going on around me*

**More interested in science or technology job/career (5%)**

- *Medical advance because I want to be a doctor*
- *Gives me hope I can go to space*
- *I learned about it more and I find it a more interesting job*
- *It brought me closer into becoming a programmer*
- *I think that maybe when I grow up I would want to be a technologist*
- *It made me think that it would be a cool job*

**Commented on observing or imitating nature (4%)**

- *I'm more interested in observing nature now, and noticing small details*
- *Because I feel more excited about seeing things in nature*
- *There are many things we could make with the idea of nature*
- *I think it will be interesting, and I am interested in inventing things based off of nature*
- *Robots that copy animals are a distinct possibility*

**Miscellaneous (10%)**

- *I feel weird knowing all this information*
- *I think about some stuff in the film and then I'd get confused*
- *It made me feel more confident about my future*
- *I already knew most of the things they were talking about*
- *Some of it is creepy*

• **No, it has not changed how I think or feel about science or technology (35%)**

**Don't care/don't like science (7%)**

- *Cause I don't care about that topic*
- *I haven't been interested/thought about it*
- *I don't really like science*

**The film didn't impact me in that way (7%)**

- *The movie didn't move me at all*
- *Cause the world was the same to me before and after the film*
- *Well, basically, because I didn't really have "flashbacks" on the video, so nothing really changed for me*

**Haven't thought about it/don't remember (5%)**

- *I don't really think about it*
- *I haven't been interested/thought about it.*

**Don't know (3%)**

- *I have no clue*
- *Because I don't know*

**Miscellaneous (10%)**

- *Well I've already heard a fair bit from my dad so I kind of understood, so it was kind of like a review*
- *Because I already do see it differently before the film (I smart)*
- *I couldn't find anything too fast, slow or small*
- *Cause I like the simple things*
- *As long as my science grade is a B+ (which it is) I'm fine with the original way of thinking*
- *I didn't like the scientists' priorities*

## Question 4: Did students “see” the world differently a few weeks after viewing the film?

The majority of students said they “saw” the world differently in the weeks since viewing the film, explaining that they had a new knowledge of and appreciation for things that are *Invisible*, things that are *Too Small*, things that are *Too Fast* and/or *Too Slow*, and the world around them in general. Those who indicated that they hadn’t “seen” the world differently most often noted that they hadn’t thought about the film and/or that the world around them remained the same.

When asked if they had seen the world around them differently after watching *Mysteries of the Unseen World*, nearly three-fifths of students indicated that they *did* see the world differently (59%), while two-fifths said they did not (40%).

Those who said Yes were asked to provide one or more examples of how they had seen the world differently since viewing the film. As shown in the table to the right, the largest group, nearly one-fifth, described being more aware of things that are *Invisible* (18%), with some commenting on how other animals see the world and some imagining what these different ways of seeing look like, among other responses. A slightly smaller group described being more aware of and knowledgeable about things that are *Too Small* (17%), including insects, the nanoworld, things on our bodies, and particles in the air. Just under a tenth expressed a new appreciation for things that are *Too Fast* and/or *Too Slow* to see with the naked eye (9%), such as water droplets, insect flight patterns, and plant growth, among other examples. A handful of students expressed having more general knowledge and awareness of the world around them (6%), and just under a tenth shared miscellaneous responses (9%).

<b>Whether students “saw” the world differently a few weeks after viewing the film (N=174)</b>	
<b>Yes, I have “seen” the world about me differently</b>	<b>59%</b>
Have more knowledge and awareness of things that are <i>Invisible</i>	18%
Have more knowledge and awareness of things that are <i>Too Small</i>	17%
Have more knowledge and awareness of things that are <i>Too Fast</i> and/or <i>Too Slow</i>	9%
Have more general knowledge and awareness of the world around me	6%
Miscellaneous	9%
<b>No, I have not “seen” the world around me differently</b>	<b>40%</b>
Haven’t thought about/forgot about the film	10%
The world around me remains the same	8%
Already knowledgeable	3%
Don’t know	3%
Miscellaneous	13%

As noted above, two-fifths of students said they did not “see” the world differently after viewing the film (40%). When asked why not, a tenth explained that they hadn’t thought about or forgot about the film (10%), while less than a tenth said the world around them remained the same (8%). A handful each explained that they

were already knowledgeable (3%) or said they didn't know (3%). Finally, more than a tenth shared miscellaneous responses (13%).

Examples of students' comments on each theme follow below:

- **Yes, I have “seen” the world about me differently (59%)**

- Have more knowledge and awareness of things that are Invisible (18%)**

- *For example now I know that there is a lot of light wave around me that I cannot see*
    - *Cause I know these waves work*
    - *There are many waves*
    - *I think about the x-rays and imagine things using x-ray*
    - *The different frequencies of photons going through objects*
    - *Whenever I turn on the t.v, I think about all the sound waves that bounce off each other*
    - *That animals can see the world in a totally different manner*
    - *Mosquitos detecting heat*
    - *I avoid mosquitoes more now*
    - *When I see flies and how they see human's blood*
    - *I try to imagine how a mosquito would see me in different temperatures*
    - *I envisioned how the world would look to me in ultraviolet*
    - *Every time I see bees how they look differently*
    - *I saw bees hopping to other plants/flowers*
    - *I can respect bees*
    - *Now when I see bees, I wonder how they see the world*
    - *Because I imagine how I could see the world different*

- Have more knowledge and awareness of things that are Too Small (17%)**

- *Things are so much smaller than they appear*
    - *I noticed the details on a petal of a flower*
    - *There have been lots of more insects I see around me*
    - *I pay more attention to insects and small objects*
    - *Every time I see a flower or a butterfly, I think of how a compound microscope can help you see the items in a different perspective*
    - *Nanoworld*
    - *When I'm taking a shower or washing my hands I always think about the little bacteria on my body*
    - *There are bugs on me*
    - *I'm scared of bugs on my eyelashes*
    - *I realize the air had dead skin and other nasty stuff*
    - *The air contains more than I think*
    - *I feel like I breathe in bugs*
    - *I can see stuff in air when they are in the light*

- Have more knowledge and awareness of things that are Too Fast and/or Too Slow (9%)**

- *I was attempting to see things different like carefully looking at things to see changes*
    - *Specific things changing*
    - *I see that water bounces*
    - *Droplet*
    - *When I go to a creek I always remember the part of the water drops*
    - *Everyday when it rains I am going to watch the raindrops carefully*
    - *I've been closely looking at water*
    - *I pay more attention to insects that fly and their wing movement*
    - *Fireflies: I notice the different wing patterns of fireflies*



- *I have seen the world differently by the way leaves change color*
- *Sometimes I try to observe plants growing in my garden*
- *I'm noticing how slowly plants grow and I'm also noticing bugs and where they're headed*
- *One thing I saw was a flower that didn't bloom yet and the day after it bloomed*
- *How plants grow*

**Have more general knowledge and awareness of the world around me (6%)**

- *Yes because I am way more interested in nature*
- *I've been more caring and excited about nature. For example we went on a hike for the first time in a long time and it was amazing*
- *I have seen the world differently because how I know how many things are going around the world*
- *I am more aware of what is around me*
- *I saw it differently because I noticed more in nature*
- *I've seen the world a little clearer*
- *I think the world is much more than humans*

**Miscellaneous (9%)**

- *Yes because I focus a bit more*
- *Thought about everyday objects*
- *I am not so scared of animals anymore*
- *I shouldn't be that grossed out anymore*
- *Every time I see a flower or a butterfly, I think of how a compound microscope can help you see the items in a different perspective*
- *Yes many people have been exploring and inventing new technology*

• **No, I have not “seen” the world about me differently (40%)**

**Haven't thought about the film/forgot the film (10%)**

- *Because I did not really think about it*
- *I haven't thought much about the film but I don't worry or have interest in everything*
- *I really haven't thought about the video since I've seen it. It was interesting, but the part I remember the most is playing around the museum; not the video.*
- *I mostly forgot about the movie and just carried on normally with life*

**The world around me remains the same (8%)**

- *It's still the same despite what I've been taught*
- *I haven't seen any changes from usual sight*
- *I never really became changed by the film. The world is the same as it always was.*
- *Because everything that they put in the film is unseeable with the human eye*
- *Since these things are "invisible" I can't see them in my daily life, so I just don't care*

**Already knowledgeable (3%)**

- *Most of the stuff I saw in the film I already knew*
- *I've already known about this*
- *In the beginning, I already knew about invisible waves around me*

**Don't know (3%)**

- *I don't know if I've ever seen the world differently or not*

**Miscellaneous (13%)**

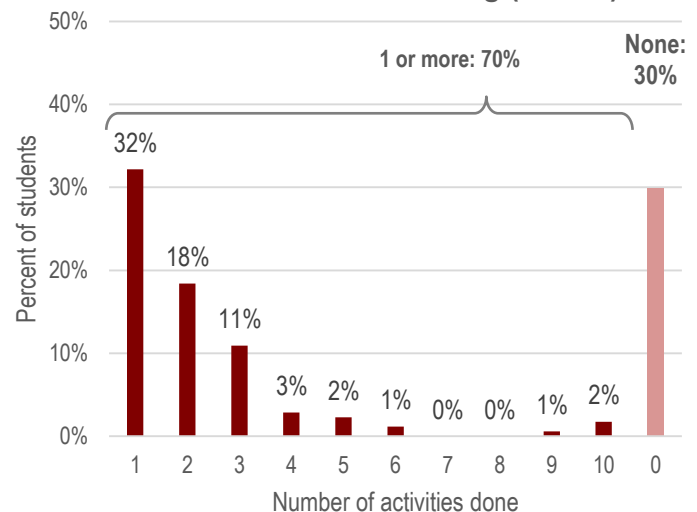
- *I have better things to do*
- *It wasn't revolutionizing*
- *I didn't really pay attention, too distracted by other things*

## Question 5: What activities did students do within a few weeks of viewing the film?

The majority of students engaged in one or more activities in the weeks after viewing the film. The largest groups explained that they *talked to others* about the film, *saw something* on TV or in a movie that made them think of the film, and/or *thought about jobs/careers* that use the science or technology shown in the film.

Next, students were asked which, if any, of the following activities they did after viewing the film: 1) *talked to others about the film*; 2) *looked into/looked up on something from the film that interested them*; 3) *tried an exploration/experiment on their own based on something they saw in the film*; 4) *saw something on television or in a movie that made them think of the film*; 5) *heard something on the radio or while listening to music that made them think of the film*; 6) *read something (e.g., in a book, magazine, newspaper) that made them think of the film*; 7) *went online to the Mysteries of the Unseen World website*; 8) *looked for more information about the film on social media (e.g., Facebook, Twitter)*; 9) *downloaded the Mysteries of the Unseen World app from iTunes*; and 10) *thought about or looked into jobs/careers that use the science or technology shown in the film*.

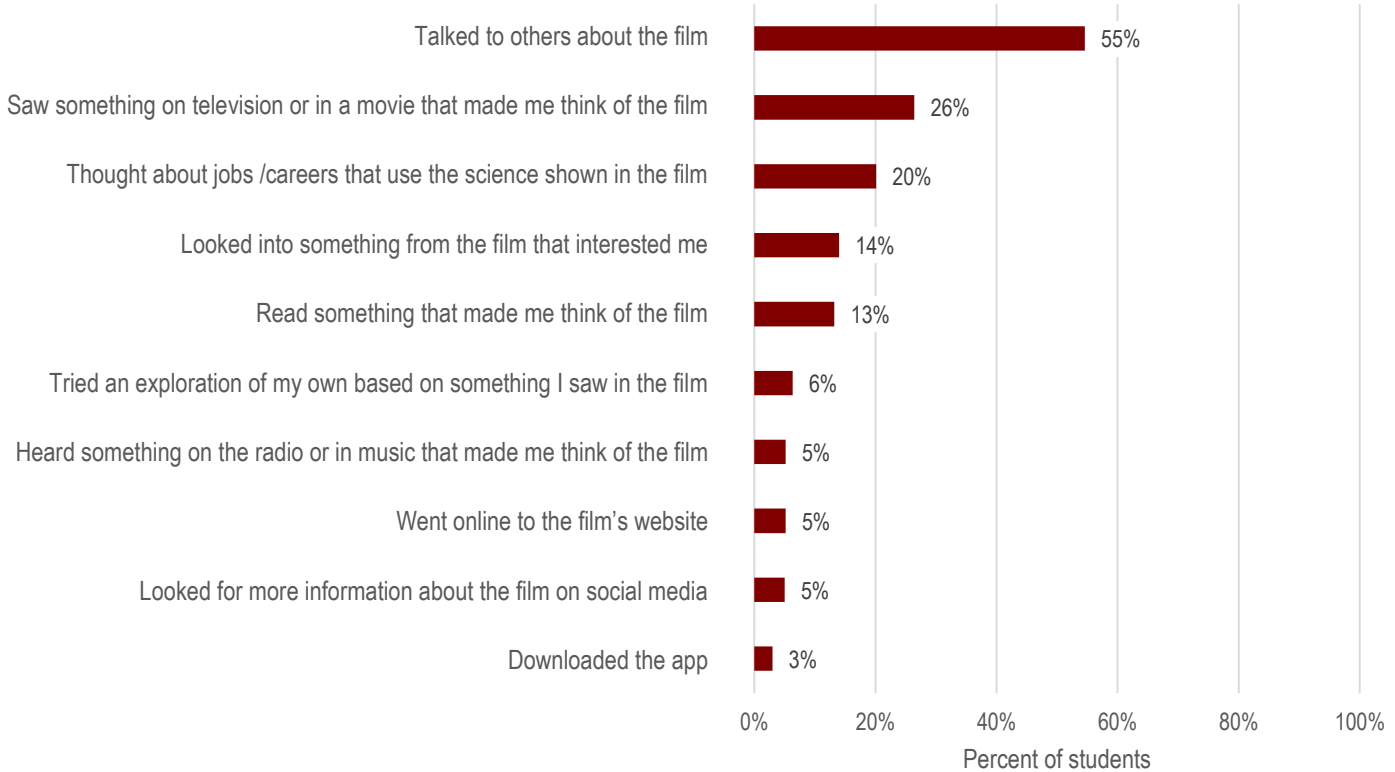
How many activities students did within a few weeks of viewing (N=174)



As shown in the chart above, within a month of viewing the film, more than two-thirds of students indicated that they did at least one activity in that time frame (70%). About a third did one activity (32%), nearly one-fifth did two activities (18%), and just over a tenth did three activities (11%). A handful each did four (3%), five (2%), six (2%), nine (1%), and ten activities (2%). None of the students did seven or eight activities (0% each). Finally, less than a third of students indicated that they did not do any of the activities (30%).

As shown in the chart on the following page, the largest group of students, more than half, *talked to others* about the film (55%). At the same time, around a quarter explained that they *saw something* on TV or in a movie that made them think of the film (26%), and a fifth *thought about jobs/careers* that use the science or technology shown in the film (20%). More than a tenth each *read something* that made them think of the film (14%) and/or *looked into* something from the film (13%). Less than a tenth each *tried an exploration/experiment* (6%), *looked for information about the film on social media* (5%), *visited the film's website* (5%), *heard something* that made them think of the film (5%), or *downloaded the app* (3%).

## Activities done by students within a few weeks of viewing the film (N=174)

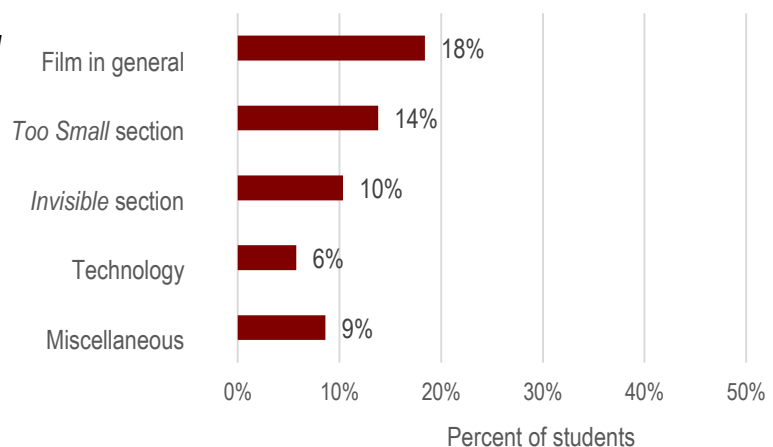


More information about the activities done by the students is presented below, from highest frequency to lowest frequency among students.

### Talked to others about the film (55%)

More than half of students who completed the follow-up survey indicated that they discussed *Mysteries of the Unseen World* with others in the weeks after viewing the film (55%). When asked what they talked about, the students shared a range of responses. As shown in the chart to the right, the largest group, nearly one-fifth, said they talked about the film in general (18%), while a slightly smaller group explained that they talked about something from the *Too Small* section (14%). A tenth talked to others about the *Invisible* section (10%), and a handful talked to others about technology (6%). About a tenth of students talked about miscellaneous subjects (9%), including things that are *Too Fast* and/or *Too Slow* to see with the naked eye, among other topics. Examples of students' responses on each of these subjects are shared on the following page:

### What about the film students discussed within a few weeks of viewing (N=174)



**The film in general (18%)**

- The visuals
- How cool the graphics [were]
- How interesting and informational it is
- How cool it was to see it on a big screen
- I talked about the film and what I learned
- How the film was presented and the facts
- I talked to my friends about how cool the film was and what they should have changed
- I told my mom about the film and how it was good
- How it made me dizzy, How I thought it was also cool
- How it was weird

**Too Small section (14%)**

- Butterfly wings
- Germs
- How there is bacteria everywhere
- The mites on there
- How weird it is that we have so much bacteria on us
- The dead skin and eyelash bugs
- The bugs that are on us all
- About what kind of air we are breathing
- How the lizard can stick to things
- How certain types of leaves have raindrops left on them
- I talked about the nanoworld

**Invisible section (10%)**

- Mosquitos detecting heat
- Seeing in different waves (insects)
- How we and other creatures see
- The different light waves
- We talked about how if we studied more of our visions like ultraviolet what will we discover that is new
- How the film talked about the light and how we see the world
- About how we see things differently
- The sound waves

**Technology (6%)**

- The compound microscope
- I talk about how cool it was and how people invented technology to see new things
- New technology possibilities
- About how nanotechnology could help us
- How the technology there making will become smarter than us
- How nanotechnology works
- Space elevator

**Miscellaneous (9%)**

- When raindrops hit puddles
- How dragonflies fly
- Fast and slow photography
- How cool...the decomposing rat was
- I really talked...about the things that were too slow for us
- How the world decomposes over time

- *Invisibility cloaks*
- *About stuff you can't see with the human eye*
- *The unseen things we never paid attention to*

### **Saw something on television or in a movie that made them think of the film (26%)**

More than a quarter of students explained that they saw something on TV or in a movie that made them think of *Mysteries of the Unseen World* (26%). When asked what they saw that reminded them of the film, the students pointed to a variety of topics and a range of platforms, including films, television shows, commercials, and online videos. For example:

- *Scientist tried to make people invisible*
- *In the film he saw it in a lot of different ways*
- *An earthquake film*
- *I saw a science film about nanotechnology that reminded me of the film we saw*
- *I saw a documentary of nanotech*
- *I saw a nature movie*
- *I was watching "Doctor Who" and they were talking about how new tech can help everyone "evolve"*
- *I watched NOVA and it reminded me of the science in the IMAX movie*
- *The film was on Netflix/I saw some articles about it*
- *Bill Nye the science guy*
- *I saw an episode where the kid was doing an atom project*
- *I have seen films like this one on television*
- *I saw a show about animals in nature and their different abilities*
- *I saw Netflix's Daredevil enough said.*
- *YouTube video on chemistry*
- *A national geography commercial*
- *It was a pest control [ad] with looking through a fly's eye*
- *I saw an ad which was about cleaning germs and that reminded me about the film*

### **Thought about or looked into jobs/careers that use the science or technology shown in the film (20%)**

A fifth of students said they thought about or looked into job or careers that use the science or technology shown in the film (20%). When asked what they thought about or looked into, they shared a range of responses about careers in science, engineering, computer design, and photography, among others:

- *I thought about what cool jobs there are in the nanoworld*
- *I thought about possible jobs in the future that has to do with "nano" stuff*
- *Becoming a scientist (nanotechnology and sound waves)*
- *I thought about being a scientist or a technologist*
- *I talk to people that work with technology and see small things like germs*
- *(1) web designer (2) computer engineer (3) programmer*
- *Chemistry and space exploration*
- *Electrical engineering*
- *I thought about the different possibilities of jobs and thought about which one I would want to be*
- *Thought about being a robot scientist*
- *Becoming an inventor that can see light waves that animals can see*
- *I thought about how imitating nature would help us with the problems we have now*
- *I'm thinking more about being a scientist that mimics nature*
- *The time-lapse photographer*

### **Read something that made them think of the film (14%)**

More than a tenth of students explained that they read something (e.g., in a book, magazine, newspaper) that made them think of *Mysteries of the Unseen World* (14%). When asked what they read that reminded them of the film, students pointed to the source, topic, or source and topic, as in:

- *Science world magazine*
- *National geographic about the world*
- *A magazine because it was talking about it*
- *I have read a couple of magazine articles about nanotechnology*
- *A few articles that talked about nanotech*
- *Magazine I saw an article on light waves*
- *I found a cool page in a library book about new invention to see small things*
- *I had to read this scope magazine about bacteria*
- *A person getting his arm checked out with x-ray*
- *I read about light*

### **Looked into or followed up on something from the film (13%)**

More than a tenth of students indicated that they looked into or followed up on something from the film that interested them (13%). When asked what they looked into, the students pointed to a range of topics, including time-lapse and high-speed photography, things from the *Too Small* and/or *Invisible* sections, the nanoworld, nanotechnology, and technological inspiration from nature. For example:

- *Time-lapse and high-speed photography*
- *The thing that the film interested me is when they showed us the bugs*
- *The different waves that animals and people see*
- *I looked more into the visions of everything and also about the whales*
- *The way other things see*
- *I looked into learning more about the different light waves*
- *The x-rays*
- *Light + sound*
- *The sound waves*
- *The nanoworld*
- *I looked into the nanoworld*
- *The nanoworld by trying to see up close to things*
- *Nature technology ideas*
- *Robots imitating nature*

### **Tried an exploration or experiment based on something in the film (6%)**

A handful of students explained that they tried an exploration or experiment on their own based on something they saw in the film (6%). When asked about their exploration or experiment, a few students pointed to experimenting with or noticing water drops, one mentioned that s/he noticed small things, another commented on being inspired by the trailer for *Humpback Whales*, and one gave an example of something s/he explored online, as in:

- *Splashing water in a pool*
- *Seeing water drops fall*

- *Starting noticing smaller things*
- *I saw how the whales were in the nature so I looked out and saw what was happening in nature*
- *Reasoned more on the website that bugs can see through us*

#### **Looked for more information about the film on social media (e.g., Facebook, Twitter) (5%)**

A handful of students explained that they looked for more information about the film on social media (5%). When asked where they looked and what they found, a few students shared miscellaneous responses:

- *Instagram*
- *Looked at Twitter*
- *I looked at bugs and unseen bugs. I found pic of unseen bugs*
- *I looked at plants*

#### **Went online to the *Mysteries of the Unseen World* website (5%)**

A handful of students indicated that they visited the film's website (5%). When asked what they did at the website, a few students shared additional feedback, as in:

- *I looked around at the different articles and other movies*
- *I looked at stuff*
- *A bit*
- *Saw the movie MUW*
- *Had trouble with tech tag log in*

#### **Heard something on the radio or while listening to music that made them think of the film (5%)**

A handful of students said they heard something on the radio or while listening to music that made them think of *Mysteries of the Unseen World* (5%). When asked what they heard that reminded them of the film, a few students pointed to specific topics from the film:

- *About some bug story*
- *How a lot of people are getting sick because we have a lot of bacteria*
- *Talk about x-rays*
- *The waves*

#### **Downloaded the *Mysteries of the Unseen World* app from iTunes (3%)**

A handful of students indicated that they downloaded the film's app from iTunes (3%). When asked how they used the app, one explained that s/he "explored it."

## Summary of findings

The Study 2 summative evaluation examined middle school students' experience with *Mysteries of the Unseen World* when the film was viewed at their local science center during part of a school field trip. The evaluation centered on five key questions based on direction provided by National Geographic relating to the film's goals and consultation of the following materials for context and further specification: the film and script, the project's original NSF proposal, the evaluation team's original and revised summative evaluation plan, the project's Impact and Indicator statements submitted to the NSF, the formative evaluation reports on the film's rough cuts completed by Multimedia Research in 2012, and Knight Williams' prior summative evaluations focused on middle school students' learning from giant screen films produced by National Geographic. The five key questions were: 1) How appealing and engaging did students find the film? 2) Did students find the film content to be clearly presented? 3) What did students learn from viewing the film? 4) Did viewing the film impact students' STEM interests and perceptions? 5) What was the film's motivational impact on students within a few weeks of viewing?

To assess the five areas of impact, the evaluation was conducted in two phases, as follows:

- **Phase 1: Pre-post questionnaire assessment of the film's immediate appeal and learning value:**  
The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by student performance on a post-viewing questionnaire, as compared to the students' performance on the same set of content questions prior to seeing the film. One week prior to seeing the film, students in eight middle school classes completed a pre-viewing/pretest questionnaire that included demographic and background questions about students' gender, ethnicity/race, number of IMAX films seen, and interest in and knowledge of the film's main topic areas. The questionnaire also included a short knowledge quiz of content covered in the film. One day after seeing the film, all eight classes completed a post-viewing/posttest questionnaire. The questionnaires collectively addressed the impact questions 1-4, described above.
- **Phase 2: Follow-up evaluation of extended impact:** Approximately 15-20 days after students viewed the film they were asked to complete a brief questionnaire exploring the film's longer-term impact.

Statistical analyses were conducted on all quantitative data generated from the evaluation. Differences in student ratings and scores from pre to posttest as well as subgroup differences are noted where significant differences of less than .05 were found. To explore for significant differences, the analyses used t-tests and Mann Whitney tests, as appropriate. Demographic and background variables used in the subgroup analyses included: gender, location/grade, and number of IMAX films viewed. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the film's objectives, and inductive, by looking for overall themes, keywords, and key phrases.

### Sample information

Beginning in January 2015, Knight Williams and National Geographic staff collaborated to locate middle school teacher representatives whose classes were scheduled to see or expressed an interest in seeing *Mysteries of the Unseen World* during the spring of the 2014-2015 school year at a partner science center. Working from a list of four partner sites that were showing *Mysteries of the Unseen World* in the spring and had middle school classes booked to see the film, the evaluation team used the following four criteria to help select schools to participate in the evaluation: 1) The schools' scheduled viewing had to occur one month before the end of the school year to ensure time for completion of the Phase 2 follow-up, and during a timeframe that did not include



school holidays to ensure no disruptions to the evaluation process; 2) The schools had to have a minimum of two classes scheduled to see the film; 3) The schools were public schools; and 4) The schools served a diverse cross-section of students from different backgrounds and metropolitan areas.

In March and April of 2015, the evaluation team located two middle schools that fit the above evaluation criteria. The two participating schools were respectively located in the Alabaster, Alabama and San Jose, California metropolitan areas. The supervising teachers in each case confirmed they were interested in and able to complete all of the required evaluation activities within the requested evaluation timeframe, from the initial pretesting of students one week prior to seeing the film through to the follow-up questionnaire 15-20 days later. To ease the burden of the evaluator requests for the above set of activities, both schools that participated in the evaluation were provided honoraria.

During the month of May 2015, a total of four classes from each school attended a field trip to either the McWane Science Center in Birmingham, Alabama or the Tech Museum of Innovation in San Jose, California, respectively. In both cases students viewed the film on a dome screen as both science centers host an IMAX dome theater. A total of 194 students from 8 classrooms completed both the pretest and posttest questionnaires, of which 90% (n=174) also completed a follow-up questionnaire 15-20 days later. The sample included:

- A balance of boys and girls (50% each).
- An age range that spanned 11-14 years, with a mean and median age of 12.
- A racial/ethnic distribution comprising 55% White, 10% Asian, 4% African-American, 13% mixed-race, and 14% Other. Sixteen percent (16%) of the students were of Hispanic origin.
- A comparable number of students from each of the two participating schools in California (54%) and Alabama (46%).
- A combination of frequent vs. occasional viewers of giant screen films, including 45% who reported they had seen only 0-2 films prior to seeing *Mysteries of the Unseen World* and 55% who reported they had seen 3 or more films.
- A majority of students who felt they knew a little about the five main topics featured in the film (median ratings 2.0 across).
- A majority of students who felt they knew were a little or fairly interested in the film's topics, with the discoveries about nature, inventions by studying nature, and technologies to see the unseen world being rated somewhat higher overall (median ratings 3.0) than the light waves or nanoworld properties and possibilities (median ratings 2.0).
- A combination of students that indicated they were not at all or slightly interested (35%) somewhat interested (33%) or very or extremely interested (32%) in a future job/career involving science.

## **Phase 1: Pre-post assessment of the film's immediate appeal and learning value**

This section summarizes the Phase 1 evaluation findings relating to the following four questions: 1) How appealing and engaging did students find the film? 2) How successful did students find the film in terms of: overall and visual clarity, pacing, density of information, density of science, and level of scientific explanations? 3) What did students learn from the film? 4) How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?

## Question 1: How appealing and engaging did students find the film?

**1.1 How did students rate the film in terms of overall likeability, visual excitement, impact on curiosity, engagement with the storyline, and likelihood of recommending the film?** Overall, students indicated that they liked *Mysteries of the Unseen World*, with some explaining that it was “cool,” “fun,” and “interesting.” When asked to rate the film on a seven point scale with 1 being lowest and 7 being highest, the students indicated they generally liked *Mysteries of the Unseen World* (median rating 6.5), found it visually exciting (median rating 6.0), indicated that the film increased their curiosity (median rating 6.0), and thought they would recommend the film to others their age (median rating 6.0). They also generally found the film’s story about the family and their friends somewhat engaging (median rating 5.0).

Mann-Whitney tests determined a few subgroup differences for this set of questions. First, boys indicated that watching the film increased their curiosity significantly more than did girls, though the effect size was small ( $U = 3929$   $p = .045$ ,  $r = .14$ ). Second, 6th graders in California found the film’s story about the family/friends significantly more engaging than did the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama though the effect size was small ( $U = 3642$   $p = .008$ ,  $r = .19$ ). The 6<sup>th</sup> graders also indicated they were significantly more likely to recommend the film than did the 7<sup>th</sup> and 8<sup>th</sup> graders though here again, the effect size was small ( $U = 3775$   $p = .017$ ,  $r = .17$ ).

**1.2 What did students like about the film?** When asked to describe what they liked most about *Mysteries of the Unseen World*, the majority (95%) of students identified at least one thing about the film that they found appealing, with many citing two or more elements. Nearly three-tenths of students commented on the educational value of the film (29%), while just over one-quarter explained that they most liked something the film showed them about the unseen world (26%). More than one-fifth of students indicated that they most liked something in the *Too Small* section (22%), while around one-sixth each explained that they most liked something in the *Invisible* section (18%) and/or something in the *Too Fast* section (17%). Slightly less than one-sixth most liked something in the *Too Slow* section (15%). About one-seventh each pointed to something they learned about past and future technological innovations (14%) and/or something to do with the audiovisual aspects of giant screen filmmaking (14%). Slightly smaller groups specifically described something about the film as “cool” (13%) and/or explained that they most liked an aspect of the presentation of information (12%). Finally, less than one-tenth each indicated that they liked everything in the film (4%), explained that they liked nothing (2%), noted that they did not know what they liked most about the film (1%), or declined to provide a response (2%). A handful shared miscellaneous responses (7%), including 2 students who indicated that they most liked something in the trailer for another IMAX film, *Humpback Whales*.

**1.3 What did students not like about the film?** Nearly one-third of students indicated that there was *nothing* they disliked about the *Mysteries of the Unseen World* (32%). One-fifth of students pointed to elements they considered “gross” (20%), including scenes focused on the mites on our eyelashes, particles in the air we breathe, decomposition, and close-ups of small organisms. One-tenth of students explained that they were physically uncomfortable during the screening (10%), with most explaining that the film gave them “a headache,” made them “dizzy,” or “hurt their eyes.” Just under a tenth of students indicated that they didn’t like an aspect of the filmmaking (9%), while a slightly smaller group noted that they thought the film was too short and/or wanted more information (7%). A handful each said they didn’t know what they did not like (4%), found the film boring or uninteresting (3%), thought parts were confusing (2%), and/or thought the film was too long (2%). Finally, a tenth shared miscellaneous responses (10%), and just under a tenth declined to answer the question (7%).

**Question 2: How successful did students find the film in terms of: overall clarity, visual clarity, pacing, density of information, density of science, and level of scientific explanations?**

**2.1 How did students feel about the film's overall clarity and the ease or difficulty of following the film visually?** Using a scale from 1 (confusing) to 7 (clear), students generally indicated they found the film fairly clear (median rating 6.0). Similarly, using a scale from 1 (visually hard to follow) to 7 (visually easy to follow) they also indicated that they thought the visuals were fairly easy to follow (median rating 6.0).

**2.2 How did students feel about the film's pacing, amount of information and science, and level of scientific explanations?** Students rated *Mysteries of the Unseen World* for how they felt about the pacing of the film, the amount of information in the film, and the amount of science and level of scientific explanations on a scale of 1.0 (lowest rating) to 7.0 (highest rating), with 4.0 being just right in each case. Overall students generally thought the film was well paced and that the amount of information, amount of science, and level of scientific explanations were about right (median rating 4.0 each). In addition, Mann-Whitney tests revealed that girls found the film's level of scientific explanations significantly more advanced than did boys, although here again the effect size was small ( $U = 3854$ ,  $p = .018$ ,  $r = .17$ ).

**Question 3: What did students learn from the film?**

**3.1 How much did students think they learned from the film?** Using a scale from 1.0 (learned nothing) to 7.0 (learned a lot), overall students indicated that they learned a considerable amount from watching *Mysteries of the Unseen World* (median rating 6.0).

**3.2 What did students think were the most interesting things learned from the film?** When asked to describe the most interesting things they learned from *Mysteries of the Unseen World*, nine-tenths (90%) of students identified one or more new subjects of interest. More than a quarter pointed to technological innovations (27%), while a slightly smaller group said they learned something interesting in the *Too Small* section (26%). Just over a fifth of students indicated that they learned something interesting in the *Invisible* section (21%). Slightly less than one-sixth of students pointed to something they learned in the *Too Fast* section (16%), and less than a tenth shared something interesting they learned in the *Too Slow* section (7%). A handful said they didn't know what they found most interesting in the film (3%), and less than a tenth declined to answer the question (7%). Finally, one-seventh of students shared miscellaneous responses (14%).

**3.3 How successful did students think the film was in communicating specific themes about science and technology?** Asked to rate the film's success in communicating five key science and technology content themes on a scale from 1 (not at all successful) to 7 (very successful), the students generally thought the film was successful in each regard (median rating 6.0 each), including that: *scientists have invented technology to look at things in nature that we cannot see with our own eyes, technology opens up new frontiers to explore, technology reveals things about nature that could change our understanding of the planet we live on, there is a lot to learn from the invisible worlds that surround us, and that when we study nature we discover new things that could improve our lives.*

**3.4 How much did students think they learned from the film about science and technology topics?** Overall, when asked to rate the amount they felt they learned about five specific topics using a scale from 1 (learned nothing) to 4 (learned a lot), students generally indicated that they learned a lot (median rating 4.0 each) about two topics: *the kinds of discoveries we can make about nature using new technologies* and *the*

kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature. They also thought they learned a fair amount (median rating 3.0 each) about the following three topics: *the kinds of light waves humans and other animals see*, *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)*, and *the properties and possibilities of the nanoworld*. Mann-Whitney tests found one subgroup difference in this question set in that 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama rated the amount they learned from the film about the nanoworld significantly higher than did 6<sup>th</sup> graders in California though the effect size was small ( $U = 3734$   $p = .01$ ,  $r = .19$ ).

**3.5 What was the film's impact on students' knowledge of unseen worlds?** To evaluate the impact of *Mysteries of the Unseen World* on students' knowledge of content covered in the film, students were asked to complete a 40 point assessment consisting of multiple choice, true/false, fill in the blank, and short answer questions one week before seeing the film and then one day after viewing. Each question set was assigned a point value based on the relative importance the film placed on the content addressed and National Geographic's informal science learning goals as prioritized for middle school students.

Overall the evaluation found students made significant gains in their content learning from *Mysteries of the Unseen World*. A paired sample t-test showed that students' scores were significantly higher after watching the film than before, and the effect size was large ( $t(193) = 32.5$ ,  $p < .001$ ,  $d = 1.96$ , 95% CI [13.2,15.0]). Where students averaged 17 out of 40 correct answers on the pre-viewing questionnaire, they scored 31 correct responses on the post-viewing questionnaire.

In addition to this higher overall score, students also scored significantly higher on each of the five main topic areas assessed, as follows: For *The types of light waves that humans and other animals see*, out of a total possible score of 6, students averaged 3.1 correct answers before seeing the film and 5.0 correct answers after ( $t(193) = 11.8$ ,  $p < .001$ ,  $d = 1.18$ , 95% CI [1.6,2.2]). For *The technologies used to see and study things that humans can't see with normal vision*, out of a total possible score of 10, students averaged 3.4 correct answers before the film and 7.1 after ( $t(193) = 11.8$ ,  $p < .001$ ,  $d = 1.53$ , 95% CI [1.6,2.2]). For *the Discoveries scientists have been able to make about nature through new technologies*, out of a total possible score of 6, students averaged 2.1 correct answers before seeing the film and 4.4 after ( $t(193) = 21.5$ ,  $p < .001$ ,  $d = 2.01$ , 95% CI [2.0,2.4]). For *Things scientists can learn from nature to make innovative materials and devices*, out of a total possible score of 12, students average 6.0 correct answers before seeing the film and 10 after ( $t(193) = 15.2$ ,  $p < .001$ ,  $d = 1.13$ , 95% CI [3.5,4.6]). Finally, for *Properties and possibilities of the nanoscale*, out of a total possible score of 6, students averaged 2.2 correct answers before seeing the film and 4.1 correct answers after ( $t(193) = 15.4$ ,  $p < .001$ ,  $d = 1.23$ , 95% CI [1.9,2.5]). The effect sizes in each case were large.

#### **Question 4: How did viewing the film impact students' interest in science and technology, science and technology jobs/careers, and the way they "see" the world?**

**4.1 What was the film's impact on students' interest in science and technology topics?** Using a scale from 1 (decreased strongly) to 7 (increased strongly), students generally indicated that the film increased their interest in the subject of *the properties and possibilities of the nanoworld* (median rating 6.0) and somewhat increased their interest (median rating 5.0 each) in the following four additional topics: *the kinds of light waves humans and other animals see*, *the kinds of discoveries we can make about nature using new technologies*, *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature*, and *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)*.

#### **4.2 What was the film's impact on students' interest in a job/career involving science or technology?**

After viewing *Mysteries of the Unseen World*, students were asked to rate how much the film increased or decreased their interest in a future job/career involving science or technology on a scale from 1.0 (decreased strongly) to 7.0 (increased strongly), with 4.0 being neither increased nor decreased. Overall students indicated that viewing the film somewhat increased (median rating 5.0) students' interest in a future job/career involving science or technology.

When asked to identify sections of the film that influenced their interest in a job/career in science or technology, more than a tenth of students pointed to something in the nanotechnology section (11%), while just under a tenth commented on a scene highlighting technology inspired by nature (9%). Slightly smaller groups explained that they were impacted by something in the *Invisible* section (7%) and/or pointed to the *Too Small* section (6%). At the same time, a handful each noted that they were impacted by what they learned about something *Too Fast* (5%), high-powered microscopes (5%), and/or something in the *Too Slow* section (3%). One-seventh of students provided miscellaneous responses (14%), and a tenth said they weren't influenced by any part of *Mysteries of the Unseen World* (10%), including two students who noted that they were *already* interested in this career path prior to seeing the film. Finally, less than a tenth said they didn't know which sections of the film influenced their interest in a job/career in science or technology (6%), and more than a third of students declined to answer the question (35%).

**4.3 Did students think they would "see" the world differently after watching the film?** When students were asked if they thought they would "see" the world around them differently as a result of watching the film, nearly three-fourths of students said *Yes* (72%), while a tenth said *No* (10%) and nearly two-fifths identified as *Unsure* (18%). Those who said *Yes* were asked how they would "see" the world differently. One-fifth of students explained that they would generally have more knowledge and awareness of unseen worlds (20%), just under a fifth said they would think about things from the *Too Small* section (17%), and more than one-seventh said they would think about something from the *Invisible* section (15%). Less than one-tenth each explained that they would observe more (4%), would think about things from the *Too Fast* section (3%), would be inspired to learn more (3%), would think about things from the *Too Slow* section (2%), or provided miscellaneous responses (8%).

Those who said *No* were asked why not. A handful each explained that they would be limited by (human) sight and experience (3%), that they were already knowledgeable (2%), that they weren't impacted by the film (2%), or said the world around them would remain the same (1%). A similarly small group shared miscellaneous responses (2%).

And finally, those who were *Unsure* were asked why this was the case. A handful each explained that they would be limited by (human) sight and experience (4%), said they were unsure (4%), noted that the subject of the film wouldn't be on their minds (3%), indicated that they were already knowledgeable (2%), or said they didn't understand something in the film or needed to learn more (1%). A similarly small group provided miscellaneous responses (2%).

## Phase 2: Follow-up evaluation of extended impact

This section summarizes the Phase 2 evaluation findings relating to the following five questions: 1) How much did students continue to think about the film within a few weeks of viewing? 2) How much did students look into topics from the film within a few weeks of viewing? 3) Did the film change how students think or feel about science or technology? 4) Did students “see” the world differently a few weeks after viewing the film? 5) What activities did students do within a few weeks of viewing the film?

### Question 1: How much did students continue to think about the film within a few weeks of viewing?

The majority of students indicated that they thought about the film in the weeks since viewing (80%). More than half thought about the film a little or a moderate amount (53%), and more than a quarter thought about the film quite a bit to a lot (26%). A fifth of students indicated that they hadn't thought about the film (20%).

When asked to describe what they thought about from the film in the weeks since viewing, about one-sixth explained that they thought about things from the *Too Small* section (17%), while a slightly smaller group thought about things from the *Invisible* section (16%). More than a tenth of students thought about technology (13%), and less than a tenth thought about things from the *Too Fast* section (7%). A handful each said they thought about something related to unseen worlds (5%) and/or things from the *Too Slow* section (4%). Finally, more than one-seventh shared miscellaneous feedback (15%).

### Question 2: How much did students look into topics from the film within a few weeks of viewing?

When asked to rate the extent to which they looked into 5 science and technology topics after viewing the film, about three-fifth each indicated that they looked into *the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature* (60%) and *the kinds of discoveries we can make about nature using new technologies* (59%). More than half each explained that they looked into *the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes)* (55%), *the kinds of light waves humans and other animals see* (52%), and *the properties and possibilities of the nanoworld* (51%).

Next, students were asked if they looked into (e.g., talked to someone about, read about, watched videos, or researched online) 5 additional topics from the film: 1) *the invisible world*, 2) *time-lapse photograph*, 3) *high-speed photography*, 4) *things nanotechnology makes possible*, and 5) *electron microscopy*.

Nearly three-quarters of students looked into at least of 1 of these 5 topics (72%). Just under one-quarter looked into 1 topic (24%), and about a sixth each looked into 2 (17%) or 3 (17%) topics. Less than a tenth each looked into 4 (8%) or 5 topics (6%). More than a quarter didn't look into any topics (28%).

More than two-fifths of students (43% each) indicated that they looked into: *the invisible world/things you can't see*, *time-lapse photography (to help see things too slow to see)*, and *high-speed photography (to help see things too fast to see)*. More than a quarter said they looked into *the things that nanotechnology makes possible (e.g., new materials, devices)* (28%), while about a sixth noted that they looked into *electron microscopy (to help see things too small to see)* (17%).

### **Question 3: Did the film change how students think or feel about science or technology?**

Nearly two-thirds of students thought seeing the film changed how they think or feel about science or technology (64%), while about a third said it did not (35%). Those who said *Yes* were asked how seeing the film changed how they think or feel. More than a tenth said they now think or feel differently about technology, including nanotechnology (15%). A slightly smaller group commented on things they learned about unseen worlds (12%), while a tenth each explained that they think or feel differently about science (10%) and/or the world in general (10%). A handful each described being more interested in a science or technology job/career (5%) and/or commented on observing or imitating nature (4%). A tenth of students shared miscellaneous responses (10%).

Those who said *No* were asked why they didn't think or feel differently. Less than a tenth each explained that they didn't care about the film or didn't like science (7%) and/or that the film didn't impact them in that way (7%). A slightly smaller group said they hadn't thought about it or didn't remember (5%), and a handful indicated that they didn't know why they didn't think or feel differently (3%).

### **Question 4: Did students “see” the world differently a few weeks after viewing the film?**

Next, students were asked if they had seen the world around them differently after watching *Mysteries of the Unseen World*. Nearly three-fifths of students indicated that they *did* see the world differently (59%), while two-fifths said they did not (40%). Those who said *Yes* were asked to provide one or more examples of how they had seen the world differently since viewing the film. Nearly one-fifth of students described being more aware of things that are *Invisible* (18%), while a slightly smaller group described being more aware of and knowledgeable about things that are *Too Small* (17%). Just under a tenth expressed a new appreciation for things that are *Too Fast* and/or *Too Slow* to see with the naked eye (9%), and a handful expressed having more general knowledge and awareness of the world around them (6%). Just under a tenth of students shared miscellaneous responses (9%).

Those student who indicated that they *did not* see the world differently were asked why this was the case. A tenth explained that they hadn't thought about or forgot about the film (10%), and less than a tenth said the world around them remained the same (8%). A handful each explained that they were already knowledgeable (3%) or said they didn't know (3%). Finally, more than a tenth shared miscellaneous responses (13%).

### **Question 5: What activities did students do within a few weeks of viewing the film?**

When asked if they did ten specific activities within a month of viewing the film, more than two-thirds of students indicated that they did at least one activity in that time frame (70%). About a third did one activity (32%), nearly one-fifth did two activities (18%), and just over a tenth did three activities (11%). A handful each did four (3%), five (2%), six (2%), nine (1%), and ten activities (2%). None of the students did seven or eight activities (0% each). Finally, less than a third of students indicated that they did not do any of the activities (30%).

The largest group of students, more than half, *talked to others* about the film (55%). At the same time, around a quarter explained that they *saw something* on TV or in a movie that made them think of the film (26%), and a

fifth *thought about jobs/careers* that use the science or technology shown in the film (20%). More than a tenth each *read something* that made them think of the film (14%) and/or *looked into* something from the film (13%). Less than a tenth each *tried an exploration/experiment* (6%), looked for information about the film on *social media* (5%), *visited the film's website* (5%), *heard something* that made them think of the film (5%), or *downloaded the app* (3%). More information about the activities done by the students is presented below, from highest frequency to lowest frequency among students.

- Talked to others about the film (55%)  
When asked what they talked about with others, nearly one-fifth said they talked about the film in general (18%), while a slightly smaller group explained that they talked about things from the *Too Small* section (14%). A tenth talked to others about things from the *Invisible* section (10%), and a handful talked to others about technology (6%). Finally, about a tenth of students talked about miscellaneous subjects (9%), including things from the *Too Fast* and/or *Too Slow* sections, among other topics.
- Saw something on television or in a movie that made them think of the film (26%)  
When asked what they saw that reminded them of the film, students pointed to a variety of topics and a range of platforms, including films, television shows, commercials, and online videos.
- Thought about or looked into jobs/careers that use the science or technology shown in the film (20%)  
When asked what they thought about or looked into, students shared a range of responses about careers in science, engineering, computer design, and photography, among others.
- Read something that made them think of the film (14%)  
When asked what they read that reminded them of the film, students pointed to a variety of topics and a range of sources, including magazines, books, and articles.
- Looked into or followed up on something from the film (13%)  
When asked what they looked into or followed up on from the film, students pointed to a range of topics, including time-lapse and high-speed photography, things from the *Too Small* and/or *Invisible* sections, the nanoworld, nanotechnology, and technological inspiration from nature.
- Tried an exploration or experiment based on something in the film (6%)  
When asked about their exploration or experiment, a few students pointed to experimenting with or noticing water drops, one mentioned that s/he noticed small things, another commented on being inspired by the trailer for *Humpback Whales*, and one gave an example of something s/he explored online.
- Looked for more information about the film on social media (e.g., Facebook, Twitter) (5%)  
When students were asked which social media sites they looked at and what they found, one pointed to Instagram, another mentioned Twitter, and a few described what they looked up (“bugs” and “plants”).
- Went online to the *Mysteries of the Unseen World* website (5%)  
When asked what they did at the website, a few students shared general information about their online activities, such as “I looked around at the different articles and other movies,” “I looked at stuff,” and “had trouble with tech tag log in.”
- Heard something on the radio or while listening to music that made them think of the film (5%)  
When asked what they heard that reminded them of the film, a few students pointed to specific topics (“bugs,” “bacteria,” “x-rays,” and “waves”).
- Downloaded the *Mysteries of the Unseen World* app from iTunes (3%)  
When asked how they used the app, one student explained that s/he “explored it.”



## Discussion

The evaluation results indicate that the *Mysteries of the Unseen World* film was a successful informal science learning initiative with the students recruited for Study 2 of the summative evaluation, meeting the project's goals in each of the five impact areas detailed in the introduction of this report: 1) appeal and engagement, 2) clarity of presentation, 3) knowledge acquisition, 4) STEM interest and perceptions, and 5) motivational impact.

The findings in Study 2 show that *Mysteries of the Unseen World* appealed to and engaged the students who participated in the evaluation. Overall, they liked the film, found it visually exciting, indicated that it increased their curiosity, and thought they would recommend it to others their age. Additionally, the students generally found the film well-paced, fairly clear, and fairly easy to follow visually. As a group, they also indicated that the film struck the right balance in terms of the amount of information, amount of science, and level of scientific explanations provided. Furthermore, *Mysteries of the Unseen World* had a significant impact on students' knowledge of the content covered in the film, increased their interest in and awareness of the unseen world, and increased their interest in STEM careers and the film's STEM content. Finally, the majority of students who completed the follow-up questionnaire indicated that they thought about the film in the weeks after viewing, that they looked into topics from the film, and that they did one or more activities related to the film post-viewing.

Mann-Whitney tests found a few subgroup differences across the evaluation. First, with respect to gender, boys indicated that watching the film increased their curiosity significantly more than did girls, meanwhile, girls found the film's level of scientific explanations to be significantly more advanced than did boys. Second, with respect to grade level/location, the evaluation found that the 6<sup>th</sup> graders in California found the film's story about the family/friends significantly more engaging than did 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama and they also indicated they were significantly more likely to recommend the film. Meanwhile, the 7<sup>th</sup> and 8<sup>th</sup> graders in Alabama rated their learning about the properties and possibilities of the nanoworld significantly higher than did the 6<sup>th</sup> graders from California.

For each of these subgroup differences though, it is important to bear in mind that the effect sizes were small, and students' ratings were very positive across all subgroups. Therefore, taken together with the film's overall lack of other major subgroup differences, the findings indicate that *Mysteries of the Unseen World* was well received by and successful with both boys and girls, as well as with students from different middle school grades (6<sup>th</sup>-8<sup>th</sup>).

Although this evaluation wasn't designed to consider theater type, location, or screen format differences, as other giant screen studies have done<sup>28</sup>, *Mysteries of the Unseen World* showed in many different theater types (including IMAX, IMAX Dome, and 3D). Recognizing that the evaluation was not designed to specifically assess these differences, both of the Study 2 evaluation sites were giant screen dome theaters that were selected for reasons detailed in the introduction of this report. Although a couple of differences, with small effects, were found for the California 6<sup>th</sup> graders compared to the Alabama 7<sup>th</sup> and 8<sup>th</sup> graders, these differences could relate to any number of age, school, location, or other factors not explored in the evaluation. There were no other apparent differences in students' ratings of the film at the two locations.

Below, we briefly summarize aspects of the film that stood out for students in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions. Reflecting on the findings that stood out from this vantage point, we highlight 12 themes, each of which we briefly discuss

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<sup>28</sup> Heimlich, J. E., Sickler, J., Yocco, V., & Storksdieck, M. (2010). Influence of immersion on visitor learning: Maya skies research report. Edgewater, MD: Institute for Learning Innovation.

below with sample comments that capture the spirit of the theme:

- ***I liked the educational value/learned from the film:*** When asked what they liked most about *Mysteries of the Unseen World*, the largest group of students pointed to the film's educational value (as in, "*I liked all of the information and details given because I did not know most of it*" and "*I liked how it was very educational. It told us all the different topics there are*"). Additionally, students generally thought that they learned a considerable amount from the film and that they learned a lot about specific STEM topics, including: *the kinds of discoveries we can make about nature using new technologies and the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature*. They also thought they learned a fair amount about other STEM topics, including: *the kinds of light waves humans and other animals see, the kinds of technologies that help us see and study the invisible world (things we can't see with our own human eyes), and the properties and possibilities of the nanoworld*.

The evaluation of the film's impact on students' knowledge indicates that their perceptions of these personal knowledge gains were generally accurate. As detailed in this report, the evaluation found that students made significant gains from pre-viewing to post-viewing in learning from the film overall and on each of the following five topics: *Types of light waves that humans and other animals see, Technologies used to see and study things that humans can't see with normal vision, Discoveries scientists have been able to make about nature through new technologies, Things scientists can learn from nature to make innovative materials and devices, and Properties and possibilities of the nanoscale*.

Finally, some students noted that the film challenged and taught them while being well-explained/easy to understand. For example, "*I liked the fact that the information was advanced but I still knew what they meant,*" and "*It gave very descriptive details that could allow us to understand what it wanted us to know.*"

- ***I wanted even more information:*** Throughout the post-viewing and follow-up questionnaires, a number of students expressed an interest in learning more, either wishing the film had provided more information (as in, "*I wanted to see more things in each category*" and "*I wish it gave more examples*") or that the film had been longer (as in, "*It was too short. I wanted to learn more*").
- ***I like that the film showed me and enabled me to see the unseen world:*** Throughout their responses to the questionnaires, many students indicated that they liked that the film showed them the unseen world (as in, "*I liked the way it showed how other bugs see because well you don't get to see through your eyes like that every day*" and "*I liked how it showed rain drops falling and bouncing*"), with several noting that the ability to see things they "*don't get to experience...on a daily basis*" and may "*never see again*" was particularly appealing. Additionally, a number of students explained that seeing the unseen world gave them a new perspective on their surroundings (as in, "*Now I know what [the objects around us look] like and how they work*" and "*I will think about all that's going on around me that I can't actually see*").
- ***Since viewing the film, I will see (or have seen) the world differently:*** Nearly three-quarters of students reported immediately after viewing that they thought they would "see" the world differently as a result of viewing the film (72%). A few weeks later, a slightly smaller group indicated they *had* seen the world differently in the weeks since viewing (59%). In both cases their comments included examples like, "*I will see it differently because I know more than I use to know*" and "*I have seen the world differently because how I know how many things are going [on] around the world,*" as well as specific examples of things from the film that they would see and think about (or had seen and thought about) in a new way.

Immediately after viewing the film, one-tenth of students thought they would not “see” the world differently (10%), and about a fifth were unsure (18%), compared to the two-fifths of follow-up students who indicated that they had not “seen” the world differently in the weeks since viewing the film (40%). Students who thought they would not or did not “see” the world differently most often explained that this was because they were limited by human sight and experience (as in, “*because since I still physically see the same, I don’t think about it differently either*”) or that they hadn’t thought about the film in the weeks since viewing (as in, “*I forgot about the movie*”).

- **The film was well suited to the giant screen format:** Some students commented on the experience of watching the film on the giant screen. Most often, they felt the giant screen experience maximized and was central to their enjoyment of the film’s visuals, as in “*I liked how it made you have the feeling that you were there every step of the way*” and “*It felt like we were inside of the film.*”

Meanwhile some students raised negative experiences about their viewing the film on the giant screen, although no one issue stood out as a problem among the students as a whole. These issues, raised by a handful of students, included that the viewing experience made them “*dizzy*” or “*nauseous*” and that “*the sound was too loud.*” Meanwhile, one student felt the giant screen experience was bearable, noting that s/he enjoyed the film in spite of his or her physical discomfort (as in, “*The film was constantly moving, making my eyes hurt (loved it though),*” and a few commented on the setup and shape of the theater rather than the IMAX experience itself (as in, “*Projector was too close at Tech museum*” and “*I did not like the way the theatre was shaped. I know this is something you cannot change, I just got very dizzy and did not like it 100%*”).

- **I was particularly interested in the content of the Too Small section:** In comparison with the *Too Fast*, *Too Slow*, and *Invisible* sections of the film, students more often pointed to content from the *Too Small* section when asked questions about the film, including: what they liked most, what they found most interesting, if and how they thought they would “see” the world differently after viewing, what they thought about from the film in the weeks after watching, and what they talked about with others after viewing.

Though these findings indicate that students were particularly interested in the content of the *Too Small* section, further research would be needed to determine the extent to which this content stood out because the *Too Small* section was the final section of the film and/or because the *Too Small* section was the longest of the four sections (approximately 14 minutes long) and likely contained more visuals, information, and ideas that might “stick” with students.

- **I was interested in the technology featured in the film:** In both the post-viewing and follow-up questionnaires, students generally indicated that they were interested in the technology featured in the film, including x-rays, time-lapse and high-speed photography, microscopes, inventions imitating nature, and nanotechnology, among other innovations. Several also expressed excitement about technological advances that have yet to be made (as in, “*I liked how it told us all the things our future could have*” and “*more excited for technology*”). Additionally, when asked in the follow-up questionnaire if seeing *Mysteries of the Unseen World* changed how they think or feel about science or technology, the majority of students said Yes, with the largest subgroup explaining that the film changed how they think or feel specifically about technology, and nanotechnology in particular (as in, “*Now I know that things can be built extremely small, I’m thinking of possible things that are to come*” and “*I started thinking about the nanoworld and its possibilities*”). A handful of students also raised concerns about the ethics of nanotechnology and the relative benefits to humanity, as in, “*I didn’t like that people are inventing things with nanotechnology that*

*are just luxuries when there are kids starving in Africa. They should spend their money on that and not on an elevator to space!!!”*

Additionally, it should be noted that, although students were generally interested in learning about technology, the range of technology and the density of information presented in the film may have confused some students. For example, in the content assessment section, some students appeared to have been confused about the difference between a compound microscope and an electron microscope. After viewing the film, just over a fifth of students (22%) correctly answered *False* to the true/false statement *A compound microscope uses electrons to produce magnified images*. However, when given the opportunity to explain the differences between compound and electron microscopes in a later question, more than half of the post-viewing students were able to do so successfully (with 62% giving a full explanation in response to the question *When might a scientist use an electron microscope over a compound microscope?* and 55% being able to share an example).

- **The film increased my curiosity about and interest in science and technology:** Students generally agreed that the film increased their curiosity, with many pointing to an increased curiosity about science and technology topics in particular (as in, *“Well the film made me curious to know more about visibility and things like that”*). Additionally, the film generally increased students’ interest in *the properties and possibilities of the nanoworld*. It also slightly increased their interest in each of the following science and technology topics: *the kinds of light waves humans and other animals see, the kinds of discoveries we can make about nature using new technologies, the kinds of inventions (e.g., devices, materials) we can create by studying/imitating nature, and the kinds of technologies that help us see and study the invisible world (things we can’t see with our own human eyes)*.
- **After viewing the film, my interest in a job or career in science or technology somewhat increased:** Prior to viewing *Mysteries of the Unseen World*, students generally indicated that the film slightly increased their interest in a future job/career in science or technology. However, in the weeks after viewing, a number of students indicated that they thought about or looked into jobs or careers that use the science shown in the film. When asked what they thought about or looked into, students shared a range of responses about careers in science, engineering, computer design, and photography, among others areas of interest, as in, *“Thought about being a robot scientist”* and *“I thought about what cool jobs there are in the nanoworld.”*
- **I thought the film or an aspect of the film was “cool”:** Throughout their post-viewing and follow-up questionnaires, many students indicated that the film or something about it was “cool.” They frequently pointed to what the film showed them about unseen worlds (as in, *“Seeing how bees and mosquitoes see. It was cool”*), knowledge gained (as in, *“I thought it was really cool to know that droplets float”*), technological advancements (as in, *“I liked the part where they taught us about how they can move atoms and I thought that was cool!”*), and the very existence of the unseen world (as in, *“That some things are too small for the human brain to comprehend. It’s cool”*), among other topics deemed “cool” by the students.
- **I was somewhat engaged by the story about the family and their friends:** In general, students indicated that they found the film’s story about the family and their friends somewhat engaging. Some students explained that it was a *“nice idea”* and an *“interesting way”* of structuring the film, while others said they *“disliked”* or *“[didn’t] remember”* the storyline, and/or that they thought it was *“boring”* or *“[a distraction] from the real important stuff.”* At the same time, several students had mixed feelings about the storyline, as in, *“It did not relate, but kept the film moving.”* Given this diverse feedback, the use and value of fictional human characters in educational giant screen films may be an area for future research.

- ☛ ***I was confused by the trailer for Humpback Whales:*** Feedback from a handful of students indicated that they thought the trailer for *Humpback Whales* – which was shown before *Mysteries of the Unseen World* at one of the evaluation sites – was part of the main attraction. Though the reasons for this confusion are unknown, it may have to do with the language in the film’s trailer, which opens with, “*Hidden within our planet’s ocean is another world,*” and later continues with, “*Join us as we follow a brilliant team of scientists and rescuers on an adventure into this hidden world, where new discoveries will take your breath away.*” For students who were aware that they were seeing a film called *Mysteries of the Unseen World*, the trailer’s language about “*hidden worlds*” may have been somewhat confusing.

The above list of 12 themes are ones that we found to be most pertinent to the goals of the current evaluation, and with possible implications for future work produced by National Geographic and other groups focused on producing giant screen films funded by the NSF. As always, caution should be taken in drawing broad implications from any one evaluation. In this case, *Mysteries of the Unseen World* is a multi-faceted giant screen media project, which presented many alternative ways to evaluate the project’s success in meeting its informal science learning goals.

The findings from *Mysteries of the Unseen World* offer broader implications for other giant screen film projects aiming to informally educate students about science facts, concepts, or research. Although the evaluation was conducted at only two theater sites due to scheduling/availability and budget, the findings add further support to a conclusion reached in a review of 10 giant screen films funded by the NSF (Flagg, 2005):<sup>29</sup>

*Summative evaluations of 10 giant screen films indicate that the NSF’s grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers’ understanding of what scientists do; and positively impacts viewers’ actions after a museum visit.*

This evaluation assessed students’ scientific knowledge of the unseen world, their interest in and attitude toward the unseen world, their understanding of what scientists do, and the extent to which the students ultimately pursued actions in the weeks after viewing the film. In each of these areas, the film was found to be successful.

## Final remarks

Beyond confirming that the film met the project’s goals in each of the five impact areas, this evaluation also raises new issues for consideration around three aspects of the giant screen viewing experience that have received little evaluation attention to date: the use of a cross-promotional project kiosk, students’ access to and interest in online resources, and the impact of immersive visualization on students’ imaginations.

First, though students were not asked about their interest in or interaction with the *Mysteries of the Unseen World* kiosk at the two evaluation sites, both science centers hosted the kiosk, as did many other sites around the country. Future research might explore the use of similar kiosks across a variety of theater sites, considering the impact on students’ initial interest in a film and their post-viewing engagement with a film’s content, among other topics.

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<sup>29</sup> Flagg, B. (2005). Beyond entertainment: Educational impact of films and companion materials. *Big Frame*, 22(2), 50-56.

Second, though the majority of students ultimately made some connection to the film, thought about it further, or pursued a follow-up activity within a few weeks of viewing, relatively few noted that they followed up on *Mysteries of the Unseen World* online. A few students indicated that they looked for more information about the film on social media, a handful said they visited the film's website, and a couple explained that they downloaded the *Mysteries of the Unseen World* app from iTunes. Future work could assess students' access to and interest in using these materials and/or could consider how to maximize the visibility and use of a project's online resources, among other areas for research.

Finally, though it was not directly addressed in the questionnaires, a number of students indicated that seeing things that are too fast, too slow, too small, and invisible to the naked eye inspired them to imagine the unseen world around them (as in, "*I try to imagine how a mosquito would see me in different temperatures*" and "*I will imagine I am a bee*"). Further research might examine the extent to which the immersive qualities of the giant screen format impact the imaginations of students of various ages and backgrounds, as well as the influence of imagination on knowledge gains, among other subjects.

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- The eight classrooms of students and their respective teachers at the participating schools in San Jose, California and Alabaster, Alabama for viewing the film and participating in the two phases of the evaluation.



## **Evaluation of the national and local educator workshops and partner outreach activities**

**(Summative evaluation study 3 of 3)**

*Knight Williams Inc.*

Valerie Knight-Williams, Ed.D.

Divan Williams Jr., J.D.

Rachael Teel MEd

Gabriel Simmons

Sauleh Rahbari

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# Table of Contents

<b>Introduction</b>	<b>5</b>
<b>Evaluation goals</b>	<b>6</b>
<b>Report outline</b>	<b>8</b>
<b>Phase 1: Museum Educator National Workshop: Evaluation of educator feedback</b>	<b>9</b>
<b>Introduction</b>	9
<b>Method</b>	9
<b>Findings</b>	10
<b>Question 1: What was the value of the workshop?</b>	10
1.1 What were the most useful aspects of the workshop?	10
1.2 What were the least useful aspects of the workshop?	11
1.3 What were the relative values of the workshop sessions?	12
1.4 What were the main “take-aways” from the working groups?	14
1.5 Were the outreach goals for <i>Mysteries of the Unseen World</i> made clear?	15
1.6 Did the museum educators feel prepared to use the educational resources and outreach award?	16
<b>Question 2: What ideas and resources did museum educators gain from the workshop?</b>	17
2.1 What were the most valuable ideas gained from the workshop?	17
2.2 What were the most valuable resources gained from the workshop?	18
2.3 What workshop resources did museum educators think they were unlikely to recommend to others?	19
2.4 What ideas and resources did museum educators think they were most likely to use in events and activities?	20
2.5 What ideas and resources did museum educators think they were most likely to use in outreach to educators?	21
2.6 Did museum educators have suggestions regarding further support from National Geographic?	22
<b>Question 3: What did museum educators think of the workshop’s organization, length, and density of programming?</b>	23
3.1 How did museum educators find the workshop’s organization?	23
3.2 What did museum educators think about the workshop’s length and its use of their time?	24
3.3 What did museum educators think about the density of the workshop?	25
<b>Question 4: What did museum educators think about the <i>Mysteries of the Unseen World</i> film?</b>	27
4.1 How did museum educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, learning value for students, and likelihood of recommending the film?	27
4.2 What did museum educator think were the film’s most appealing aspects?	29
4.3 What did museum educators think were the film’s least appealing aspects?	30
4.4 How did museum educators rate the relative appeal of the film’s four acts?	31
4.5 How did museum educators rate the film’s success in conveying STEM-related education content?	32
<b>Question 5: What were museum educators’ final reflections and thoughts moving forward?</b>	33
5.1 What did museum educators think was missing from the workshop?	33
5.2 Were museum educators interested in additional resources from National Geographic Education?	35
	2

5.3 Were museum educators interested in additional resources from National Geographic Entertainment?	36
<b>Phase 2: Evaluation of educator feedback on the <i>Mysteries of the Unseen World</i> local workshops, film, and educational resources</b>	<b>37</b>
<b>Introduction</b>	37
<b>Method</b>	37
<b>Educator background information</b>	40
<b>Findings</b>	43
<b>Question 1: What feedback did Workshop attendees share about the local workshops?</b>	43
1.1 How did Workshop attendees learn about the local workshops and why did they attend?	43
1.2 How did Workshop attendees rate the local workshops?	47
1.3 Did the local workshops meet Workshop attendees' expectations, and did they think any topics were omitted or not covered well enough?	48
<b>Question 2: What feedback did educators share about the film and educational resources?</b>	50
2.1 How did educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, likelihood of engaging and educating students, and likelihood of recommending the film?	50
2.2 How did educators rate the value of the educational resources?	54
2.3 How did educators rate the workshop's coverage of the educational resources, their level of comfort in using the resources, and the potential impact on students?	58
<b>Question 3: How had educators used the resources and/or how did they intend to use them within 12 months?</b>	61
3.1 Which activities had educators done and/or did they plan to do within 12 months?	61
3.2 Which resources had educators used or did they plan to use within 12 months, how did they use or foresee using them, and how many students did they reach or think they would reach?	63
3.3 What challenges or obstacles did educators encounter or think they might encounter in implementing the resources?	69
3.4 Did educators expect to use the film and/or educational resources to encourage students' interest in STEM or STEM careers?	72
3.5 Did educators think their use of the film and/or educational resources had or would help facilitate outreach among underserved students?	76
<b>Question 4: What feedback did Film only attendees share about future workshops related to <i>Mysteries of the Unseen World</i>?</b>	79
4.1 Why didn't Film only attendees participate in local workshops in their areas?	79
4.2 How did Film only attendees rate aspects of the opportunity to attend a local workshop?	81
4.3 How likely were Film only attendees to participate in a future <i>Mysteries of the Unseen World</i> workshop, what would they hope to gain from the experience, and what topics would they want to have covered?	83
4.4 In the future, would Film only attendees prefer to participate in a local workshop or a webinar?	86
4.5 Without having attended a local workshop or webinar, how did Film only attendees think they would determine which resources to use?	88
<b>Phase 3: Museum educator post report findings</b>	<b>90</b>
<b>Introduction</b>	90
<b>Method</b>	90

<b>Findings</b>	<b>91</b>
<b>Question 1: What was the overall reach of <i>Mysteries of the Unseen World</i>, as facilitated by partner organizations?</b>	<b>91</b>
<b>Question 2: What was the reach of the <i>Mysteries of the Unseen World</i> field trips to partner organizations?</b>	<b>93</b>
<b>Question 3: How did the partner organizations reach out to underserved communities?</b>	<b>94</b>
3.1 How did partner organizations use the Underserved Community Outreach funding to support underserved students?	94
3.2 How many educators and students were reached through the Underserved Community Outreach funding?	96
3.3 How many students saw the film with assistance from the Underserved Community Outreach funding?	96
3.4 Did partners have additional feedback about the value of the Underserved Community Outreach funding?	97
<b>Question 4: How many local workshops were coordinated by the partners, and how many educators attended?</b>	<b>98</b>
<b>Question 5: What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached?</b>	<b>100</b>
<b>Question 6: What feedback did partners share about the value, distribution, and use the <i>Mysteries of the Unseen World</i> media and materials?</b>	<b>103</b>
6.1 How were the DVD, Museum Educator Guide, poster, and “fun facts” handout valued by the partners, distributed, and used?	103
6.2 How did partners use and value the lobby kiosk?	107
6.3 How did partners rate the value of the other <i>Mysteries of the Unseen World</i> media and materials?	109
<b>Question 7: How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring?</b>	<b>111</b>
7.1 Did partners use the activities?	111
7.2 Which activities did the partners use, how many educators and students were reached, and what value did the activities bring?	112
<b>Question 8: What feedback did partners have about the outreach award requirements and the project overall?</b>	<b>114</b>
8.1 How reasonable did partners find the outreach award requirements?	114
8.2 How did partners rate the ease of accomplishing the outreach award deliverables?	116
8.3 Did the partners think they would be likely to participate in the award program again?	118
8.4 Did the partners have suggestions for future programs?	119
8.5 Did the partners have additional feedback to share about the project?	120
<b>Summary of findings</b>	<b>121</b>
<b>Discussion</b>	<b>137</b>
<b>Appendix 1: <i>Mysteries of the Unseen World</i> Museum Educator National Workshop Agenda</b>	<b>147</b>
<b>Appendix 2: <i>Mysteries of the Unseen World</i> outreach award fact sheet</b>	<b>150</b>

# Introduction

*Mysteries of the Unseen World* is a National Geographic project centered on a giant screen film that highlights the sciences used to illuminate the amazing worlds around us, invisible to the naked eye.<sup>1</sup> As described on the National Geographic project website:

*Mysteries of the Unseen World* reveals phenomena that can't be seen with the naked eye, taking audiences into earthly worlds secreted away in different dimensions of time and scale.

Experience events that unfold too slowly for human perception; "see" the beauty, drama, and even humor of phenomena that occur in the flash of a microsecond; enter a microscopic world once reserved for scientists, but now made accessible to the rest of us; and begin to understand that what we actually see is only a fraction of what there is to see on Earth.

High-speed and time-lapse photography, electron microscopy, and nanotechnology are just a few of the advancements in science that allow us to see a universe of things, events, creatures, and processes we never even knew existed. These technologies give us new "superpowers" to see beyond what's in front of us.

Visually stunning and rooted in cutting-edge research, *Mysteries of the Unseen World* will leave audiences in thrall as they begin to understand the enormity of the world they can't see—a world that exists in the air they breathe, on their bodies, and in all of the events that occur around them minute by minute and nanosecond by nanosecond. And with this understanding comes a new appreciation of the wonder and possibilities of science.

<http://movies.nationalgeographic.com/movies/mysteries-of-the-unseen-world/about-the-film/>

In 2009 National Geographic was awarded a grant from the National Science Foundation (NSF) which provided funding for the film, related educational programming and outreach, and independent formative and summative evaluation. Beginning in 2013 the film debuted in science center theaters within and beyond the U.S., with some of these theaters also booking a hands-on kiosk developed by National Geographic for use in theater lobbies or surrounding museum spaces to help extend viewers' interest in and learning from the film. The project further included an outreach program involving educators from 17 partner museums who were invited to attend the Museum Educator National Workshop and participate in an awardee program designed to promote the film, related events, and education resources among local and underserved audiences. These educational resources included: a Museum Educator Guide, videos and classroom activities accessible from the project website, an iPad app, and a customized package of materials for use in the Engineer in the Classroom program.

As part of the NSF funding for the project, the independent evaluation firm, Knight Williams Inc. conducted the project's summative evaluation in the form of four separate studies. The first study focused on the immediate and longer-term impact of the film on a general audience that viewed the film in a local science center theater context on their own accord. The second study focused on the immediate and longer-term impact of the film on middle school students who viewed the film at their local science center as part of a school field trip. The third study, the subject of this report, examined the implementation, effectiveness, and longer-term impact of the Museum Educator National Workshop, focusing on the educators who participated in the workshop and those they respectively trained in their local settings, as well as educators who didn't attend the training but saw the film and potentially used or planned to use the educational resources. The fourth study explored the use and effectiveness of a set of educational materials implemented within the context of the Engineers in the

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<sup>1</sup> Text in this Introduction in italics, other than titles, is borrowed from the project description section of the NSF proposal.

Classroom middle school program, as experienced by the engineers that implemented them and the students and teachers that participated in their sessions.

## Evaluation goals

The *Mysteries of the Unseen World* giant screen film project marked the first time that National Geographic implemented a program in which select partner organizations were offered a \$2,600 outreach award along with an all-expense trip to DC for the 2-day Museum Educator National Workshop, in exchange for a certain level of commitment from the partners. National Geographic required award recipients to:

- Share their outreach plan with National Geographic
- Utilize \$1,000 of the grant to enable underserved students to see the film
- Disseminate and promote the film's outreach materials to their educator network
- Reach educators via local workshops (either dedicated workshops around this film's content or integrating this film's content into existing educator workshops)
- Execute two types of educator surveys, one for local workshop attendees and one for non-workshop attendees in their educator network
- Complete the follow-up questionnaire, the "post report"

The Study 3 summative evaluation captured the experiences of the museum staff that initially attended the Museum Educator National Workshop hosted by National Geographic and then returned to their institutions to promote the film, conduct outreach with public and student audiences, and train teachers to use the materials with their own students. This study further captured the value of these local educator workshops, measuring impact on the teachers that attended. Finally, the evaluation process gathered feedback from educators who did not attend the local educator workshops but who saw the *Mysteries of the Unseen World* film and used or potentially used the educational resources.

To assess these efforts, the evaluation was conducted in 3 phases, as follows:

### **Phase 1: Museum Educator National Workshop: Evaluation of educator feedback**

On October 24 and 25, 2013, National Geographic hosted a Museum Educator National Workshop to introduce the educational materials and film outreach strategies to 20 museum educators. In the Phase 1 evaluation, Knight Williams assessed the appeal and effectiveness of this workshop as perceived by the educators who attended. All workshop participants were asked to complete a questionnaire about their experience during the workshop, focusing on: the appeal and comprehensibility of the film and the subject matter covered; the usefulness of the presentation and materials to their educational needs and to meeting science curriculum standards; the anticipated gains and challenges of implementing the featured activities; and the motivational impact from attending the workshop.

### **Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources**

Following the Museum Educator National Workshop, the partner organizations were expected to implement a number of activities upon the film's premiere at their respective institutions. Those who "activated" the *Mysteries of the Unseen World* outreach awards in this capacity received funds in order to promote the film, conduct outreach, and train local teachers on use of the film's companion materials. As a condition of the award program, each partner organization was responsible for recruiting educators to attend their local

workshop. Additionally, each museum distributed an online survey to their network of educators that saw the film but did not attend a local workshop in order to assess their perceptions of the film and use of companion materials. The Phase 2 evaluation considers feedback from both groups of educators about the local workshops, the film, and the educational resources.

### **Phase 3: Museum educator post report findings**

As part of the awardee reporting requirement, staff at the 11 *Mysteries of the Unseen World* partner organizations that activated the outreach award completed a follow-up post report about their: experience participating in the grantee program, use of the *Mysteries of the Unseen World* materials, satisfaction with the materials (challenges and highlights), and perception of the effectiveness of the film and activities in meeting the project's learning objectives. In addition, as the partner organizations received funds to help with their outreach promotion and efforts to draw local and underserved audiences to see the film, the evaluation also considers whether and how the participating sites: disseminated and promoted *Mysteries of the Unseen World* education materials to educators; hosted local educator workshops or integrated *Mysteries of the Unseen World* materials into existing educator workshops; drew underserved audiences to see the film and engage in outreach; used the kiosk to engage visitors and the factors that influenced their decision to order or not order the kiosk; and used the educational materials to engage visitors and students.

# Report outline

The Study 3 findings are presented in 3 phases. Phase 1 contains 5 questions, Phase 2 contains 4 questions, and Phase 3 contains 8 questions, as follows:

## **Phase 1: Museum Educator National Workshop: Evaluation of educator feedback**

Question 1: What was the value of the workshop?

Question 2: What ideas and resources did museum educators gain from the workshop?

Question 3: What did museum educators think of the workshop's organization, length, and density of programming?

Question 4: What did museum educators think about the *Mysteries of the Unseen World* film?

Question 5: What were museum educators' final reflections and thoughts moving forward?

## **Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources**

Question 1: What feedback did Workshop attendees share about the local workshops?

Question 2: What feedback did educators share about the film and educational resources?

Question 3: How had educators used the resources and/or how did they intend to use them within 12 months?

Question 4: What feedback did Film only attendees share about future workshops related to *Mysteries of the Unseen World*?

## **Phase 3: Museum educator post report findings**

Question 1: What was the overall reach of *Mysteries of the Unseen World*, as facilitated by partner organizations?

Question 2: What was the reach of the *Mysteries of the Unseen World* field trips to partner organizations?

Question 3: How did the partner organizations reach out to underserved communities?

Question 4: How many local workshops were coordinated by the partners, and how many educators attended?

Question 5: What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached?

Question 6: What feedback did partners share about the value, distribution, and use the *Mysteries of the Unseen World* media and materials?

Question 7: How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring?

Question 8: What feedback did partners have about the outreach award requirements and the project overall?

# Phase 1: Museum Educator National Workshop: Evaluation of educator feedback

## Introduction

Phase 1 presents the findings from an evaluation of the 20 museum educators who attended National Geographic's *Mysteries of the Unseen World* Museum Educator National Workshop at the National Geographic Society (NGS) headquarters in Washington, DC on October 24 and 25, 2013.

## Method

The museum educators provided feedback through a written survey administered at the end of the 2-day workshop. The survey was developed collaboratively by National Geographic Education and Knight Williams Inc. The survey was then administered by National Geographic to the museum educators at the end of the workshop, after which the surveys were sent to Knight Williams for analysis and reporting. Basic descriptive statistics were performed on the quantitative data generated from the survey questions. Content analyses were performed on the qualitative data generated in the open-ended questions.<sup>2</sup> The analysis was both deductive, drawing on the workshop's objectives, and inductive, by looking for overall themes, keywords, and key phrases. All analyses were conducted by two independent coders. Any differences that emerged in coding were resolved with the assistance of a third coder.

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<sup>2</sup> The museum educators frequently provided multiple answers to the open-ended questions, often resulting in response categories that added up to more than 100% for these questions.



# Findings

## Question 1: What was the value of the workshop?

The 20 museum educators were invited to complete a set of written questions about the value of the workshop and its individual sessions, their main “take-aways” from the working groups, the clarity of the goals of the educational outreach program, and how well they felt the workshop prepared them to use the educational resources and outreach award.<sup>3</sup> These findings are presented below in 1.1 through 1.6.

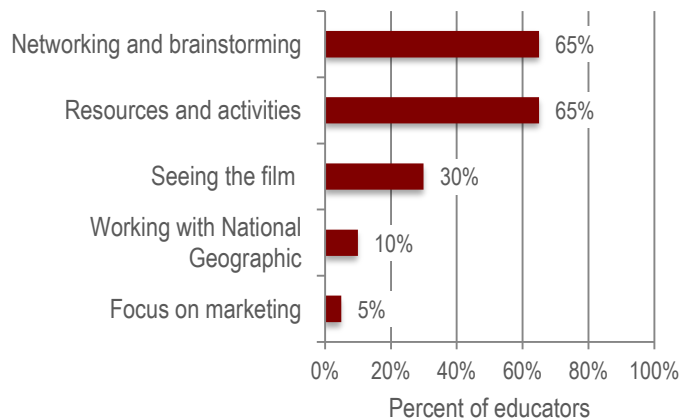
### 1.1 What were the most useful aspects of the workshop?

When asked to identify the most useful aspects of the workshop, the museum educators most frequently pointed to the opportunity to network and brainstorm, the resources and activities, and the opportunity to see the film, among other responses.

As shown in the chart to the right, when asked to describe what they found to be most useful about the workshop, nearly two-thirds of the museum educators felt that the opportunity to *network* and *brainstorm* was the most useful part (65%), as in:

- *Brainstorming and networking with others who work in informal education.*
- *Getting to brainstorm with all these wonderful minds! Both from National Geographic and from museums and teachers from across the country. I loved to hear how programs work and how others have been problem solving.*
- *The motivation factor. Everything from seeing the film, sharing ideas, and most importantly being around other museum educators who share their motivation to create impact.*

What museum educators found most useful about the workshop (N=20)



Another two-thirds indicated that they found the resources and activities to be the most useful part (65%). Though most responses in this category were fairly general, two museum educators specifically mentioned the nanoscience activity, one mentioned the engineering activity, and one mentioned the Too Slow activity, as in:

- *Going over the educational materials online; expanding with hands-on activities.*
- *Demonstrating activities that can be done with museum guests that will further explain concepts. Making the connection between movie and "real life" examples.*

<sup>3</sup> Please see Appendix 1 for the workshop agenda.

- *The introduction to new networks of resources I can bring back to my museum to implement in current programming, especially nanoscience.*
- *Also I loved when we did the "Too Slow" hands-on. Working with the "stop and go" app was great!*

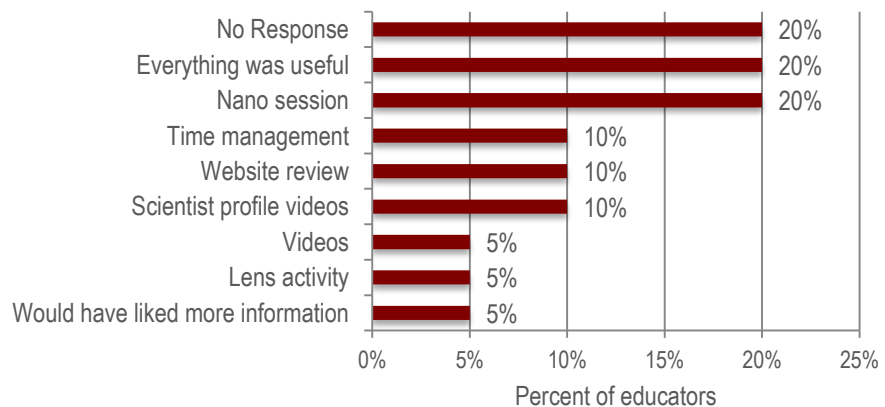
Just under a third of museum educators felt that *seeing the film* was the most useful part of the workshop but didn't elaborate (30%). Finally, two museum educators pointed to the opportunity to work specifically with National Geographic (10%) (as in, *"interacting with National Geographic crew, so amazing"*), and one commented on the value of the workshop's focus on marketing (5%) (as in, *"talk about marketing was useful, but since our marketing department is so separate from education it's difficult for me personally to apply it"*).

## 1.2 What were the least useful aspects of the workshop?

When asked what they found least useful about the workshop, the largest groups of museum educators indicated that all aspects were useful or left the question blank. Other groups pointed to the difficulty of incorporating information from the nanotechnology session into educational programming, time management, the website review, and the scientist profile videos, among other comments.

When asked to describe what they found *least* useful about the workshop, no one aspect stood out for the majority of the museum educators. As shown in the chart to the right, one-fifth of museum educators indicated that they found every part useful (20%) (as in, *"I found everything to be useful in this workshop"* and *"no bad parts"*), while another fifth left the question blank (20%).

What museum educators found least useful about the workshop (N=20)



One-fifth felt that the information presented in Engaging Children with the Nano World (with Alyssa Calabro, research teacher of Electron Microscopy) might be difficult to incorporate into educational programming (20%) (as in, *"Alyssa's segment was interesting, but I don't understand how it really applies to museums and schools that can't possibly afford the equipment"* and *"Though I loved to learn about the [National Geographic] classroom with high tech nanoscopies it is something that I could not actually use"*).

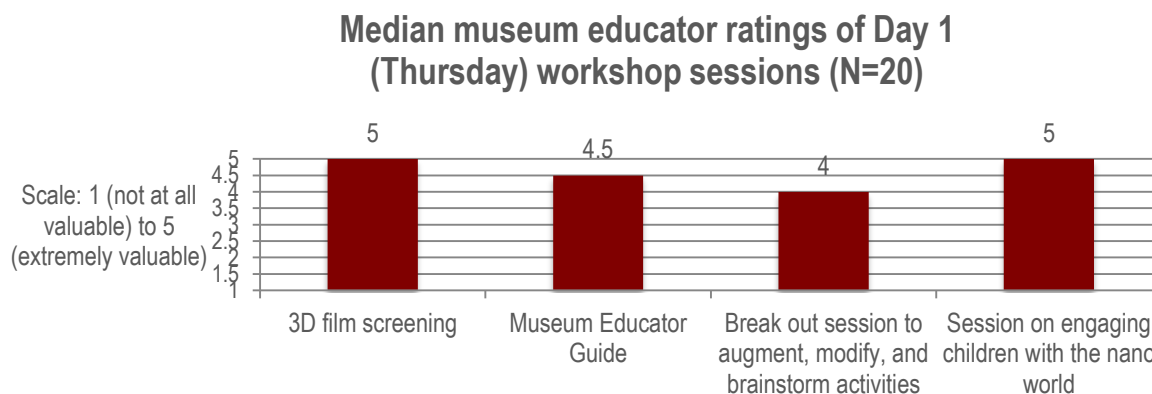
A tenth of museum educators mentioned that time management over the course of the workshop could have been improved (10%) (as in, *"Some convo sessions went on too long"* and *"Time that was set aside for the activities. We were not managed well at all therefore really didn't want to 'get into it.' The time could have been used for something else or our feet could have been held to the fire"*). Another tenth each mentioned *"the website review"* (10%) and the *"scientist profile videos"* (10%), but did not provide details on either topic.

One museum educator pointed to the workshop videos as the least useful activity (5%) (as in, “*watching the videos, however I believe they will be useful to teachers and understand why we watched them*”) and another mentioned one of the hands-on activities (5%) (as in, “*the lens activity with the candle and the water. It was hard to do with adults – I can’t see this working in the classroom*”). Finally, one museum educator – who provided multiple answers – felt that s/he would have benefited from more information overall (5%), as in, “*Some of the lectures/speeches...I would have liked to see examples of lessons and activities that we could use. The Dinner speech could have been more relevant to the overall topic.*”

### 1.3 What were the relative values of the workshop sessions?

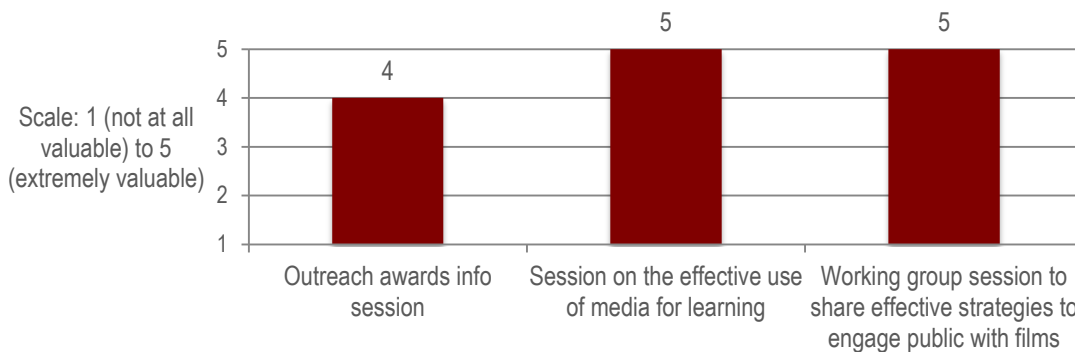
The museum educators found all of the workshop sessions to be valuable, although they tended to rate some sessions higher than others. On the first day of the workshop, the 3D screening of *Mysteries of the Unseen World* and the session on engaging children with the nano world were the most highly rated, with the session focused on the Museum Educator Guide and the session to augment, modify, and brainstorm activities receiving slightly lower median ratings. On the second day of the workshop, the session on the effective use of media for learning and the working group to share effective strategies to engage the public with films were the most highly rated, with the outreach awards info session receiving a slightly lower median rating.

The museum educators found all of the workshop sessions to be valuable, although they tended to rate some sessions higher than others. As shown in the chart below, on the first workshop day, the 3D screening of *Mysteries of the Unseen World* and the session on engaging children with the nano world were the most highly rated sessions, each receiving a median rating of 5.0 (extremely valuable) on a scale of 1.0 (not at all valuable) to 5.0 (extremely valuable). The break out session to augment, modify, and brainstorm activities had the lowest median rating, 4.0 (very valuable), and the session focused on the Museum Educator Guide fell in the middle, with a median rating of 4.5.



As shown in the chart below, on the second workshop day, the session on the effective use of media for learning and the working group to share effective strategies to engage the public with films were the most highly rated, each receiving a median rating of 5.0 (extremely valuable). The outreach awards info session received the lowest median rating of the day's sessions, 4.0 (very valuable).

### Median museum educator ratings of Day 2 (Friday) workshop sessions (N=20)



Though most of the museum educators declined to elaborate on their session ratings (70%), nearly a third provided additional feedback (30%). Their comments included:

- *Love the flexibility and openness to new ideas and suggestions. LOVE, LOVE, LOVE.*
- *Most of the nano activities we do already – but it was still fun!*
- *I think I will use the media leaving when I got back. Also share that with teachers. Also any time we can do group thoughts were valuable.*
- *The outreach awards are hard because of programs and events already booked. I wish there was more time before the showing of the movie.*
- *Would have liked more resources for how to teach about light and waves in a concrete, hands-on way. More educator resources on web on light, waves.*
- *For the section engaging children, I would have liked to see more lesson plans and examples.*

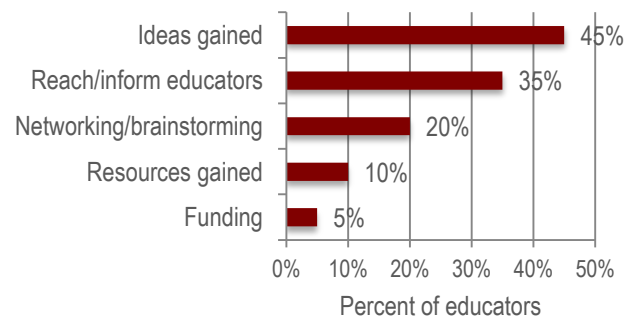
## 1.4 What were the main “take-aways” from the working groups?

When asked to describe the main “take-aways,” the largest groups of museum educators pointed to ideas they gained for developing local programs and activities, the opportunity to learn about how to use the *Mysteries of the Unseen World* materials to reach out to and inform educators, and the opportunity to network with, brainstorm with, and gain inspiration from their peers, among other responses.

The museum educators indicated they gained valuable ideas and outreach strategies from their workshop working groups. As shown in the chart to the right, when asked to describe the main “take-aways,” the largest group of museum educators pointed to the wealth of ideas they gained for developing programs and activities (45%), as in:

- *New ideas for outreaches, camps.*
- *Ideas for cart activities.*
- *Learning different methods to engage children.*
- *New teaching skills, for example, draw what you think a raindrop looks like.*
- *Ideas for new programs and improving existing programs.*
- *The discovery of overlap between NISE Net and this film and leveraging past success to inform new programs.*

Main museum educator “take-aways” from the working groups (N=20)



More than a third cited the opportunity to learn about how to use the *Mysteries of the Unseen World* materials to reach out to and inform educators (35%), as in:

- *Strategies for marketing to teachers.*
- *Need for multi-faceted approach to reaching educators.*
- *Ways to get teachers involved/get them to museum.*
- *Ideas to market to teachers and develop relationship with districts and educator groups.*
- *How to use educator resources to develop a great leaders workshop.*
- *We are excited about the film based on everything. We learned we should have an easy sell on our hands.*

A fifth of museum educators indicated that they found the opportunity to network with, brainstorm with, and gain inspiration from their peers to be one of the main “take-aways” of their working groups (20%), as in:

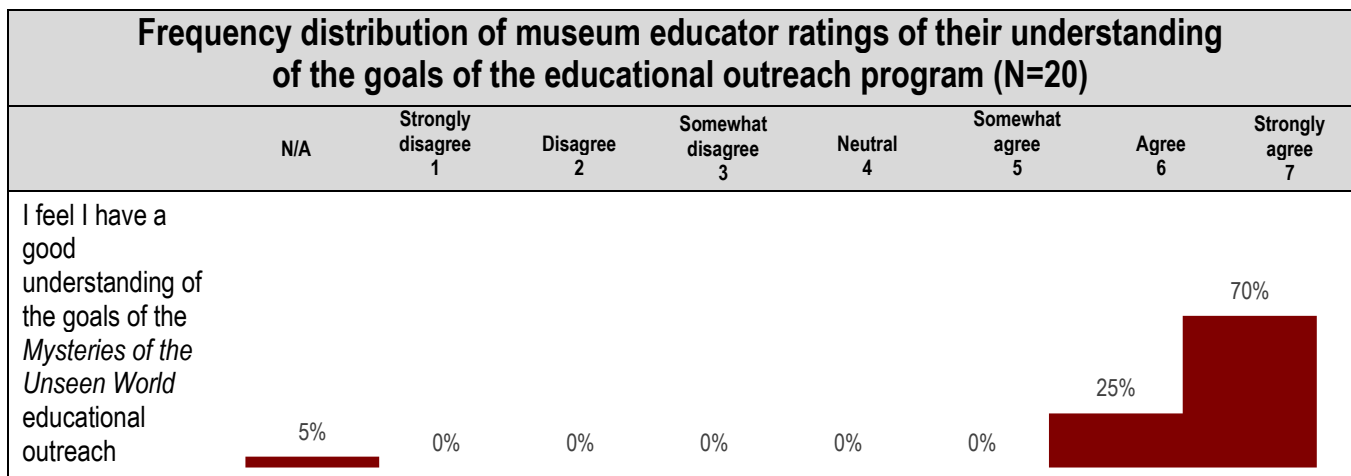
- *Making connections with other museum professionals.*
- *Finding out what works and doesn't work with different institutions.*
- *Honestly, what I got out of it was the jump start to my brainstorming process – being surrounded by creative people helps me to crystallize my own ideas.*
- *Inspiration/motivation. It's always important to rejuvenate and get excited about what we do. Workshops like this get me excited to implement new programs and reach a larger audience.*

Finally, a tenth pointed to the value of resources gained (10%) (as in, “materials” and “availability of materials/resources”), and one commented on the value of the “outreach award funding” (5%).

## 1.5 Were the outreach goals for *Mysteries of the Unseen World* made clear?

After the workshop, the museum educators generally felt that they had a *good understanding of the goals of the Mysteries of the Unseen World educational outreach program.*

On a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), the museum educators were asked to rate how strongly they agreed or disagreed with the following statement: *I feel I have a good understanding of the goals of the Mysteries of the Unseen World educational outreach program.* Though there were some differences of opinion, as evidenced by the range of ratings in the table below, in general the museum educators strongly agreed (median rating 7.0) that they *have a good understanding of the goals of the Mysteries of the Unseen World educational outreach program.*

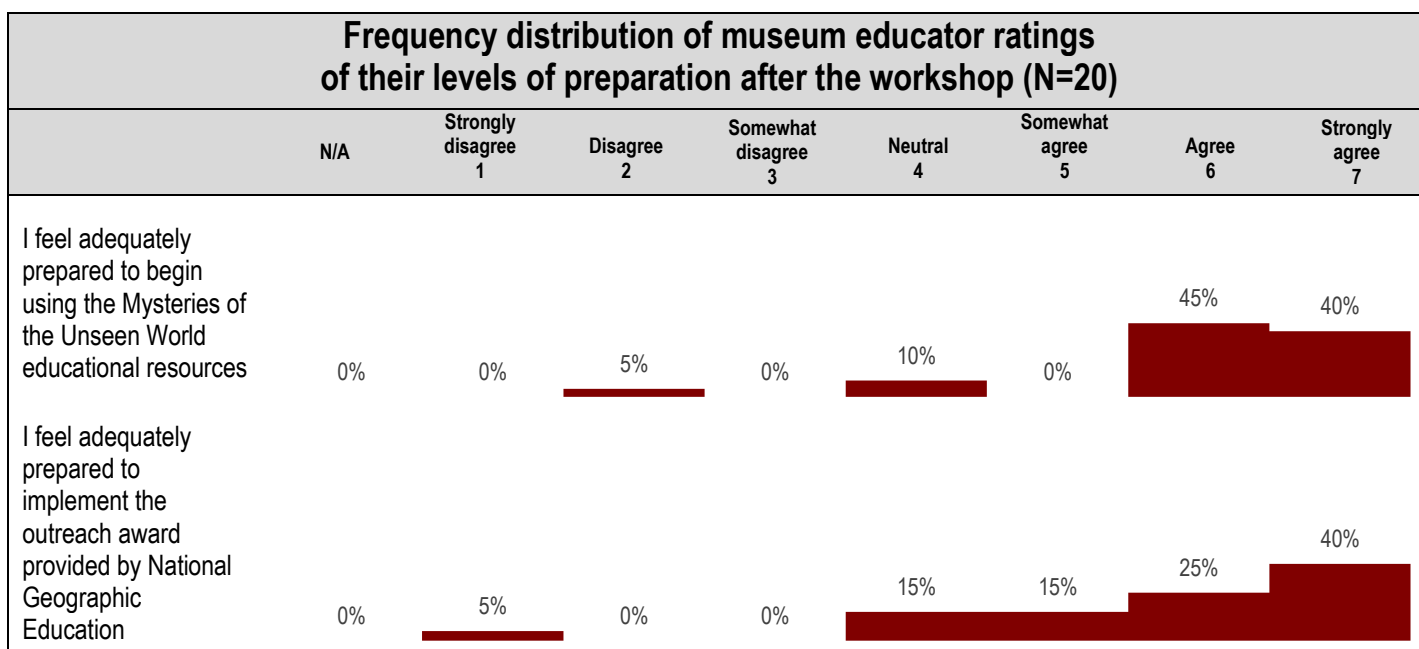


When given the opportunity to provide additional feedback, one museum educator elaborated on his or her enthusiasm (5%) (as in, *“I really enjoyed myself and I am excited to implement MOTUW activities”*) and another commented on his or her concerns (5%) (as in, *“I think I would like to inform myself more to strongly agree that I can teach this program”*).

## 1.6 Did the museum educators feel prepared to use the educational resources and outreach award?

By the end of the workshop the museum educators indicated they generally felt *adequately prepared* to use the educational resources and implement the outreach award. When given the opportunity to provide additional feedback, those who responded to the question pointed to internal institutional challenges, rather than a lack of preparation or effectiveness by the workshop's organizers.

On a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), the museum educators were asked to rate how strongly they agreed or disagreed with the following statements: *I feel adequately prepared to begin using the Mysteries of the Unseen World educational resources* and *I feel adequately prepared to implement the outreach award provided by National Geographic Education*. The table below presents the percentages of museum educators selecting each rating.



Though there were some differences of opinion, as evidenced by each range of ratings, museum educators generally agreed (median rating 6.0 each) that they felt *adequately prepared to begin using the Mysteries of the Unseen World educational resources* and *adequately prepared to implement the outreach award provided by National Geographic Education*. When given the opportunity to provide additional feedback, those who responded to the question pointed to internal institutional challenges, rather than a lack of preparation or effectiveness by the workshop's organizers. For example:

- *Workshop did a great job giving resources and information; the problem lies with my institution. Since we don't already do teacher workshops, this is going to be a great deal of work to implement.*
- *I do not make the final decision about the outreach award, so that is why I gave it a "5." I will be presenting a report to my director and sharing my ideas. She will be utilizing this information to make her decisions.*
- *I need to bring this back to my museum in order to implement any of it. I am not the one that can make the call on using the info.*

## Question 2: What ideas and resources did museum educators gain from the workshop?

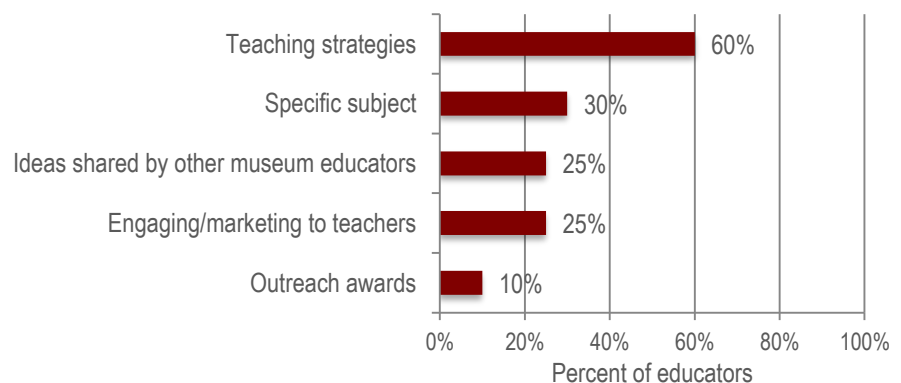
The 20 museum educators were invited to complete a set of written questions about the ideas and resources gained – their value (or lack thereof), how they intend to use them, and suggestions for how National Geographic might further support their implementation. These findings are presented below in 2.1 through 2.6.

### 2.1 What were the most valuable ideas gained from the workshop?

The museum educators indicated they gained valuable ideas from the workshop, including teaching strategies shared, specific subjects from the film, ideas gained from other museum educators, and ideas about engaging with and marketing to teachers, among other topics.

The museum educators indicated they gained valuable ideas from the workshop. As shown in the chart to the right, the largest group indicated that the teaching strategies shared throughout the workshop were especially valuable (60%), including ways to incorporate media and hands-on activities, the use of local experts, ways to reframe topics for various groups, and/or ways to reach out to at risk communities, as in:

The most valuable ideas museum educators gained from the workshop (N=20)



- *Best ways to use videos and technology while teaching science concepts from the movie.*
- *Activities to implement in our museum.*
- *I loved the integration of "experts" into the classroom.*
- *Different ways to frame topics we might already cover, but in new and more exciting ways.*
- *How to teach students in different ways. Possibility of outreach for at risk communities.*

Just under a third of museum educators pointed to the value of a specific subject covered during the workshop and/or film (30%), such as nanotechnology or the electromagnetic spectrum. For example:

- *Understanding nanotech!*
- *Nano in action presentation by Lockheed [Martin].*
- *Learning new ways to present ideas about electromagnetic spectrum.*
- *The film and its connection between "seeing" things that are too small, fast, and slow.*



One quarter indicated that the ideas shared by other museum educators were among the most valuable ideas gained (25%), and some felt that additional time to learn about others' programs and reflect on a personal level would have been even more helpful. For example:

- *Brainstorming/sharing ideas with fellow educators.*
- *Strategies from other educators for engaging teachers.*
- *Best pictures from other museums. It would have been nice to have more time to hear about and understand all the educators' programs and plans for outreach award and teacher workshops.*
- *My own for my institution based on shared ideas from all! Brainstorms were good to get info out verbally but most helpful to me to stew over for implement them back home.*

Another quarter pointed to the value of the ideas shared about engaging with and marketing to teachers (25%), as in:

- *Strategies from other educators for engaging teachers.*
- *Talking about how to get teachers invested.*
- *How to market in my area based on what is offered with the materials.*

Finally, a tenth of museum educators pointed to the value of the outreach awards (10%), though no details were given.

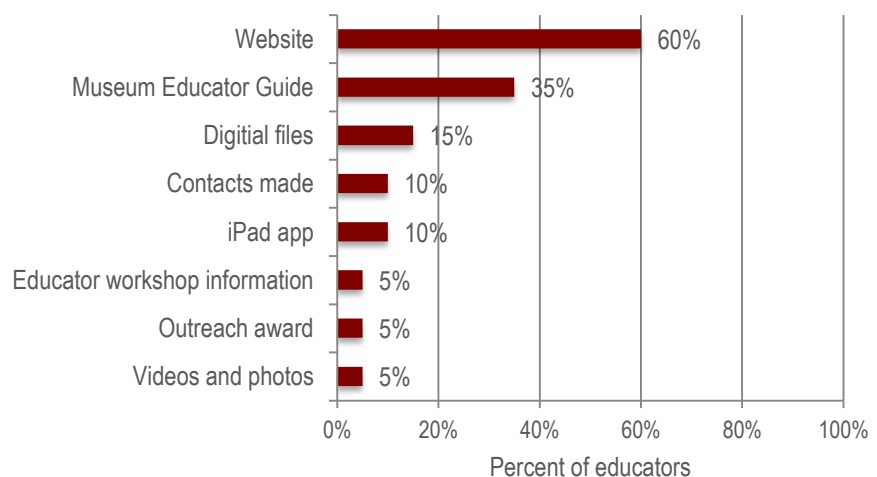
## 2.2 What were the most valuable resources gained from the workshop?

The museum educators found National Geographic's online resources, the Museum Educator Guide, and the CD of back issues of *National Geographic* magazine to be among the most valuable resources gained from the workshop.

As shown in the chart to the right, when asked to identify the most valuable resources gained from the workshop nearly two-thirds of the museum educators pointed to the website (60%), as in:

- *The use of the National Geographic website and all the materials that even went beyond mysteries. Outreach award.*
- *The website, which I had never used as a resource.*
- *Walking through the National Geographic website with us so we are more familiar with it.*

The most valuable resources educators gained from the workshop (N=20)



Just over one-third pointed to the value of the Museum Educator Guide (35%), as in:

- *Seeing the Ed materials to plan what will work best in my area.*
- *Museum Educator Guide.*
- *The materials we will pass on to educators and the educator's guide.*

About a sixth of museum educators commented on the value of a CD provided by National Geographic – containing old issues of the magazine – and other digital files (15%), as in:

- *CDs/materials for teachers.*
- *Complete CDs of National Geographic magazines.*
- *Digital files.*

A tenth of museum educators indicated that they greatly valued the contacts made (10%) (as in, “*Contacts with people who have great ideas. Rarely have the opportunities to network. It's important*”). Additionally, another tenth pointed to the value of the *Mysteries of the Unseen World* app (10%) (as in, “*iPad apps*” and “*Mysteries app*”), which was released in August 2013 and is available for free through iTunes, a screenshot of which is shown in the image to the right.

Finally, one museum educator each indicated that s/he found information about organizing a “*teacher workshop*” (5%), the “*outreach award*” (5%), and the “*video clips and photos*” (5%) to be among the most valuable resources gained from the workshop.



Screenshot from the *Mysteries of the Unseen World* iPad app

## 2.3 What workshop resources did museum educators think they were unlikely to recommend to others?

The majority of museum educators said there weren't any educational resources they would not recommend to others, and remaining museum educators left the question blank.

When asked if there were any workshop resources that they would not recommend to others, the majority of museum educators said *No* (60%). For example:

- *No, I think every educator can pick up what they can use for their class/student. What works for them.*
- *The resources were all appropriate.*
- *No everything was useful in some form.*
- *No – the more informed educators are on a topic, the more likely they are to use it in the classroom.*
- *No, it would just be nice if there were more ideas to adjust the activities for different age groups.*

The remaining museum educators left the question blank (40%).

## 2.4 What ideas and resources did museum educators think they were most likely to use in events and activities?

When asked to identify the ideas and resources from *Mysteries of the Unseen World* that they were most likely to use in the future, the museum educators pointed to a variety of activities, media, and materials, including camp and/or field trip-related activities, the table and cart activities, and general activities shared throughout the workshop, among others.

When asked to identify the ideas and resources from *Mysteries of the Unseen World* that they were likely to use in the future, the museum educators pointed to a variety of activities, media, and materials. As shown in the chart to the right, the largest group, one-quarter, pointed to the camp and/or field trip-related activities (25%), as in:

- *Field trip/camp activities – it is a major component of my department.*
- *The optics demos to be used in our upcoming camp-in program.*
- *Camp themes.*

Museum educators also pointed to the table and cart activities, with one-fifth saying they plan to use them at their sites (20%). For example:

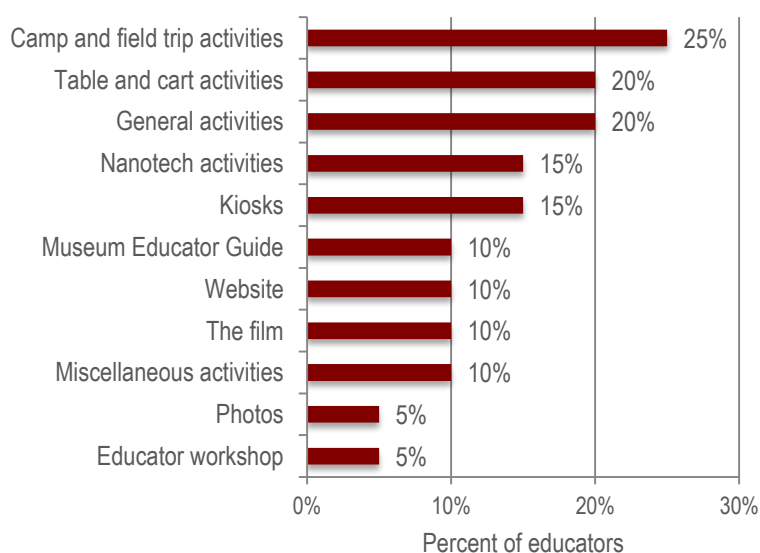
- *Tables with iPad app.*
- *Table/cart activities.*
- *The table top activities to be implemented in our existing nanoscience cart.*

Another fifth of museum educators noted that they are likely to use some of the general activities discussed at the workshop (20%), as in:

- *The shorter activities for families.*
- *Integrate activities into Monday night family activities.*
- *Hands on activities.*

Nearly one-sixth each specifically pointed to the nanotechnology activities (15%) (as in, “*Improving our nano activities*” and “*Expanding nano-days to roll into public weekend programming. We’re looking to do something like this but have not had the means!*”) or the kiosk and its components (15%) (as in, “*kiosk activities if can be used as components (not attached to kiosk)*” and “*the ‘kiosk’ kit would be a great way to integrate it into the public domain*”). A tenth each indicated that they would likely use the Museum Educator Guide (10%), the website (10%), the film (10%), and/or some specific, miscellaneous activities (10%) (for example, “*microscope handling*” and “*scavenger hunt*”). Additionally, one educator said that s/he would likely use “*photos of microscopic images*” (5%), while another pointed to the “*workshop for teachers*” (5%).

Ideas and resources likely to be used in museum educators' events/activities (N=20)



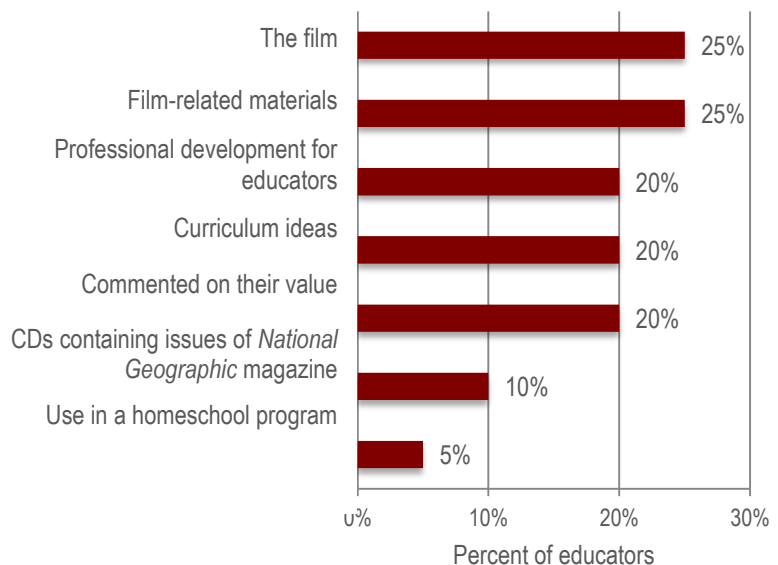
## 2.5 What ideas and resources did museum educators think they were most likely to use in outreach to educators?

When asked to identify the ideas and resources they would most likely use in their outreach to educators in their market, the largest groups of museum educators pointed to the film or footage from the film and the film's educational materials, like the website, Museum Educator Guide, poster, and kiosk.

When asked to identify the ideas and resources they would most likely use in their outreach to educators in their market, the museum educators gave a range of responses, from specific ideas and resources to the groups they intend to target and their larger outreach goals. As shown in the chart to the right, one-quarter of museum educators pointed to using the film or footage from the film (25%), as in:

- DVDs.
- Workshops and screening.
- Movie screening just for educators.
- The movie clips and associated content.

Ideas and resources museum educators expected to use in outreach to local educators (N=20)



Another quarter described an intent to use the film's related materials (25%), specifically mentioning the website, Museum Educator Guide, poster, and kiosk. One-fifth commented on the value of the workshop's resources and ideas as they relate to professional development workshops for educators (20%) (as in, "I feel that we can use a lot of the activities for our teacher [professional development programs]") while another fifth pointed specifically to curriculum ideas (20%) (as in, "lesson ideas to be incorporated into labs and develop curriculum ideas"). Additionally, a group of the same size elaborated on their reasons for incorporating the new resources and ideas into their outreach to educators (20%), as in:

- [To] be able to provide insight into a world that is not explored regularly in school hours.
- Use to get teachers to understand wealth of materials that are free and can support learning goals.
- [The materials] will likely encourage them to book a field trip to our museum.
- [The materials] are a great way to reach classroom teachers.

Finally, two museum educators pointed to the CDs containing issues of *National Geographic* magazine (10%), and one mentioned the possibility of using the resources/ideas with a homeschool program (5%).

## 2.6 Did museum educators have suggestions regarding further support from National Geographic?

The largest groups of educators suggested that National Geographic provide additional resources and facilitate a more dynamic relationship within and between workshop attendees, among other responses.

As shown in the chart to the right, when asked what National Geographic could do to further support their efforts to integrate the new workshop ideas and resources into their educational setting(s), nearly half of the museum educators pointed to an interest in additional resources (45%), including web materials, images, kits for teachers, and kiosk components, as in:

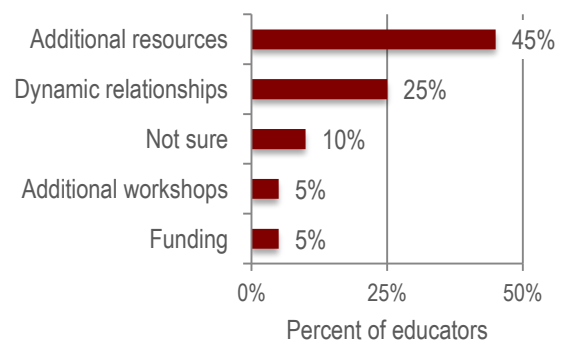
- *Continually offer updated activities and evolving programs to suit current science.*
- *Physical copies of SEM [scanning electron microscope] images.*
- *Kits of materials for teachers to take to their classrooms from workshops.*
- *Material you have is great. Perhaps activities that tap resources informal science because you have to extend to lots of teachers now.*
- *Kits/supplies on more activities that we can create with low budget materials.*
- *Offer kiosk components to be used more broadly for wider audience than kiosk.*

A quarter of museum educators advocated for a dynamic relationship with National Geographic and/or other workshop attendees (25%), as in:

- *Keep in touch- give us up dates and new ideas as you get feedback keep in touch, via email.*
- *Be available for questions and give us feed back of what is working/not working in other museums as they implement these tools.*
- *Asking all of us to regard our ideas; what we actually implement and then sharing it with everyone.*
- *Keep open communication so we can get answers to questions and create anything within reason, which may assist teacher training.*

A few museum educators said they were not sure (10%), one suggested that National Geographic “*continue these workshops*” (5%), and one requested that National Geographic provide “*funding for educator screening/workshops*” (5%).

Museum educator suggestions regarding further support from National Geographic (N=20)



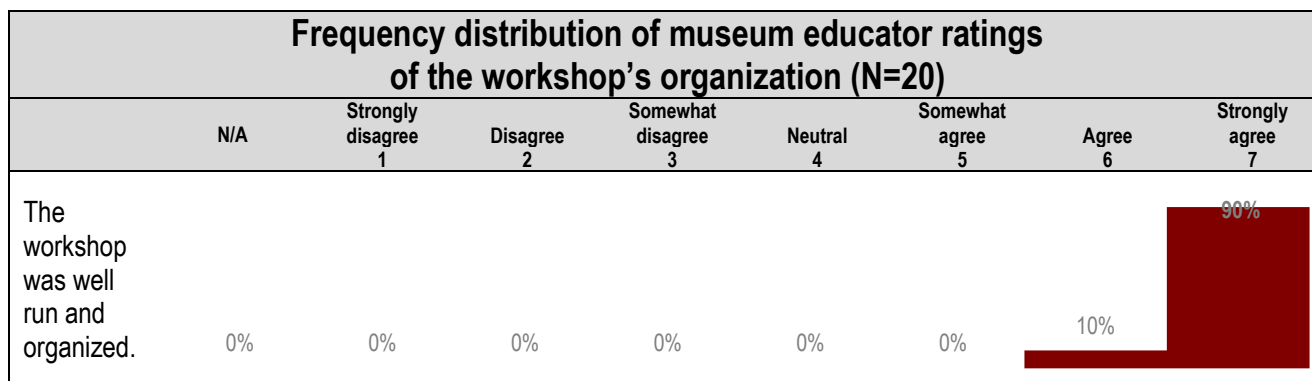
## Question 3: What did museum educators think of the workshop's organization, length, and density of programming?

The 20 museum educators were also invited to complete a set of written questions about the organization, length, and programming of the workshop. These findings are presented below in 3.1 through 3.3.

### 3.1 How did museum educators find the workshop's organization?

Overall, the museum educators felt the workshop was well run and organized.

On a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), the museum educators were asked to rate how strongly they agreed or disagreed with the following statement: *The workshop was well run and organized.* The table below presents the percentages of museum educators selecting each rating.



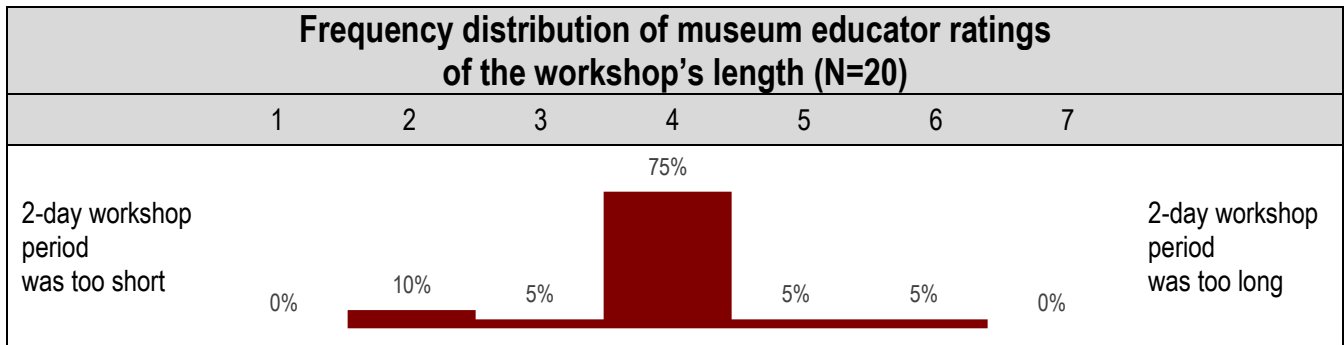
Though there were some differences of opinion, as evidenced by the range of ratings, overall museum educators strongly agreed (median rating 7.0) that they thought the workshop was well run and organized. A handful of museum educators provided additional feedback. Their responses focused on how much they enjoyed the workshop, as in:

- *This was really great. I feel that you said went to great lengths to make us feel important and part of the process. You have a great team! I'm going on my 18th year in the "museum" biz and I can honestly say that this was one of my better experiences bar-none! Everyone is professional, but totally approachable. Thanks for the VIP treatment. I felt part of the family.*
- *Everyone was incredibly friendly, helpful, engaging! Always asking for our opinions and introducing themselves. They are also super knowledgeable! It was superb.*

### 3.2 What did museum educators think about the workshop's length and its use of their time?

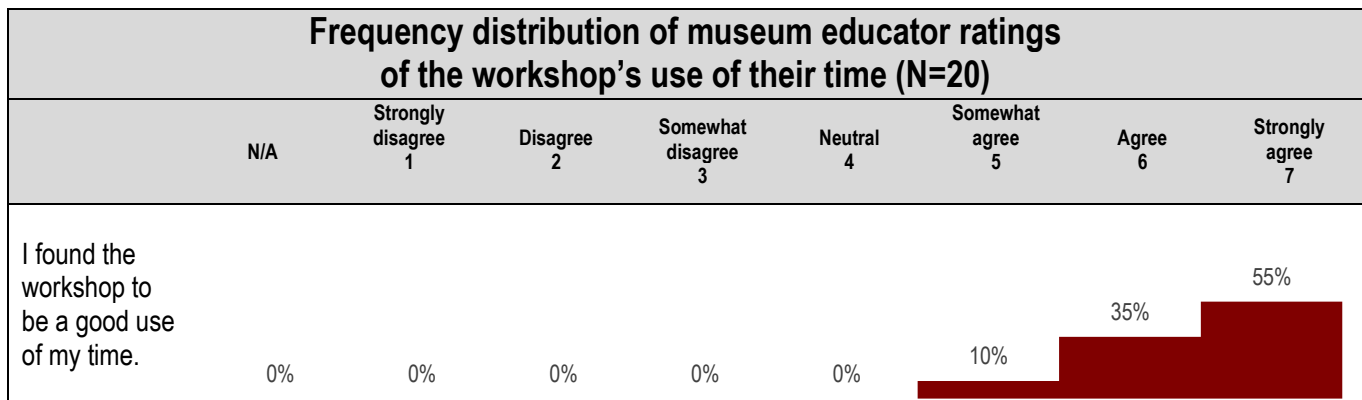
Overall, the museum educators felt the workshop was a good use of their time. When asked how they felt about the length of the two-day workshop, they generally indicated that it was just right.

When asked how they felt about the length of the two-day workshop on a scale from 1.0 (too short) to 7.0 (too long). The table below presents the percentages of museum educators selecting each rating.



Though there were some differences of opinion, as evidenced by the range of ratings, overall museum educators indicated that they thought the workshop's length was just right (median rating 4.0).

Additionally, on a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), the museum educators were asked to rate how strongly they agreed or disagreed with the following statement: *I found the workshop to be a good use of my time.* The table below presents the percentages of museum educators selecting each rating.

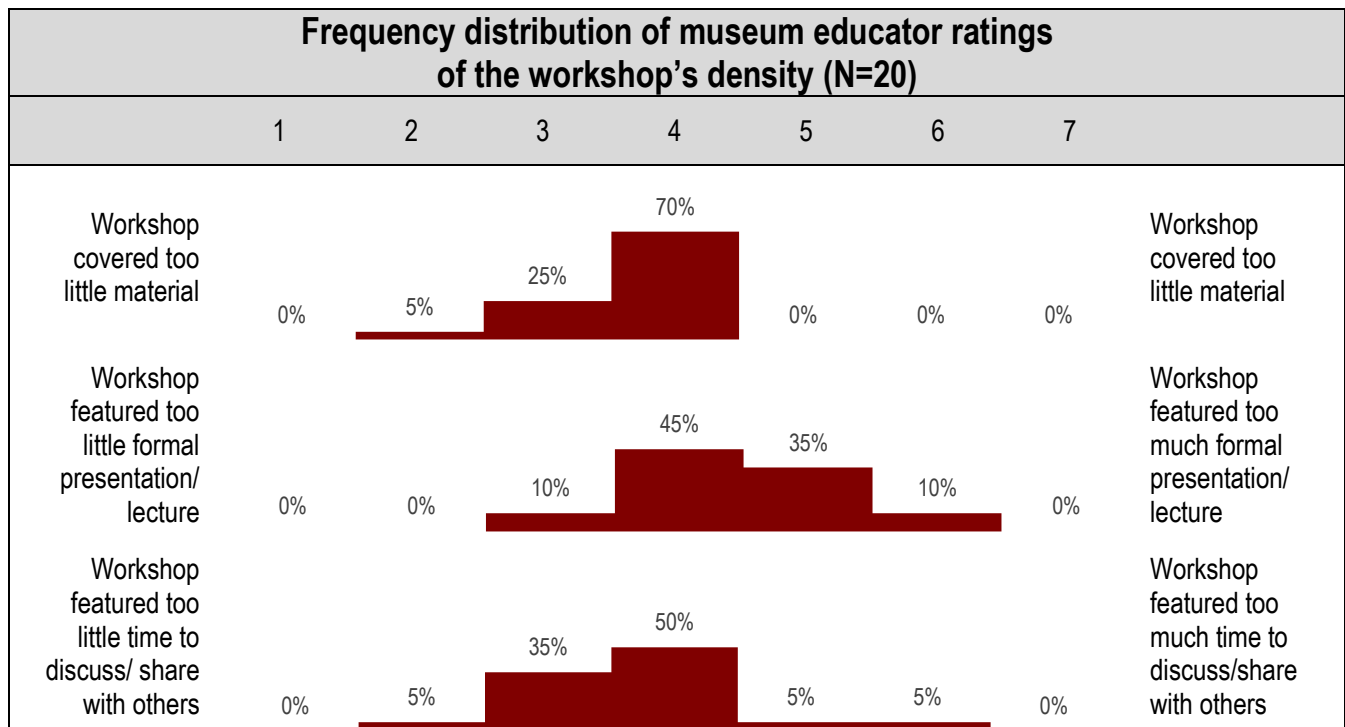


Though there were some differences of opinion, as evidenced by the range of ratings, overall museum educators strongly agreed (median rating 7.0) that they thought the workshop was a good use of their time.

### 3.3 What did museum educators think about the density of the workshop?

The museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right.

The museum educators were asked how they felt about the amount of material covered during the workshop, the amount of formal presentation and lectures, and the amount of time allocated for discussion and shared on a scale from 1.0 (too little) to 7.0 (too much), with 4.0 being just right in each case. The table below presents the percentages of museum educators selecting each rating. Though there were some differences of opinion, as evidenced by each range of ratings, the museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right (median rating 4.0 each).



When invited to explain the above ratings, a number of the museum educators expressed a desire to have done *more* at the workshop – more activities, more discussion sessions, and/or a longer workshop overall. More specifically, a quarter commented on the discussion and networking element of the workshop (25%), either expressing an interest in dedicating more time to discussions/networking or providing additional suggestions for future workshops. For example:

- *I would have liked more...discussion time.*
- *There was enough time to talk but not always when ideas were fresh. Small group decisions felt more fruitful than large group.*
- *Group discussions were good, but it would have been better if we were grouped by similar jobs. (Exhibits, educators, etc.)*
- *More time to network on practical ideas is always nice.*



- *More opportunity to brainstorm through application of content next time.*

Another quarter pointed to the workshop activities, commenting on their enjoyment of the activities that took place and/or their desire to do more (25%). For example:

- *More hands-on activities.*
- *I would have benefited from more hands-on activities.*
- *It was all great! The only thing I would like to "do" more of the hands-on activities.*
- *Loved the chance to get to the hands-on aspect, but to be fair, that's my thing.*

One tenth specifically suggested that National Geographic lengthen future workshops (10%), as in:

- *A few more days to discuss more resources would be great. Or a related workshop.*
- *Two days for the workshop should be minimum. There is so much to share and learn. Any shorter and we would have missed out on a lot of cool things.*

Finally, one each provided miscellaneous programming feedback (5%) (as in, "*I wish the award had been explained earlier in the workshop; it would have given me a framework through which to view information given on the first day*") or commented on his/her enjoyment of the workshop (5%) (as in, "*Good experience*").

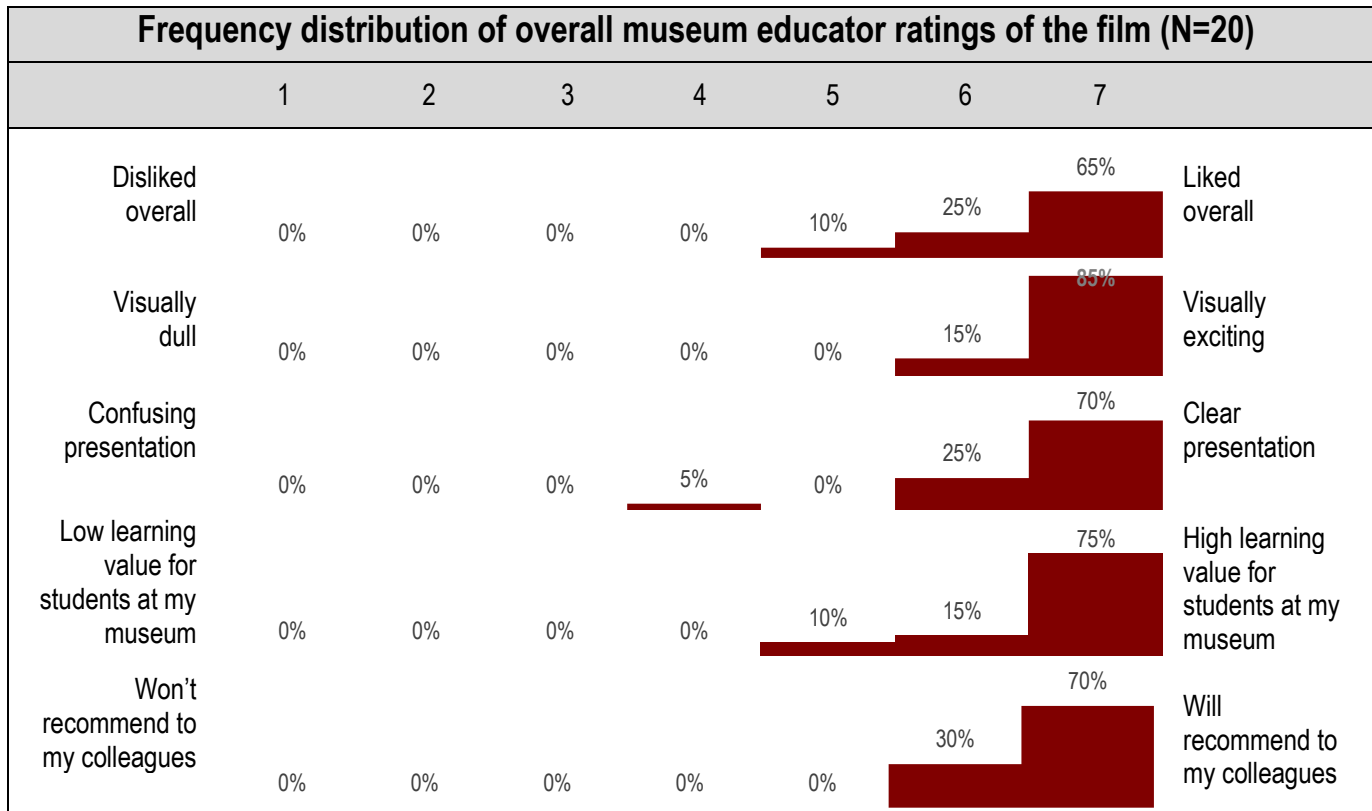
## Question 4: What did museum educators think about the *Mysteries of the Unseen World* film?

The 20 museum educators were next invited to complete a set of written questions about the appeal, visual interest, clarity, and learning value of the *Mysteries of the Unseen World* film, which they screened on the first day of the workshop. These findings are presented below in 4.1 through 4.5.

### 4.1 How did museum educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, learning value for students, and likelihood of recommending the film?

Overall, the museum educators indicated that they liked *Mysteries of the Unseen World*, found it visually exciting, and thought the presentation was clear. They also generally thought it had a high learning value for students at their museums or science centers and that they would recommend it to their colleagues.

Museum educators were asked to rate *Mysteries of the Unseen World* for the extent to which they liked the film, found it visually exciting or dull, thought the presentation was clear, thought it would have a high learning value for students at their museum, and were likely to recommend the film to their colleagues on a scale from 1.0 (rated the lowest) to 7.0 (rated the highest) in each case. The table below presents the percentage of



museum educators selecting each rating. Though there were some differences of opinion, as evidenced by the range of ratings in each case, museum educators generally liked *Mysteries of the Unseen World* (median

rating 7.0), found it visually exciting (median rating 7.0), thought the film's presentation was clear (median rating 7.0), thought it would have a high learning value for students at their museum (median rating 7.0), and said they were likely recommend the film to their colleagues (median rating 7.0). When invited to elaborate on their ratings, some of the museum educators provided additional feedback, shared below:

***Liked or disliked overall***

- *Amazing*

***Visually exciting or dull***

- *The ESM [electron scanning microscope] photo colors are not the real colors*

***Clear or confusing presentation***

- *It was really difficult to have any context of scale during the whole movie. It was really effective with wow factors, less so for understanding context.*
- *More of a narrative and added that the way it was framed felt like information dumping.*

***High or low learning value for students***

- *Perfect for a science center*
- *[The filmmakers did a] great job...this is a tough subject for such a large format.*
- *Not as direct of a connection to the museum that it's being shown at, but definitely connect to a lot of our core-based activities.*

***Will or won't recommend to colleagues***

- *Relevant to teacher's STEM goals and showing connections*
- *Needs to make connections about why kids should care. But that can be our job!*

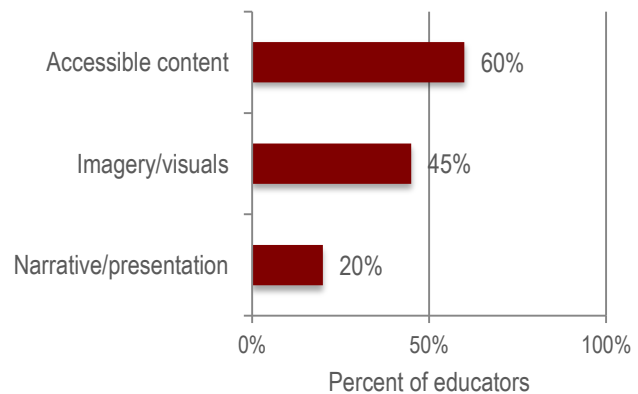
## 4.2 What did museum educator think were the film's most appealing aspects?

When asked what they liked most about the film, the largest groups of museum educators pointed to the accessibility of the film's informative content and its imagery and visuals, while a smaller group commented on the strength of the film's narrative and presentation.

As shown in the chart to the right, when asked what they liked most about *Mysteries of the Unseen World*, nearly two-thirds of museum educators pointed to the accessibility of the film's informative content (60%). For example:

- *Makes some complicated material accessible to people. Very "friendly" presentation of science concepts.*
- *Very STEM oriented- will work well with new exhibit/interactives.*
- *Made abstract content concrete. Covered a range of content aligned with standards- how eye works, light, waves, nano.*
- *De-mystifies idea of micro/nano world when "nano technology" is an emerging field/buzzword.*
- *The explanation of hard concepts in such a way that it's understandable for younger age groups.*
- *The invisible light was the best because I find it to be one of the hardest things to teach.*

What museum educators liked most about the film (N=20)



Nearly half appreciated an aspect of the film's imagery and visuals (45%). For example:

- *I loved the SEM [scanning electron microscope] images!*
- *Visually great.*
- *It was exciting, inspiring, and visually appealing.*
- *Visually stimulating photos and videos keep [students'] attention.*
- *The visualizations. SEM images and CG animations about concepts difficult to understand, like light waves traveling all around us.*

A fifth pointed to the film's narrative and presentation (20%), as in:

- *Wow factor in so much of the film. I liked how it followed an average person and highlighted so much that is unseen.*
- *It provided a narrative with these apartment dwellers without cheesy dialogue to distract. The narrator is isolated from the film and used to help explain the things we normally don't see.*
- *I did appreciate the way the information was organized ("Too Fast, Too Slow, Too Small").*
- *Clear presentation.*

### 4.3 What did museum educators think were the film's least appealing aspects?

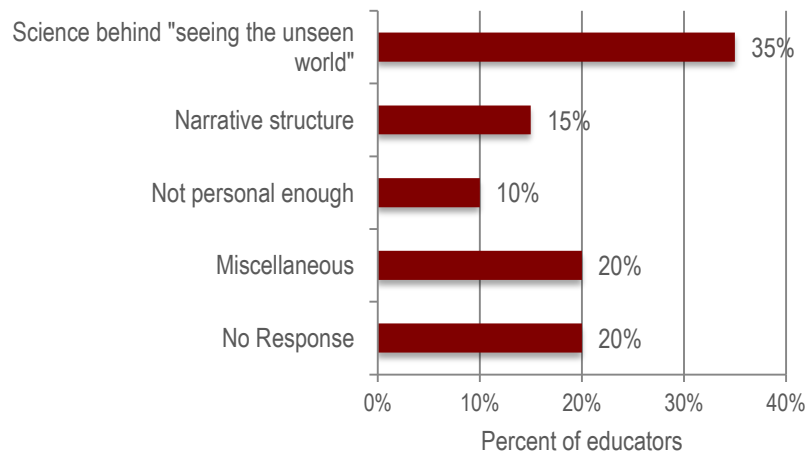
When asked what they disliked about the film, the largest group of museum educators indicated that the film's examination and imagery of the science behind "seeing the unseen world" could have been stronger. At the same time, smaller groups felt that the four-part narrative was lacking in some way and/or thought the film would have benefited from a more personal storyline.

When asked what they disliked about the film, the museum educators, as a group, most often pointed to three aspects. As shown in the chart to the right, more than a third of museum educators indicated that the film's examination and imagery of the science behind "seeing the unseen world" could have been stronger (35%).

For example:

- *No explanation on how we are able to "see" the unseen world.*
- *Didn't show a lot of the machines and process of capturing images.*
- *No science of how images are produced.*
- *No imagery of images being acquired to understand technology.*
- *There was no explanation on tools like prisms/diffraction gratings/electron microscope that helps us see this information.*
- *There was no image on a SEM [scanning electron microscope].*

What museum educators liked least about the film (N=20)



Nearly a sixth of museum educators felt that the film's four-part narrative was lacking (15%) (as in, "the narrative was very disjointed" and "[I thought] the segments labeled Too Fast, Too Slow, etc...disrupted from the film"), and a tenth thought the film would have benefited from a slightly more personal storyline (10%) (as in, "would like to have it explain what this research means to them and maybe show the machines/scientist that work in the labs?"). The remaining museum educators who answered the questions gave miscellaneous answers (20%). One each said s/he did not like learning about microorganisms on his or her eyelids, expressed concern about the "level of general audience appeal," expressed a desire to "see more," or said "I felt like it made microorganisms scary, and didn't explain why being able to see things in other areas of the electromagnetic spectrum is important." A fifth of the museum educators left the question blank (20%).

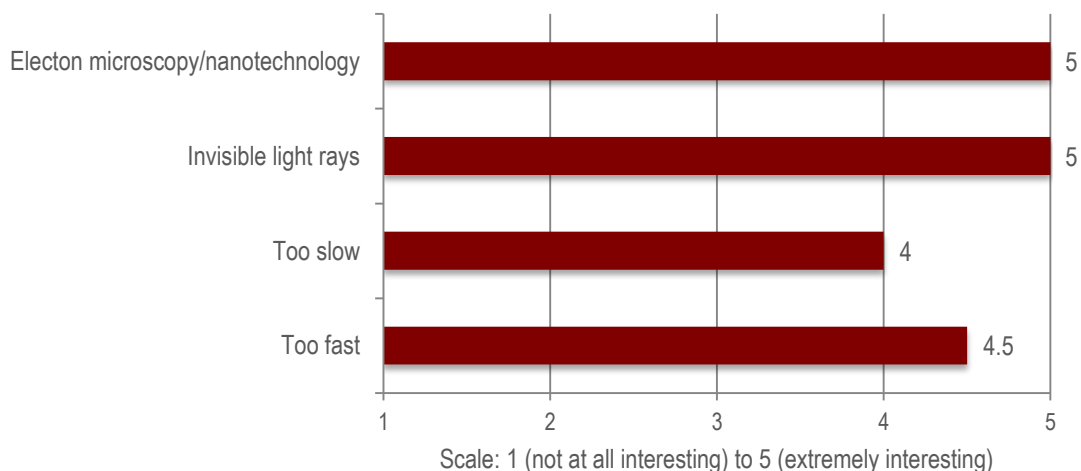
## 4.4 How did museum educators rate the relative appeal of the film's four acts?

The museum educators generally rated the acts of the film that considered “Invisible light rays” and “Electron microscopy/nanotechnology” as slightly more interesting than the acts that considered things that are “Too fast (slow motion photography)” and “Too slow (time-lapse photography).”

As shown in the chart below, when the museum educators rated the appeal of individual acts on a scale from 1.0 (not at all interesting) to 5.0 (extremely interesting):

- Their ratings of “Too fast (slow motion photography)” ranged from 3.0 to 5.0, with the median rating being 4.5;
- Their ratings of “Too slow (time-lapse photography)” also ranged from 3.0 to 5.0, with the median rating being 4.0;
- Their ratings of “Invisible light rays” ranged from 2.0 to 5.0, with the median rating being 5.0; and
- Their ratings to “Electron microscopy/nanotechnology” ranged from 3.0 to 5.0, with the median rating being 5.0.

**Median museum educator appeal ratings of individual acts (N=20)**



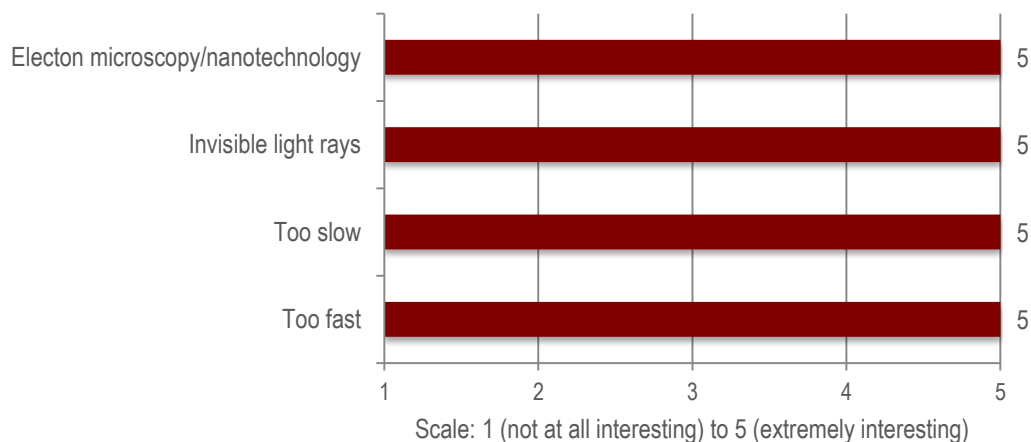
## 4.5 How did museum educators rate the film's success in conveying STEM-related education content?

When asked to rate the success of individual acts in conveying STEM-related content, the museum educators generally indicated that they found all four acts to be extremely successful.

As shown in the chart below, when the museum educators rated the success of the film's individual acts in conveying STEM-related education content on a scale from 1.0 (not at all successful) to 5.0 (extremely successful):

- Their ratings of "Too fast (slow motion photography)" ranged from 3.0 to 5.0, with the median rating being 5.0.
- Their ratings of "Too slow (time-lapse photography)" also ranged from 3.0 to 5.0, with the median rating being 5.0.
- Their ratings of "Invisible light rays" ranged from 3.0 to 5.0, with the median rating being 5.0, and
- Their ratings of "Electron microscopy/nanotechnology" ranged from 4.0 to 5.0, with the median rating being 5.0.

**Median museum educators ratings of the success of individual acts in conveying STEM-related education content (N=20)**



## Question 5: What were museum educators' final reflections and thoughts moving forward?

Finally, the 20 museum educators were invited to complete a set of written questions addressing any final thoughts or suggestions regarding future work with National Geographic. Their feedback is summarized below in 5.1 through 5.3.

### 5.1 What did museum educators think was missing from the workshop?

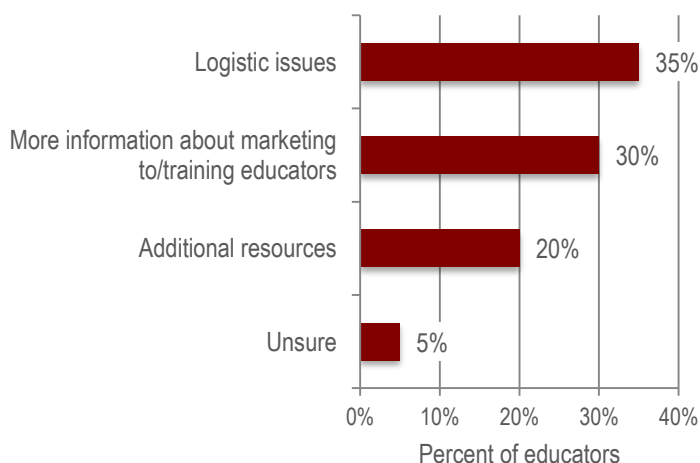
When asked if there was anything missing from the workshop that they might have found useful, the largest groups of museum educators commented on improving an aspect of the workshop logistics, expressed an interest in receiving additional information about marketing to and training educational professionals, and/or explained that the workshop would have benefitted from additional resources.

When asked if there was anything *missing* from the workshop that they might have found useful, no one item stood out for the majority of the museum educators, although a few issues were raised. As shown in the chart to the right, the largest group of museum educators, just over a third, mentioned something about the workshop logistics (35%), such as the reorganization of the schedule, shared contact lists, additional venue space, follow-up workshop sessions, and/or the inclusion of an offsite visit in DC. For example:

- *Nothing missing. Maybe reorganizing...showing the materials online before we do breakout sessions so we have more ideas for implementing the materials in our venues.*
- *Better-dedicated time to actually running through the majority of the activities without saying, "now go ahead and flip through the rest of the materials." We could have watched segments of the film again and ran activities in parallel. Also, a document with everyone's contact info of who we met here this week would have been great!*
- *There either wasn't enough materials or enough space to break into smaller groups.*
- *Perhaps offsite lunch/dinner to see more DC.*
- *Maybe conduct the workshop a few times before the movies comes out so we have more time to develop programs about it.*

Nearly a third of museum educators expressed an interest in receiving additional information about marketing to and training educational professionals (30%). For example:

What museum educators thought was missing from the workshop (N=20)





- *How to market to teachers (language). What has worked, what didn't. In depth discussion.*
- *I would have liked to talk more about what a teacher workshop is, how you structure it, how you sell it to teachers, how long they should run, etc.*
- *For others – more "training" to make sure non-science educators can handle questions about micro/nano-scale science.*
- *Opportunity to learn from peers about their successes with film associated content.*

One-fifth thought that the workshop would have benefited from additional resources, from images to subject-specific activities (20%). For example:

- *Access to more images?*
- *Physical copies of the images.*
- *Activities on waves. More non-technology activities.*
- *More hands-on. There either wasn't enough materials or enough space to break into smaller groups.*

Finally, one museum educator said s/he was unsure at this time (5%).

## 5.2 Were museum educators interested in additional resources from National Geographic Education?

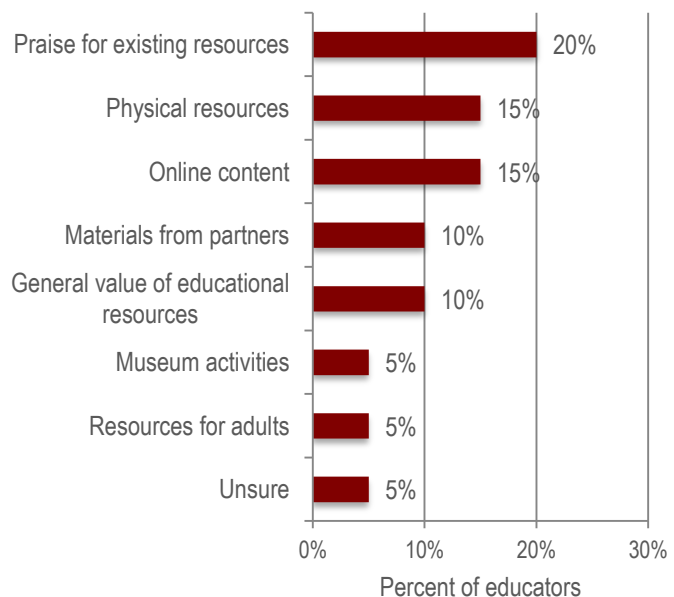
Of the museum educators who expressed an interest in receiving additional resources from National Geographic Education, the largest groups requested physical resources and/or content that could be shared online.

After learning about some of the resources available on the National Geographic Education website, the museum educators provided feedback about other types of resources they might find useful. As shown in the chart to the right, a fifth praised the existing resources (20%) as in, *“I love the webpage”* and *“Continue what you offer. National Geographic is a consistent, trusted source for high quality resources.”*

Approximately one-sixth requested physical resources (15%), such as *“kits that could be checked out,”* *“activities in a box typically are most useful,”* and *“resources that are more portable...for outreach and school videos.”* Another sixth requested content that could be shared online (15%), including *“maps,”* *“educator guides,”* *“films,”* and *“pictures and visuals [and] activities or ideas for activities.”*

A tenth each requested materials from potential partners (10%) (for example, *“Nano Day resources from NISE [Nanoscale Informal Science Education] network”* and *“The connections to Lockheed Martin and their contribution to the film”*) or discussed the general value of educational materials (10%) (as in, *“any other resources that teach students why it is important to learn about this and career possibilities”* and *“well-written, step-by-step activities are invaluable to educators, especially primary and middle school teachers”*). One museum educator specifically requested *“more activities for the museum floor”* (5%), another requested resources for adults (5%), and one said s/he was unsure (5%).

Museum educators' interest in additional resources from National Geographic Education (N=20)



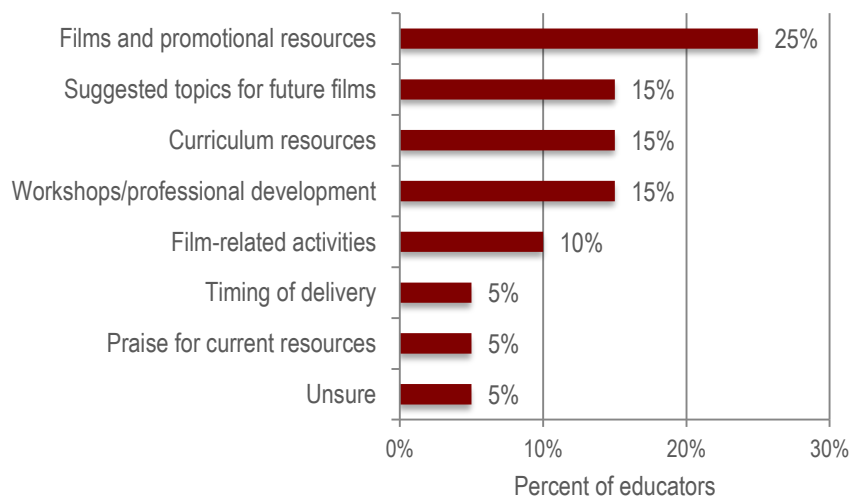
### 5.3 Were museum educators interested in additional resources from National Geographic Entertainment?

Reflecting on their future needs as they relate to National Geographic Entertainment films, the largest groups of museum educators suggested specific topics for future productions, commented on the value of curriculum resources, and/or expressed an interest in workshops and professional development materials.

In reflecting on their future needs as they relate to National Geographic Entertainment films, the museum educators suggested information and additional resources they might like to see developed. As shown in the chart to the right, the largest group, one-quarter, pointed to the value of shareable films and their promotional resources (25%). For example:

- *I would like a way to give DVDs of the film out to teachers after they see the movie, or do the workshop.*
- *Make the DVD available to teachers when it comes out.*
- *More videos that can be used in presentations/labs?*
- *Posters and DVDs are so helpful.*

Museum educators' interest in additional resources from National Geographic Entertainment (N=20)



Just under a sixth indicated an interest in specific topics for future productions (15%), as in: “*Films on 6th extinction and biodiversity as relates to climate,*” “*Too Bright/ Too Dark,*” and “*Planetarium "Fall-Dome" shows! Distribution will be incredible and reach all of our outreach demographics.*”

The same number of museum educators commented on the value of curriculum resources (15%), as in: “*Teachers still love the ‘paper’ resources as well*” and “*I sound like a broken record, but organized themed curriculum is valuable by both teachers and museum staff.*” And another sixth expressed an interest in workshops and professional development materials (15%), as in: “*Ways to start offering teacher workshops if you don’t already. (I know people at my institution have more information that I do so I’ll talk to them...)*” and “*More workshops like this one!*”

One-tenth of museum educators pointed to film-related activities (10%) (as in, “*kiosk materials*” and “*more activities for the museum floor*”). One commented on the timing of the delivery of resources (5%) (as in, “*[it] would be helpful for educator materials to come out free in advance (3 months?) of the film release so we can better market to teachers what curriculum connections and alignment*”), one praised National Geographic’s current resources (5%), and another said s/he was unsure (5%).

## Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources

### Introduction

Following the Museum Educator National Workshop held in Washington D.C. in 2013, the partner organizations were asked to implement a number of activities upon the film's premiere at their respective institutions. Those who "activated" the *Mysteries of the Unseen World* outreach awards in this capacity received funds in order to promote the film, conduct outreach, and train local teachers on use of the film's companion materials. As a condition of the award program, each partner organization was responsible for recruiting educators to attend their local workshop and disseminating an online survey developed by the project's independent evaluation team to gather participant feedback. Additionally, each partner museum was asked to distribute a separate but similar online survey to their network of teachers who saw the film, but *didn't* participate in the workshop, in order to gather non-workshop participants' feedback on the film and their perceptions of and expected use of the companion materials. The findings from both survey efforts are presented in this section to allow for an informal comparison between the two. To account for the educators' different experiences with the *Mysteries of the Unseen World* resources, those who attended the workshop and saw the film are referred to as "Workshop attendees" in the report while those who only saw the film are referred to as "Film only attendees."

### Method

#### Questionnaire development

The independent evaluation team of Knight Williams Inc. worked with National Geographic to develop two surveys that gathered educator feedback on three main areas relating to the *Mysteries of the Unseen* local workshop goals and related educator outreach:

- 1) What feedback did educators share about the local workshops?
- 2) What feedback did educators share about the film and educational resources?
- 3) How had educators used the resources and/or how did they intend to use them within 12 months?

The first survey, for Workshop attendees, was prepared as an online form that could be emailed directly to workshop participants at the conclusion of the workshop or administered as a paper version on site. The second survey, for Film only attendees, was also prepared as an online form that the partner educators could email directly to their local educator contacts who had seen the film but not participated in a workshop. The two surveys were similar in content, although the survey for Film only attendees asked the educators for input on their interest in attending workshops since they didn't actually attend one at their local science center. The workshop organizers hoped to learn from these educators how prepared they felt to use the resources without having attended a workshop but having seen the film, and to explore their views on the potential value they saw in participating in local vs. virtual workshops via webinar.

## Procedure

To gather educator feedback on the workshops, the evaluation team worked with National Geographic and the workshop coordinators at six partner science center sites that were scheduled to conduct local workshops between February 2014 and February 2015.

The workshop coordinators for four of these six partner sites distributed the post-workshop questionnaire to participants following the workshop, either via email or paper form as worked best for the participants in each case. The remaining two science center science workshop coordinators ran into challenges either hosting the workshop or disseminating the survey. In one case the coordinator anticipated more than 200 attendees but then a local sports team made it to the national playoffs, which occurred the same evening of the workshop, resulting in “*a rash of cancellations*” and many attendees who stayed long enough to see the film and then presumably proceeded to see the game. In another case the coordinator who hosted the event with a colleague discovered that the colleague in charge of survey dissemination inadvertently overlooked sending the survey link after the event. She tried to follow-up but was unable to have the survey invitations directed to the educators in a timely manner as the workshop occurred at the end of the school year and her colleagues and participating teachers were preparing for summer break.

A copy of the online survey invitation emailed to Workshop attendees is provided on the next page. The survey invitation to Film Only attendees was similar except it requested the educators to provide feedback on their experience with the film and initial expectations for using *the Mysteries of the Unseen World* resources and directed them to the following link: <http://knightwilliams.com/ngm/educ.aspx>

## Data analysis and reporting

Basic descriptive statistics were provided on the quantitative data generated from the evaluation. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the workshop objectives, and inductive, by looking for overall themes, keywords, and key phrases. The educator responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder.



Dear educator,

Thank you for participating in the *Mystery of the Unseen World* (MUW) workshop at COSI. We greatly appreciate your willingness to complete a short survey about your experience. In appreciation for your time and input, we are pleased to offer you a 20% discount in National Geographic's online store. You will be able to click on the coupon code at the end of the survey.

We are working with National Geographic Education to gather independent feedback about participants' experience at the workshop and initial expectations for using the MUW resources. This survey is an important part of the feedback we are gathering for National Geographic Education and for the National Science Foundation, which provided funding for the MUW film, resources, and evaluation. If you have any questions or comments about the evaluation or about completing this online survey, please feel free to contact us at [muw@knightwilliams.com](mailto:muw@knightwilliams.com) or by calling toll free (888) 204-3939.

When you are ready to complete the survey, please click on the link below. If you have trouble clicking on the link, you can copy the link into your browser window.

<http://knightwilliams.com/ngm/mysteries.aspx>

**Please be sure to complete the survey as soon as possible, while the workshop material is still fresh in your mind.**

Thanks very much for your input!

Dr. Valerie Knight-Williams  
Divan Williams Jr., J.D.  
Directors, *Mysteries of the Unseen World* evaluation  
Knight Williams Inc.

## About Us

Knight Williams Research Communications ("Knight Williams Inc. ") specializes in the development and evaluation of health and science media-based programs targeting diverse audiences. The projects we collaborate on are frequently national or regional in scope, incorporate outreach programs in a wide range of settings, and feature one or more of the following media: television or radio programs, giant screen films, museum exhibits, websites, interactive multimedia, and curricula or other print materials.

# Educator background information

## Where educators attended the workshops or saw the film

### Workshop attendees

Workshop attendees who provided feedback in the Phase 2 evaluation participated in a workshop at one of four science centers. As shown in the table to the right, the majority participated in a workshop at either the Buffalo Museum of Science (37%) or Thanksgiving Point (30%), followed by Perot Museum of Nature and Science (16%) and the Center of Science and Industry (11%).

Science centers where Workshop attendees participated in local workshops (N=63)	
37%	Buffalo Museum of Science
30%	Thanksgiving Point
16%	Perot Museum of Nature and Science
11%	Center of Science and Industry
6%	No response

### Film only attendees

Film only attendees who provided feedback in the Phase 2 evaluation saw the film at one of two science centers. As shown in the table to the right, the majority of educators saw the film at the Saint Louis Science Center (76%), while remaining educators saw the film at the Buffalo Museum of Science (24%).

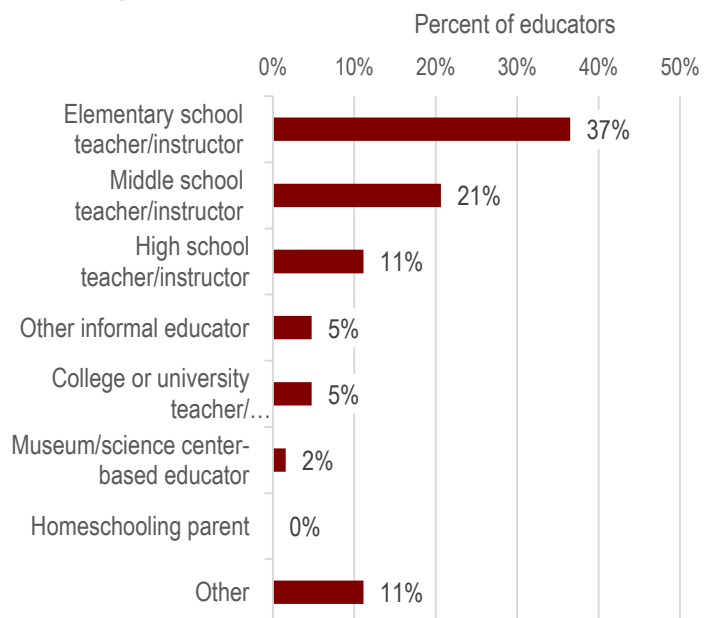
Science centers where Film only attendees saw the film (N=29)	
76%	Saint Louis Science Center
24%	Buffalo Museum of Science

## Types of workshop and film attendees

### Workshop attendees

The workshops drew educators who worked with various grades and in various capacities. As shown in the chart to the right, more than a third of Workshop attendees identified as elementary school teachers/instructors (37%). About a fifth of the educators were middle school teachers/instructors (21%) and just over a tenth were high school teachers/instructors (11%). Less than a tenth each explained that they were another kind of informal educator (5%), a college or university teacher/instructor/professor (5%), or a museum or science center-based educator (2%). None of the workshop attendees were homeschooling parents, and just over a tenth identified as another kind of educator, including “2nd Grade Spanish Immersion Class,” “Special Education Preschool Teacher,” “early childhood education specialist, supporting providers and programs,” “High School Equivalency Instructor,” and “District Science Coordinator.”

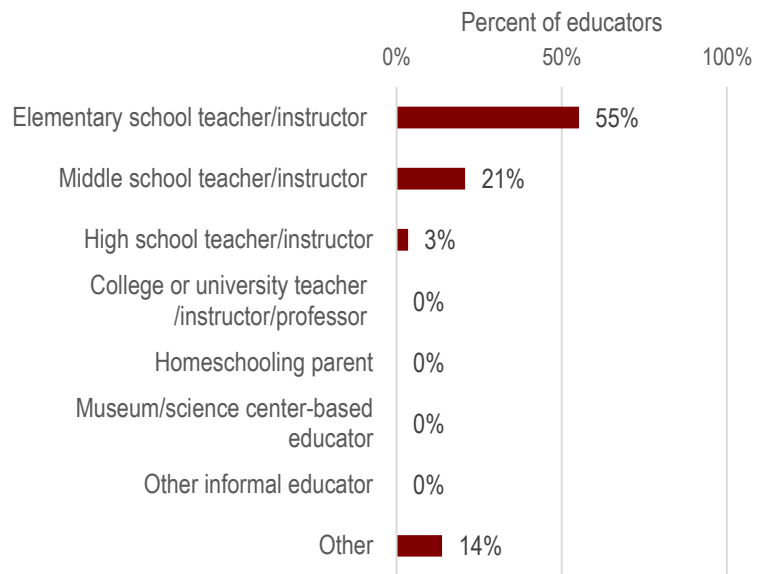
### Types of Workshop attendees (N=63)



### Film only attendees

As shown in the chart to the right, the majority of Film only attendees identified as elementary school teachers/instructors (55%). About a fifth identified as middle school teachers/instructors (21%), and less than one-twentieth indicated that they were high school teachers/instructors (3%). Just over a sixth explained that they were another kind of educator (14%), such as: “STEAM coordinator,” “Assistant Superintendent,” “parent,” and “early childhood educator.” None of the Film only attendees identified as a college or university teacher/instructor/professor, a homeschooling parent, a museum or science center-based educator, or another kind of informal educator.

Types of Film only attendees (N=29)

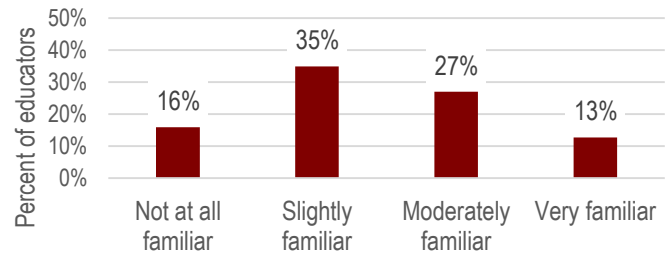


### Familiarity with the workshop or film STEM content

#### Workshop attendees

The Workshop attendees were also asked about their familiarity with the *Mysteries of the World* STEM content presented at the workshop prior to attending. As shown in the chart to the right, the largest group, more than a third, said they were slightly familiar (35%), while more than a quarter indicated that they were moderately familiar (27%) and more than a tenth noted that they were very familiar (13%). One-sixth of educators were not at all familiar with the project’s STEM content prior to the workshop (16%).

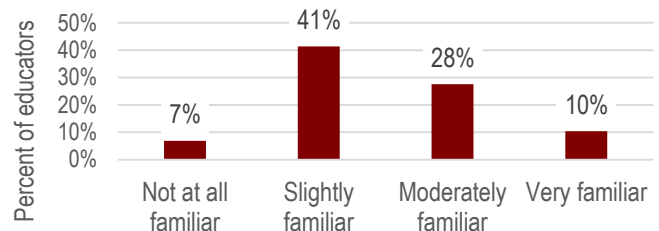
Workshop attendee familiarity with workshop STEM content prior to attending (N=63)



#### Film only attendees

Film only attendees were asked about their familiarity with the *Mysteries of the Unseen World* STEM content in the film and resources prior to seeing the film or reviewing the resources. As shown in the chart to the right, two-fifths said they were slightly familiar with the STEM content (41%), while more than a quarter indicated that they were moderately familiar (28%) with the material. A tenth were very familiar (10%) and less than a tenth were not at all familiar (7%).

Film only attendee familiarity with film STEM content prior to seeing the film or reviewing the resources (N=29)

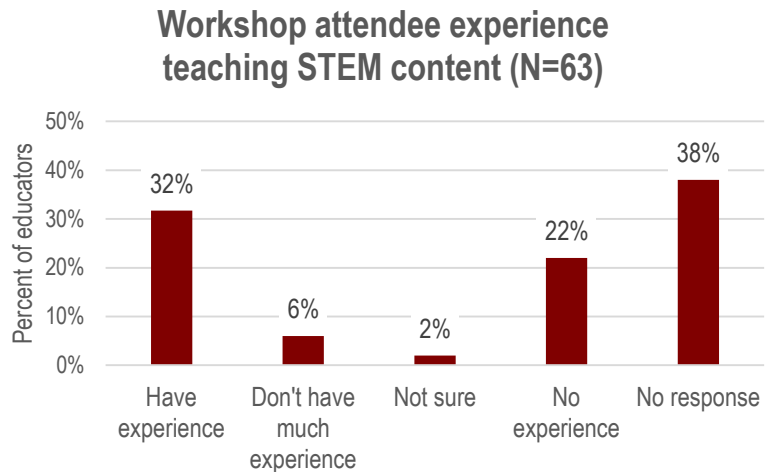




## Prior experience teaching STEM content

### Workshop attendees

Workshop attendees were asked to share their prior experience teaching the STEM content presented in the film and resources. As shown in the chart to the right, nearly a third said they had (some or a lot of) experience teaching this content (32%), while a handful each said they didn't have much experience (6%) or that they were not sure (2%). More than a fifth said they hadn't taught the STEM content (22%) and nearly two-fifths declined to answer the question (38%). Examples of comments from the Workshop attendees are shared below:



#### **Have experience (32%)**

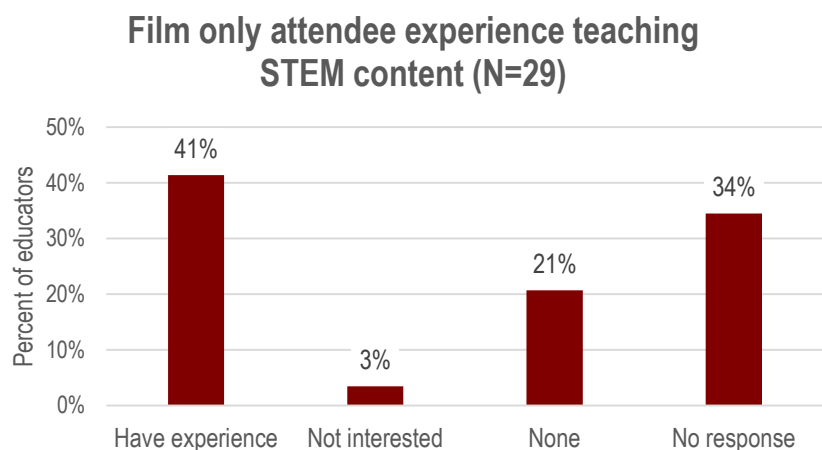
- *It is part of our 7th grade science core.*
- *Using microscopes, the high speed camera on Mythbusters*
- *We have used diffraction grating glasses to observe the spectra of differently colored strings of Christmas lights, and explored why we see color, how color affects us, and (a little) about light waves.*
- *I teach Biology. We cover microscopes and microscopic organisms. We also cover pigments and the nature of light.*
- *Three years ago, I was able to borrow a couple of microscopes to investigate what a drop of water from the rain has in it. Last year, I presented the light spectrum to my students prior to a visit to the Perot museum.*
- *Some-From a similar movie that is now outdated*
- *Some- we had looked at some time lapse work, and infrared, but none with nanoscience, or content too fast.*

#### **Don't have much experience (6%)**

- *I am just familiar with what STEM is and have had a little training but nothing extensive.*
- *Not very much*

### Film only attendees

Film only attendees were asked to share their prior experience teaching students the STEM content presented in the film and resources. As shown in the chart to the right, more than two-fifths said they had taught some of this STEM content (41%) (for example, “the electromagnetic spectrum,” “things that are too small to see with the naked eye,” and “electron microscopy”), and one said s/he wasn't interested in teaching STEM (3%). About a fifth explained that they hadn't taught any of the STEM content (21%), and more than a third declined to answer the question (34%).



# Findings

## Question 1: What feedback did Workshop attendees share about the local workshops?

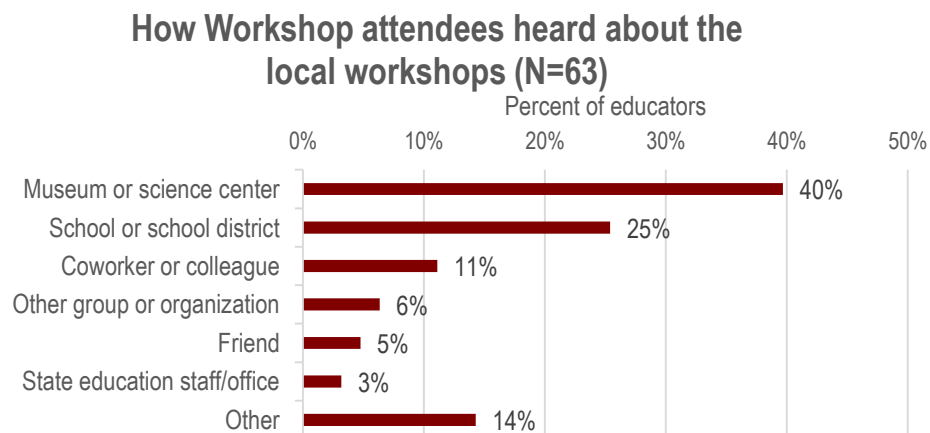
Workshop attendees were asked to comment on how they learned about their local workshop and why they decided to attend. They were also invited to rate the workshop they attended in terms of whether or not it was well run and organized, gave them a good overview of the educational goals of the film and resources, was a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person. Finally, they were asked if the workshop met their expectations and if there were topics it omitted or didn't cover in enough depth. These findings are presented below in 1.1 through 1.3.

### 1.1 How did Workshop attendees learn about the local workshops and why did they attend?

The largest groups of Workshop attendees explained that they heard about their local workshop directly from the coordinating museum or science center and/or that they heard about it through a school or school district. When asked why they decided to attend their local workshop and what they were hoping to gain, the largest groups pointed to the value of gaining new teaching strategies, curriculum ideas, and resources and/or explained that they wanted to see the film and/or visit the museum or science center.

#### 1.1a How educators heard about the workshop

As shown in the chart below, the largest group of Workshop attendees, two-fifths, indicated that they heard about their local workshop directly from the coordinating museum or science center (40%), while a quarter explained that they heard about it from a school or school district (25%). About a tenth heard about it from their coworkers or colleagues (11%), while smaller groups of less than a tenth each pointed to other groups or organizations (6%), friends (5%), or state-level education staff or offices (3%). About one-seventh shared miscellaneous responses (14%).



Examples of their responses are shared below:

**Museum or science center (40%)**

- *I received an email from the Perot Museum education staff*
- *I am part of a Leaders in Science group with the Perot Museum and it was offered to us.*
- *The staff at the Perot sent out an email. I am part of the Leaders in Science program and have participated in past workshops.*
- *Flier then subsequent email and phone call from Thanksgiving point.*
- *Email from Buffalo Museum of Science*
- *Science Museum flyer*
- *This was part of the Buffalo Museum of Science Educators Open House*
- *I learned about this workshop through my teacher advisory board with the Center of Space and Industry.*
- *A teacher of science workshop at COSI in Columbus.*
- *The Museum contacted me*

**School or school district (25%)**

- *I received an email about it from my principal.*
- *Canyons School District newsletter for science teacher opportunities*
- *Online Track through school district*
- *Through an email that was sent on our school computers*
- *I received an e-mail from our Instructional Specialist in our district (Tom Bird, Williamsville CSD)*
- *School email*

**Coworker or colleague (11%)**

- *A co-worker gave me the flyer for this event.*
- *I was invited by a member of my team, who had received an email about it from the curriculum department.*
- *Another teacher forwarded the email flyer to me; her principal had sent it to her but she did not want to go alone.*
- *A colleague who received an email from the museum.*
- *Colleague had attended previous workshop at museum and shared information.*

**Other group or organization (6%)**

- *Received an email from Utah Education Network about it.*
- *I received an e-mail from the Utah Geography Alliance.*
- *Shared by staff member from the Child Care Resource Network*

**Friend (5%)**

- *A friend told me about it.*
- *Invited by a friend*

**State level education staff or offices (3%)**

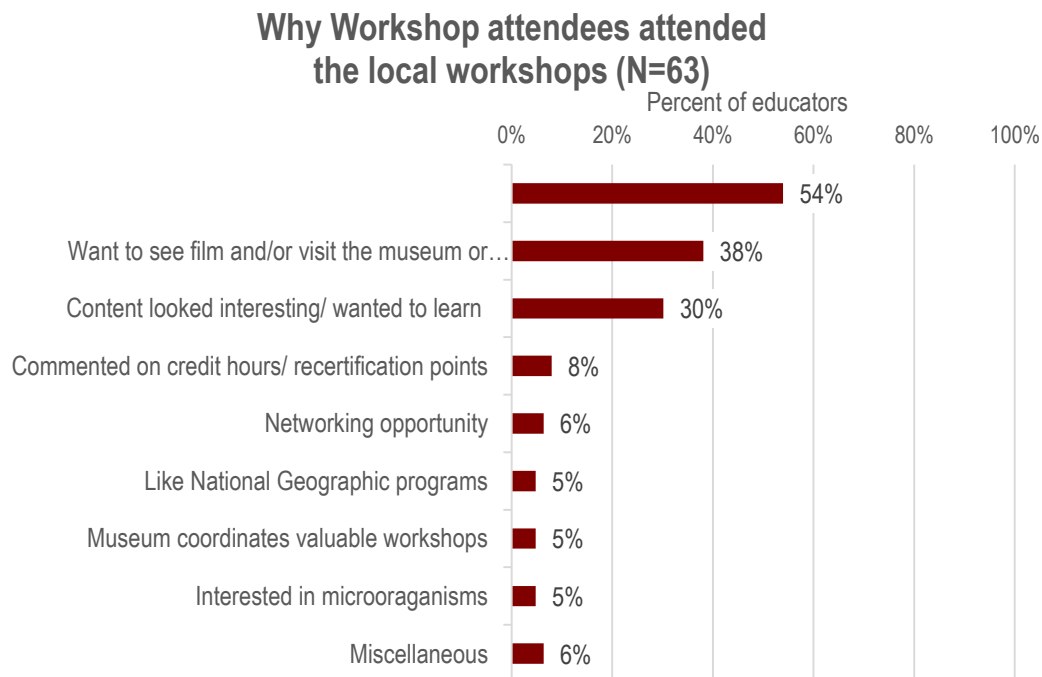
- *An email announcement from the state science specialist.*
- *I received an email about this from the state science educators email list.*

**Miscellaneous (14%)**

- *From an e-mail that was sent to me.*
- *Through a professional development flyer/invitation.*
- *I received an email.*
- *A flyer in my mailbox at work*
- *Science Newsletter from Stephanie Wood (email)*

## 1.1b Why educators attended the workshop

As shown in the chart below, when asked why they decided to attend their local workshop and what they were hoping to gain, more than half of the Workshop attendees pointed to the value of gaining new teaching strategies, curriculum ideas, and resources (54%), while nearly two-fifths explained that they wanted to see the film and/or visit the museum or science center (38%). Just under a third said the content looked interesting or that they wanted to learn something (30%). Less than a tenth each commented on credit hours or recertification points (8%), noted that the workshop would be a good opportunity to network (6%), said they like National Geographic programs (5%), explained that the museum generally coordinates valuable workshops (5%), said they were interested in the topic of microorganisms (5%), or shared miscellaneous responses (6%).



Examples of Workshop attendees' responses are shared below:

### **Gain new teaching strategies, curriculum ideas, and resources (54%)**

- *I am always looking for better ways to teach a subject.*
- *Hoping for new activities to try in the classroom*
- *It looked like it would fit well with what I was teaching at the time*
- *I was hoping to find some new ideas to help make science more hands-on.*
- *I enjoy all the workshops provided at Perot. I always get great things to use in my classroom*
- *I wanted to gain resources that would help me be a better science teacher.*
- *I was hoping to learn new ways to introduce this subject to my students and be able to add hands on learning to our science lessons.*

### **Want to see film and/or visit museum or science center (38%)**

- *I was interested in seeing the movie.*
- *The workshop caught my interest. I was hoping to be able to see the 3-D movie as it explored light and sound.*
- *I wanted the opportunity to take my students on a field trip to Thanksgiving Point, I believe the more I can my students out of the classroom the better.*

- *I was interested in the content and the possibility of a field trip for my school.*
- *Background Information I plan to visit the BM of S with my class*
- *I attended the workshop in order to learn more about the museum collection and opportunities for my students. I am always interested in visiting the museum.*
- *To make stronger connections between my school and the museum...and to become more familiar with the exhibits at the museum.*

**Content looked interesting/wanted to learn (30%)**

- *It looked interesting, and it looked like it would fit well with what I was teaching at the time*
- *I was interested in the content...*
- *It looked interesting and I wanted to learn more about the topic*
- *To learn more science for my students*
- *I like science and wanted to learn more so I could be a better teacher.*
- *I wanted to find out more about the natural world from an unusual perspective. I hoped to gain a greater understanding and appreciation of things that affect us but we tend to overlook.*
- *Additional knowledge to bring back to the classroom.*
- *Information about new discoveries*

**Commented on credit hours or recertification points (8%)**

- *I need credit hours for relicensing*
- *I also wanted to get recertification points.*
- *I attended to gain PD hours*

**Networking opportunity (6%)**

- *I wanted to...network with other educators*
- *Attending workshops with colleagues is an opportunity to network and stay current with new educational materials.*
- *Hoping to network with after-school staff; limited opportunity to do that.*

**Like National Geographic programs (5%)**

- *I attended the workshop because Thanksgiving Point always offers excellent educational services and I love National Geographic Documentaries. I thought the training had to be good. Well, it was better than what I expected!*
- *When I learned about National Geographic showing the film, I quickly knew it was going to be great!*
- *I love Nat Geo programs!*

**Museum coordinates valuable workshops (5%)**

- *I attended the workshop because Thanksgiving Point always offers excellent educational services and I love National Geographic Documentaries. I thought the training had to be good. Well, it was better than what I expected!*
- *I enjoy all the workshops provided at Perot...*
- *I have attended professional development sessions at the Buffalo Museum of Science during the past year and enjoyed the event.*

**Interested in microorganisms (5%)**

- *Microorganisms are part of our sixth grade science core and I was intrigued by the visual learning I could share with my students as we have not microscopes to see these organism with.*
- *I teach sixth grade and hoped that the title included some interesting ideas in how to teach microorganisms.*
- *I teach a variety of courses, including a brief introduction to microbiology. I was hoping to update some of my background info and see what resources might be applicable to my courses.*

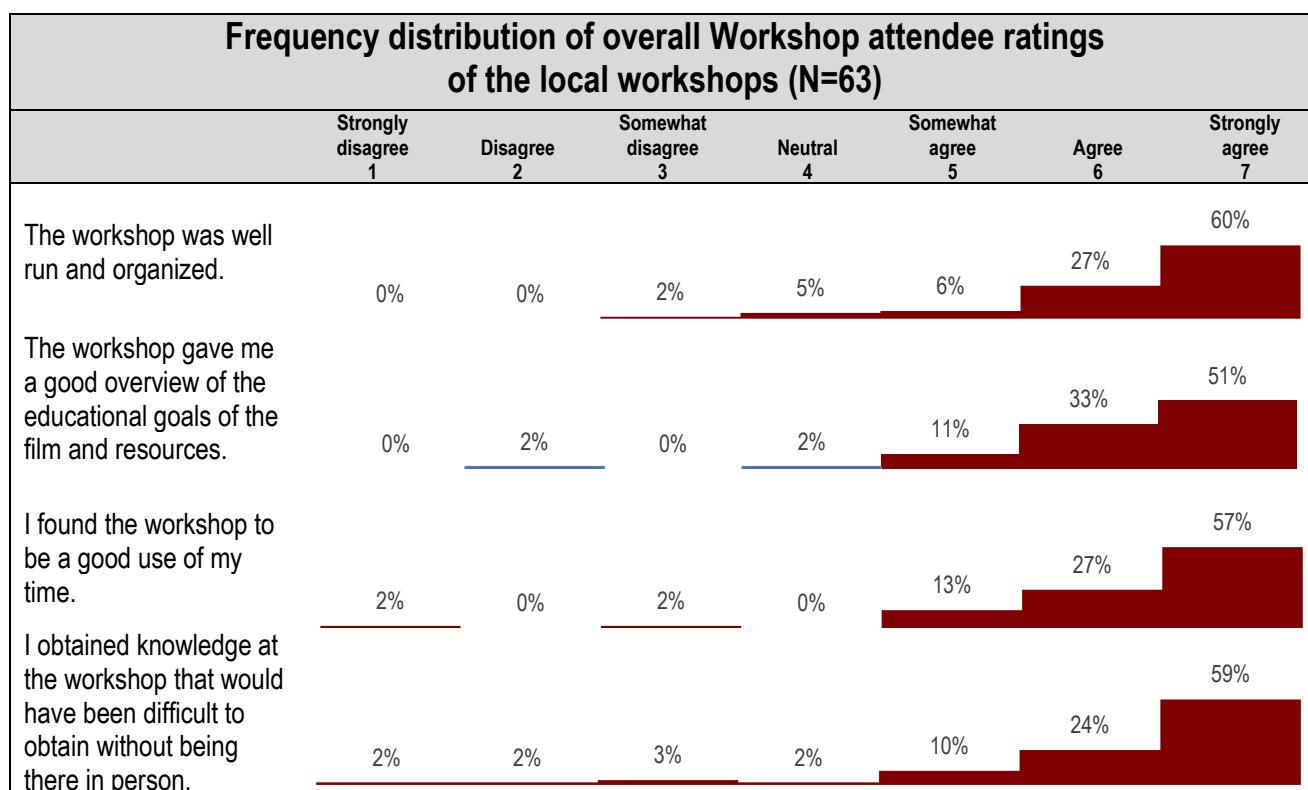
**Miscellaneous (6%)**

- *The fact that it was close, offered food, and paid a little was a blessing*
- *Fun with friends who also teach science*

## 1.2 How did Workshop attendees rate the local workshops?

Overall, the Workshop attendees strongly agreed that their local workshops were well run and organized, gave them a good overview of the educational goals of the film and resources, were a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person.

Workshop attendees were asked to rate their local workshop for the extent to which they agreed or disagreed that it was well run and organized, gave them a good overview of the educational goals of the film and resources, was a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person and on a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), with 4.0 being neutral in each case. The table below presents the percentages of Workshop attendees selecting each rating.



Though there were some differences of opinion, as evidenced by each range of ratings in each case, overall the Workshop attendees strongly agreed (median rating 7.0 each) that the local workshops were well run and organized, gave them a good overview of the educational goals of the film and resources, were a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person.

When invited to elaborate, a number of Workshop attendees shared feedback about their ratings, though none commented on whether the workshops gave them a good overview of the educational goals of the film and the resources. Examples of their responses are shared on the next page:

### **The workshop was well run and organized**

- *Excellent workshop. I loved the movie and hands-on activities.*
- *I was very impressed with how things were ran and must say the food was delightful as well.*
- *The staff was organized and managed the lessons in a manner that informed and was also interesting to the teachers.*

### **I found the workshop to be a good use of my time**

- *It's one of the best workshops I've ever attended. Speakers were very knowledgeable and helpful, and materials will be a good resource to look at when preparing lesson plans.*
- *Sometimes I need to be taken out of where I am to focus on a new idea/learning method. If I were to do it on my own I'd get distracted by [everything] that is yapping at me to do.*
- *Like I said I teach upper levels and felt it was just too geared towards elementary students which I don't feel it made it clear it in the description it was going to be.*

### **I obtained knowledge at the workshop that would have been difficult to obtain without being there in person**

- *I liked the hands on activities afterward. I couldn't have gained the same depth of knowledge by reading about them.*
- *Although I could not replicate the cow eye dissection in my classroom, the experience gave me a much better understanding of how the eye functions. I can explain the workings of vision with greater confidence.*
- *I learned a lot and it really got me thinking about the world around me. I would definitely recommend to everyone.*
- *It was very practical. I was able to immediately apply my learning with my class.*
- *I have access to real world science videos like Making Stuff, but the language is geared for adults. Mysteries of the Unseen world is designed to reach elementary lower grades. I was looking for something that could explain or show abstract concepts in easy ways. That's why I assign the highest rating that you provide.*

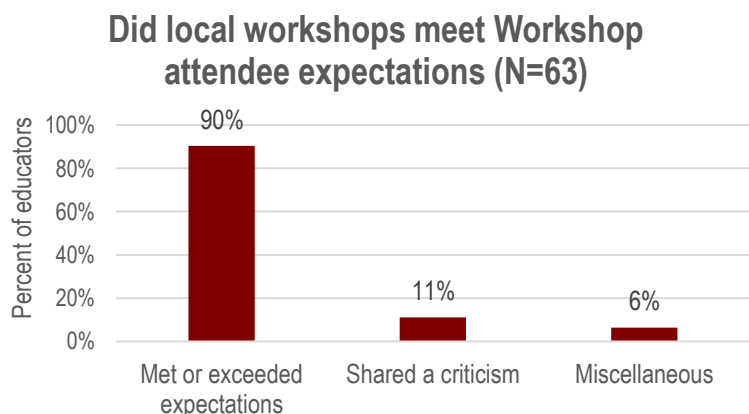
## **1.3 Did the local workshops meet Workshop attendees' expectations, and did they think any topics were omitted or not covered well enough?**

The majority of Workshop attendees indicated that their local workshop met or exceeded their expectations. When asked if there were topics the workshop omitted or didn't cover in enough depth, the largest groups said **No** or decline to answer the question.

As shown in the chart to the right, the majority of Workshop attendees indicated that their local workshop met or exceeded their expectations (90%), while about a tenth shared criticisms of one or more aspects of the workshop (11%) and less than a tenth shared miscellaneous responses (6%). Examples of their responses are shared below:

### **Met or exceeded expectations (90%)**

- *It more than met my expectations. I was pleasantly surprised at the depth of inquiry and the presenters.*



- Yes. It was really interesting and a lot of fun.
- It was an awesome workshop. I have been to many (over 35 years in education) and it was one of the best ran workshops I have attended.
- It did meet my expectations. The film was excellent, the instructors enthusiastic and the activities were interesting.
- Yes, it did. It was very dynamic and all the activities presented can be easily adapted to different grade levels and to different learning styles. Finally, I learned things I didn't know!
- It exceeded my expectations with the wonderful activities around the topic. I was amazed by the new perspectives we were able to experience.

**Shared a criticism (11%)**

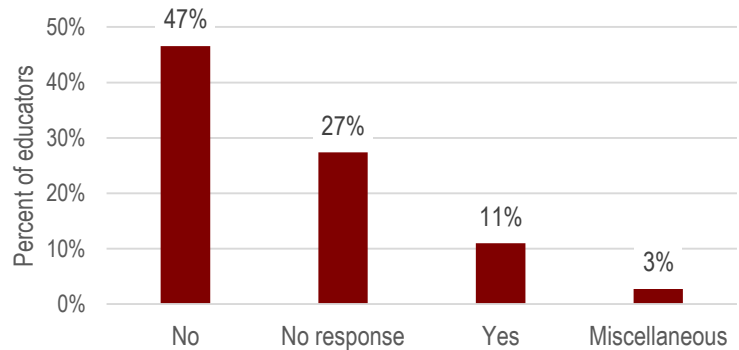
- Unfortunately, most of the things had more to do with the 6th grade core than the 5th grade core (I teach 5th grade).
- For the early childhood field some of the items were too advanced
- Yes, the movie was amazing, but I thought there might be some options for activities for use in the upper levels as well.
- Yes, except the cow eye dissection.
- I expected more interaction between participants and that really didn't happen
- No, unfortunately the "Happy Hour" was unexpected and a waste of my time. I came to learn not socialize. After eating a sandwich I walked around the lobby to find the 4-5 tables of information unmanned. I made my way into the theater and began to close my eyes waiting for the film to start. Also a suggestion would be for the presenter to practice her presentation before the event. I enjoyed the film yet left right after it.
- Activities were not great. Didn't feel that they were aligned and in the era of testing accountability, they needed more alignment to fit the needs of our teachers/students.

**Miscellaneous (6%)**

- I could not stay for the entire workshop and really did not socialize as I did not know anyone there. If there could have been workshops for that time.
- I had no particular expectations. I found the film to be very interesting and engaging.
- I was not sure what to expect, but I thoroughly enjoyed this open house event.
- I didn't know much about the workshop to begin with. I was able to receive some new resources to help me teach science through inquiry.

Next, the Workshop attendees were asked if there were topics their local workshops omitted or didn't cover in enough depth. As shown in the chart to the right, nearly half said No (47%), as in, "No, the material covered was very appropriate" and "[I] can't think of any omissions." More than a quarter declined to answer the question (27%), and just over a tenth pointed to omissions (11%), generally asking for more information about STEM topics and resources targeted at other ages (for example, "I would have liked to have had some attention given to nature's waves (heat, light and sound) and to astronomy, too," "How to use in high school," and "I would have enjoyed items to support the early childhood field...It would be wonderful to offer a portion of the materials to support this age group or a night similar focusing on this young age.") Less than a tenth shared miscellaneous responses (3%), as in, "I thought the workshop was good but the film was the highlight of the evening."

**Did Workshop attendees feel the workshop lacked anything (N=63)**





## Question 2: What feedback did educators share about the film and educational resources?

Workshop attendees who saw *Mysteries of the Unseen World* at their local workshops and Film only attendees who saw it at a science center or museum outside of a workshop were asked to rate the film in terms of overall likeability, visual excitement, clarity of presentation, the likelihood that it would engage and educate their students, and their likelihood of recommending the film. Both groups were also invited to rate the value of the educational resources.

Additionally, Workshop attendees were invited to rate the extent to which they felt they had *learned valuable ways to use the resources* at the workshop and whether or not they thought the workshop should have spent *more time going over the resources*. Finally, Workshop attendees and Film only attendees rated the extent to which they felt *prepared to begin using the resources*, the extent to which they thought the resources would help their students learn about *phenomena that are too fast, slow, or small to see with the naked eye*, and the extent to which they thought the resources would help their students *explore advances in nanoscience and nanotechnology*. These findings are presented below in 2.1 through 2.3.

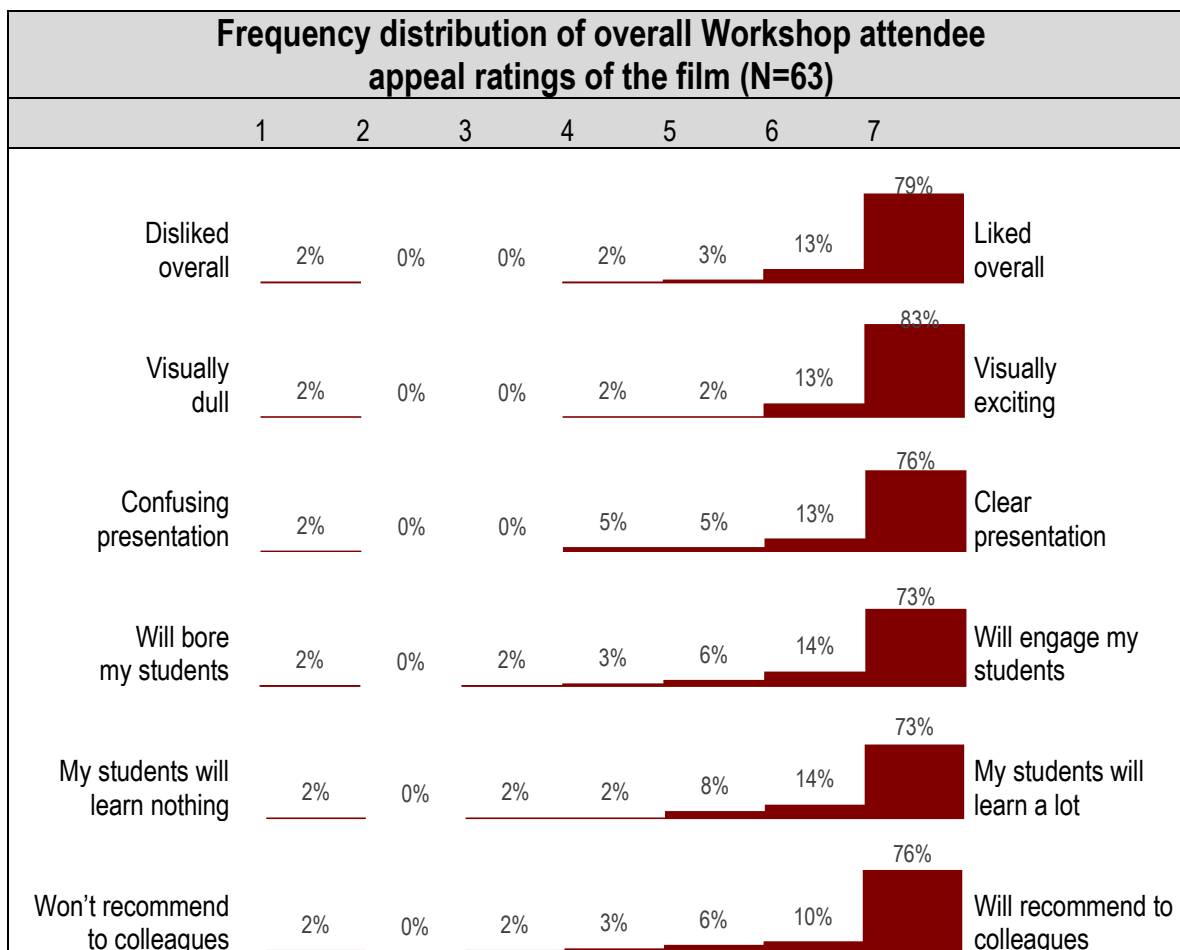
### 2.1 How did educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, likelihood of engaging and educating students, and likelihood of recommending the film?

Workshop attendees and Film only attendees both generally indicated that they liked the film, found it visually exciting, and thought the presentation was clear. Both groups also thought it would engage their students, that their students would learn a lot from the film, and that they would recommend it to their colleagues.

#### **Workshop attendees**

Workshop attendees were asked to rate *Mysteries of the Unseen World* for the extent to which they liked the film, found it visually exciting or dull, thought the presentation was clear, thought it would engage their students, thought their students would learn a lot, and were likely to recommend the film to their colleagues on a scale from 1.0 (rated the lowest) to 7.0 (rated the highest) in each case. The table on the next page presents the percentage of Workshop attendees selecting each rating.

Though there were some differences of opinion, as evidenced by the range of ratings in each case, Workshop attendees generally liked *Mysteries of the Unseen World* (median rating 7.0), found it visually exciting (median rating 7.0), thought the film's presentation was clear (median rating 7.0), thought it would engage their students (median rating 7.0), thought their students would learn a lot from the film (median rating 7.0), and said they were likely recommend the film to their colleagues (median rating 7.0).



When invited to elaborate, a number of Workshop attendees shared additional feedback about their ratings, examples of which are shared below:

**Liked or disliked**

- *Excellent movie.*
- *It was very well done.*
- *I could watch the movie all over and all over again! This is one of the best films I have ever seen in Imax.*
- *The film was well done, and I believe would be good for all ages.*

**Visually exciting or dull**

- *Nothing beats up a 3D show.*

**Clear or confusing presentation**

- *I think it would be easier to use in segments - focusing on each section individually before moving on to the next segment. I found the entire film to be so packed with information it was hard to really focus on any one aspect of it.*

**Will engage or bore my students**

- *The knowledge is not very in-depth, but it is very engaging.*
- *Students will love it. It was very engaging for children and adults.*
- *The only thing I thought was it might scare young students.*
- *The younger the students, the less they are likely to become engaged by some of the details, since they don't have the background to understand the nature of light and color. Nonetheless, the film could get them questioning and wondering if the teacher follows up on the ideas.*

- *I feel that my elementary students will become bored. The novelty of having the glasses will wear off quickly and the film was not captivating.*

**My students will learn a lot or nothing**

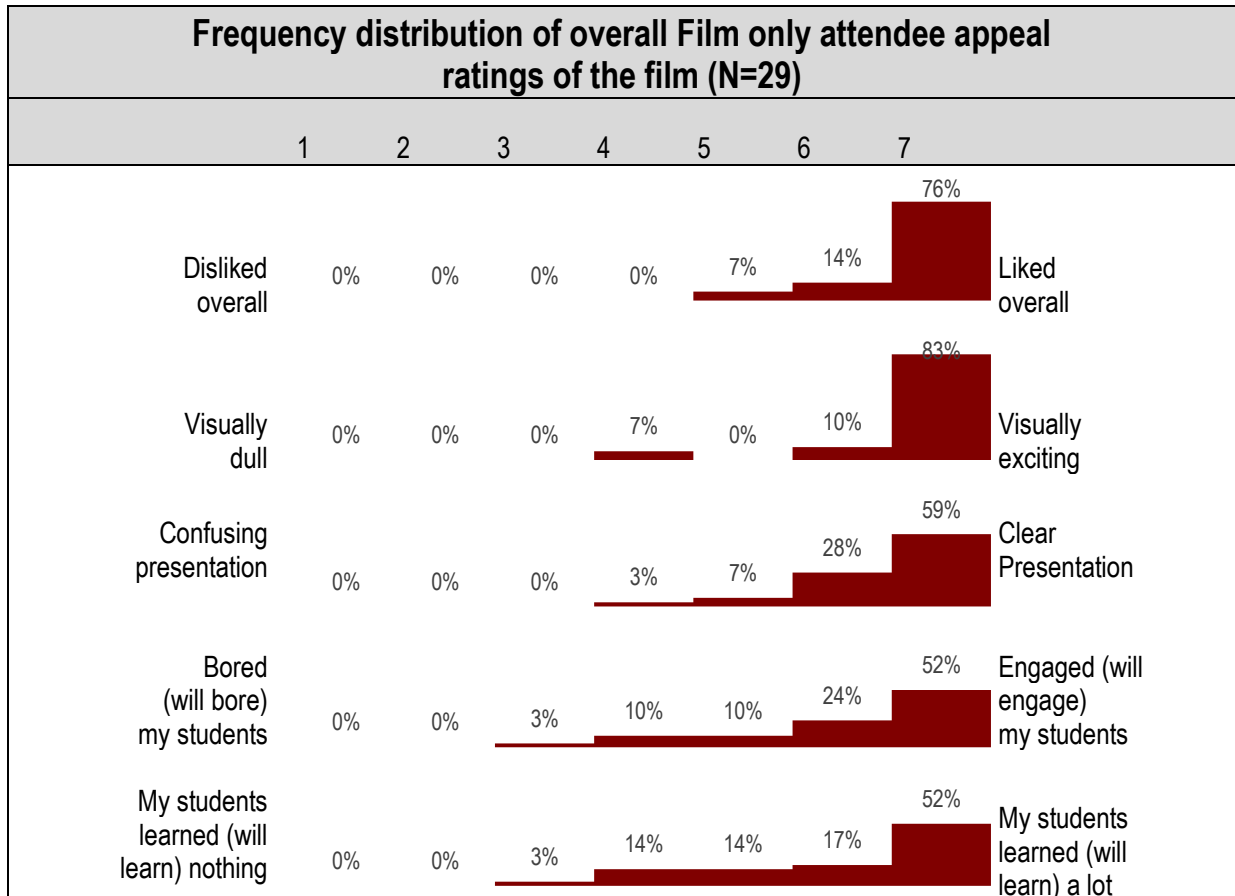
- *I felt the film would make a great connection with the subject the students are being taught. It was interesting and the explanations were very understandable for the students.*
- *Great way to extend upon classroom materials because it showcases technologies that are unable in most classrooms and address concepts that are difficult to visualize for students.*
- *I work with providers of children 5 or younger, this film was to high to meet the young child's cognitive skills. But I would recommend to anyone working with school age children*

**Will or won't recommend to colleagues**

- *I work with providers of children 5 or younger, this film was to high to meet the young child's cognitive skills. But I would recommend to anyone working with school age children*

**Film only attendees**

Film only attendees were asked to rate the extent to which they liked the film, found it visually exciting or dull, thought the presentation was clear, thought it would (or did) engage their students, and thought their students would (or did) learn a lot on a scale from 1.0 (rated the lowest) to 7.0 (rated the highest) in each case. The table below presents the percentage of Film only attendees selecting each rating.



Though there were some differences of opinion, as evidenced by the range of ratings in each case, Film only attendees generally liked *Mysteries of the Unseen World* (median rating 7.0), found it visually exciting (median rating 7.0), thought the film’s presentation was clear (median rating 7.0), thought it would or did engage their students (median rating 7.0), and thought their students would or did learn a lot from the film (median rating 7.0).

When invited to elaborate, a number of Film only attendees shared additional feedback about their ratings, examples of which are shared below:

**Liked or disliked**

- *I loved the film and recommended it to my colleagues for most of our first through fifth grade students.*
- *I really liked all the variety of things that are unseen for so many different reasons.*

**Visually exciting or dull**

- *Emphasized with 3D many facts that are taught in the various Sciences in middle school*
- *Great visuals*

**Clear or confusing presentation**

- *Good explanations*

**Will (or did) engage or bore my students**

- *The movie was extremely informative, moved quickly enough to hold the attention of my students, and was presented in an entertaining manner.*
- *The subjects you chose will be familiar to students, but they will experience them in ways they have never imagined.*
- *I learned a lot and I thought it would be over my 5 yr. old grandson’s head, but he thought it was very exciting, too!*

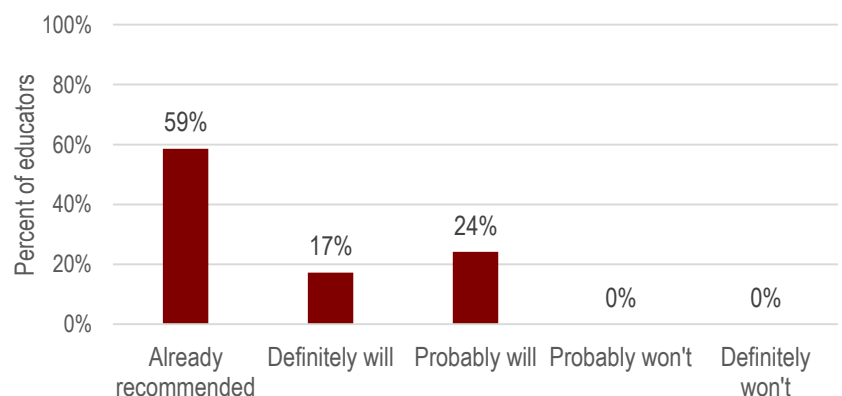
**My students will learn (or learned) a lot or nothing**

- *My son is 15 years old and he loved it and amazed with what he learned. He is still talking about it.*
- *I teach K - 2nd Special Education. The movie was not horrible or not educational, but for my students it would be too high of a level.*
- *It was a very in depth movie that I'm not sure my First graders will fully understand, but I think they will enjoy most of it.*
- *I'm not sure it would be appropriate for all of my students.*
- *IMAX movies are overwhelming for students.*

**Likelihood to recommend**

Separate from the rating questions, Film only attendees were asked about the likelihood that they would recommend the film to their colleagues. As shown in the chart to the right, the majority explained that they already had recommended the film to their colleagues (59%). Less than a fifth said they *definitely would* (17%) and about a quarter noted that they *probably would* (24%). None of the Film only attendees indicated that they *probably wouldn't* (0%) or *definitely wouldn't* (0%) recommend the film.

**How likely Film only attendees were to recommend the film to colleagues (N=29)**



## 2.2 How did educators rate the value of the educational resources?

Workshop attendees who had used the resources generally thought the online activities/lessons and the iPad app/game were both extremely valuable. Overall, they found the educator DVD, Museum Educator Guide and poster, website, online videos, standards sheet, and “fun facts” handout to be very valuable.

Film only attendees who had used the resources generally found the educator DVD, website, and online videos to be between very and extremely valuable. Overall, they also indicated that the following resources were each very valuable: the Museum Educator Guide, the standards sheet, the online activities and lessons, and the iPad app/game. Finally, they noted that they generally found the poster and “fun facts” handout to be moderately valuable.

### **Workshop attendees**

Workshop attendees were asked to rate the value of the following educational resources on a scale from 1.0 (not at all valuable) to 5.0 (very valuable) each: educator DVD, Museum Educator Guide and poster, website, online videos, standards sheet, “fun facts” handout, online activities/lessons, and iPad app/game. Workshop attendees who hadn’t used a resource or thought it wasn’t applicable to their setting were instructed to select Not Applicable. The table on the next page presents the percentages of Workshop attendees selecting each rating.

Though there were some differences of opinion, as evidenced by each range of ratings in each case, Workshop attendees who had used each resource generally found the online activities and lessons extremely valuable (median rating 5.0) and the iPad app/game extremely valuable (median rating 5.0). They also found the following resources to be very valuable (median rating 4.0 each): educator DVD, Museum Educator Guide and poster, website, online videos, standards sheet, and “fun facts” handout.

When invited to elaborate, some of the Workshop attendees shared additional feedback about their ratings, examples of which are shared below:

#### **Educator DVD**

- *I would like to receive an educators dvd with resources.*
- *The disc didn't work when I tried it. So I couldn't access the information on it.*
- *The Educator DVD has no audio with the clips from the movie. :(*
- *The DVD will not play on my school Dell computers, but it will play on the Mac at home.*
- *Disc did not work*

#### **Museum Educator Guide**

- *Didn't see educator guide and poster*
- *I didn't receive an Educator Guide*

**Poster**

- Didn't see educator guide and poster

**Standards sheet**

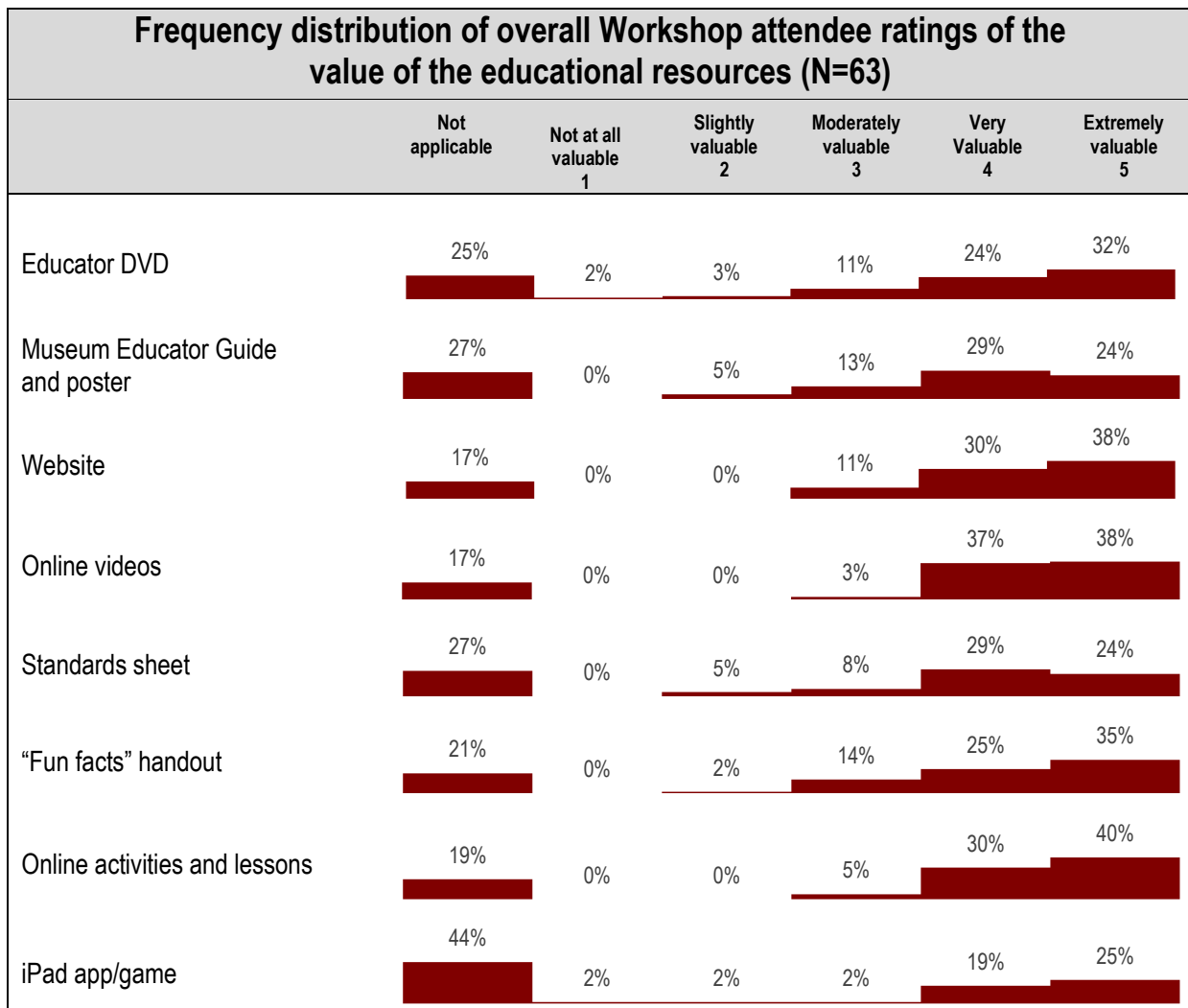
- Explain standard sheets to me. Is it just papers? I like easy access to great high quality educational sources.

**Online activities and lessons**

- All of the activities were engaging.

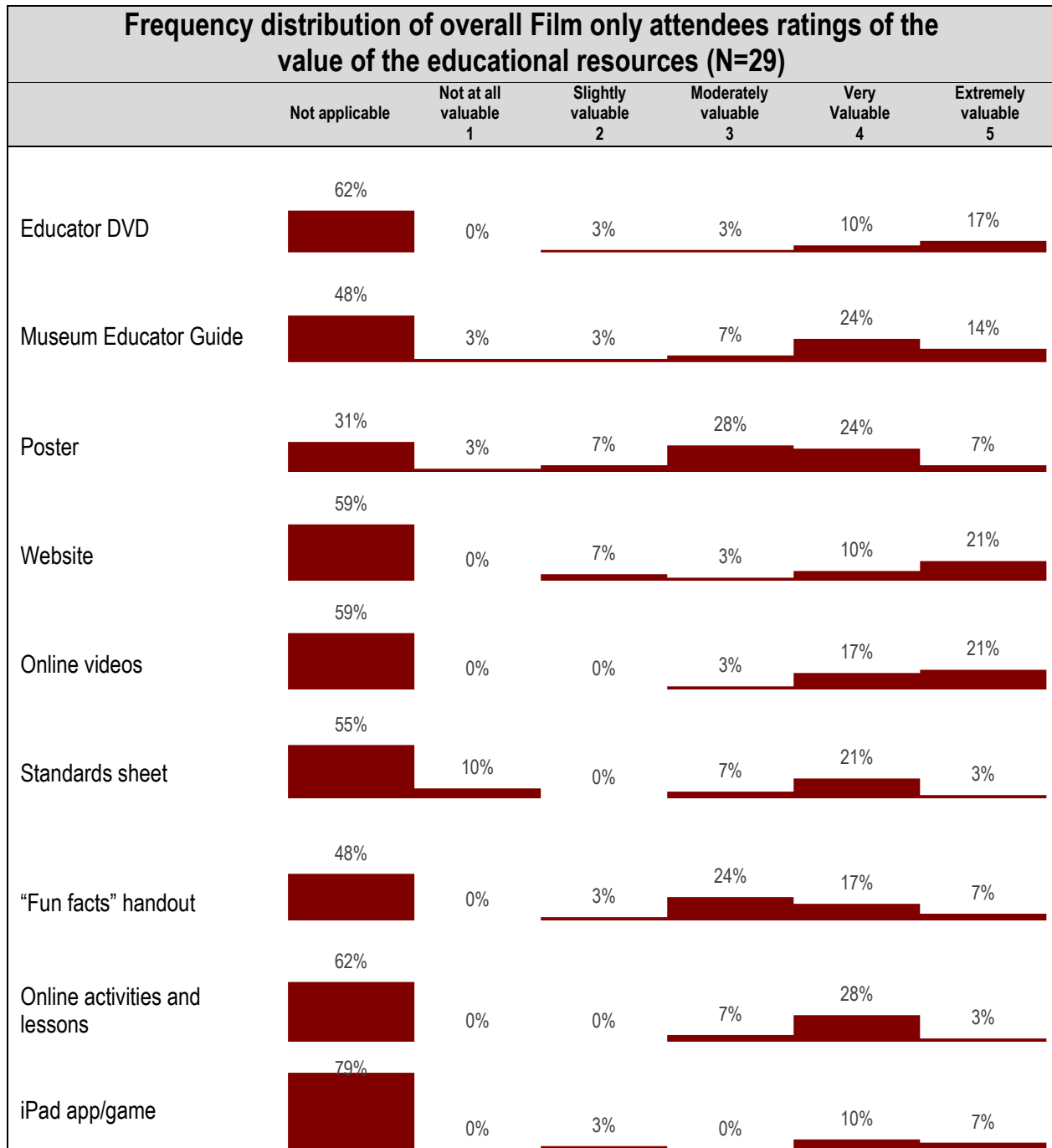
**iPad app/game**

- Where is the iPad app/game? Do I need to download that? Is an iPad required? Can a Chromebook, or other technological tool be used instead?
- Our students don't have iPads.
- I didn't realize there was an iPad app/game.



**Film only attendees**

Film only attendees were asked to rate the value of the following educational resources on a scale from 1.0 (not at all valuable) to 5.0 (very valuable) each: educator DVD, Museum Educator Guide, poster, website, online videos, standards sheet, “fun facts” handout, online activities/lessons, and iPad app/game. Those who hadn’t used a resource or thought it wasn’t applicable to their setting were instructed to select Not Applicable. The table below presents the percentages of Film only attendees selecting each rating.



Though there were some differences of opinion, as evidenced by the range of ratings in each case, Film only attendees who had used each resource generally found the educator DVD, website, and online videos to be between very and extremely valuable (median rating 4.5 each). Overall, they also indicated that the following resources were each very valuable (median rating 4.0 each): the Museum Educator Guide, the standards sheet, the online activities and lessons, and the iPad app/game. Finally, they noted that the poster and “fun facts” handout were both moderately valuable (median rating 3.0 each).

When invited to elaborate, a handful of Film only attendees shared additional feedback. Rather than providing feedback about specific resources, they commented on how they didn’t have the resources, how they did not or could not use them (specifically because of technology, in some cases), how they hadn’t had time to review the resources, or how they had used or planned to use them. Examples of their responses are shared below:

- *Didn't receive the teacher resources*
- *I do not know where to find some of these resources - I would like to check them out.*
- *I don't teach Science.*
- *MUW is not applicable to my age group.*
- *I do not have access to iPads where I teach.*
- *We limit the use of technology in the classroom to research purposes only. We do not usually use resources such as DVD's, apps, or online activities*
- *I haven't had a chance to check them all out yet.*
- *In our gifted program we teach a variety of classes to a range of students. The materials, therefore will be applicable to varying degrees across our curricula.*
- *I recently retired, so I won't be using these. However, I would have used them if I was teaching. I will share the info with other teachers though.*
- *I hung the poster in my classroom, but have not looked at the DVD and did not know about these other items available.*
- *I have already begun to prepare some of the activities from the Educator DVD. I look forward to checking on the online videos and Website. (Have not used them yet)*



## 2.3 How did educators rate the workshop's coverage of the educational resources, their level of comfort in using the resources, and the potential impact on students?

Overall, Workshop attendees agreed that they *learned valuable ways to use the resources in [their] local setting*, that they felt *adequately prepared to begin using the resources*, that *the resources will help their students learn about phenomena that are too fast, slow, or small to see with the naked eye*, and that *the resources will help [their] students explore advances in nanoscience and nanotechnology*. They were generally neutral about if they would have *preferred the workshop spend more time going over the resources*.

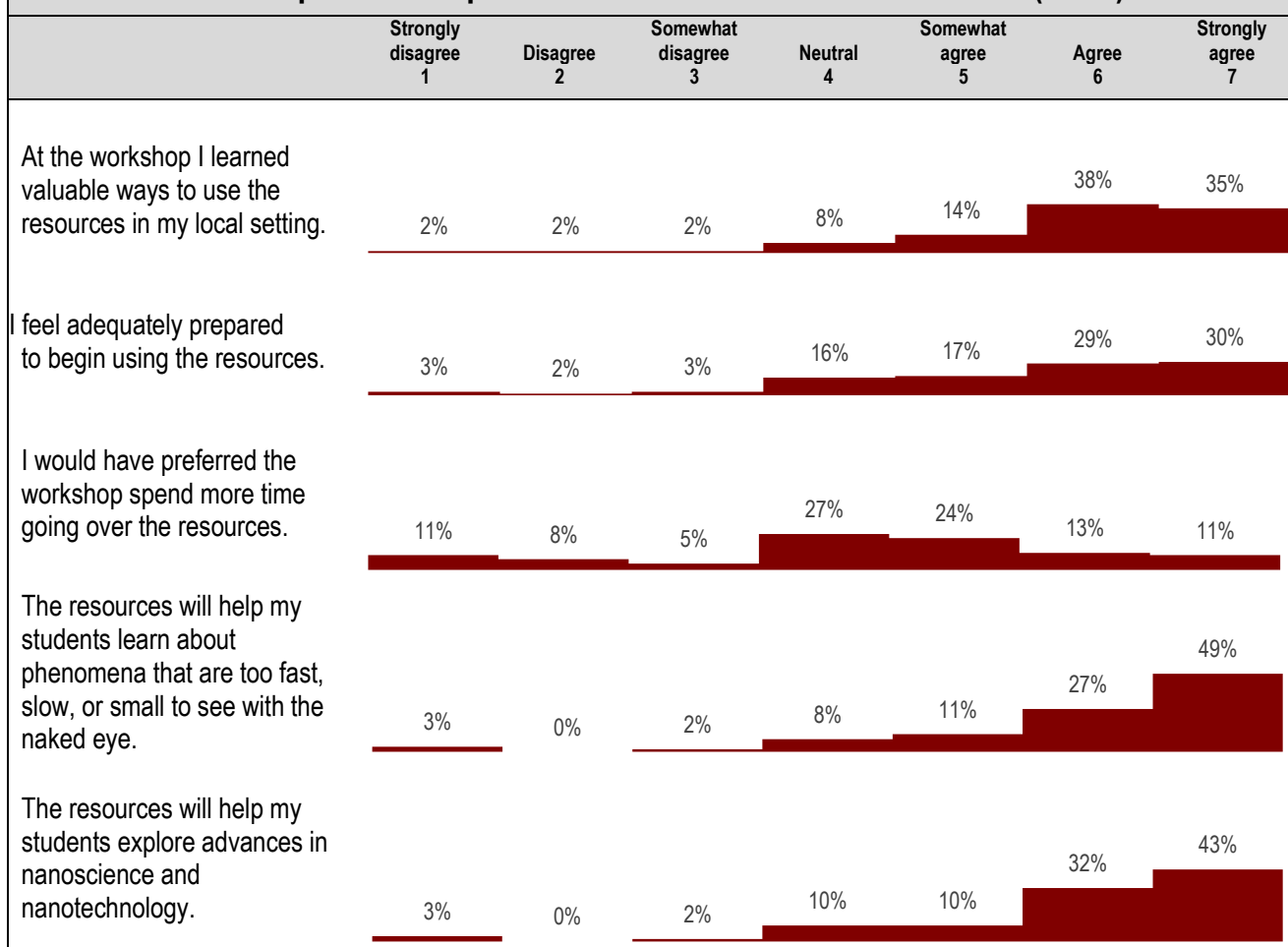
At the same time, Film only attendees who indicated that they had used the resources somewhat agreed to agreed that *the resources have helped (or will help) their students explore advances in nanoscience and nanotechnology*. They also somewhat agreed that they felt (or feel) *adequately prepared to begin using the resources* and that *the resources have helped (or will help) their students learn about phenomena that are too fast, slow, or small to see with the naked eye*.

### **Workshop attendees**

Workshop attendees were asked to rate their agreement with a series of statements about the workshop's coverage of the educational resources, their level of comfort in using the resources, and the potential impact on students on a scale from 1.0 (strongly disagree) to 7.0 (strongly agree) with 4.0 being neutral in each case. The table on the next page presents the percentage of Workshop attendees selecting each rating.

Though there were some differences of opinion, as evidenced by each range of ratings in each case, overall the Workshop attendees agreed that they *learned valuable ways to use the resources in [their] local setting* (median rating 6.0), that they felt *adequately prepared to begin using the resources* (median rating 6.0), that *the resources will help their students learn about phenomena that are too fast, slow, or small to see with the naked eye* (median rating 6.0), and that *the resources will help [their] students explore advances in nanoscience and nanotechnology* (median rating 6.0). They also were neutral about if they would have *preferred the workshop spend more time going over the resources* (median rating 4.0).

**Frequency distribution of overall Workshop attendee ratings of the local workshops' coverage of the educational resources, their comfort in using the resources, and the potential impact of the resources on their students (N=63)**

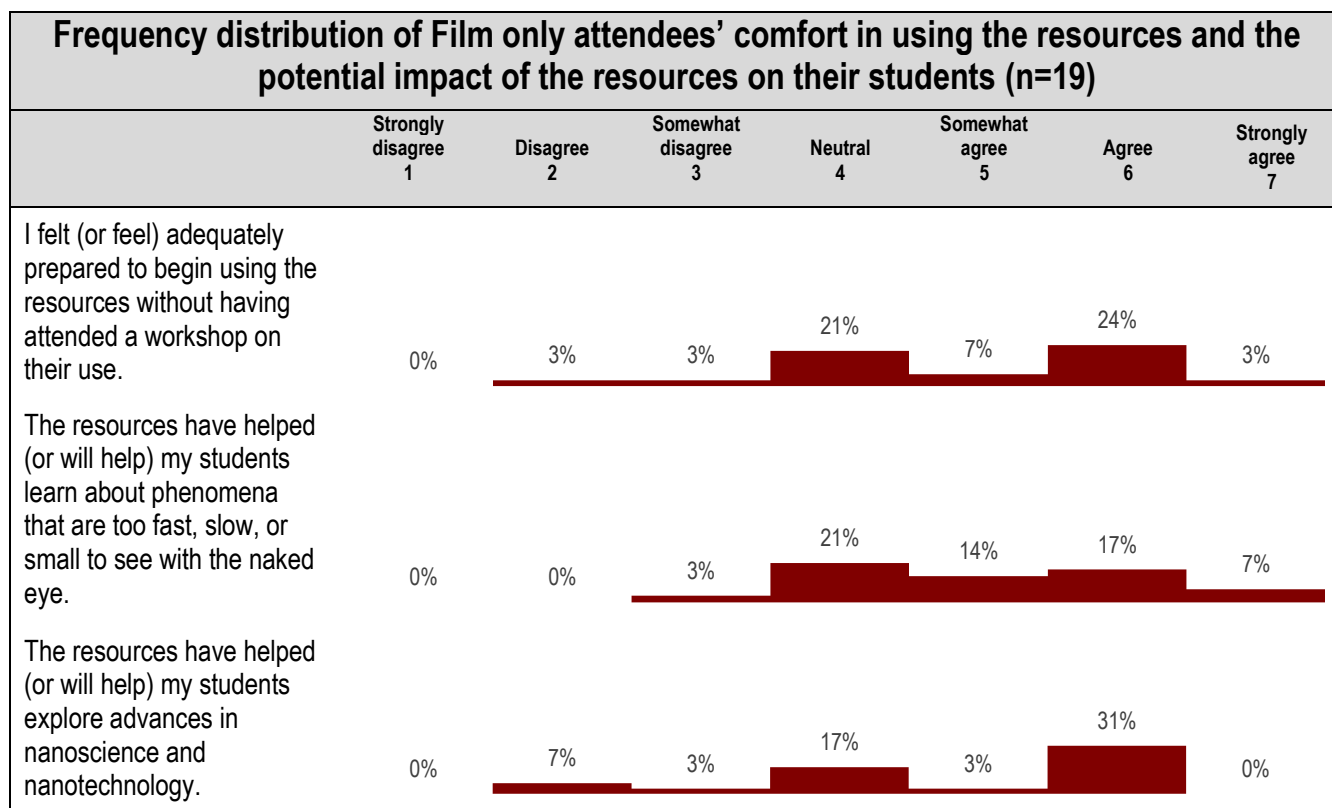


A handful of educators opted to elaborate on their ratings, as in:

- They had some of the activities set up & gave out the website to look up more information.
- Still not sure how to use in my classroom fully but I am excited about it and feel encouraged to try. It is like I have been told a child needs to be introduced to a vegetable 5-7 times before they will eat it sometimes I feel like I have to be exposed to new teaching techniques a number of times to feel competent to teach it.
- I usually prefer to have resources given but to use my own time to go through and explore them, since I know what I need and what would best fit my students. Class time is better spent on activities.
- More hands on time
- Really great way to explain nano science.
- When I first thought of nanotechnology the only thing that cam to mind were tiny computers and medical science. I didn't realize all that it encompassed.
- The movie supports my goals of helping students see themselves as future engineers, architects and chemists.

### **Film only attendees**

Film only attendees who indicated that they had used the resources (n=19) were asked to rate their agreement with a series of statements about their level of comfort in using the resources and the potential impact on students on a scale from 1.0 (strongly disagree) to 7.0 (strongly agree), with 4.0 being neutral in each case. The table below presents the percentage of Film only attendees selecting each rating.



Though there were some differences of opinion, as evidenced by each range of ratings in each case, in general the Film only attendees who indicated that they had used the resources somewhat agreed to agree that *the resources have helped (or will help) their students explore advances in nanoscience and nanotechnology* (median rating 4.5). They also somewhat agreed that they felt (or feel) *adequately prepared to begin using the resources* (median rating 5.0) and that *the resources have helped (or will help) their students learn about phenomena that are too fast, slow, or small to see with the naked eye* (median rating 5.0).

A handful of Film only attendees opted to elaborate on their ratings, as in:

- *Have not yet been used; however, I can tell that they are useful activities to have and will be quite helpful in preparing lessons!*
- *At this time MUW is above the level of my students' understanding.*
- *There was not enough information in the resources and not written for my level.*

### Question 3: How had educators used the resources and/or how did they intend to use them within 12 months?

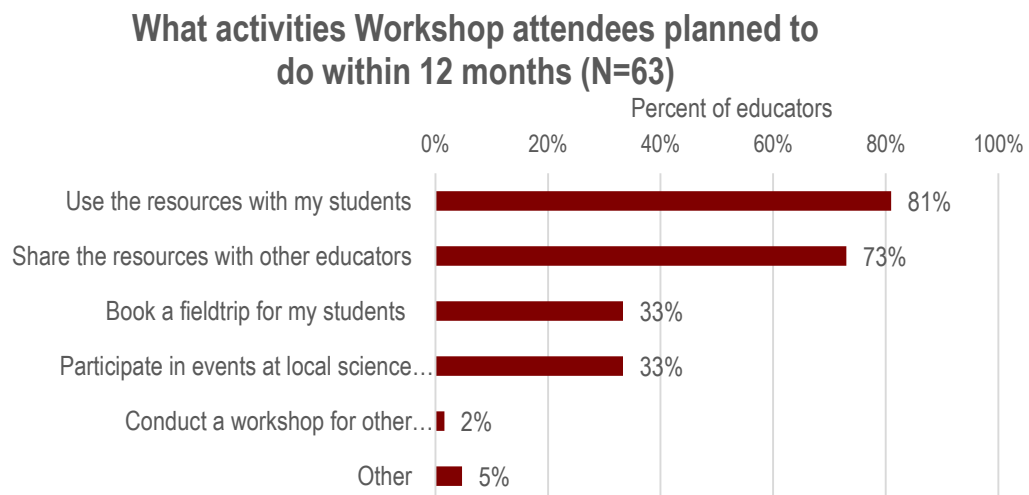
Workshop attendees and Film only attendees were both asked which if any of the *Mysteries of the Unseen World* activities they had done or planned to do within 12 months. They were also asked to comment on the resources they had used or planned to use within the same timeframe, how they used or foresaw using them, the number of students they had reached or thought they would reach with the resources, the challenges or obstacles they had encountered or thought they might encounter, and whether they expected to use the film and its educational resources to encourage students' interest in STEM or STEM careers. Finally, they were asked if their use of the film and its educational resources had or would help facilitate outreach among underserved students. These findings are presented below in 3.1 through 3.5.

#### 3.1 Which activities had educators done and/or did they plan to do within 12 months?

Of Workshop attendees, the largest groups explained that they planned to use the *Mysteries of the Unseen World* resources with their students and/or planned to share the resources with other educators within the next 12 months. The largest groups of Film only attendees said they had shared the resources with other educators and/or participated in *Mysteries of the Unseen World* activities or events at their local science center or museum. At the same time, the largest groups of Film only attendees who were planning to use the resources indicated that they intended to use them with their students, share them with other educators, and/or take their students to see the film within 12 months.

##### Workshop attendees

As shown in the chart below, when asked which activities they planned to do within 12 months, more than four-fifths of Workshop attendees explained that they planned to use the *Mysteries of the Unseen World* resources

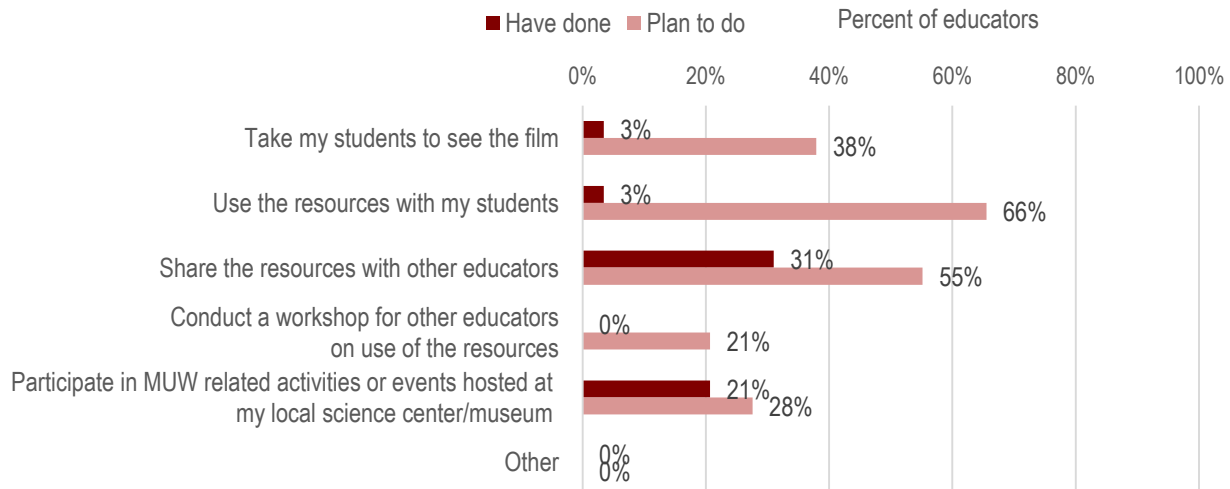


with their students (81%), while a slightly smaller group of just under three-quarters planned to share the resources with other educators (73%). A third each planned to book a field trip with their students to see the film (33%) and/or participate in *Mysteries of the Unseen World* events at the science center or museum that hosted the workshop (33%). A handful planned to conduct a workshop for other educators on use of the resources (2%) and/or share miscellaneous responses (5%), such as “visit with my family” and “possibly try to book film.”

**Film only attendees**

Film only attendees were asked which activities they had done or planned to do within 12 months. As shown in the chart below, of activities they *had* done, the largest group of about a third had shared the resources with other educators (31%). About a fifth had participated in *Mysteries of the Unseen World* activities or events at their local science center or museum (21%), and a handful each had taken their students to see the film (3%) and/or used the resources with their students (3%).

**Activities educators have done or plan to do within 12 months of viewing (N=29)**



In terms of what they planned to do, as shown in the chart above, the largest group of Film only attendees, two-thirds, indicated that they intended to use the resources with their students within 12 months (66%). More than half planned to share the resources with other educators (55%), and more than a third said they would take their students to see the film (38%). More than a quarter explained that they would participate in *Mysteries of the Unseen World* activities or events at their local science center or museum (28%), and about a fifth said they would conduct a workshop for other educators on the use of the resources (21%). None of the Film only attendees pointed to other activities they had done or would do within 12 months. The Film only attendees who indicated that they didn't plan to do any activities related to *Mysteries of the Unseen World* in the next 12 months were asked why this was the case. As shown in the responses below, two mentioned the expense of visiting the science center/museum (7%) and one each said their field trips for the year were already planned (3%), that they didn't know about the activities (3%), that the material would be too advanced for their students (3%), and that they don't teach science (3%), as in:

- *The cost is prohibitive after paying for a bus as well. I plan on telling my students how cool it is and encouraging them to see it with their families.*
- *Our field trips for this year were already planned, and bus cost to the Science Center has been an issue in the past.*
- *I didn't know there was a website with activities*

### 3.2 Which resources had educators used or did they plan to use within 12 months, how did they use or foresee using them, and how many students did they reach or think they would reach?

Workshop attendees thought they were most likely to use the website or online videos, followed by the “fun facts” handout, educator DVD, online activities and lessons, and Museum Educator Guide and poster. The majority expected to use these resources in a classroom or afterschool setting, and the majority expected to use them in elementary or middle school programming. Fifty (50) Workshop attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 6,498 students.

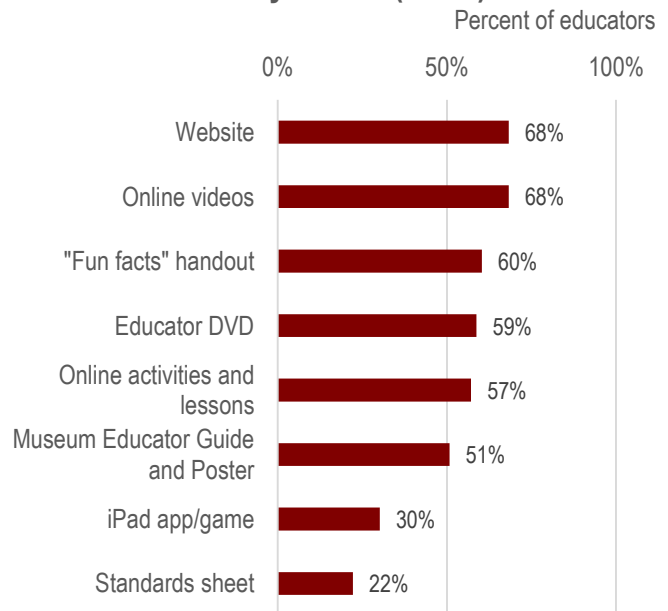
Small groups of Film only attendees indicated that they had used the Museum Educator Guide, poster, and “fun facts” handout, with other resources being used by even smaller groups. At the same time, Film only attendees who noted which resources they *planned* to use most often pointed to the poster, website, online videos, educator DVD, “fun facts” handout, and online activities/lessons, among other resources. The largest group expected to use these resources in a classroom or afterschool setting, and the largest groups expected to use them in elementary or middle school programming. Thirteen (13) Film only attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 894 students.

#### 3.2a Resources educators were most likely to use

##### Workshop attendees

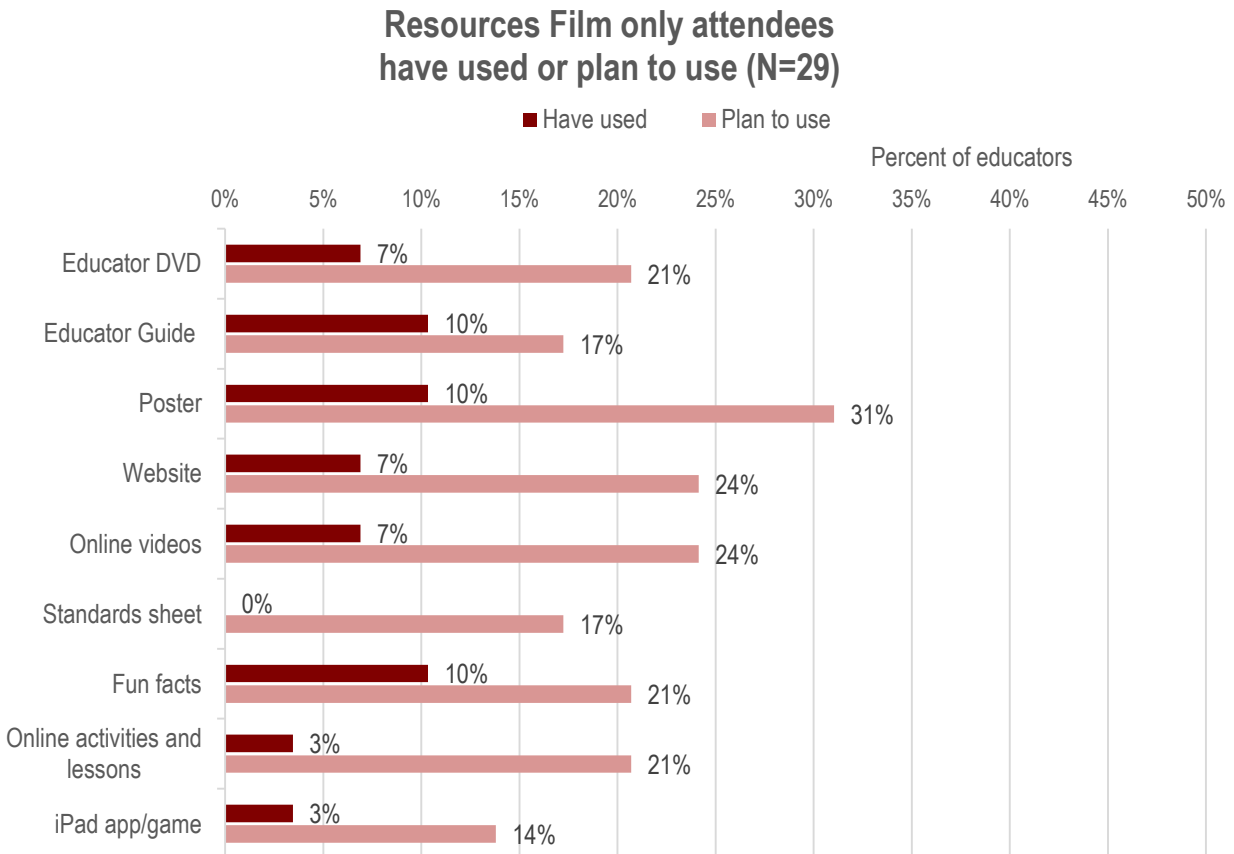
Workshop attendees were asked to reflect on the various *Mysteries of the Unseen World* resources they were introduced to during the workshop, and to indicate which they were most likely to use in their educational setting. As the chart to the right shows, nearly three-quarters each (68% each) pointed to the website and online videos. Slightly smaller groups pointed to the “fun facts” handout (60%), educator DVD (59%), and/or online activities and lessons (57%). About half pointed to the Museum Educator Guide and poster (51%) while nearly one-third pointed to the iPad app/game (30%) and one-fifth to the standards sheet (22%).

Educational resources Workshop attendees thought they were most likely to use (N=63)



### Film only attendees

Recognizing that Film only attendees may have seen the film some time prior to receiving the survey request, this group of educators were asked to indicate which resources they *had* used or *planned* to use. As shown in the chart below, a tenth each of Film only attendees indicated that they *had* used the Museum Educator Guide (10%), poster (10%), and “fun facts” handout (10%). Less than a tenth explained that they had used the educator DVD (7%), website (7%), online videos (7%), online activities and lessons (3%), and iPad app/game (3%).



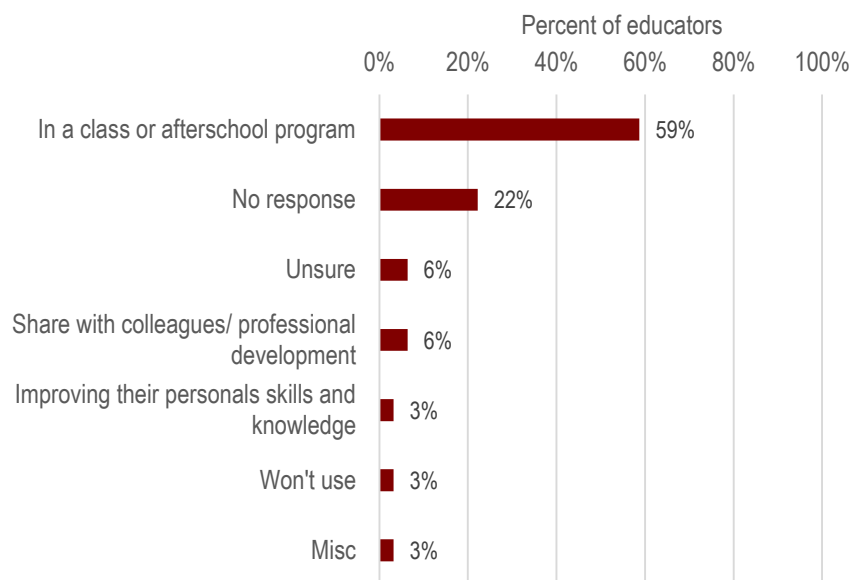
With respect to what they *planned* to use, the largest group, about a third, pointing to the poster (31%). Just under a quarter each thought they would use the website (24%) and online videos (24%), while about a fifth each planned to use the educator DVD (21%), “fun facts” handout (21%), and/or the online activities and lessons (21%). About a sixth each indicated they would use the Museum Educator Guide (17%) and/or the standards sheet (17%), and a slightly smaller group thought they would use the iPad app/game (14%).

## 3.2b How educators were most likely to use the resources

### Workshop attendees

When asked how they intended to use the educational resources, more than half of the Workshop attendees explained that they would be used in a classroom or afterschool setting (59%), as shown in the chart below. Less than one-tenth each said they were unsure (6%), described how the resources would be shared with colleagues or used for professional development (6%), said they would be used to improve their personal skills and knowledge (3%), explained that they weren't planning to use them (3%), or gave miscellaneous responses (3%). More than a fifth of Workshop attendees declined to answer the question (22%).

**How attendees intend to use educational resources (N=63)**



Examples of feedback from Workshop attendees are shared below:

#### **In a classroom or afterschool setting (57%)**

- *I will use these things to help strengthen my science lessons.*
- *Once the test is over, I plan on following the lesson plan used at my training as closely as possible.*
- *I can use the poster and the videos to help show examples to go with the lesson being taught. What student doesn't like fun facts.*
- *All can be included in my classes*
- *When some of my students need to be retaught, I can use some of this for extension learning for the ones that have learned it already.*
- *To "hook" my students as we begin our unit on microscopy.*
- *We are studying plants and I plan to use the time lapse app to record beans sprouting.*
- *I started using the part on how the eye sees.*
- *These will be great resources that I will utilize as they correspond directly with the 6th grade core curriculum.*
- *The videos will be used to help explain what students are experiencing in the hands-on activities, either before or after the activity.*
- *During our after school science club.*



**Unsure (6%)**

- *I really need to explore the online activities and iPad app/game to determine application in my classroom.*
- *Awaiting grant that will allow programming in after-school setting*
- *I am honestly not quite sure yet but I am still trying to work out how I will use them in my mind.*

**Shared with colleagues/used for professional development (6%)**

- *Sharing the information to staff with older students of which they may find more appropriate for their classes.*
- *I plan on sharing resources with other educators*
- *Age group I work with is too young. But I did share the resource with a co worker that supports afterschool programs, I also encourage her to attend any future events you offered. I would still attend because overall you shared wonderful info and I like to keep informed of resource in the...area.*
- *Professional development sessions.*

**To improve personal skills and knowledge (3%)**

- *I think having the DVD to use as a resource to refresh my learning is great.*
- *Enhancement*

**Won't use them (3%)**

- *Right now it doesn't fit into the Core that I teach*
- *I'm a coordinator so I am not directly with students*

**Miscellaneous (3%)**

- *I will work on grants to obtain science tools to motivate my students to gain knowledge*
- *I think I missed much of this information*

**Film only attendees**

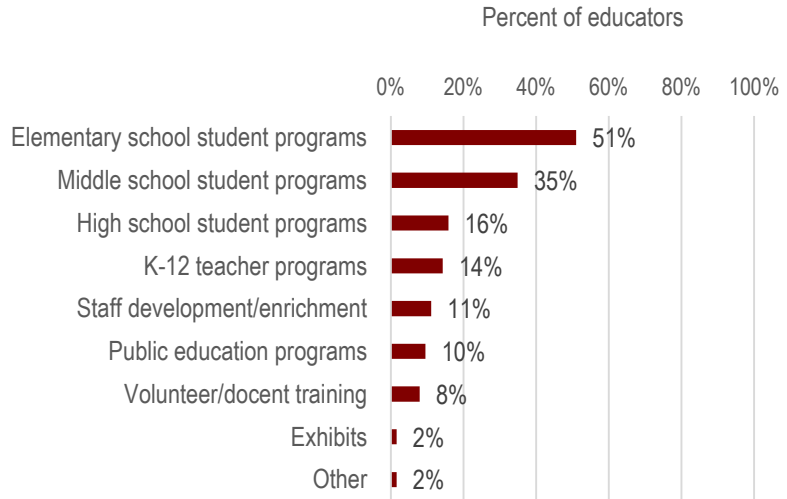
Two-thirds of Film only attendees declined to answer the question (66%) about how they would use the resources. The largest group, about one-seventh, said they would use the resources in a classroom or afterschool setting (14%), as in, "*Some of the resources fit into classes we offer on microscopy, photography, and robots*" and "*I plan to use them with my students. I may need to adapt the information to bring to their level.*" One educator said s/he would use them in a workshop (3%), as in, "*I will use these in a workshop with teachers and make them aware of the resources,*" and another said s/he would use them as note supplements (3%). A tenth described why they wouldn't be using the resources (10%), as in, "*too advanced for my students*" and "*I don't teach science.*"

### 3.2c Program areas for using resources

#### Workshop attendees

Workshop attendees were also asked to specify in which program areas they foresaw using the resources. As the chart to the right shows, about half expected to use the resources in elementary student programs (51%) while just over a third pointed to middle school student programs (35%). Smaller groups expected to use the resources in high school student programs (16%), K-12 teacher programs (14%), staff development/enrichment (11%) public education programs (10%), volunteer/docent training (8%), exhibits (2%), and other program areas (2%).

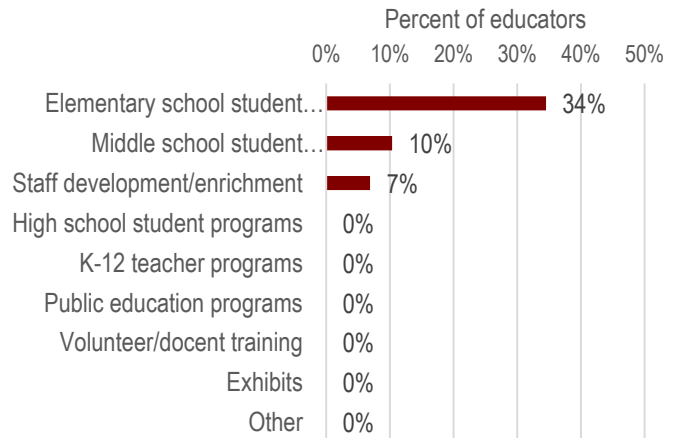
**Program areas in which Workshop attendees expected to use the resources (N=63)**



#### Film only attendees

Film only attendees were also asked to specify in which program areas they foresaw using the resources. As the chart to the right shows, just over a third expected to use the resources in elementary student programs (34%) while a tenth pointed to middle school student programs (10%). Less than a tenth indicated that they would use the resources with staff development/enrichment program (7%). None expected to use the resources in high school student programs, K-12 teacher programs, public education programs, volunteer/docent training, exhibits, and other program areas.

**Program areas in which Film only attendees expected to use the resources (N=29)**



### 3.2d Approximate number of students reached by the resources

#### **Workshop attendees**

Fifty (50) Workshop attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 6,498 students. From those who provided estimates, responses ranged from a low of 20 to a high of 1,000, averaging 130 per Workshop attendee.

<b>Workshop attendees (n=50)</b>	
Low	20
High	1,000
Average	130
Total	6,498

#### **Film only attendees**

Thirteen (13) Film only attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 894 students. From those who provided estimates, responses ranged from a low of 7 to a high of 150, averaging 69 per Film only attendee.

<b>Film only attendees (n=13)</b>	
Low	7
High	150
Average	69
Total	894

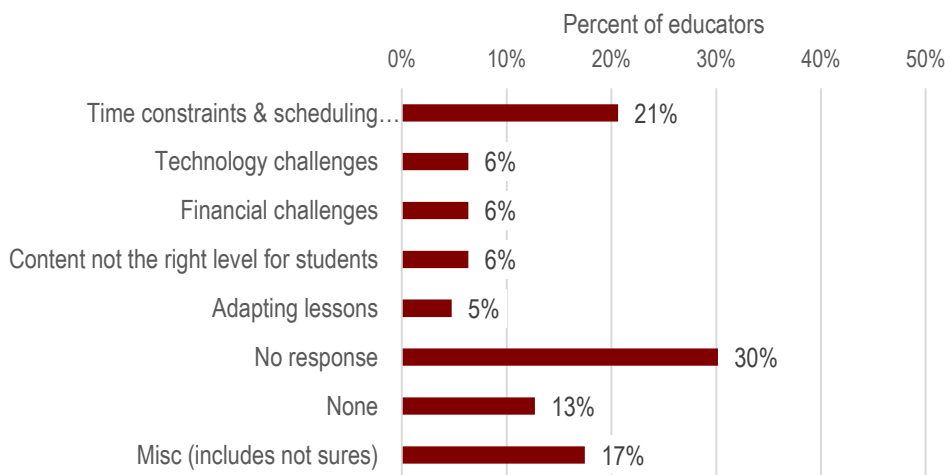
### 3.3 What challenges or obstacles did educators encounter or think they might encounter in implementing the resources?

Of Workshop attendees, the largest groups pointed to time constraints and scheduling challenges, said they didn't think they would encounter any challenges, or declined to answer the question. When asked if they had encountered or thought they would encounter a challenge or obstacle in implementing the resources, the largest groups of Film only attendees declined to answer the question or said they hadn't encountered or didn't think they would face any challenges.

#### **Workshop attendees**

When asked what challenges or obstacles they thought they might face in implementing the *Mysteries of the Unseen World* resources, Workshop attendees shared a range of comments. As shown in the chart below, of those who pointed to a specific challenge or obstacle, about a fifth commented on time constraints and scheduling challenges (21%). Less than one-tenth each said they might face challenges with the technology (6%), find that the content isn't the right level for their students (6%), face financial obstacles (6%), and/or have trouble adapting the resources (5%). Nearly a third declined to answer the question (30%), more than a tenth said they didn't think they would face any challenges (13%), and about a sixth shared miscellaneous responses (17%), including a few who said they weren't sure what obstacles they might face.

#### **What obstacles Workshop attendees thought they would face implementing the resources (N=63)**



Examples of responses from Workshop attendees on each of these issues are shared below:

#### **Time constraints and scheduling challenges (21%)**

- *Time or the lack of it.*
- *Time to review them.*
- *Time to plan the activities*
- *Scheduling within our daily schedule time limits.*

**Challenges with technology (6%)**

- No audio on the Educator DVD.
- I need a new working disc!
- No or little technology to help share it with the students.
- Access to technology: lack of iPads, restriction on how many and how long videos may be, even if educational, fluctuating internet access.

**Content isn't the right level for their students (6%)**

- Higher level thinking for higher level students
- Some were too simplistic for high school.
- The biggest challenge will be making it simplistic enough for the kindergarten students.
- I teach pre-K and this might be over their ability level at this time.

**Financial obstacles (6%)**

- Money to see the film
- I wish we were able to go see the film- we just don't have the budget money available.
- The expense of taking all of the students to COS.

**Trouble adapting the resources (5%)**

- I will have to try and adapt them to fit with my 5th grade core as best as I can.
- The biggest challenge will be making it simplistic enough for the kindergarten students.

**None (13%)**

- I really don't foresee any problems.
- None that I foresee

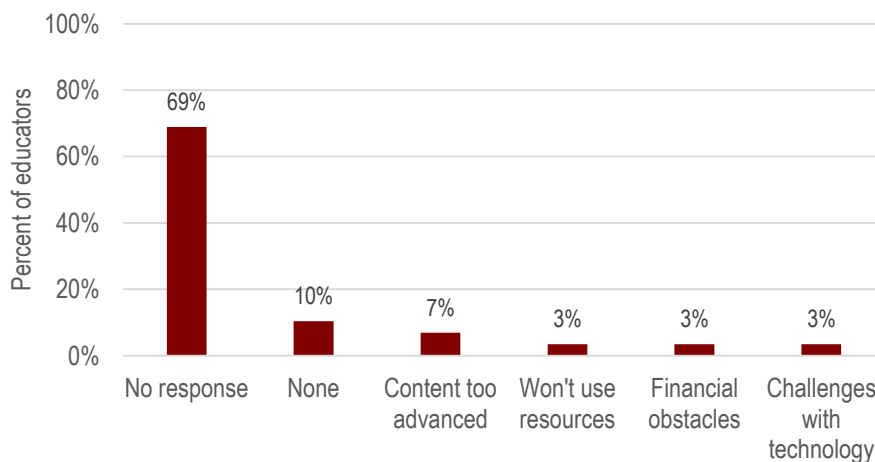
**Miscellaneous (17%)**

- I have no idea?
- Not sure yet
- Just feeling brave enough to do some of the things in my own classroom.
- I think I took great notes, but I may have missed key information. Hopefully I can deliver it the way it was delivered to me.
- Pressure due to testing and accountability...My teachers would need more PD.
- I don't teach science but I'm looking for ways to implement some of the information
- I will most likely start using the resources next year. I have my science lessons planned and ready for this year.

## **Film only attendees**

As shown in the chart below, when asked what challenges or obstacles they had encountered or thought they might face in implementing the *Mysteries of the Unseen World* resources, the largest groups of Film only attendees declined to answer the question (69%) or said they hadn't encountered or didn't think they would face any challenges (10%). A handful each explained that the content might be too advanced (7%), said they wouldn't be using the resources (3%), or pointed to financial obstacles (3%) or challenges with technology (3%).

### **What obstacles Film only attendees thought they would face implementing the resources (N=29)**



Examples of their responses are shared below, as in:

#### **None (10%)**

- *No challenges*
- *No problems have been encountered to date.*

#### **Content too advanced (7%)**

- *I teach K-2nd special education...the level of information is a bit high.*
- *I loved the movie and additional items. I work in our Primary building and will have to modify some things to our level.*

#### **Won't be using the resources (3%)**

- *At this time I will not be using the resources with my students.*

#### **Financial obstacles (3%)**

- *Because we are a small school group rates do not generally apply to us. A flat educator rate per student would be very helpful.*

#### **Challenges with technology (3%)**

- *Frequent tech glitches at school. Our school iPads do not support videos.*

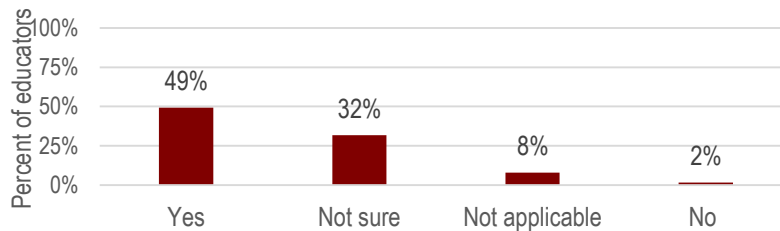
### 3.4 Did educators expect to use the film and/or educational resources to encourage students' interest in STEM or STEM careers?

The largest group of Workshop attendees indicated that they expected to use the film and/or its educational resources to encourage students' interest in STEM or STEM careers. Of Film only attendees, the largest group also indicated that they expected to use the film and/or its educational resources to encourage students' interest in STEM or STEM careers.

#### Workshop attendees

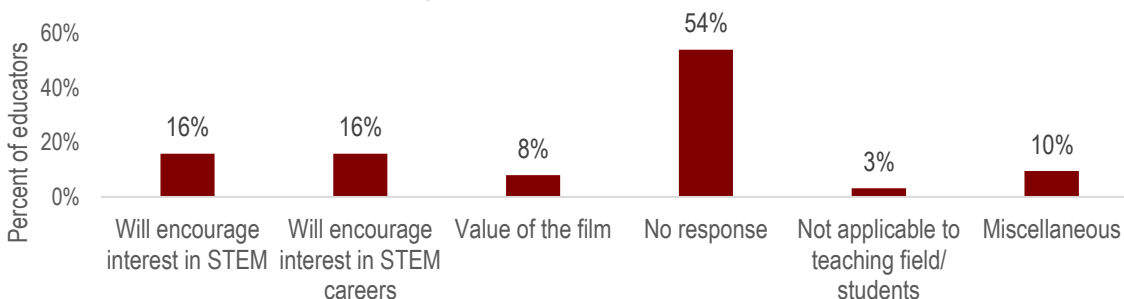
Workshop attendees were asked if they expected to use the film and/or its educational resources to encourage students' interest in STEM or STEM careers. As shown in the chart below, nearly half said *Yes* (49%), about a third said they were *Not sure* (32%), and less than a tenth each said *No* (2%) or noted that the question was *Not Applicable* to their setting (8%).

Workshop attendees who expected to use the film and/or resources to encourage interest in STEM or STEM careers (N=63)



Next, the Workshop attendees were invited to explain how they might use the film and/or its educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. As shown in the chart below, one-sixth each described how they would use the resources to encourage interest in STEM (16%) and/or STEM careers (16%), and less than a tenth talked about the value of the film (8%). More than half declined to answer the question (54%), a handful explained that the resources weren't applicable to their teaching field or students (3%), and a tenth provided miscellaneous responses (10%).

How Workshop attendees thought they would use the media and materials to encourage interest in STEM/STEM careers (N=63)



Examples of their comments are shared below:

**Will encourage interest in STEM (16%)**

- *If we were to see the film, it would be interesting to discuss all the ways things we normally don't see affect how we understand and use our world. Ideally, we'd see the film two or three times, because there is so much information in it.*
- *Students always ask questions about what makes lightning. The water droplet was also very interesting.*
- *Science interests and well as interests in how to make the technology identified in the film work*
- *Anytime I can connect students to STEM, I do. I talk about it every time we do anything like this.*
- *I will use the film to introduce my students to technologies that are new and cutting edge. The film introduces topics that my students might not otherwise have been introduced to.*

**Will encourage interest in STEM careers (16%)**

- *Not only science careers, but careers in technology and in communications can be related to the MUW resources.*
- *The resources point out the different fields science explores and the need of scientists, engineers, researchers, lab assistants, etc.*
- *I think many students are unaware of what options they have in the science field. This can expose them to other career paths.*
- *Because I work with adult students, it is not the norm that an individual student has the opportunity to retrain to the extent that STEM careers would involve. If individual students would be able to realistically pursue a STEM career, I would provide whatever resources are available, including your resources.*

**Value of the film (8%)**

- *I hope to take students to see the video on a field trip, and to purchase it when it comes available.*
- *All you have to do is play the film. It ignites curiosity. Curiosity leads to exploration. That is all I need.*
- *The films speaks for it self. It is a very exciting movie and very motivating.*

**Not applicable (3%)**

- *Teachers may use it in this way, but we will not be directly serving students with these materials.*
- *STEM is not available at my building.*

**Miscellaneous (10%)**

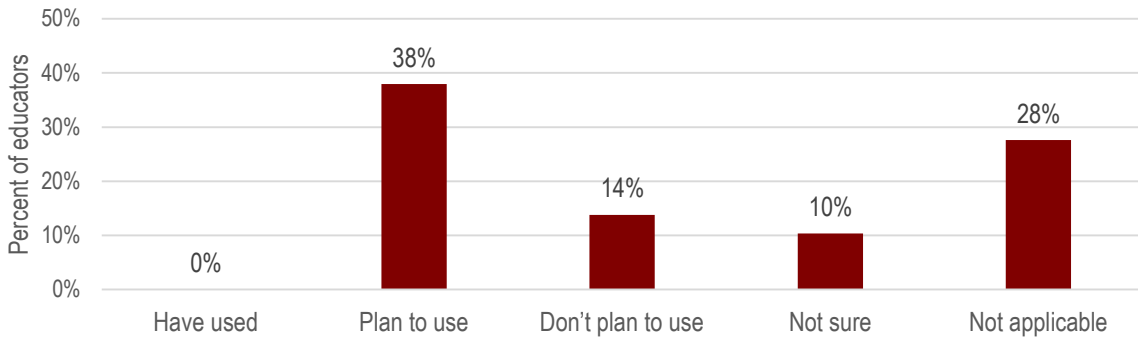
- *The "Givit" app on the iPad*
- *If I have any troubles it would be due to all the unfunded Mandates the state education places on us as well as the pressure to pass the corporate tests that unteachers place on us teachers. This is especially due to the test makers and data processors. Not to mention the greed from corporate powers on the public and how much families are at work each day.*



### Film only attendees

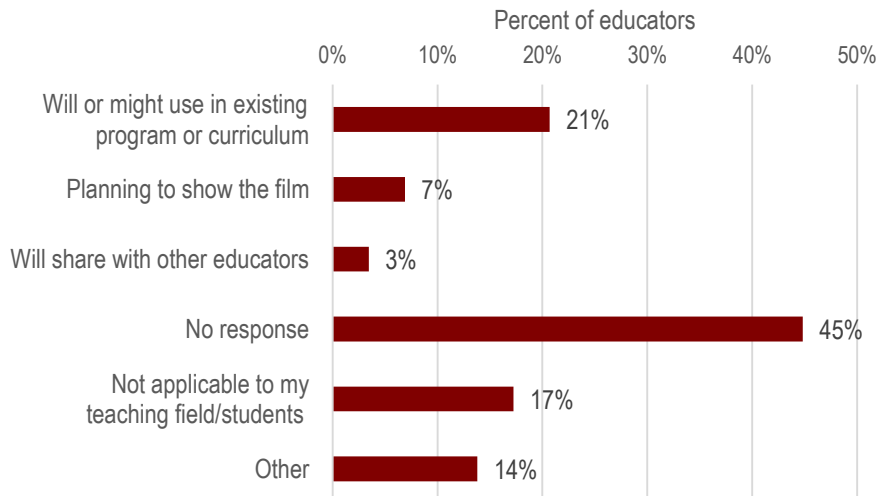
Film only attendees were asked if they had used or expected to use the film and/or educational resources to encourage students' interest in STEM or STEM careers. As shown in the chart below, none of the Film only attendees indicated that they had used the resources in this way. About two-fifths said they planned to use the resources to encourage students' interest in STEM or STEM careers (38%), while one-seventh said they did not plan to use the resources in this manner (14%). A tenth said they were *Not sure* (10%), and more than a quarter noted that the question was *Not Applicable* to their setting (28%).

**Film only attendees who expected to use the film and/or resources to encourage interest in STEM or STEM careers (N=29)**



Next, the Film only attendees were invited to explain how they might use the film and/or educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. As shown in the chart below, more than a fifth said they would or might use the resources in their program or curriculum (21%), while less than a tenth each said they were planning to show the film (7%) or said they would share the resources with other educators (3%). Just under half declined to answer the question (45%), one-sixth explained that the resources weren't applicable to their teaching field or students (17%), and one-seventh shared miscellaneous responses (14%).

**How Film only attendees plan to use the the resources to encourage interest in STEM/STEM careers (N=29)**



Examples of their comments are shared below:

***Might or will use resources in program/curriculum (21%)***

- *If I use the resources it will be as part of our units of study on careers or science.*
- *Our "career day" will happen in January at school, and these resources will be implemented into our forensics presentation, so thank you!*
- *We have already had community day in which they met several people in various careers. I will build on that prior knowledge by adding these types of careers.*
- *Will be using many of the DVD activities/online activities to prepare students to watch MUW. They will be completing many of the worksheets and exploring the websites/online activities before watching the film.*

***Planning to show the film (7%)***

- *We always strive to encourage students' interests in science and math-related fields at our gifted center, offering a wide range of classes for their exploration. We will be taking all of our first and second grade students to view the film in hopes of stimulating just such interest.*
- *Will be using many of the DVD activities/online activities to prepare students to watch MUW. They will be completing many of the worksheets and exploring the websites/online activities before watching the film.*

***Will share resources with other educators (3%)***

- *I will raise teacher awareness*

***Not applicable to my teaching field or students (17%)***

- *I don't teach Science*
- *I am a language arts teacher.*
- *I am currently retired.*
- *We won't be studying that kind of thing.*

***Miscellaneous (14%)***

- *It was a great explanation of the very small - nano technology.*
- *The movie doesn't detail career information well.*
- *I feel like this video introduces students to many different career fields.*

### 3.5 Did educators think their use of the film and/or educational resources had or would help facilitate outreach among underserved students?

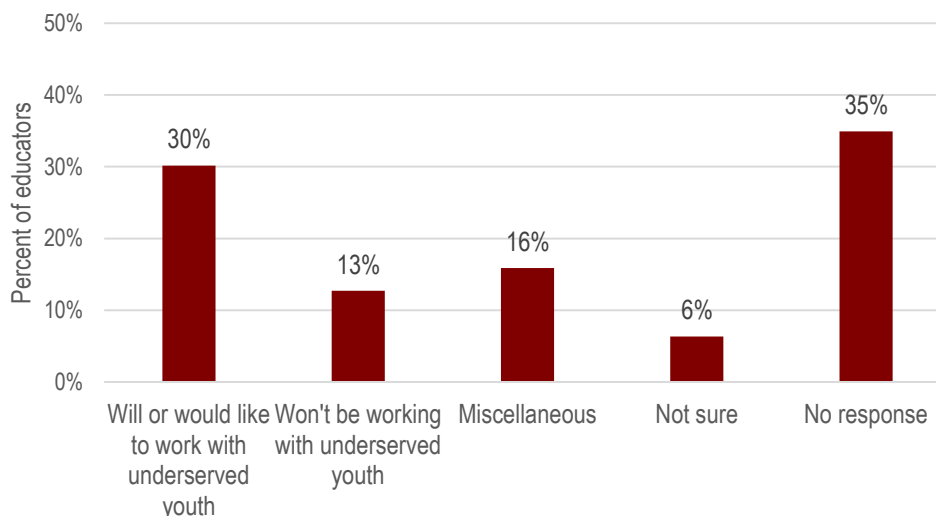
Many of Workshop attendees indicated that they would or would like to share *Mysteries of the Unseen World* with underserved youth, with some commenting on the specific populations they would reach and/or how they might use the resources.

Additionally, many of the Film only attendees indicated that they would or would like to share the film and its resources with underserved students, with some of also commenting on the specific populations they would reach and/or how they might use the resources.

#### Workshop attendees

Workshop attendees were asked if and how their work with the film and its resources might contribute to the project goal of facilitating outreach among underserved students. As shown in the chart below, about a third said they would (or would like to) be working with underserved youth (30%) and just over a tenth said they would not (13%). A sixth shared miscellaneous responses (16%), less than a tenth said they were unsure (6%), and more than a third declined to answer the question (35%).

How Workshop attendees' film and resource use might contribute to outreach among underserved youth (N=63)



Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources, as in:

- *I work at a Title 1 school. They are all underserved youth.*
- *We live in an area in which 50% of our students are free/reduced lunches. They don't have the ability many times to experience what other students can. This, hopefully, will fill that gap.*
- *The district where I teach offers free and reduced lunches to more than 40% of its students.*
- *Yes, all of the students I work with are considered to be "at risk" under-served, under-funded youth*

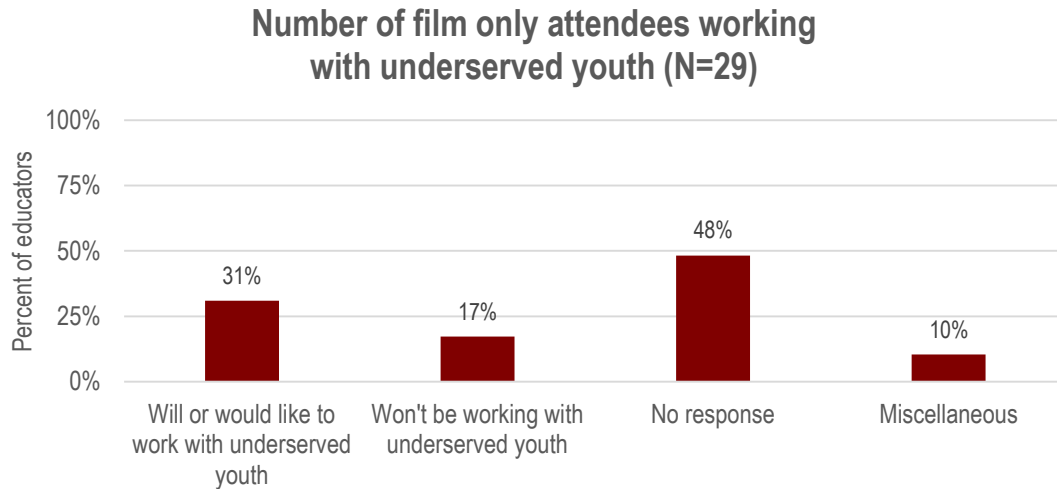
- *Our school's community is financially needed w/ neighbors of "starter homes" and condos. Therefore, my students come from families who are at below average to average income levels.*
- *All my students are minority, low-income students, and the great majority are also English language learners. My goal is that working with these materials will help them think about their world in new ways, and allow them to consider careers that they might not even have known about.*
- *This year 97% of my students are on free lunch. My students' exposure to things out in the world is very limited. This will open their eyes to a world beyond their imaginations. It will definitely help meet your goals.*
- *I work in a very high poverty neighborhood. The film engages the students, presents information in an interesting and understandable way that will lead to conversation and instruction in the classroom.*
- *100% poverty level at our school... The film and the additional resources are extremely important in engaging our students*
- *I teach in a very poor, rural district. The film and resources can introduce students to modern, cutting edge technologies that they might be unaware of. Sparking their interest can hopefully help guide their interests and later, career choices.*
- *It might be possible to use the materials to supplement and spark interest. Our students definitely include underserved youth, but in a basic education and high school equivalency training setting. As such, the goals are very specific and focused on what is necessary for success in these areas. Our vocational programs are relatively short term, also with very specific objectives, and not a lot of time for "extras".*
- *It would be great to take our MESA students to see the movie and the facility.*
- *I will share materials with our MESA advisor who works with underserved youth.*

At the same time, many of the Workshop attendees who shared miscellaneous responses noted the potential value of the film and its resources to their students (without specifying if they were underserved), as in:

- *Our area has little access to advanced technology and limited in the school itself. So any exposure I give my students is much more than they would have otherwise. The pictures and illustrations are visually enticing and beautifully done.*
- *My students have very limited or no access to this kind of resources or information. However, they feel so excited when presented with this kind of activities and resources that they usually continue to talk about it until the end of the course.*
- *Many of my students are lacking in activities that make them wonder, think and observe.*
- *The Perot offers scholarships for schools that need financial assistance. If the students still can't make it, the video clips and hands on learning that come with this program will help level the playing field.*
- *By exposing students to the resources we received, I feel that they will be given the opportunity to take part in stimulating and meaningful activities that will boost their interest in science.*
- *Better understanding of Science.*
- *I will find financial resources to buy microscopes to show students the miniature world they don't perceive.*

## **Film only attendees**

Film only attendees were asked if and how their work with the film and its resources had or might contribute to the project goal of facilitating outreach among underserved students. As shown in the chart below, about a third said they would (or would like to) be working with underserved youth (31%) and just over one-sixth said they would not (17%). Nearly half declined to answer the question (48%) and a tenth shared miscellaneous responses (10%).



Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources, as in:

- *I would like to get our inner city school faculty interested in MUW.*
- *I teach in a Catholic school where a good portion of the students are on some kind of scholarship. Some of them are considered underserved I believe.*
- *We are a Title 1 school that receives government funds due to our low socioeconomic status. Many of our students are underprivileged.*
- *My students do not have access to microscopes and/or funding for them, so I used the online videos to help explain micro organisms, etc.*
- *I have many students in my class that will never get the chance to go to the Science Center. The resources you provided will give them a chance to share in these experiences.*
- *~90% of my students are "traditionally underserved youth." MUW is something they will definitely enjoy and find an interest in. It covers topics and questions they've already been asking.*

At the same time, those who shared miscellaneous responses commented on the potential value of the film and its resources (without specifying if their students were underserved), as in:

- *Give them a different way of presenting information they probably have not seen before*
- *It will give experiences to students who may not have the opportunity to otherwise gain this knowledge.*
- *I think that is an admirable goal. I will encourage other educators to see the film. I think many of the topics in the film will be new to the students, so they will be more engaged in learning.*

## Question 4: What feedback did Film only attendees share about future workshops related to *Mysteries of the Unseen World*?

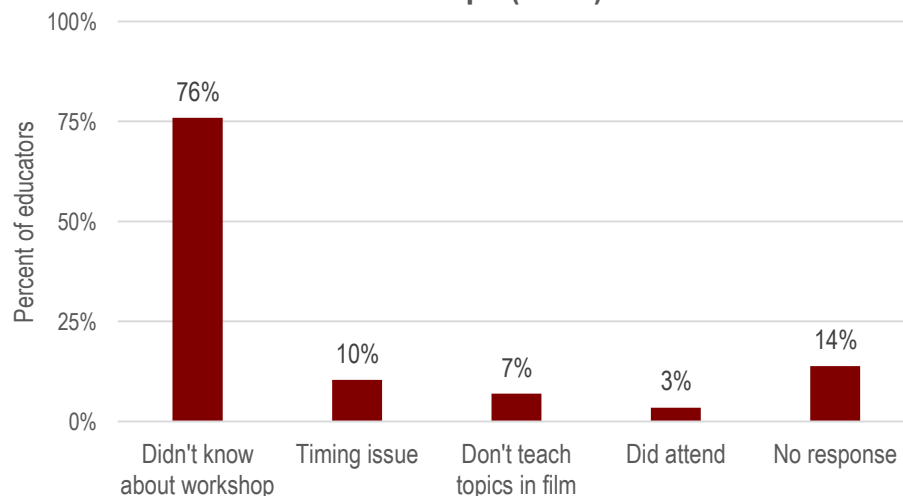
Film only attendees were first asked why they did not participate in the local *Mysteries of the Unseen World* workshop that was held in their area earlier in the year. Next, they were invited to rate aspects of the opportunity to attend a local workshop, to note the likelihood that they would participate in a future workshop (if it were to be offered), what they would hope to gain from this future workshop, and what topics they would want to have covered. They were also asked to note their preference for a local workshop or a webinar, if National Geographic was to coordinate one or the other in the future. Finally, they were invited to describe how they thought they would use the *Mysteries of the Unseen World* resources without having attended a workshop or a webinar. These findings are presented below in 4.1 through 4.5.

### 4.1 Why didn't Film only attendees participate in local workshops in their areas?

The majority of Film only attendees explained that they did not participate in the local workshop in their area because they did not know about it.

The Film only attendees were asked why they didn't attend the *Mysteries of the Unseen World* local workshop held in their area earlier in the year. As shown in the chart below, more than three-quarters said they didn't know about the workshop (76%). A tenth pointed a timing issue (10%) and less than a tenth noted that they don't teach the topics in the film (7%). One said s/he did attend (3%), though the workshop this educator planned to attend was shortened to just a film screening when a local sports team made national playoffs the same evening and the workshop coordinator received "a rash of cancellations." Finally, one-seventh of Film only attendees declined to answer the question (14%).

Why Film only attendees did not attend local workshops (N=29)



Examples of their responses are shared below:

***Didn't know about the workshop (76%)***

- *I was not aware of this workshop. As a museum member, I would have attended.*
- *I did not know about it.*
- *I didn't know about the workshop. If it was while I was still teaching, I would have been interested.*
- *I was unaware that the workshop was going on.*

***Timing issue (10%)***

- *It could have been a lack of time.*
- *If I knew about it, it didn't fit in my schedule.*
- *Conflicted with other plans.*

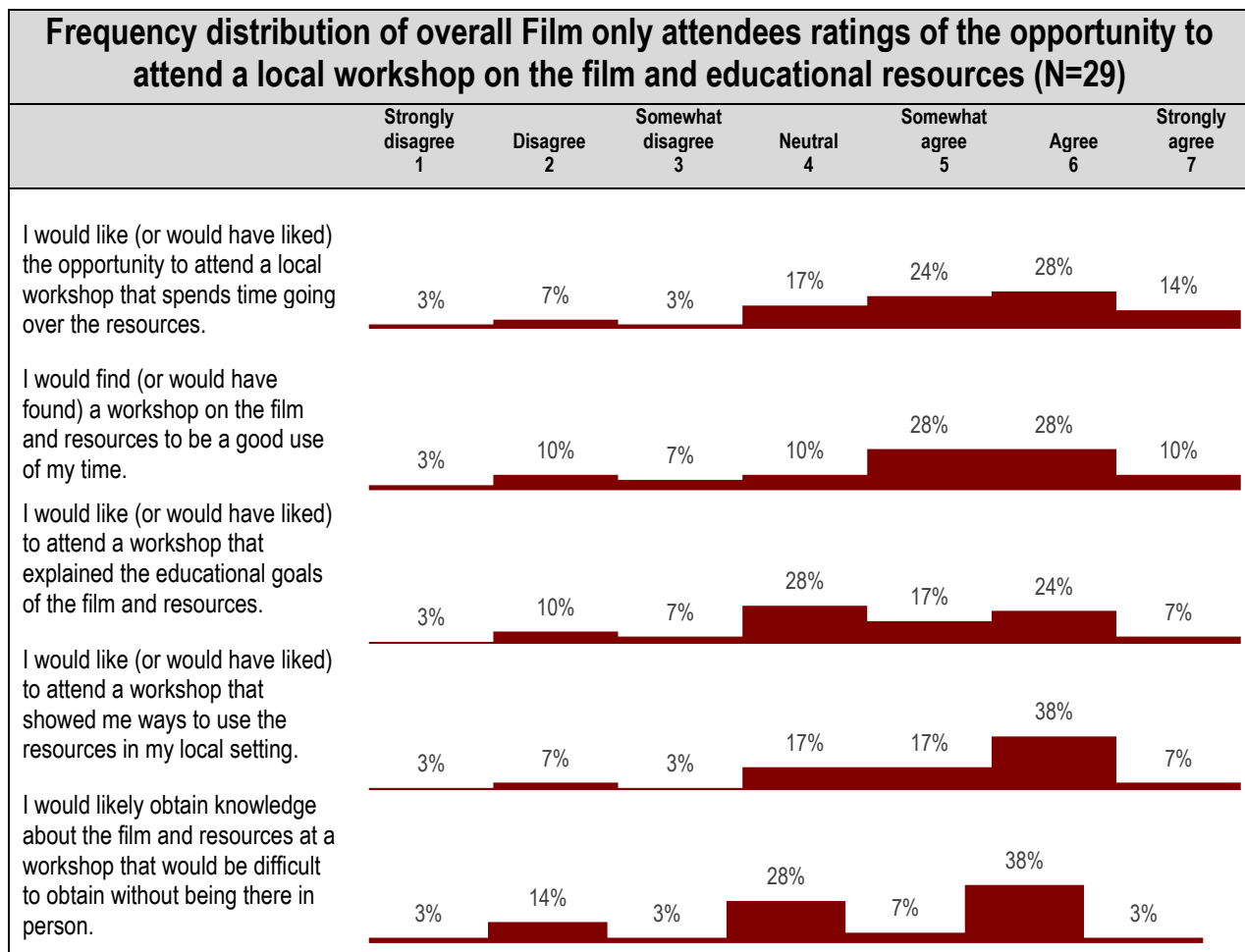
***Don't teach topics in the film (7%)***

- *Don't teach the topics in the film*
- *Don't teach topics featured in film*

## 4.2 How did Film only attendees rate aspects of the opportunity to attend a local workshop?

Overall, the Film only attendees somewhat agreed that: *they would like (or would have liked) the opportunity to attend a local workshop that spends time going over the resources, they would find (or would have found) a workshop on the film and resources to be a good use of my time, and they would like (or would have liked) to attend a workshop that showed me ways to use the resources in my local setting.* They also fell between being neutral and somewhat agreeing that *they would like (or would have liked) to attend a workshop that explained the educational goals of the film and resources and that they would likely obtain knowledge about the film and resources at a workshop that would be difficult to obtain without being there in person.*

Film only attendees were asked to rate their agreement with a series of statements about the opportunity to attend a local workshop focused on the *Mysteries of the Unseen World* film and educational resources on a scale from 1.0 (strongly disagree) to 7.0 (strongly agree) with 4.0 being neutral in each case. The table below presents the percentage of Film only attendees selecting each rating.





Though there were some differences of opinion, as evidenced by each range of ratings in each case, overall Film only attendees somewhat agreed (median rating 5.0 each) that: *they would like (or would have liked) the opportunity to attend a local workshop that spends time going over the resources, they would find (or would have found) a workshop on the film and resources to be a good use of my time, and they would like (or would have liked) to attend a workshop that showed me ways to use the resources in my local setting.* The Film only attendees also were between being neutral and somewhat agreeing (median rating 4.5 each) that *they would like (or would have liked) to attend a workshop that explained the educational goals of the film and resources and that they would likely obtain knowledge about the film and resources at a workshop that would be difficult to obtain without being there in person.*

A handful of Film only attendees provided additional feedback about their ratings and how they would or would not benefit from a workshop. Their responses are shared below, as in:

- *I like science workshops, so I would enjoy learning more about the resources. I would want to know the details about the workshop first though, so that's why I didn't say strongly agree. This is also assuming that I was still teaching.*
- *Workshops were well developed and helpful. Please keep presenting them.*
- *I do not have classroom time to learn about new materials. It would be a much better use of my time to learn from someone familiar with the resource than to fumble through the items on my own.*
- *The MUW film and resources are excellent, but since I am already comfortable with the topics covered, I don't feel a workshop would necessarily be beneficial for me. However, if another one were available, I would definitely promote it to my colleagues and would consider going myself.*
- *Concepts are too difficult for the students I teach*

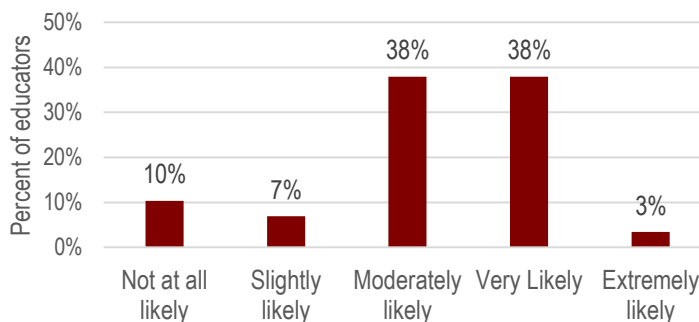
### 4.3 How likely were Film only attendees to participate in a future *Mysteries of the Unseen World* workshop, what would they hope to gain from the experience, and what topics would they want to have covered?

The largest groups of Film only attendees indicated that they were moderately likely or very likely to attend a future *Mysteries of the Unseen World* workshop if it was held in their area. If they were to attend a future workshop, the largest groups explained that they would most like to gain teaching ideas and/or resources. As for topics they would want to be sure would be covered in sufficient depth, those who answered the question generally pointed to STEM content, information about the resources, and teaching ideas, among other subjects.

#### 4.3a Likelihood of participation

Film only attendees were asked about their likelihood of participating in a future *Mysteries of the Unseen World* workshop, if it were offered again in their area. As shown in the chart to the right, nearly two-fifths each said they would be moderately likely (38%) or very likely (38%) to participate. One-tenth indicated that they were not at all likely (10%), and less than a tenth each were slightly likely (7%) or extremely likely (3%).

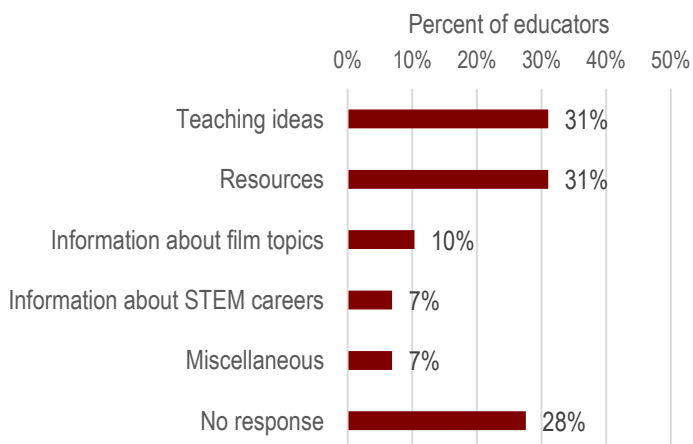
Film only attendees likelihood of participation in a future workshop (N=29)



#### 4.3b What Film only attendees would hope to gain

Film only attendees were then asked, if they were to participate in a future workshop on the *Mysteries of the Unseen World* film and resources, what they would hope to gain. As shown in the chart to the right, about a third each pointed to teaching ideas (31%) and/or resources, including information about where to find them and how to use them (31%). A tenth said they would hope to gain more information about the topics featured in the film (10%), and less than one-tenth each explained that they would like to gain information about STEM careers (7%) or shared miscellaneous responses (7%). More than a quarter declined to answer the question (28%).

What Film only attendees would hope to gain (N=29)



Examples of their responses on the subject are shared below, as in:

**Teaching ideas (31%)**

- *Practical uses to teach in my classroom that are tied to my standards*
- *Ways to convey meaning to students*
- *Ideas to incorporate non-fiction scientific reading into my curriculum.*
- *Quick ways to use materials in the classroom that does not have technology, lab space, or additional teacher support. It must work for one teacher in a traditional classroom of 30 students.*
- *I am always looking for new ways to present material.*
- *Ideas to adapt to first graders.*
- *How to bring the subject matter to a level that younger students would be able to understand it.*

**Resources (31%)**

- *Ways to access video clips for my own in-class use.*
- *Things to use in my classroom. Handouts, powerpoints*
- *Resources to broaden my students' horizons.*
- *Information on where to find the resources and best practices when using them.*
- *Ideas of how other teachers implemented the resources.*
- *I'm thinking about volunteering at the Science Center, so it would be good for me to know more about the film's resources.*

**Information about the topics in the film (10%)**

- *Expertise in the topic*
- *Information for my students*
- *More in-depth knowledge of how the information is useful in our everyday lives.*

**Information about STEM careers (7%)**

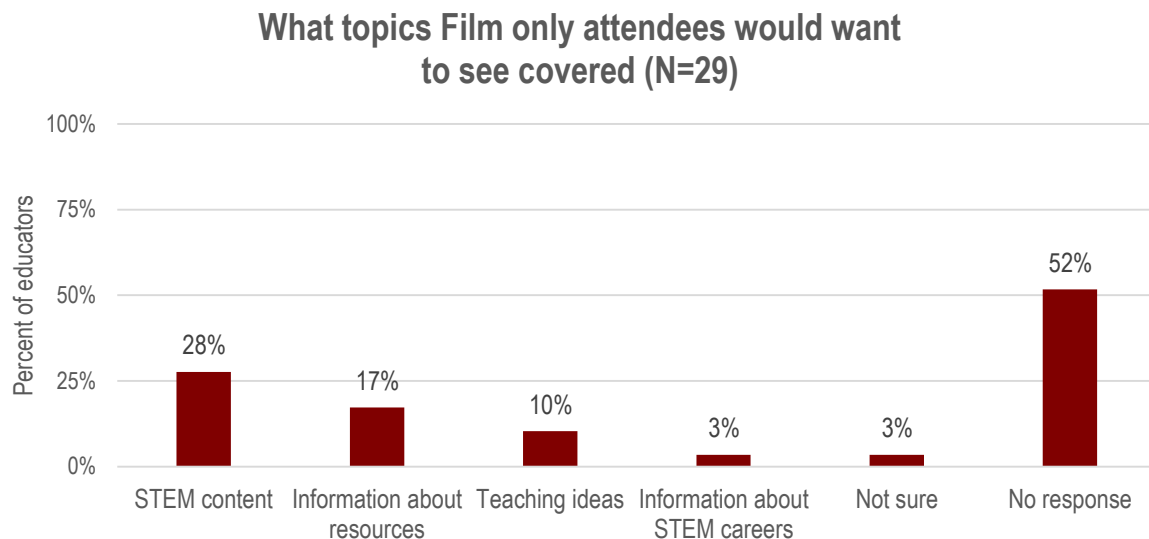
- *Observations of STEM career*
- *A connection between jobs in that field*

**Miscellaneous (7%)**

- *I'm not sure. Most of the resources seem self-explanatory. First I would need to know that the workshop would offer more than just a walk-through of the resources.*
- *Microscopes*

### 4.3c What topics would Film only attendees want covered in sufficient depth

As shown in the chart below, more than a quarter of Film only attendees explained that, if they were to attend a workshop in the future, they would want to be sure that it would cover STEM content in sufficient depth (28%). About a sixth pointed to information about the resources (17%), and a tenth identified teaching ideas (10%). One said s/he would want to be sure the workshop would cover information about “STEM careers in nanotechnology” (3%), while another was “unsure” (3%). More than half of the Film only attendees declined to answer the question (52%).



Examples of their responses are shared below:

#### **STEM content (28%)**

- *Force and Motion. Engineering ideas for first graders.*
- *Electromagnetic spectrum, nanotechnology, microscopy*
- *Any of the topics in the film would be good because they are all appropriate for middle school students.*
- *Weather and natural disasters - how the phenomena occurs and how scientists study them and what the data is useful for.*  
*Nanotechnology and electron microscopy are newer topics to my students and would be helpful to be explained to them in many ways. Would like to see what ways you would suggest.*
- *Things that are too fast and too slow*
- *Anything related to math!*

#### **Information about the resources (17%)**

- *Resources for hands-on lessons*
- *Ways to access video clips for my own in-class use.*
- *Follow-up activities to use with a class of students*
- *Where to get the materials and if any materials are consumable, where can I get them replaced at a very low or free cost?*
- *How to use the resources.*

#### **Teaching ideas (10%)**

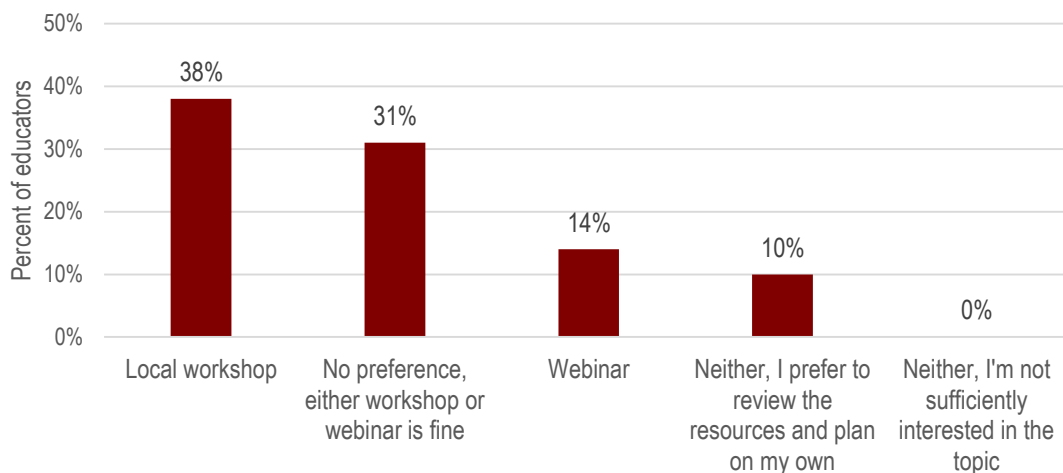
- *What would be a way to introduce younger students to this subject matter.*
- *How to teach without proper science equipment.*
- *Nanotechnology and electron microscopy are newer topics to my students and would be helpful to be explained to them in many ways. Would like to see what ways you would suggest.*

## 4.4 In the future, would Film only attendees prefer to participate in a local workshop or a webinar?

The largest groups of Film only attendees pointed to a preference for a local workshop over a webinar, or explained that they didn't have a preference. When invited to elaborate, those who preferred local workshops generally pointed to the value of learning in person, being able to ask questions, and trying the hands-on activities, while those who preferred webinars commented on the convenience of being able to view them on their own time.

Film only attendees were asked if they would prefer a local workshop or a webinar, if National Geographic could offer one or the other. As shown in the chart below, the largest group of nearly two-fifths pointed to a preference for the local workshop (38%). Just under a third said they had no preference and that either option would be fine (31%). About one-seventh explained that they would prefer a webinar (14%), and a tenth said neither, they would prefer to review the resources and plan on their own (10%). None said that they were not sufficiently interested in the topic (0%).

Film only attendee preference between local workshop and webinar (N=29)



When invited to elaborate, a handful of Film only attendees explained their preferences, with those who preferred local workshops generally pointing the value of learning in person, being able to ask questions, and trying the hands-on activities, and those who preferred the webinar commenting on the convenience of being able to view it on their own time.

Examples of their responses are shared below, as in:

### Local workshop (38%)

- *I don't seem to remember webinars.*
- *I prefer the personal interaction and questions and answers.*
- *If there were some hands-on activities with the workshop, that would be more beneficial than a webinar.*
- *I focus better in person.*

- *I learn better by seeing and hearing in person. I would feel like I couldn't ask questions at a webinar.*
- *I get more information from a workshop.*

**No preference (31%)**

- *It's difficult to explain why I don't have a preference. I guess it is because the delivery itself counts more than the delivery style.*
- *I'll do both too!*
- *Typically I have enjoyed live workshops the most; however, web-technology is getting better and easier to use. Sometimes these webinars fit into my schedule more easily.*

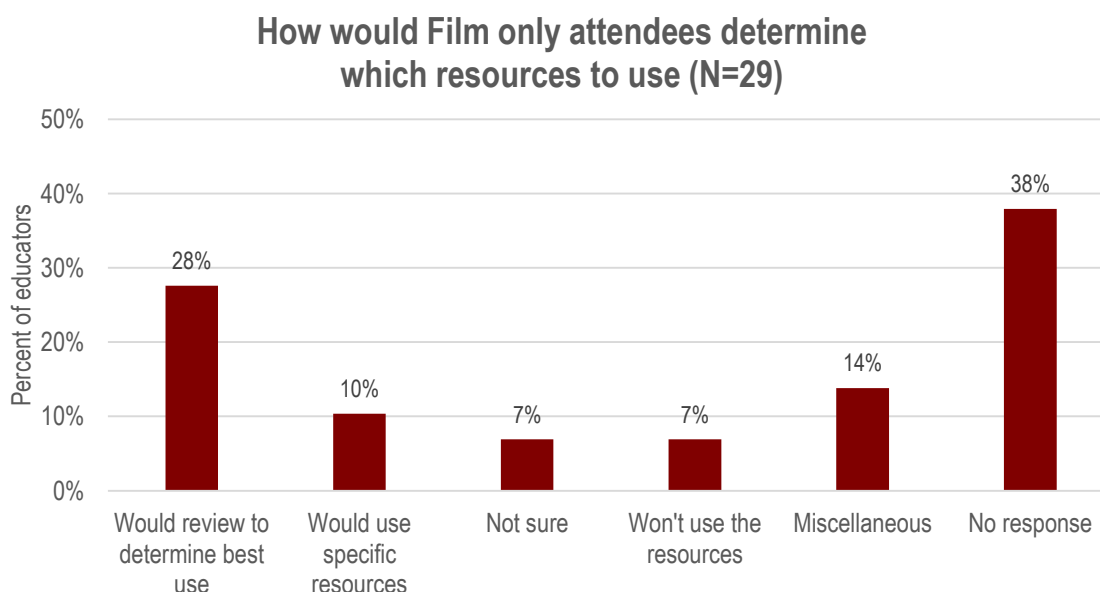
**Webinar (14%)**

- *I can view it on my own time*
- *Scheduling to be out of the office can be difficult.*
- *Webinar would probably be more convenient. A workshop outside of school might be harder to coordinate.*

## 4.5 Without having attended a local workshop or webinar, how did Film only attendees think they would determine which resources to use?

When asked how they would or had determined which *Mysteries of the Unseen World* resources to use in their educational settings, without the benefit of having attended a local workshop or webinar, the largest group of Film only attendees anticipated that they would review the resources to determine the best use for their classroom or students. Smaller groups explained which resources they would use, said they weren't sure, indicated that they wouldn't use the resources, or shared miscellaneous responses.

Film only attendees were asked how they would or had determined which *Mysteries of the Unseen World* resources to use in their educational settings, without the benefit of having attended a local workshop or webinar. As shown in the chart below, more than a quarter said they would review the resources to determine the best use for their classroom or students (28%), while a tenth pointed to specific resources they would use (10%). Less than a tenth each said they were not sure (7%) or that they wouldn't use the resources (7%), and one-seventh shared miscellaneous responses (14%). Nearly two-fifths declined to answer the question (38%).



Examples of feedback from Film only attendees are shared below, as in:

### **Review to determine best use (28%)**

- *I will be able to tell what will work in our curriculum by looking over the resources.*
- *I'll just keep clicking on the materials in the dvd (obviously I've looked at the poster, etc.) and checking them out until I determine which are best suited to my students and myself.*
- *By reviewing them and seeing where they fit in the curriculum.*
- *I will look at what is pertinent to our areas of study and if it is at appropriate grade level.*
- *I will review them on my own time.*

**Would use specific resources (10%)**

- *Try to use the website and videos.*
- *I would be able to locate the poster and educator's guide - they would be easy to use.*
- *I would have used the microscopy and light spectrum info for sure, since those were a part of my curriculum. I would have tried to fit the other topics in as well. Thank you so much for this wonderful movie! Thanks also for the gift card. I would have signed up for the additional feedback, if I was still teaching.*

**Not sure (7%)**

- *Not sure how I would know.*
- *No idea!*

**Won't use the resources (7%)**

- *I just wont use them, easier to stick with what I already use.*
- *Topic too difficult*

**Miscellaneous (14%)**

- *Internet research*
- *Technology intuition*
- *n/a Workshop was attended.*



## Phase 3: Museum educator post report findings

### Introduction

As part of the awardee reporting requirement, educators from the awardee sites that participated in the Museum Educator National Workshop were asked to complete a post report at the end of their award about their: experience participating in the awardee program, use of the *Mysteries of the Unseen World* materials to engage visitors and students, satisfaction with the materials, perception of the effectiveness of the film and activities in meeting the project's learning objectives, efforts to disseminate and promote the materials to local educators, and efforts to draw underserved audiences to see the film and engage in outreach.

### Method

The evaluation team edited a draft version of the *Outreach Award Post Report* initially developed by National Geographic for this purpose and then collaborated with the outreach coordinator from National Geographic to ensure the partners had access to the report forms well in advance of the completion of their awards. A total of 11 of the 17 museum partners that attended the Museum Educator National Workshop activated the outreach award. These 11 partners all completed the follow-up "post report," for a response rate of 100% of those sites that activated an award.

Basic descriptive statistics were provided on the quantitative data generated from the report forms. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the outreach award objectives, and inductive, by looking for overall themes, keywords, and key phrases. The educator responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder.

Many of the reach-focused statistics below are based on estimates provided by the museum partners. For values of 1000 or greater, the reported total values were rounded to three significant figures in the text for ease of interpretation. Values less than 1000 and direct references to educator estimates were left unchanged in the text.

# Findings

## Question 1: What was the overall reach of *Mysteries of the Unseen World*, as facilitated by partner organizations?

The 11 partner organizations reported reaching approximately 42,200 educators and 998,000 students with their outreach and marketing efforts.

To assess the overall reach of the project, the 11 partner organizations estimated the number of educators and students reached by their marketing and outreach efforts. As shown in the table to the right, they reported reaching approximately 42,200 educators and 998,000 students. The reported number of educators reached ranged from 29 to 25,915, the reported number of students reached ranged from 122 to 647,875, and the partners averaged reaching 3,837 educators and 90,678 students each. Partners' estimations were reported in a variety of formats.<sup>4</sup>

Overall reach as facilitated by partners (N=11)		
	Educators	Students
Low:	29	122
High:	25,915	647,875
Average:	3,837	90,678
Total:	42,205	997,467

When invited to elaborate, a number of museum educators shared feedback on their educator-focused marketing and outreach efforts related to *Mysteries of the Unseen World* (including emails, letters, preview passes, conferences, and distribution of the project materials, among other methods) and/or how they estimated the number of educators and students reached. Responses from the partners are shared below:

- *Marketing for MUW went to 17,700 educators through our field trip planner publication and 8215 educators through educator e-mails. These communications focused on the educational value of the film and the richness of the associated content.*
- *Letter and preview pass mailed to all elementary and middle school principals and science leads in [our local school system]. Field Trip Guides mailed to 3,264 elementary and middle school educators, primarily in [our county]. E-blast invitation to preview and workshop sent to 2,466. 789 educators attended preview and workshop on November 13, 2013.*
- *We attend the Conference for the Advancement of Science Teaching each year. Last year over 7,000 teachers attended. We gave out MUW posters, educator DVD's, the two sided fact card, hand sanitizer and a flyer about the movie to each teacher. We also held Educator Previews of our special exhibitions and handed out MUW materials.*

<sup>4</sup> Partners' responses are shared in this footnote in descending order, to illustrate the variety of responses. Educators reached: 25,915; 15,000; 7,000; 5,000+; 1,500; 400+; Approximately 300; 276; 185; 99 (17 Educator workshop, 80 Nano Science night, 2 underserved community); 29. Students reached: 647,875; Every teacher represents anywhere from 20-150 students (Note: This organization indicated that they reached 7000 educators, for a range of 140,000-1,050,000 students. The conservative estimate, 140,000, was used when calculating the total number of students reached by the 11 partners that activated the award); 105,000+; 45,000; 37,000; 16,000; Approximately 7,500; 7250; 5,000+; 1,120 (1100 Nano Science night, 20 underserved community); 122. As shown in these responses, one of the organizations shared estimates in each category that were significantly higher than the others in terms of educators and students reached. The reasons for this are unknown.

*We hosted a Museum District Educator Open House in which over 600 teachers from the area attended. We scheduled a screening time that allowed teachers to view the movie after the open house. We send out materials and flyers to each school we visited (1,200) during the 2013 – 2014 school year and we continue to show MUW and advertise it to schools this school year.*

- *[Staff from our organization] attended 8 teacher conferences throughout the course of the year promoting and advertising Mysteries of the Unseen World. We mailed and hand delivered our field trip guide around [3 local states.]*
- *Materials were made available and given to all teachers*
- *We had an educator preview that reached 230 educators. We then brought educational materials to additional professional development programs we delivered. All PDs combined totaled approximately 1,500 educators.*
- *We promoted the movie, website resources and the dvds to teachers at the August Teacher Resource Fair, teacher PD, field trip experiences, and summer professional development*
- *Based on the feedback I received from the educators that attended my workshop, many were excited by the opportunity to see the film and use the activities we showed them with their students. We also incorporated some of the activities into our family science night that many teachers and students attended.*
- *Most of our teachers reached are elementary or middle, so they have one class of students of approx. 25 students.*

## Question 2: What was the reach of the *Mysteries of the Unseen World* field trips to partner organizations?

Nine (9) of the 11 partners estimated the number of field trips groups that attended screenings of *Mysteries of the Unseen World* at their organizations, for a total of 852 groups. Ten (10) of the 11 partner organizations estimated the number of educators and students reached through these field trips, for an approximation of 7740 educators (including chaperones) and 41,800 students. Additionally, 3 of the partner organizations specified the grade range of the students who attended field trip screenings. Together, these 3 organizations estimated reaching 761 students in grades K-4, 4050 students in grades 5-8, 31 students in grades 9-12, and 545 other students.

Nine (9) of the 11 partners estimated the number of field trips groups that attended screenings of *Mysteries of the Unseen World* at their organizations, for a total approximation of 852 groups. As shown in the table to the right, the number of field trips hosted by each partner ranged from 1 to 297 and averaged 95 per partner that provided information. One partner declined to answer the question and another explained that, although they did not track the number of groups, they could provide information about individual attendees.

Field trip groups attending screenings by partner organizations (N=11)			
	Field Trips (n=9)	Educators (n=10)	Students (n=10)
<i>Low:</i>	1	2	20
<i>High:</i>	297	3,329	10,987
<i>Average:</i>	95	774	4,177
<i>Total:</i>	852	7,736	41,766

Ten (10) of the 11 partner organizations estimated the number of educators and students reached through field trips, for a total approximation of 7740 educators (and chaperones) and 41,800 students. As shown in the table above, the number of educators reached by the 10 partners ranged from 2 to 3329 and averaged 774 per partner that provided information, and the number of students reached by the 10 partners ranged from 20 to 10,987 and averaged 4,177 per partner that provided information. Three (3) of the partner organizations were able to specify the grade range of the students who attended field trip screenings. Together, these 3 organizations estimated reaching 761 students in grades K-4, 4,050 students in grades 5-8, 31 students in grades 9-12, and 545 "other" students whose grade level wasn't identified.

When invited to explain their estimates, some partners explained that they had no way of keeping track of the number of field trips or grade levels. One noted that the film was still showing and that their numbers weren't final, another explained that their numbers were tracked in their reservation system. One-third described inclement weather as an unforeseen challenge in scheduling field trips. Responses included:

- *We do not have a way of knowing how many trips there were, but we can tell you how many students and teachers/chaperones saw the film on a field trip.*
- *Grade levels are not listed in our current reservation detail. However, we recommended this film for our upper elementary and middle schools primarily. Teachers are also not separated out but generally speaking we still average 1 teacher per 30 students.*
- *To date, this is the number of attendees to the film. We are still offering the film in fall semester 2014 (including a Biology programming package that includes the film) and we are showing the film in spring 2015 as well.*

- These numbers reflect the actual attendance of Groups, Educators, and Students which we gathered from our reservations software system.
- We had a few groups that were scheduled to come in February, but due to weather cancelled their trip. We tried to reschedule them as we could, but it also made us have to scramble to get other groups to take their place if they were not able to reschedule

### Question 3: How did the partner organizations reach out to underserved communities?

All but one partner indicated that they used the Underserved Community Outreach funding to pay for tickets for students to see the film and, in many cases, visit the partner science center or museum. Additionally, a number of partners described having used some of the funding to coordinate students' transportation to and from their organization and/or to reach underserved students through the film's other educational materials.

Together, the 10 partners that indicated they used the Underserved Community Outreach grant reported having reached approximately 692 educators and 7,450 students through activities supported by this funding. Furthermore, the 10 partners that indicated they used the Underserved Community Outreach grant reported that approximately 5,570 students saw *Mysteries of the Unseen World* with assistance through this funding. When invited to share additional feedback about the value of the Underserved Community Outreach funding to their organizations, the partners highlighted the value of the opportunity it provided to students, schools, and the grant-receiving organizations.

The partner organizations were each asked to detail how they used the *Mysteries of the Unseen World* Underserved Community Outreach grant of \$1,000 to support underserved students. Additionally, they were asked to estimate the number of educators and students reached through this funding, as well as the number of students who saw the film with assistance from this funding. Finally, they were asked to share additional feedback about the value of the Underserved Community Outreach funding. These findings are presented below in 3.1 through 3.4.

#### 3.1 How did partner organizations use the Underserved Community Outreach funding to support underserved students?

When asked how they used the \$1,000 Underserved Community Outreach grant to support underserved students, 9 of the 10 partner organizations who reported using the funding noted that the grant was used to pay for tickets to see *Mysteries of the Unseen World*, with many partners also providing admission to their science center or museum. Additionally, a few each described having used some of the funding to coordinate students' transportation to and from their sites and/or to reach underserved students through the film's other educational materials. Details about how the grantees used the funding are shared on the following page:

- *We held a special day around the theme of the film called “Unseen Mysteries Revealed” day. We marketed this day to underserved communities and partnered with an organization call Tickets for Kids who provide unique learning opportunities to underserved populations. We offered to underwrite the cost of admission and this film to groups with Tickets for Kids. 38 students and 13 adults came in on this day through this opportunity. They not only saw the movie but also participated in learning activities that supported the film. This still left us with \$314 to use for underserved students. We are offering this money to the Tickets for Kids organization to bring underserved students in to see the movie again this fall. Students who attend this event will also have the opportunity to engage in the supplementary material provided to enhance the learning.*
- *Free field trip for 120 students given to [a low socioeconomic status middle school] as a reward for completing nano assessments for [a] State University research project. We partnered with [a professor of] mathematics, science & technology education on the launch and educational outreach for Mysteries of the Unseen World.*
- *I reached out to some of the after-school programs that work with the underserved community. I linked up with The Boys and Girls Club...and organized an afterschool field trip during one of our late night events. \$415 was spent to accommodate about 20 student admissions to the museum and special exhibits as well as to see the film. I also did a post-visit and follow-up with some of the educator activities provided by Nat Geo.*
- *[A local elementary school] was provided with a free field trip...The students received tickets to see Mysteries of the Unseen World and 1 day field trip admission to the [science center]*
- *We applied this money as part of our subsidy program; allowing access to students who are receiving free/reduced rate lunch to receive a low or no cost admission. We also work to cover bussing fees when needed. Our primary goal with the \$1000 was access to the program.*
- *Spent \$1020 on field trips and classroom supplies for 2 Title One schools. \$650 on a field trip and classroom supplies for [a local high school] and \$370 on a field trip for [a local elementary school.]*
- *Money was spent on film tickets for underserved students in the [public school] and for Out of School time field trips for Boys and Girls Club. We were also able to offer the movie to the middle and high school students, parents and teachers participating in [a science and engineering student summit] that was held at the Museum. We also used some of the funds to add a “Mysteries” component using the activities to our Saturday programs. We also offered it to parents and students at our attached Science Magnet School’s Family Night at the Museum.*
- *We utilized the \$1,000 to provide transportation and ticket costs to provide a school within the [school district] a 3 hour field trip package which included, lunch, Mysteries of the Unseen World, a private educational program and guided tours of the museum.*
- *For most, we were able to just cover the movie cost for the students. If we were to cover museum and movie admission, we would only be able to have served 71 individuals, but because we found other ways to cover their admission costs, we were able to serve more than 3 times that amount.*
- *[We have] multiple Title 1 schools who attended overnight adventures during the months of January 2015 – April 2015. We utilized the money to allow the students to view the film and attend programs based on the activities from the Mysteries of the Unseen World resources.*

Additionally, one of the grantees explained that they weren’t able to use the funding and another described some of the challenges they faced in working with underserved students:

- *We were unable to use the funding. The way our accounting works is complicated*
- *It was difficult to organize a school field trip to support underserved students because of timing of the film at our museum. Because of the length of the film, it was shown too late in the afternoon for schools to attend. Liability issues do not allow buses to run after a certain time of day.*

### 3.2 How many educators and students were reached through the Underserved Community Outreach funding?

Together, the 10 organizations that indicated they used the Underserved Community Outreach grant reported having reached approximately 692 educators and 7,450 students through activities supported by this funding. As shown in the table below, the number of educators reached by these 10 partners ranged from 2 to 400 and averaged 69, and the number of students reached by the 10 partners ranged from 20 to 4,000 and averaged 745. One grantee noted, “*While not all 4000 students received the funding, the vast majority of the groups were supported at least in part by subsidized access. Our survey responses from teachers tell us that, without the funding for students in need, none of their students would be able to take the trip.*”

Educators and students reached through Underserved Community Outreach grant (n=10)		
	Educators	Students
Low:	2	20
High:	400	4,000
Average:	69	745
Total:	692	7,453

### 3.3 How many students saw the film with assistance from the Underserved Community Outreach funding?

Together, the 10 organizations that indicated they used the Underserved Community Outreach grant reported that approximately 5,570 students saw *Mysteries of the Unseen World* with assistance through this funding. As shown in the table below, the number of students who saw the film with assistance from this funding ranged from 20 to 4,000 and averaged 557 per partner.

Student viewership of film through Underserved Community Outreach grant (n=10)	
	Students
Low:	20
High:	4,000
Average:	557
Total:	5,574

### 3.4 Did partners have additional feedback about the value of the Underserved Community Outreach funding?

When invited to share additional feedback about the value of the Underserved Community Outreach funding to their organizations, comments from the partners were entirely positive. The majority described how the funding helped them subsidize film tickets, museum tickets, and/or transportation costs, benefitting the students, the schools, and the partner organizations, as in:

- *We get many requests throughout the year for reduced or free admission to the Science Center. It is wonderful to have an opportunity to offer admission and a film to groups who would not otherwise be able to attend. And we rarely have funding that permits us to underwrite an Omnimax movie. This was an 'elite' opportunity for the students who were able to attend.*
- *It's fantastic to be able to provide assistance to these schools.*
- *I think this was a great part of the award. I am certain that many of the students and teachers that attended would have not been able to visit the museum or benefit from my post visit with the activities developed by NatGeo.*
- *It was great to have these funds to offer the movie as an added component to our outreach to community groups. Our Museum has an attached science magnet school in an underserved community. Having the ability to offer the movie made it a special time that they would not have been able to experience.*
- *Students at this particular school may never have had the opportunity to take a field trip to our museum.*
- *Funding for underserved audience is something that we get increasing requests from schools every year. As school budgets are cut, field trips and other out of class learning experiences are the first thing that is cut. Programs like this allow students to participate in activities and enrichment that they would not normally get to. We are very grateful to our funders for their assistance each year.*
- *It is very important to note what teachers say about this type of funding – many of our groups added the film directly as a result of the funding. Otherwise it would not have been an option. In most (but not all) cases we were able to assist an entire class when only funding the portion that received free/reduced rate lunch. We also used the funds for those groups who needed transportation subsidy – this was also often the difference between students getting the experience and not.*

Additionally a handful of the partner organizations explained that educators were appreciative of the materials they were able to use in their classrooms, as in: “Teachers were SO excited about the opportunity to...receive help to attend the film or get classroom supplies that support the activities and core concepts taught in the film” and “*The students and teachers were very thankful...the teachers took the activities and information back to their schools and shared with other colleagues.*”



## Question 4: How many local workshops were coordinated by the partners, and how many educators attended?

The 11 partner organizations coordinated 11 educator workshops dedicated solely to *Mysteries of the Unseen World*, reaching a total of 758 educators. At the same time, they coordinated an additional 23 educator workshops that included *Mysteries of the Unseen World*, reaching approximately 1,280 educators.

The 11 partner organizations coordinated 11 educator workshops dedicated solely to *Mysteries of the Unseen World*, reaching a total of 758 educators.<sup>5</sup> As shown in the table to the right, the number of educators reached per dedicated workshop ranged from 3 to 230 and averaged 69.

At the same time, the partners coordinated an additional 23 educator workshops that included *Mysteries of the Unseen World* in addition to other programming, reaching approximately 1,280 educators.<sup>6</sup> As shown in the table above, the number of educators reached ranged per workshop ranged from 43 to 364 and averaged 55 per workshop.

Local workshops planned by partner organizations, and educators reached (N=11)		
	Dedicated	Included
Workshops:	11	23
Low:	3	43
High:	230	364
Average:	69	55
Total:	758	1,276

When invited to elaborate, the largest group of partners shared details about the workshops they coordinated that included (rather than focused on) *Mysteries of the Unseen World*, as in:

- We held a teacher open house where MUW was a featured part of the night. Teachers could see the film, engage with Science Center staff who were presenting demonstrations that supported the science of MUW and teachers were given educator materials associated with the film. We also hosted a teacher preview focusing on the film where teachers saw the film and received materials and instruction on using the film in their classrooms.
- We held a MUW workshop in conjunction with our Educator's Open House in the Fall. We also added components to Professional Development workshops for the [local] Catholic Diocese teachers Workshop and for our Magnet School teachers. They love the freebies!
- In August, 2014, at our Teacher Resource Fair, teachers were able to view the movie and also had access to the DVD resources. In January of 2015, we held a workshop as part of an Adult-only event at the museum. It included free admission to the movie and the workshop activities. Unfortunately, there was a winter storm that came up that day and attendance was adversely affected. This Summer, I taught two workshops on Project Based learning, one on Integrating Science and Language Arts, and one on new Science Content Standards for [our state]. In each of these workshops, I mentioned the MUW movie and also disseminated the Dvd with activities and clips, and referenced the website as a resource for educators to use in their classroom.
- The [local university's] Department of Education attended an Overnighter Adventure where 115 student teachers participated in the Education workshop activities.

<sup>5</sup> Nine (9) of the partners planned one workshop dedicated solely to *Mysteries of the Unseen World*, 1 partner planned 2 such workshops, and 1 partner planned 0.

<sup>6</sup> The number of workshops planned that included the film among other programming ranged from 0 to 7 per partner. Four (4) partners planned 0 such workshops, 2 partners each planned 1 such workshop, and 1 partner each planned 2, 3, 4, 5, and 7 such workshops.

A few of the partners commented on the workshops they coordinated that were dedicated to *Mysteries of the Unseen World*, shared below:

- *We held one half day workshop dedicated to MUW.*
- *[We are] developing our teacher professional development offerings. This funding provided an opportunity to launch our teacher workshops and we will continue to use the activities and information in future workshops as they occur.*
- *We had one, successful on its face, workshop evening for teachers to explore science concepts at the museum and science center. They were able to see the film in Nat Geo GIANT screen theater. They were excited and took resources, asked questions, etc.*

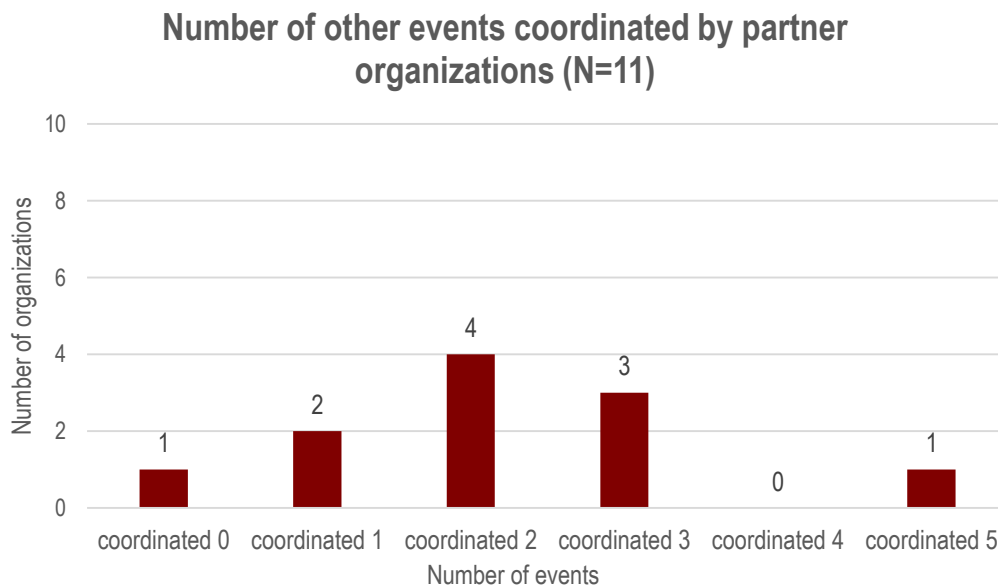
In their comments about the workshops, a handful of partners described the challenges they faced, including inclement weather, scheduling issues, and trouble following up with their coordinator, as in:

- *In January of 2015, we held a workshop as part of an Adult-only event at the museum. It included free admission to the movie and the workshop activities. Unfortunately, there was a winter storm that came up that day and attendance was adversely affected*
- *If I had known we were getting the movie and that there was a possibility of doing a workshop earlier we would have had much better attendance.*
- *We had one, successful on its face, workshop evening for teachers to explore science concepts at the museum and science center. They were able to see the film in Nat Geo GIANT screen theater. They were excited and took resources, asked questions, etc. However, the follow up with the coordinator was not good and we will take a different approach if we have the option to do this again.*

## Question 5: What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached?

Ten (10) of the 11 partner organizations coordinated other educator and student events that featured *Mysteries of the Unseen World* in some way. Together, they planned a total of 24 other events (that is, events other than the educator workshops considered in the previous section) for the general public, students, educators, and board members, among others. The majority of these 24 events featured the subject of nanotechnology. Additionally, the events used a variety of resources, including the giant screen film and DVD, the Museum Educator Guide and activities, the poster, videos related to the film, and the “fun facts” handout. Finally, the partners were able to approximate educator attendance at 20 of the 24 events, for an estimate of 1,820 educators. The partners were also able to approximate student attendance at 8 of the 24 events, for an estimate of 2,380.

Ten (10) of the 11 partner organizations coordinated other educator and student events (that is, events other than the educator workshops considered in the previous section) that featured *Mysteries of the Unseen World* in some way. As shown in the chart below, partners coordinated between 0 and 5 events each. Together, they planned a total of 24 other events that featured *Mysteries of the Unseen World*.



## Event types

The partners planned a range of events for the general public, students, educators, and board members, among others. Examples of events planned by the partners are shared below:

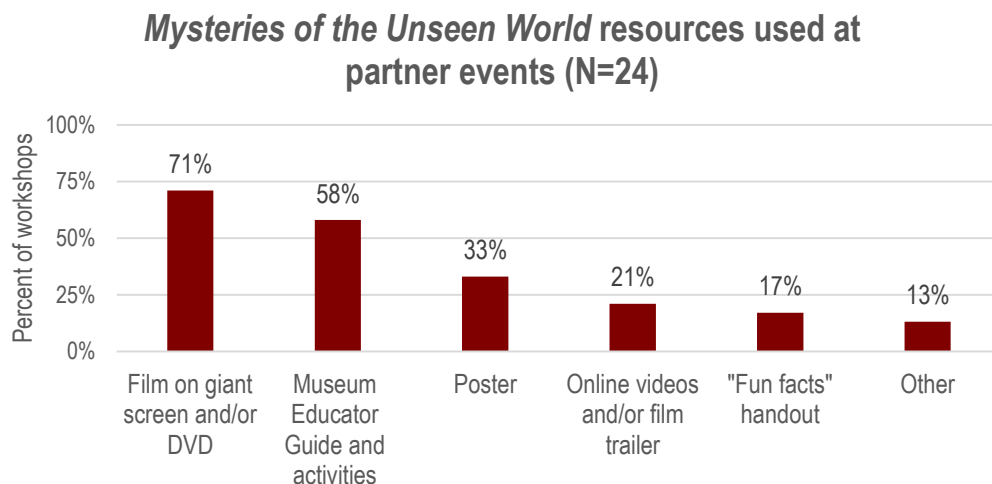
- *Public Nano Days*
- *First Thursday late night*
- *Unseen Mysteries Revealed day for the general public*
- *Catholic school convocation*
- *Engineering kids day camp*
- *Field trip package*
- *Homeschool family day*
- *Summer science teacher institute*
- *State science teachers conference*
- *Kick-off to Kindergarten for educator volunteers*
- *Nanotechnology educators conference*
- *Educator advisory board*
- *Department of Public Instruction Regional Science Lead Meetings*

## Content featured

Three-quarters of the 24 events planned by the partners featured the subject of nanotechnology (75%). Two (2) partners noted that their events featured “all” of the *Mysteries of the Unseen World* content (8%), and 1 event each focused on the following subjects: biology (4%), electron microscopy (4%), and infrared light (4%).

## Resources used

The partners described using a range of the *Mysteries of the Unseen World* resources at the 24 events. As shown in the chart below, nearly three-quarters of the events featured the film on giant screen and/or DVD (71%), while just under three-fifths made use of the Museum Educator Guide and activities (58%). A third of the events used the poster (33%), a fifth used online videos and/or the film’s trailer (21%), and about one-sixth used the “fun facts” handout (17%). Just over a tenth used other materials (13%), including “*NatGeo Kids and other NatGeo giveaways*,” the “*FEI Guide*,” and “*materials from NISE network Nano day*.”



## Number of educators and students in attendance

As shown in the table to the right, the partners were able to estimate educator attendance at 20 of the 24 events, for a total of 1,820 educators. The number of educators per event ranged from a low of 2 to a high of 700, with an average of 91 per event. The partners were also able to estimate student attendance at 8 of the 24 events, for a total of 2,380. The number of students per event ranged from a low of 20 to a high of 900, with an average of 297 per event. Finally, though the information was unsolicited, one partner noted that their public Nano Days event drew 100 members of the general public.

<b>Attendance at other events (N=24)</b>		
	<b>Educators (n=20)</b>	<b>Students (n=8)</b>
<i>Low:</i>	2	20
<i>High:</i>	700	900
<i>Average:</i>	91	297
<i>Total:</i>	1,819	2,379

## Question 6: What feedback did partners share about the value, distribution, and use of the *Mysteries of the Unseen World* media and materials?

First, the partners were asked to rate the value of the educator DVD, Museum Educator Guide, poster, and “fun facts” handout, and to provide the number of each they distributed, the audiences they shared these resources with, and how they thought they were used (if known). Next, they were asked to comment on their use of the lobby kiosk and to rate the value of the kiosk. Finally, they were asked to rate the value of 6 additional *Mysteries of the Unseen World* resources: the giant screen film, the standards sheet, the website, the online videos, the online activities and lessons, and the iPad app/game. These findings are presented below in 6.1 through 6.3.

### 6.1 How were the DVD, Museum Educator Guide, poster, and “fun facts” handout valued by the partners, distributed, and used?

The partners were asked to rate the value of the educator DVD, Museum Educator Guide, poster, and “fun facts” handout on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), and to estimate the number of each they distributed, as well as the audiences they shared these resources with and how they were used (if known). Details about each resource are shared below.

#### Educator DVD

Overall, the partners found the educator DVD to be very valuable. Ten (10) of the 11 partner organizations were able to detail the number of educator DVDs they distributed, for an approximate total of 4,040. The partners noted that they shared the DVDs primarily with educators.

When invited to rate the value of the educator DVD to their organizations on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), the partners generally thought it was very valuable (median rating 4.0). The table below presents the number of partners selecting each rating.

Value of the <i>Mysteries of the Unseen World</i> educator DVD, as determined by the partner organizations (N=11)						
	N/A	Not at all valuable 1	Slightly valuable 2	Moderately valuable 3	Very Valuable 4	Extremely valuable 5
Educator DVD value	0	0	0	1	5	5

As shown in the table to the right, ten (10) of the 11 partner organizations were able to detail the number of educator DVDs they distributed, for an approximate total of 4,040. Responses ranged from a low of 29 to a high of 2,000, and averaged 404. The remaining partner organization was unable to report how many had been distributed, but shared information about the audiences that received the educator DVD and how it had been used.

Educator DVDs distributed (n=10)	
Low:	29
High:	2,000
Average:	404
Total:	4,043

All 11 partners indicated that they shared the educator DVD with educators (including homeschool parents), and one of the partners said it was also shared with a general audience. Some of the partners provided details about how the educator DVD was used, as in *“Professional Dvlp/Classroom,” “Teachers mentioned that they used some lessons in class,” “Teacher’s Night/ Member opening,” “Activities,”* and *“Used in classrooms.”*

### Museum Educator Guide

**Overall, the partners found the Museum Educator Guide to be very valuable. Six (6) of the 11 partner organizations were able to detail the number of Museum Educator Guides they distributed, for an approximate total of 3,080. The partners noted that they only shared the resource with educators.**

When invited to rate the value of the Museum Educator Guide to their organizations on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), the partners generally thought it was very valuable (median rating 4.0). The table below presents the number of partners selecting each rating.

Value of the <i>Mysteries of the Unseen World</i> Museum Educator Guide, as determined by the partner organizations (N=11)						
	N/A	Not at all valuable 1	Slightly valuable 2	Moderately valuable 3	Very Valuable 4	Extremely valuable 5
Museum Educator Guide value	1	0	0	2	4	4

As shown in the table to the right, six (6) of the 11 partner organizations were able to detail the number of Museum Educator Guides they distributed, for an approximate total of 3,080. Responses ranged from a low of 29 to a high of 2,000, and averaged 513. Two (2) of the remaining partner organizations were unable to report how many had been distributed, but shared information about the audiences that received the Museum Educator Guide and how it had been used.

Educator Guides distributed (n=6)	
Low:	29
High:	2,000
Average:	513
Total:	3,079

The 6 partners who noted that they shared the Museum Educator Guide described sharing it with educators (including homeschool parents). Some of the partners provided details about how the Museum Educator Guide was used, as in *“Professional Dvlp/Classroom,” “Teachers mentioned that they used some lessons in class,” “Teacher’s Night/ Member opening,” “Activities,” “In classrooms,”* and *“Used in classrooms.”*

## Poster

**Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of posters they distributed, for an approximate total of 2,680, and the partners noted that the posters were primarily shared with educators.**

When invited to rate the value of the poster to their organizations on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), the partners generally thought it was very valuable (median rating 4.0). The table below presents the number of partners selecting each rating.

<b>Value of the <i>Mysteries of the Unseen World</i> poster, as determined by the partner organizations (N=11)</b>						
	N/A	Not at all valuable 1	Slightly valuable 2	Moderately valuable 3	Very Valuable 4	Extremely valuable 5
Poster value	1	0	1	3	2	4

As shown in the table to the right, nine (9) of the 11 partner organizations were able to detail the number of posters they distributed, for an approximate total of 2,680. Responses ranged from a low of 29 to a high of 1,000, and averaged 298. One (1) of the remaining partner organizations was unable to report how many posters were distributed, but shared information about the audiences that received the resource and how it was used.

<b>Posters distributed (n=9)</b>	
<i>Low:</i>	29
<i>High:</i>	1,000
<i>Average:</i>	298
<i>Total:</i>	2,680

The 10 partners who noted that they shared the poster all described sharing it with educators (including homeschool parents), with smaller groups explaining that they also shared with the general public and/or with students. Finally, some of the partners provided details about how the poster had been used, as in: “*Excitement for the film/promo,*” “*During regular business hours (from the front line),*” “*To hang in classrooms,*” “*Classroom use and handouts,*” “*In classrooms/prizes,*” and “*Used in classrooms.*”



## “Fun facts” handout

**Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of “fun facts” handouts they distributed, for an approximate total of 3,760. The partners noted that they were primarily shared with educators.**

When invited to rate the value of the “fun facts” handout to their organizations on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), the partners generally thought it was very valuable (median rating 4.0). The table below presents the number of partners selecting each rating.

<b>Value of the <i>Mysteries of the Unseen World</i> “fun facts” handout, as determined by the partner organizations (N=11)</b>						
	N/A	Not at all valuable 1	Slightly valuable 2	Moderately valuable 3	Very Valuable 4	Extremely valuable 5
“Fun facts” handout value	1	0	1	3	4	2

As shown in the table to the right, nine (9) of the 11 partner organizations were able to detail the number of “fun facts” handouts they distributed, for an approximate total of 3,760. Responses ranged from a low of 29 to a high of 1,500, and averaged 417. One (1) of the remaining partner organizations was unable to report how many had been distributed, but shared information about the audiences that received the handout and how it had been used.

<b>“Fun facts” handouts distributed (n=9)</b>	
<i>Low:</i>	29
<i>High:</i>	1,500
<i>Average:</i>	417
<i>Total:</i>	3,755

Of the 10 partners who noted that they shared the “fun facts” handout, the majority described sharing it with educators (including homeschool parents). Smaller groups explaining that they shared with the general public and/or students or campers. Finally, some of the partners provided details about how the handout was used, as in: “*Supplement film, in-class activities,*” “*Used in classrooms,*” “*Out for the gen. visitor, in take-away bags for campers,*” “*We used them to get teachers excited about the film,*” and “*We gave them out to parents to get young kids interested in the film.*”

## 6.2 How did partners use and value the lobby kiosk?

The majority of partners hosted the kiosk at their organizations. Those who used it explained that they put in their lobbies to promote the film, entertain audiences while they waited to enter the theater, and connect the film to other exhibits, among other responses. In general, the partners found the kiosk to be very valuable to their organizations. When invited to comment on the value that the kiosk brought (or did not bring), some partners described its value in terms of use by potential film viewers, museum visitors, and members, while other described liking previous National Geographic materials more than the kiosk and having trouble with the kiosk's iPads.

### 6.2a Whether partners used the kiosk

When partners were asked if their organization chose to host the kiosk, 10 said *Yes*, while the remaining partner said *No*. The partners who used the kiosk – shown in the image to the right – explained that they put in their lobbies to promote the film, entertain audiences while they waited to enter the theater, and connect the film to other exhibits, among other responses. Feedback from the partners who used the lobby kiosk is shared below:

- *We hosted it because we built it and because we thought it would be very useful in promoting the film and providing an engaging, educational activity in our main lobby.*
- *We hosted the kiosk to help promote the movie to school groups and general audiences.*
- *That was not a decision made by myself, however I imagine it was thought to be a good way to engage our public in our large main lobby and promote the movie.*
- *We thought it was a good way to engage the audience and encourage them to want to see the movie*
- *It provided educational and fun activities to do while students and public waited in line.*
- *The exhibit was very interactive and it gave the guest a sneak peek of the movie before they viewed the film.*
- *It connected MUW with our Nano Exhibit.*
- *It was offered to us!*

*Mysteries of the Unseen World* lobby kiosk  
Image courtesy of the outreach award fact sheet,  
shared in Appendix 2

The one partner organization that declined to use the kiosk explained that this was because: *“We did not have a staff member who could be dedicated to manning the kiosk. There was a concern about losing/breaking parts. We also felt that once we had them in the door they had already been convinced to see the film.*

## 6.2a How valuable partners found the kiosk

When invited to rate the value of the lobby kiosk to their organizations on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable), the partners generally thought it was very valuable (median rating 4.0). The table below presents the number of partners selecting each rating.

Value of the <i>Mysteries of the Unseen World</i> lobby kiosk, as determined by the partner organizations (N=11)						
	N/A	Not at all valuable 1	Slightly valuable 2	Moderately valuable 3	Very Valuable 4	Extremely valuable 5
Lobby kiosk value	1	0	0	2	5	3

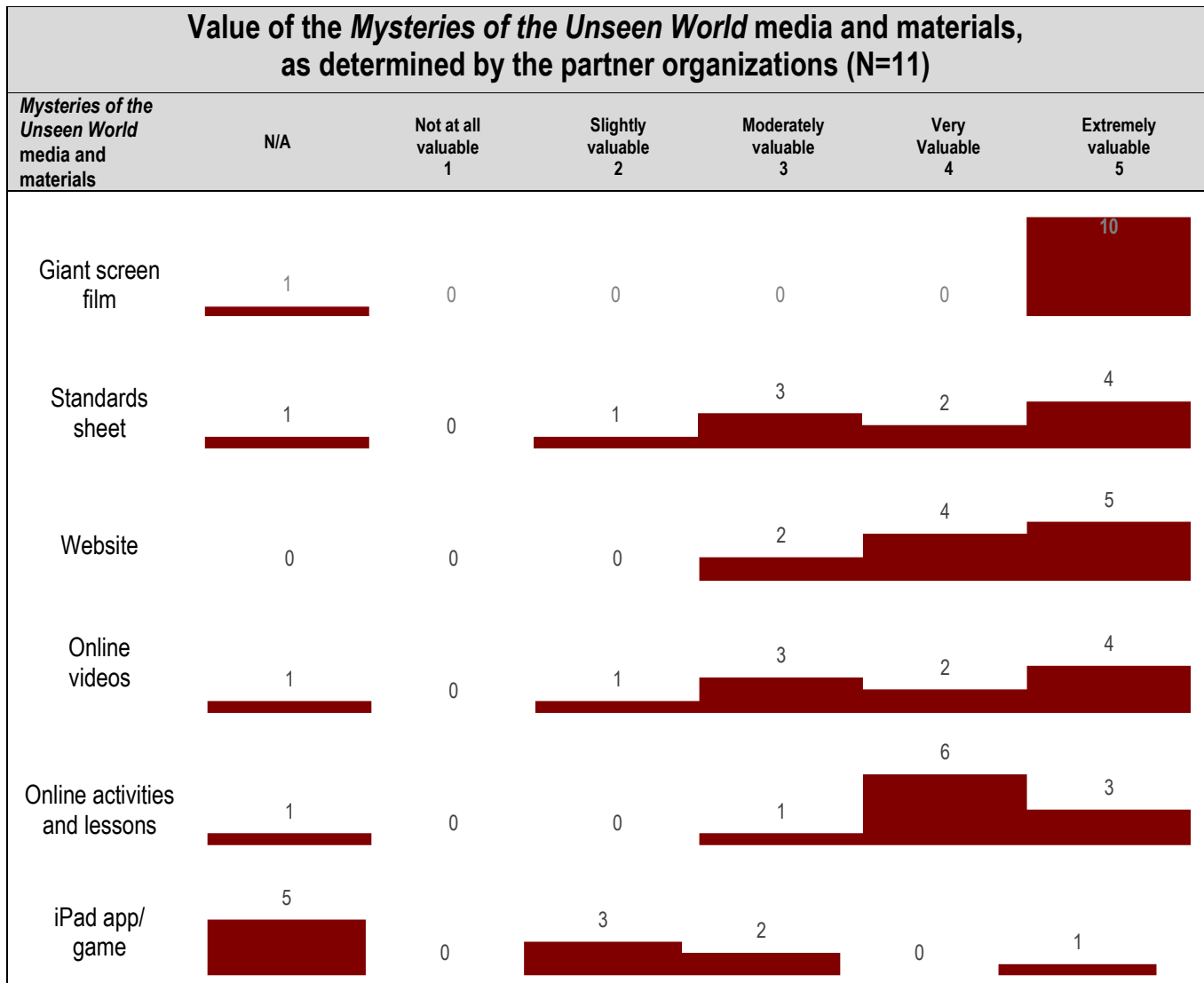
The partners who hosted the lobby kiosk were also invited to comment on the value that it brought (or did not bring). Some partners described its value in terms of use by potential film viewers, museum visitors, and members, while other described liking previous National Geographic materials more than the kiosk and having trouble with the iPads. Responses from the partner organizations are shared below:

- *It's been very valuable. Visitors have used it pretty regularly. It was nice to have a teaser for the film in our main lobby. And while we don't have much evidence about how the kiosk prompted add-on movie ticket sales, we are pleased with the presence it provided for the film.*
- *It added a lot of value to the experience of seeing the movie. Parents were able to occupy their children or students while they waited in line which put everyone into a better mood.*
- *It definitely got a lot of use in the museum.*
- *The kiosk provided an additional enriching experience for guests related to the film.*
- *It sparked a lot of interest in the film to regular guests who may not have been interested otherwise. It also helped the guests to use inquiry to explore in the venue, even if they didn't see the film.*
- *I think it added value, especially to our member audience. I believe it was place in the lobby for special events for members to use.*
- *It worked well to link the movie to our exhibit. We actually put it in our Nano exhibit on a different floor. When we saw visitors engaged with it we promoted the movie and we encouraged people after the movie to visit Nano and see it. Was it worth the money. . . no, I like the activity kit for Robots better. It will get much more use.*
- *This kiosk was cute –the design held up nicely although there were often iPad problems. We had this in our grand lobby, which met it was frequented by many children as their parent or group leader bought tickets. They liked it but I can't say I saw a ton of kids really 'get' what was happening.*
- *Unfortunately it was not a good fit for [us] as the app was temperamental in performance in our dimly lit lobby, and we weren't able to leave out the loose parts for fear of them walking off.*

### 6.3 How did partners rate the value of the other *Mysteries of the Unseen World* media and materials?

The partners generally thought the giant screen film was extremely valuable to their organizations. Additionally, they indicated that each of the following materials was very valuable: the standards sheet, the website, the online videos, and the online activities and lessons. Finally, they generally found the iPad app/game to be between slightly and moderately valuable.

Partners were asked to rate the value of the following *Mysteries of the Unseen World* media and materials on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable): the giant screen film, the standards sheet, the website, the online videos, the online activities and lessons, and the iPad app/game. The table below presents the numbers of partners selecting each rating.



While there were some differences in opinion, as evidenced by the range of ratings in each case, the partners generally felt that the giant screen film was extremely valuable (median rating 5.0) to their organizations. Additionally, they indicated that each of the following materials was very valuable (median rating 4.0 each): the standards sheet, the website, the online videos, and the online activities and lessons. Finally, they generally found the iPad app/game to be slightly-to-moderately valuable (median rating 2.5).

When invited to explain their ratings, some of the partners provided additional feedback about the project as whole, while others pointed to specific materials they did or did not like, as in:

- *The material package (promotional and educational) for this film was incredibly compelling and exceptionally valuable. It was one of the strongest packages we've seen for any film. Some of the material we've not used yet to its fullest potential [standards sheet, website, online videos, online activities and lessons]. But since we are continuing to screen the film for school groups, we plan to continue to use these materials in already successful ways and to add additional uses for them.*
- *I loved the technology (best, actually) but our visitors can be a bit behind the curve so they didn't necessarily utilize the technology more than the paper.*
- *All of the information used and given out was both useful and beneficial.*
- *I used the website all the time and send teachers to it. Love the how to use films to teach section all the time. I am trying to incorporate focused attention techniques with our staff to preview each movie with students. All on line resources are great. Used the rain drop and lightning video all the time.*
- *I thought most of the materials were good ways for teachers to supplement the film. I don't think there is a need for the app in a school setting, but should be geared more towards the general public.*

## Question 7: How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring?

All but two of the partner organizations used activities from the Museum Educator Guide, with some describing them as “*useful*,” “*simple*,” and “*easy to implement*.” Those who didn’t use the activities said they either adapted some of the concepts or hadn’t found the right group to share them with.

Partner organizations were asked if and how they used the activities in the Museum Educator Guide, which activities they used, and the number of educators and students reached. They were also asked to comment on the value of the activities. Their feedback is summarized below in 7.1 through 7.2.

### 7.1 Did partners use the activities?

Partners were asked if their organizations used any of the activities in the Museum Educator Guide with educators and/or students. Nine (9) of the 11 partners said *Yes*, while the remaining 2 said *No*.

Those who utilized the activities in the Museum Educator Guide described using them in a variety of ways (for example, with field trips and in curriculums) and finding them “*useful*,” “*simple*,” and “*easy to implement*.” One partner noted that some of the activities “*took too much time*.” Feedback from the partners about their general use of the activities is shared below:

- *We modified a few activities for use in school group programs.*
- *They were good STEM based activities. Useful and simple.*
- *Some of the activities were used in our very own exhibit halls. We try to engage our public with special activities that supplement our permanent exhibit halls and films. I also used some activities during the post visit to the school we funded through the award to see the film and visit the museum.*
- *We used some of the activities in our Field Trip Package program.*
- *We saw them as a valuable curriculum resource*
- *Excellent resource of tools to enhance the film. Very easy to implement*
- *They were connected to curriculum and standards. Some took too much time*

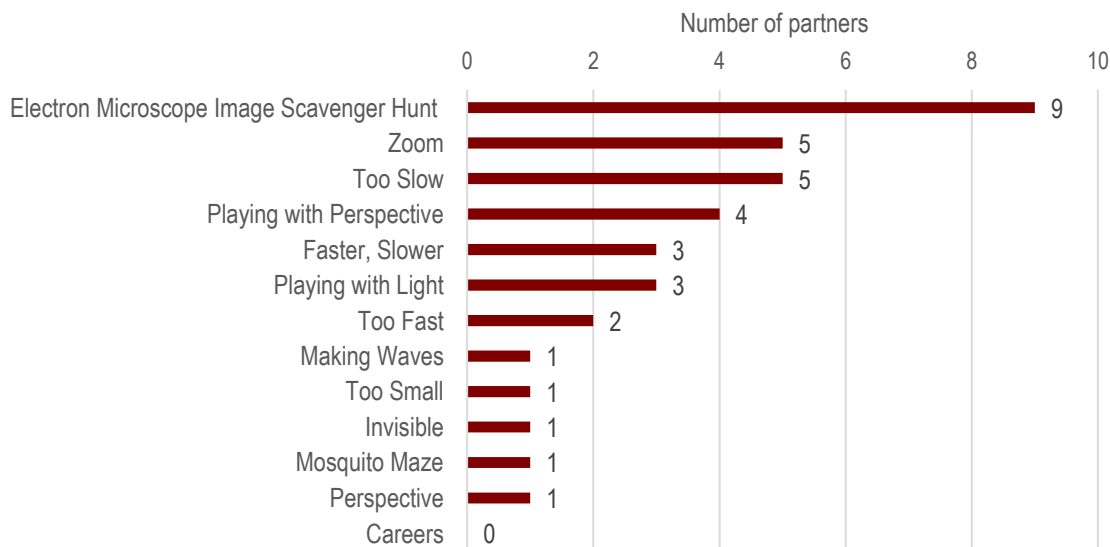
The 2 partners who didn’t use the activities explained that they either adapted some of the concepts or hadn’t found the right group to share the activities with, as in:

- *We did not use these activities, per se, but ended up using some of the same concepts and topics in our development of lesson plans for in-class use by teachers who participated in our “Inquiry Adventure: Biology” program.*
- *We have a microbes program this would have been perfect for but we didn’t have any K-12 groups take advantage of the program during MUW’s run. Since we keep these films in our library for later use, perhaps we will still integrate something*

## 7.2 Which activities did the partners use, how many educators and students were reached, and what value did the activities bring?

As shown in the chart below, Electron Microscope Image Scavenger Hunt was used by 9 of the partners, and Zoom and Too Slow were each used by 5 of the partners. Playing with Perspective was used by 4 of the partners, while Faster, Slower and Playing with Light were each used by 3 of the partners. Two (2) of the partners used the Too Fast activity, and 1 of the partners used each of the following activities: Making Waves, Too Small, Invisible, Mosquito Maze, and Perspective. None of the partners used the Careers activity.

**Activities used by the partner organizations (N=11)**



Many of the partners were unable to provide estimates of the number of educators and students reached by their use of the activities in the Museum Educator Guide. Tallies of the estimates that *were* provided are shared in the table below. As shown in this table, from the estimates that were provided, Electron Microscope Image Scavenger Hunt reached the largest numbers of educators (209) and students (4,150).

<b>Known numbers of educators and students reached by activities coordinated by the partner organizations (N=11)</b>		
<b>Activity Name</b>	<b>Known number of educators reached</b>	<b>Known number of students reached</b>
Playing with Perspective	49	800
Electron Microscope Image Scavenger Hunt	209	4,150
Making Waves	0	0
Zoom	109	820
Faster, Slower	60	0
Playing with Light	100	1,683
Too Slow	189	1,720
Too Fast	32	800
Too Small	60	400
Invisible	0	0
Mosquito Maze	60	400
Perspective	0	0
Careers	0	0

Next, the partners were asked to comment on the value that the activities did (or did not) bring to the educators and/or students they reached. Some of the partners described how the educators and students really enjoyed and were engaged by the activities, as in:

- *The students and teachers really enjoyed the activities. Simply amazed. They were blown away by some of the answers to the activities.*
- *The activities are always good.*
- *These activities were easy for the educators to engage in. I don't know how much they have used these in practice with their classrooms.*
- *They engaged students and educators with hands-on experiences and enhanced learning.*
- *At the same time, other partners described how they used the activities in their exhibits and their trainings, and how they modified or were inspired by them, as in:*
- *These two activities would great in our exhibit halls. We have a pretty heavy flow of visitors most days, so activities that are easy to implement are preferred. I think making connections between the film and throughout the museum is very valuable to our visitors.*
- *I like to use them in Educator trainings and then direct them how to download the curriculum. I know the information is correct, so it's a real timesaver for me.*
- *I used the scavenger hunt for both homeschooling professional developments I held. We did not use any of the other programs with educators or students, but I did adapt some of the activities into our camp programs: Playing with Perspectives, Electron Microscope Image Scavenger Hunt, Zoom, Playing with Light, Mosquito Maze*
- *We modified these activities to serve school groups.*
- *As a museum educator I highly value the activities that come with the movies. Even if we were unable to use all of them directly, they always provide further inspiration for other activities.*

Finally, one of the partners expressed dissatisfaction with the activities, saying, *"Some just took too much time. I really like the Robot ones so much better. Better variety of time requirements and can easily be modified to all ages. Kit will help immensely!"*



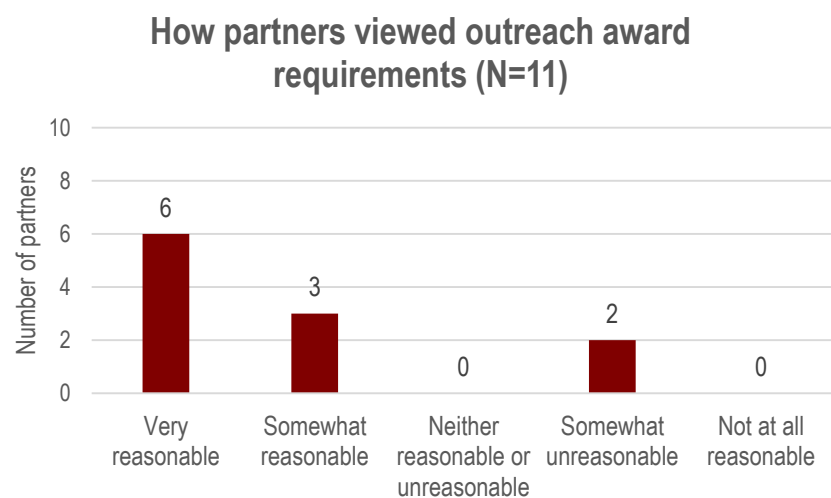
## Question 8: What feedback did partners have about the outreach award requirements and the project overall?

The majority of the partners found the outreach award requirements reasonable. A couple of partners felt they were somewhat unreasonable given challenges in registering workshop participants and tracking educator surveys. The partners generally felt that it was very easy to share their outreach plan with National Geographic and that it was easy to utilize the \$1000 for underserved students, disseminate and promote materials, and integrate *Mysteries of the Unseen World* into existing workshops. Overall, the partners indicated that it was neither easy nor difficult to host dedicated educator workshops and complete the post report. All but two partners indicated they would participate in the award program again, and those who said *It would depend* commented on the challenges of meeting some of the requirements and the amount of time they invested.

First, partner organizations were asked to rate the outreach award requirements in terms of how reasonable or unreasonable they found them. Next, they were invited to rate the ease of accomplishing the outreach award deliverables. Third, they were asked whether they thought they would be likely to participate in this program again. Fourth, they were invited to share suggestions for future programs, and finally they were given the opportunity to provide additional feedback about the program. Their feedback is summarized below in 8.1 through 8.5.

### 8.1 How reasonable did partners find the outreach award requirements?

As shown in the chart to the right, when asked how reasonable they thought the outreach award requirements were, 6 partners said they were very reasonable. Three (3) of the partners thought they were somewhat reasonable, and 2 thought they were somewhat unreasonable. None of the partners thought the requirements were not at all reasonable or neither reasonable or unreasonable.



The partners shared a range of responses when invited to explain their ratings, shared on the following page:

**Very reasonable**

- *It was valuable for us to be able to have one of our educators present in DC to discuss this programming with other educators and NatGeo officials. This brought a high-level of understanding to our team, as [this person] brought significant knowledge with him (along with much excitement about the movie and the educational programming possibilities).*
- *What you are asking for is very reasonable and fair. There's still the challenge of us being about to deliver it but it's reasonable and we'll just have to keep working to figure this out.*
- *Nat Geo was more than generous with the "perks" in exchange for data. I understand the need to receive quality feedback for your funders. Covering the travel, housing and food costs does allow me to come down. I would not be able to unless it is covered. Getting the education outreach allowed me to offer food and perks for the teacher workshop which is needed to get teachers to attend. I did not give stipends for them since I combined it with our Educator Open House, but sometimes you need to or give them plenty of perks such as classroom materials or swag. The requirements were more than realistic. The outreach to underserved is truly of value for our community. The only struggle I have is getting feedback from the teachers. We are part of a large NSF grant and it is the same issue. We had to hold back payment for the teachers to ensure filling of the post survey. There are some teachers that take it seriously and some that just "want to get it done".*
- *NG is very generous in providing the mini-grant that allows our education department the resources to do new and creative things without the red tape of traditional grants. At [our organization] we look forward to working with NG in the future with future mini-grants.*
- *Very easy reasonable. [We have] a great working relationship with all schools and non-schools groups in our area.*
- *The only problem was being able to use the money, but that is really a problem on our end, not yours.*

**Somewhat reasonable**

- *Ensuring a minimum number of survey responses was the only difficult requirement as it's mostly out of our control – we were not able to incorporate the survey into our field trip survey per restrictions on the parameters. The survey was lengthy, asking for additional time from educators*
- *I think most requirements would have been reasonable if the timing was a little better (see comments below).*
- *As I mentioned before, [we are] developing our teacher professional development offerings. Some of the requirements seemed more suitable for those with an established program.*

**Somewhat unreasonable**

- *The educator surveys were not submitted to us at all, so it was difficult to track how many surveys were submitted from educators who visited our facility. We had to have them fill out the survey onsite- which can be difficult to convince people to stay and do- or we had to trust that teachers would fill them out offsite, which was not possible for us to track.*
- *It is difficult to make educators that are just coming to see the movie participate in the evaluation piece in the end*

## 8.2 How did partners rate the ease of accomplishing the outreach award deliverables?

Next, the partners were invited to rate the ease of accomplishing the following outreach award deliverables on a scale from 1.0 (very difficult) to 5.0 (very easy): sharing the outreach plan with National Geographic, utilizing the \$1000 for underserved students, disseminating and promoting materials, hosting dedicated educator workshops, integrating *Mysteries of the Unseen World* into existing workshops, completing the post report, and ensuring response to the educator survey. The table below presents the numbers of partners selecting each rating.

Ease of accomplishing outreach award deliverables, as determined by the partner organizations (N=11)						
Outreach award deliverables	N/A	Very difficult 1	Difficult 2	Neither difficult nor easy 3	Easy 4	Very easy 5
Share outreach plan with National Geographic	0	0	0	1	4	6
Utilize \$1000 for underserved students	0	1	0	4	1	5
Disseminate and promote materials	0	0	0	5	2	4
Host dedicated educator workshops	0	1	3	2	3	2
Integrate <i>Mysteries of the Unseen World</i> into existing workshops	2	0	1	0	6	2
Complete post report	0	1	1	4	3	2
Ensure response to educator survey	0	6	1	2	0	2

While there were some differences in opinion, as evidenced by the range of ratings in each case, the partners generally felt that it was very easy to share their outreach plan with National Geographic (median rating 5.0) and that it was easy (median rating 4.0 each) to utilize \$1000 for underserved students, disseminate and promote materials, and integrate *Mysteries of the Unseen World* into existing workshops. Overall, the partners indicated that it was neither easy nor difficult (median rating 3.0 each) to host dedicated educator workshops and complete the post report. Finally, the partners noted that it was generally very difficult (median rating 1.0)

to ensure response to the educator survey. Those who rated this element lowest conducted their programs early in the grant period when they were asked to complete an online survey form developed internally by National Geographic. When the independent evaluation for the NSF grant began several weeks later, they were then asked to use an updated version of the form that would be sent to the independent evaluator instead of National Geographic. This shift in strategy likely caused some initial confusion and additional burden to the survey requirement that did not affect partners that commenced their outreach later in the grant period and were only instructed to use the independent evaluation form.

When invited to explain their ratings, the partners elaborated on the challenges they faced related to ensuring responses to the educator surveys, registering educators for dedicated workshops, lacking an established educator database, and lacking access to the information needed for the post report, among other topics. Partners' responses are shared below:

### **Challenges in ensuring responses to educator survey**

- *I was concerned about getting you the number of educator surveys that you requested. The format for the survey changed right before my workshop so I was unable to give the teachers something to fill out before they left the workshop. If you are relying on teachers to fill out a survey weeks after the workshop, you are unlikely to get as many people to respond as you would if it was filled out at the workshop. If this is the format that you prefer, then perhaps incentives should be offered? I was also working with the survey company to get special surveys made up for teachers that booked the movie, but didn't attend the workshop. I sent out DVDs and posters to these teachers and indicated that a survey would be sent to them soon. I never heard back about the survey to send out to these teachers.*
- *The educator surveys were not submitted to us at all, so it was difficult to track how many surveys were submitted from educators who visited our facility. We had to have them fill out the survey onsite- which can be difficult to convince people to stay and do- or we had to trust that teachers would fill them out offsite, which was not possible for us to track.*
- *Teachers are so tough to fill out the educator surveys. Sometimes we "bribe" them with chocolate or \$\$\$. I did not do this for our workshop with them at our Open House, though we fed them well, thanks to you. Maybe swag will help them to fill them out. Sorry, I tried really hard to get you good data.*

### **Miscellaneous**

- *We found it difficult to get educators to register for dedicated workshops for the movie and the associated educational material. We planned to hold at least 2. We promoted the first workshop in a number of ways (educator e-blasts, promoted it in person at 2 separate educator events, personal emails to highly engaged teachers) Only 3 teachers attended (and we included lunch) We did not host a second, but rather promoted the educational activities/film at other events/workshops we held that included teachers.*
- *Our biggest challenge was that we don't have an established educator base of our own yet and are working to develop that. To advertise and market Mysteries, we used other databases which made it hard to ensure that we met the minimum numbers for workshop participation and survey responses. However, having the opportunity to host a dedicated Mysteries workshop has really helped us to jumpstart that and we've made some very important steps in developing our educator network that would not have happened otherwise. It would be great to have something geared towards museums that are new to teacher/professional development and may not be able to meet the numbers you've requested for educators, but could complement those numbers with outreach to the public. I wish there were more opportunities to report on public outreach because our Nano Days activities that highlighted Mysteries content were very, very well received.*
- *One of our issues this round was out of the control of all of us – the partner rep decided to resign but was 'present' instead of leaving for several months. She had no real desire to do a lot of things – including help communicate to teachers as we planned – so that made this option even harder than usual.*
- *Completing the [post report] was difficult as there were others in my organization that had information needed and was difficult to get. In addition, there were other personal issues and work scheduling issues that made difficulty.*

### 8.3 Did the partners think they would be likely to participate in the award program again?

When asked if they would participate in this National Geographic award program again, 9 of the 11 partners said Yes, while 2 explained that *It would depend*. Those who said Yes praised the resources, the support from National Geographic, and the value of the opportunity for local educators. Those who said *It would depend* commented on the challenges of meeting some of the requirements and the amount of time they invested. Responses from the partners are shared below:

#### Yes

- *The educational resources were invaluable, the support from NG was great, the opportunity to send an educator to the workshop was so helpful, and the funding for underserved was much appreciated.*
- *It's a valuable program to offer to our educators and enhanced our educational offerings for the film.*
- *Of course. I found it invaluable. Hopefully we benefited NG in a small way as well.*
- *I think it is a great idea to connect school program curriculum with educational films that we show in our museum. I think that PD workshops for teachers that make this connection would be popular in the future. I am always open to opportunities to work with other informal educators to improve upon my on curricular development.*
- *We loved the opportunity it provided for the students and teachers in our area. It is a wonderful resource!*
- *This was our first time with the program and we did not leverage everything as well as we could have – but the mission-based educational value of this program was strong, well-conceived and unique. We'll need to 'teach' our educational community what to do with these opportunities but it is well worth the effort.*
- *I am doing Robots. It is a great way to get your valuable resources to teachers that can't afford it. It fulfills our mission to train teachers.*
- *It is an excellent opportunity to engage with schools and educators while also promoting great movies at our museum. This allows us to educate but also draw more people to our museum.*
- *Great opportunity to enhance Science Education in our area.*

#### It would depend

- *I think it was useful that we could provide a group of students with a free field trip to see the film. I used the activities they told us about when I was writing camp curriculum, but they are available for free on the website so I did not need to go to DC to get access to them. I think the PD workshop component and surveys were difficult to fulfill. The homeschooling parents seemed to enjoy it, but we had to have more than 1 because there was not a large amount of interest in it. We did not have the time and resources to do workshops with classroom teachers. We also have no way of knowing if the teachers on the field trips filled out the surveys because they went straight to National Geographic, so it's impossible to say if we had enough surveys to meet that requirement. So, I would say that we would be interested in having resources to make the Science Center/film accessible to students underprivileged schools, but not in the professional development component.*
- *Depends because the requirements do not always make the amount worth going for. In addition staff changes make it difficult when those who participate in the educator training/ are wanting the grant are different than those who are responsible for implementation of the project.*

## 8.4 Did the partners have suggestions for future programs?

When asked what changes they thought National Geographic should make the program moving forward, the partners shared a range of suggestions, including: altering the educator survey component, disconnecting activities from the kiosk, facilitating discussions among the partners, developing more activities, connecting to the Next Generation Science Standards, particularly cross cutting concepts, and making the project more interdisciplinary. Their feedback is shared below:

- *I love the idea of creating education programs around films! All the teachers in my workshop love the idea too. They agreed that making these connections increases the chances of their students understanding the content presented. I ran into several problems based on the timing of the workshop and release of film. Unfortunately, I did not have enough time to plan and implement some of the outreach award deliverables. In my case, the film was being released about 2 weeks after I attended the workshop. I would recommend holding the workshop either in late spring or early summer. It gives museum educators, like me, sufficient time to implement your education materials pertaining to the film into our school programing. This is around the time we are developing new programs and creating write-ups for the guides we send out to teachers before the next school year to help them book programs and movies during their visit. Teachers often make these decisions in Oct-Nov. The time of day the film was shown, also posed a big problem. Not many school booked the film because it was long and shown late in the day. You might have more success creating education content for shorter films (20 min) that are more likely to be shown in the morning and early afternoon.*
- *Re-evaluate the survey component as a requirement for responses. 2. We loved the kiosk activities, but not the kiosk format. Having the activities not attached to a kiosk would have given us flexibility to use them more broadly and widely. 3. It would be great to hear from other institutions about what they did with their award.*
- *Our biggest challenge was that we don't have an established educator base of our own yet and are working to develop that. To advertise and market Mysteries, we used other databases which made it hard to ensure that we met the minimum numbers for workshop participation and survey responses. However, having the opportunity to host a dedicated Mysteries workshop has really helped us to jumpstart that and we've made some very important steps in developing our educator network that would not have happened otherwise. It would be great to have something geared towards museums that are new to teacher/professional development and may not be able to meet the numbers you've requested for educators, but could complement those numbers with outreach to the public. I wish there were more opportunities to report on public outreach because our Nano Days activities that highlighted Mysteries content were very, very well received.*
- *I really liked the program. I'd say the only thing I would change would be to make it even more hands on; more activities and less listening. Now, that being said, it was fine the way it was and I really enjoyed it.*
- *Love the kit idea. 2. Provide better swag to give to teachers upon completion of educators survey. Bags, caps, classroom resource. . . 3. Connect to NGSS, particularly cross cutting concepts 4. Make it more interdisciplinary; adding math and literacy*

## 8.5 Did the partners have additional feedback to share about the project?

When invited to share additional feedback about their experience conducting outreach on behalf of *Mysteries of the Unseen World*, many partners shared positive comments about the opportunity and their experience with the project. Additionally, one reiterated that their organization had trouble using the funding and another suggested working with shorter films. Partners' responses are shared below:

- *This was a great opportunity to work with our local schools...it allowed us to reach out to schools throughout the [our region]. The outreach Award allowed [us] to create new relationships with teachers, students, and parents. If given the opportunity again, [we] would love to participate.*
- *Conducting outreach is part of our mission and job, by providing this mini-grant and the tools (including the film) and resources to do it, makes our job easier. Please keep this program up!*
- *We appreciate the opportunity. The workshop helped us develop and deliver strong programming. Money for outreach enabled us to reach audiences we may not have been able to without funding.*
- *No. National Geographic was great to work with. We're excited to work with them again.*
- *Mostly it has been a piece of cake working with you guys. Everyone is very responsive. The only problem we had was figuring out how to incorporate the \$.*
- *As I have mentioned, I use you website all the time after I got to know it at the MUW workshop. Beyond the Mysteries on line resources, I use and share it all the time. I have used a variety of resources in different PD session I run. Sometimes a 40 minute movie is tough for school groups to fit in to their Museum visit. Not all of your movies have a 20 minute version. Maybe a shorted version. . . even 30 minutes might work better. Shorter versions will allow us to do a focus intro, which would make it more meaningful.*

# Summary of findings

## Phase 1: Museum Educator National Workshop: Evaluation of educator feedback

Phase 1 presents the findings from an evaluation of the 20 museum educators who attended National Geographic's *Mysteries of the Unseen World* Museum Educator National Workshop at the National Geographic Society (NGS) headquarters in Washington, DC on October 24 and 25, 2013.

The museum educators provided feedback through a written survey administered at the end of the 2-day workshop. The survey was developed collaboratively by National Geographic Education and Knight Williams Inc. The survey was then administered by National Geographic to the museum educators at the end of the workshop, after which the surveys were sent to Knight Williams for analysis and reporting. Basic descriptive statistics were performed on the quantitative data generated from the survey questions. Content analyses were performed on the qualitative data generated in the open-ended questions. The analysis was both deductive, drawing on the workshop's objectives, and inductive, by looking for overall themes, keywords, and key phrases. All analyses were conducted by two independent coders. Any differences that emerged in coding were resolved with the assistance of a third coder.

### Question 1: What was the value of the workshop?

**1.1 What were the most useful aspects of the workshop?** The museum educators pointed to a range of elements that they found most useful about the workshop, both personally and on the institutional/educational level. Nearly two-thirds indicated that the opportunity to network and brainstorm was the most useful part of the workshop (65%), while another two-thirds felt that the resources and corresponding activities were especially useful (65%). Smaller groups commented on the value of the film (30%), the opportunity to collaborate with National Geographic (10%), and the workshop's focus on marketing (5%).

**1.2 What were the least useful aspects of the workshop?** When asked what they found *least* useful about the workshop, the largest group pointed to the difficulty of incorporating information from the nanotechnology session into educational programming (20%). Smaller groups commented on time management (10%), the website review (10%), and the scientist profile videos (10%). One each felt that the videos (5%) and the lens activity with the candle (5%) were the least useful parts of the workshop. Finally, one museum educator – who provided multiple answers – felt that s/he would have benefited from more information overall (5%), including additional examples of lessons and activities, more useful lectures/speeches, and a more relevant dinner speech. One-fifth of the museum educators indicated that they found the entire workshop useful (20%) and another fifth left the question blank (20%).

**1.3 What were the relative values of the workshop sessions?** The museum educators were also asked to rate the value of the sessions they participated in over the course of the two-day workshop. On the first day, the 3D screening of *Mysteries of the Unseen World* and the session on engaging children with the nano world were the most highly rated, each receiving a median rating of 5.0 (extremely valuable) on a scale from 1.0 (not at all valuable) to 5.0 (extremely valuable). The break out session to augment, modify, and brainstorm activities had the lowest median rating, 4.0 (very valuable), and the session focused on the Museum Educator Guide fell in the middle, with a median rating of 4.5. On the second day of the workshop, the session on the effective use of media for learning and the working group to share effective strategies to engage the public



with films were the most highly rated, each receiving a median rating of 5.0 (extremely valuable). The outreach awards info session received the lowest median rating of the day's sessions, 4.0 (very valuable).

**1.4 What were the main “take-aways” from the working groups?** When asked to describe the main “take-aways” from their working groups, the largest group of museum educators pointed to the wealth of ideas gained to develop their local programs and activities (45%). More than a third cited the opportunity to learn about how to use the *Mysteries of the Unseen World* materials to reach out to and inform educators (35%), and a fifth pointed to the opportunity to network with, brainstorm with, and gain inspiration from their peers (20%). A tenth pointed to the value of resources gained (10%), and one museum educator commented on the value of the outreach award funding (5%).

**1.5 Were the outreach goals for *Mysteries of the Unseen World* made clear?** After the workshop, the museum educators generally felt that they had a *good understanding of the goals of the Mysteries of the Unseen World educational outreach program*.

**1.6 Did the museum educators feel prepared to use the educational resources and outreach award?** In general, the museum educators felt *adequately prepared* to use the educational resources and implement the outreach award. When given the opportunity to provide additional feedback to these two questions, all those who responded (20% of all museum educators) pointed to internal institutional challenges, rather than a lack of preparation or effectiveness by the workshop's organizers.

## **Question 2: What ideas and resources did museum educators gain from the workshop?**

**2.1 What were the most valuable ideas gained from the workshop?** The museum educators pointed to a number of valuable ideas gained from the workshop. The largest group of museum educators, nearly two-thirds, pointed to the teaching strategies shared throughout the workshop (60%), including ways to incorporate media and hands-on activities, the use of local experts, ways to reframe topics for various groups, and/or ways to reach out to at risk communities. Just under a third of museum educators indicated that they valued the focus on a specific subject covered during the workshop and/or film (30%), such as nanotechnology and the electromagnetic spectrum. One quarter said that the ideas they gained from other museum educators were among the most valuable gained during the workshop (25%), though some felt that additional time to learn about other programs or reflect on a personal level would have been helpful, and another quarter pointed to the value of ideas shared about engaging with and marketing to teachers (25%). Finally, a tenth of museum educators commented on the value of the outreach awards (10%).

**2.2 What were the most valuable resources gained from the workshop?** The museum educators also indicated that they gained a number of valuable resources from the workshop. The largest group pointed to National Geographic's online resources (60%). Just over one-third of museum educators pointed to the value of the Museum Educator Guide (35%) and a sixth commented on the value of a CD provided by National Geographic – containing old issues of the magazine – and other digital files (15%). A tenth each mentioned the value of the contacts made (10%) and the *Mysteries of the Unseen World* iPad app (10%), and one each (5% each) found information about organizing an educator workshop, the outreach award, and the video clips and photos to be among the most valuable resources gained from the workshop.

**2.3 What workshop resources did museum educators think they were unlikely to recommend to others?** When asked if there were any workshop resources that they would not recommend to others, the majority of museum educators said *No* (60%). The remaining museum educators declined to answer the question (40%).

**2.4 What ideas and resources did museum educators think they were most likely to use in events and activities?** When asked which ideas and resources they were likely to use in their events and activities, the largest group pointed to the camp and/or field trip activities (25%). One-fifth indicated that they plan to use the table and cart activities (20%), and another fifth simply pointed to general activities discussed at the workshop (20%). Nearly one-sixth each specifically pointed to the nanotechnology activities (15%) or the kiosk (15%) and its components, and a tenth each indicated that they would likely use the Museum Educator Guide (10%), the website (10%), the film (10%), and a miscellaneous activities (10%). One said that s/he would likely use photos of microscopic images (5%) and another pointed to the workshop for educators (5%).

**2.5 What ideas and resources did museum educators think they were most likely to use in outreach to educators?** When asked what ideas and resources they would be most likely to use in their outreach to educators in their market, the largest group of museum educators pointed to using the film or footage from the film (25%). Another quarter described an intent to use the film's related materials (25%), specifically mentioning the website, Museum Educator Guide, poster, and kiosk. One-fifth each commented on the value of the workshop's resources and ideas as they relate to professional development workshops for educators (20%), curriculum ideas (20%), and their reasons for incorporating the new resources and ideas into their outreach to educators (20%). Finally, two museum educators pointed to the CDs containing issues of *National Geographic* magazine (10%), and one mentioned the possibility of using the resources/ideas with a homeschool program (5%).

**2.6 Did museum educators have suggestions regarding further support from National Geographic?** When asked what National Geographic could do to further support their efforts to integrate these new ideas and resources into their educational setting(s), the largest group, nearly half of museum educators, pointed to an interest in additional resources (45%), including web materials, images, kits for teachers, and kiosk components. A quarter advocated for a dynamic relationship with National Geographic and/or other workshop attendees (25%). A few museum educators said they were not sure (10%), one suggested that National Geographic continue these workshops (5%), and one requested that National Geographic provide funding for educator screenings/workshops (5%).

### **Question 3: What did museum educators think of the workshop's organization, length, and density of programming?**

**3.1 How did museum educators find the workshop's organization?** Overall, the museum educators felt the workshop was well run and organized.

**3.2 What did museum educators think about the workshop's length and its use of their time?** Overall, the museum educators felt the workshop was a good use of their time. When asked how they felt about the length of the two-day workshop, they generally indicated that it was just right.

**3.3 What did museum educators think about the density of the workshop?** In terms of the programming of the workshop, the museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right. When asked to elaborate, a number of museum educators expressed a desire to have done *more* at the workshop – more activities, more discussion sessions, and a longer workshop overall. Specifically, one quarter commented on the discussion and networking element of the workshop (25%), expressing an interest in dedicating more time to discussions/networking and providing additional suggestions for future workshops. Another quarter pointed to the workshop activities (25%), commenting on their enjoyment of the activities that took place and their desire to do more, and one tenth suggested that

National Geographic lengthen future workshops (10%). One each provided miscellaneous programming advice (5%) or commented on his/her enjoyment of the workshop (5%).

#### **Question 4: What did museum educators think about the *Mysteries of the Unseen World* film?**

**4.1 How did museum educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, learning value for students, and likelihood of recommending the film?** Overall, the museum educators indicated that they liked *Mysteries of the Unseen World*, found the film visually exciting, and thought the presentation was clear. They also generally thought it had a high learning value for students at their museums or science centers, and that they would recommend it to their colleagues.

**4.2 What did museum educator think were the film's most appealing aspects?** When asked what they liked most about the film, the largest groups of museum educators pointed to the accessibility of the film's informative content (60%) and its imagery and visuals (45%). The smallest group commented on the strength of the film's narrative and presentation (20%).

**4.3 What did museum educators think were the film's least appealing aspects?** When asked what they disliked about the film, the largest group of museum educators indicated that the film's examination and imagery of the science behind "seeing the unseen world" could have been stronger (35%). About a sixth felt that the four-part narrative was lacking in some way (15%), and a tenth thought the film would have benefited from a more personal storyline (10%). The remaining museum educators gave miscellaneous answers (20%) or declined to answer the question (20%).

**4.4 How did museum educators rate relative appeal of the film's four acts?** In terms of the appeal of the individual acts, in general the museum educators found "Invisible light rays" and "Electron microscopy/nanotechnology" to be extremely interesting. "Too slow" was the lowest rated act, at very interesting, and "Too fast" fell in the middle of the group, between very interesting and extremely interesting.

**4.5 How did museum educators rate the film's success in conveying STEM-related education content?** When asked to rate the success of individual acts in conveying STEM-related content, the museum educators generally indicated that they found all four acts to be extremely successful.

#### **Question 5: What were museum educators' final reflections and thoughts moving forward?**

**5.1 What did museum educators think was missing from the workshop?** When asked if there was anything *missing* from the workshop that they might have found useful, the largest group of museum educators, just over a third mentioned something about the logistics (35%), such as the reorganization of the schedule, shared contact lists, additional venue space, follow-up workshop sessions, and the inclusion of an offsite visit in DC. Nearly a third of museum educators expressed an interest in receiving additional information about marketing to and training educational professionals (30%). One-fifth thought that the workshop would have benefited from additional resources (20%), from images to subject-specific activities. Finally, one museum educator said s/he was unsure at this time (5%).

**5.2 Were museum educators interested in additional resources from National Geographic Education?** After learning about some of the resources available on the National Geographic Education website, museum educators were asked to provide information about other types of resources they might find useful. The largest

group praised the existing resources (20%), approximately one-sixth requested physical resources (15%), and a group of the same size requested content that could be shared online (15%). A tenth each requested materials from potential partners (10%) or discussed the general value of educational materials (10%). One requested activities for museums (5%), another requested resources for adults (5%), and one said s/he was unsure (5%).

### **5.3 Were museum educators interested in additional resources from National Geographic**

**Entertainment?** Finally, the museum educators were asked to consider their future needs as they relate to National Geographic Entertainment films, and to provide information about additional resources they might like to see developed. The largest group, one-quarter, pointed to the value of shareable films and their promotional resources (25%). Just under a sixth each suggested specific topics for future productions (15%), commented on the value of curriculum resources (15%), and/or expressed an interest in workshops and professional development materials (15%). Smaller groups pointed to the value of film-related activities (10%), commented on the timing of the release of associated materials (5%), and/or praised National Geographic's existing resources (5%). Finally, one museum educator said s/he was unsure (5%).

## **Phase 2: Evaluation of educator feedback on the *Mysteries of the Unseen World* local workshops, film, and educational resources**

Following the Museum Educator National Workshop held in Washington D.C. in 2013, the partner organizations were asked to implement a number of activities upon the film's premiere at their respective institutions. Those who "activated" the *Mysteries of the Unseen World* outreach awards in this capacity received funds in order to promote the film, conduct outreach, and train local teachers on use of the film's companion materials. As a condition of the award program, each partner organization was responsible for recruiting educators to attend their local workshop and disseminating an online survey developed by the project's independent evaluation team to gather participant feedback. Additionally, each partner museum was asked to distribute a separate but similar online survey to their network of teachers who saw the film, but *didn't* participate in the workshop, in order to gather non-workshop participants' feedback on the film and their perceptions of and expected use of the companion materials. To account for the educators' different experiences with the *Mysteries of the Unseen World* resources, those who attended the workshop and saw the film are referred to as "Workshop attendees" in the report while those who only saw the film are referred to as "Film only attendees." The findings from both survey efforts are presented in this section to allow for an informal comparison between the two.

The independent evaluation team of Knight Williams Inc. worked with National Geographic to develop two surveys that gathered educator feedback on three main areas relating to the *Mysteries of the Unseen* local workshop goals and related educator outreach: 1) What feedback did educators share about the local workshops? 2) What feedback did educators share about the film and educational resources? 3) How had educators used the resources and/or how did they intend to use them within 12 months? The first survey, for Workshop attendees, was prepared as an online form that could be emailed directly to workshop participants at the conclusion of the workshop or administered as a paper version on site. The evaluation team worked with National Geographic and the workshop coordinators at four of the six partner science center sites scheduled to conduct local workshops between February 2014 and February 2015. The workshop coordinators in each case distributed the post-workshop questionnaire to participants following the workshop, either via email or paper form as worked best for the participants in each case. The second survey, for Film only attendees, was also prepared as an online form that the partner educators could email directly to their local educator contacts who

had seen the film but not participated in a workshop. The two surveys were similar in content, although the survey for Film only attendees asked the educators for input on their interest in attending workshops since they didn't actually attend one at their local science center. The workshop organizers hoped to learn from these educators how prepared they felt to use the resources without having attended a workshop but having seen the film, and to explore their views on the potential value they saw in participating in local vs. virtual workshops via webinar.

Basic descriptive statistics were provided on the quantitative data generated from the evaluation. Content analyses were performed on the qualitative data generated in the open-ended questions. The qualitative analysis was both deductive, drawing on the workshop objectives, and inductive, by looking for overall themes, keywords, and key phrases. The educator responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder.

## **Educator background information**

### Workshop attendees

Workshop attendees who provided feedback in the Phase 2 evaluation participated in a workshop at one of four organizations. The majority participated in a workshop at either the Buffalo Museum of Science (37%) or Thanksgiving Point (30%), followed by Perot Museum of Nature and Science (16%) and the Center of Science and Industry (11%). More than a third of Workshop attendees identified as elementary school teachers/instructors (37%). About a fifth of the educators were middle school teachers/instructors (21%) and just over a tenth were high school teachers/instructors (11%). Less than a tenth each explained that they were another kind of informal educator (5%), a college or university teacher/instructor/professor (5%), or a museum or science center-based educator (2%). None of the workshop attendees were homeschooling parents, and just over a tenth identified as another kind of educator, including “*2nd Grade Spanish Immersion Class*,” “*Special Education Preschool Teacher*,” “*early childhood education specialist, supporting providers and programs*,” “*High School Equivalency Instructor*,” and “*District Science Coordinator*.”

The Workshop attendees were asked about their familiarity with the *Mysteries of the World* STEM content presented at the workshop prior to attending. The largest group, more than a third, said they were slightly familiar (35%), while more than a quarter indicated that they were moderately familiar (27%) and more than a tenth noted that they were very familiar (13%). About one-sixth of educators were not at all familiar with STEM content prior to the workshop (16%).

Workshop attendees were asked to share their prior experience teaching students the STEM content presented in the film and resources. Nearly a third said they had (some or a lot of) experience teaching this content (32%), while a handful each said they didn't have much experience (6%) or that they were not sure (2%). More than a fifth said they hadn't taught the STEM content (22%) and nearly two-fifths declined to answer the question (38%).

### Film only attendees

Film only attendees who provided feedback in the Phase 2 evaluation saw the film at one of two organizations. The majority of educators saw the film at the Saint Louis Science Center (76%), while remaining educators saw the film at the Buffalo Museum of Science (24%). The majority of Film only attendees identified as elementary school teachers/instructors (55%). About a fifth identified as middle school teachers/instructors (21%), and a handful indicated that they were high school teachers/instructors (3%). About a seventh explained that they were another kind of educator (14%), such as: “*STEAM coordinator*,” “*Assistant Superintendent*,” “*parent*,” and “*early childhood educator*.” None of the Film only attendees identified as a

college or university teacher/instructor/professor, a homeschooling parent, a museum or science center-based educator, or another informal educator.

Film only attendees were asked about their familiarity with the *Mysteries of the Unseen World* STEM content in the film and resources prior to seeing the film or reviewing the resources. Two-fifths said they were slightly familiar with the STEM content (41%), while more than a quarter indicated that they were moderately familiar (28%) with the material. A tenth were very familiar (10%) and less than a tenth were not at all familiar (7%).

Film only attendees were asked to share their prior experience teaching students the STEM content presented in the film and resources. More than two-fifths said they had taught some of this STEM content (41%) (for example, “*the electromagnetic spectrum*,” “*things that are too small to see with the naked eye*,” and “*electron microscopy*”), and one said s/he wasn’t interested in teaching STEM (3%). About a fifth explained that they hadn’t taught any of the STEM content (21%), and more than a third declined to answer the question (34%).

### **Question 1: What feedback did Workshop attendees share about the local workshops?**

**1.1 How did Workshop attendees learn about the local workshops and why did they attend?** The largest group of Workshop attendees, two-fifths, indicated that they heard about their local workshop directly from the coordinating museum or science center (40%), while a quarter explained that they heard about it from a school or school district (25%). About a tenth heard about it from their coworkers or colleagues (11%), while smaller groups of less than a tenth each pointed to other groups or organizations (6%), friends (5%), or state-level education staff or offices (3%). About one-seventh shared miscellaneous responses (14%).

When asked why they decided to attend their local workshop and what they were hoping to gain, more than half of the Workshop attendees pointed to the value of gaining new teaching strategies, curriculum ideas, and resources (54%), while nearly two-fifths explained that they wanted to see the film and/or visit the museum or science center (38%). Just under a third said the content looked interesting or that they wanted to learn (30%). Less than a tenth each commented on credit hours or recertification points (8%), noted that the workshop would be a good opportunity to network (6%), said they like National Geographic programs (5%), explained that the museum generally coordinates valuable workshops (5%), said they were interested in the topic of microorganisms (5%), or shared miscellaneous responses (6%).

**1.2 How did Workshop attendees rate the local workshops?** Overall, the Workshop attendees strongly agreed that their local workshops were well run and organized, gave them a good overview of the educational goals of the film and resources, were a good use of their time, and allowed them to gain knowledge that would have been difficult to obtain without being there in person.

**1.3 Did the local workshops meet Workshop attendees’ expectations, and did they think any topics were omitted or not covered well enough?** The majority of Workshop attendees indicated that their local workshop met or exceeded their expectations (90%), while about a tenth shared criticisms of one or more aspects of the workshop (11%) and less than a tenth shared miscellaneous responses (6%).

## **Question 2: What feedback did educators share about the film and educational resources?**

**2.1 How did educators rate the film in terms of overall likeability, visual excitement, clarity of presentation, likelihood of engaging and educating students, and likelihood of recommending the film?** Workshop attendees and Film only attendees both generally indicated that they liked the film, found it visually exciting, and thought the presentation was clear. Both groups also thought it would engage their students, that their students would learn a lot from the film, and that they would recommend it to their colleagues.

### **2.2 How did educators rate the value of the educational resources?**

Workshop attendees: Workshop attendees who had used the resources generally thought the online activities/lessons and the iPad app/game were both extremely valuable. Overall, they found the educator DVD, Museum Educator Guide and poster, website, online videos, standards sheet, and “fun facts” handout to be very valuable.

Film only attendees: Film only attendees who had used the resources generally found the educator DVD, website, and online videos to be between very and extremely valuable. Overall, they also indicated that the following resources were each very valuable: the Museum Educator Guide, the standards sheet, the online activities and lessons, and the iPad app/game. Finally, they noted that they generally found the poster and “fun facts” handout to be moderately valuable.

### **2.3 How did educators rate the workshop’s coverage of the educational resources, their level of comfort in using the resources, and the potential impact on students?**

Workshop attendees: Overall, Workshop attendees agreed that they *learned valuable ways to use the resources in [their] local setting*, that they felt *adequately prepared to begin using the resources*, that *the resources will help their students learn about phenomena that are too fast, slow, or small to see with the naked eye*, and that *the resources will help [their] students explore advances in nanoscience and nanotechnology*. They were generally neutral about if they would have *preferred the workshop spend more time going over the resources*.

Film only attendees: At the same time, Film only attendees who indicated that they had used the resources somewhat agreed to agreed that *the resources have helped (or will help) their students explore advances in nanoscience and nanotechnology*. They also somewhat agreed that they felt (or feel) *adequately prepared to begin using the resources* and that *the resources have helped (or will help) their students learn about phenomena that are too fast, slow, or small to see with the naked eye*.

## **Question 3: How had educators used the resources and/or how did they intend to use them within 12 months?**

### **3.1 Which activities had educators done and/or did they plan to do within 12 months?**

Workshop attendees: When asked which activities they planned to do within 12 months, more than four-fifths of Workshop attendees explained that they planned to use the *Mysteries of the Unseen World* resources with their students (81%), while a slightly smaller group of just under three-quarters planned to share the resources with other educators (73%). A third each planned to book a field trip with their students to see the film (33%)

and/or participate in *Mysteries of the Unseen World* events at the science center or museum that hosted the workshop (33%). A handful planned to conduct a workshop for other educators on use of the resources (2%) and/or share miscellaneous responses (5%), such as “visit with my family” and “possibly try to book film.”

Film only attendees: Film only attendees were asked which activities they had done or planned to do within 12 months. Of activities they *had* done, the largest group of about a third had shared the resources with other educators (31%). About a fifth had participated in *Mysteries of the Unseen World* activities or events at their local science center or museum (21%), and a handful each had taken their students to see the film (3%) and/or used the resources with their students (3%). In terms of what they planned to do, the largest group of Film only attendees, two-thirds, indicated that they intended to use the resources with their students within 12 months (66%). More than half planned to share the resources with other educators (55%), and more than a third said they would take their students to see the film (38%). More than a quarter explained that they would participate in *Mysteries of the Unseen World* activities or events at their local science center or museum (28%), and about a fifth said they would conduct a workshop for other educators on the use of the resources (21%). None of the Film only attendees pointed to other activities they had done or would do within 12 months.

### **3.2 Which resources had educators used or did they plan to use within 12 months, how did they use or foresee using them, and how many students did they reach or think they would reach?**

Workshop attendees: Nearly three-quarters each (68% each) thought they would use the website and online videos. Slightly smaller groups pointed to the “fun facts” handout (60%), educator DVD (59%), and/or online activities and lessons (57%). About half pointed to the Museum Educator Guide and poster (51%) while nearly one-third pointed to the iPad app/game (30%) and one-fifth to the standards sheet (22%). The majority expected to use these resources in a classroom or afterschool setting, and the majority expected to use them in elementary or middle school programming. Fifty (50) Workshop attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 6,498 students. From those who provided estimates, responses ranged from a low of 20 to a high of 1,000, averaging 130 per Workshop attendee.

Film only attendees: A tenth each of Film only attendees indicated that they had used the Museum Educator Guide (10%), poster (10%), and “fun facts” handout (10%). Less than a tenth explained that they had used the educator DVD (7%), website (7%), online videos (7%), online activities and lessons (3%), and iPad app/game (3%). The Film only attendees also indicated which resources they planned to use, with the largest group, about a third, pointing to the poster (31%). Just under a quarter each thought they would use the website (24%) and online videos (24%), while about a fifth each planned to use the educator DVD (21%), “fun facts” handout (21%), and/or the online activities and lessons (21%). About a sixth each indicated they would use the Museum Educator Guide (17%) and/or the standards sheet (17%), and a slightly smaller group thought they would use the iPad app/game (14%). The largest group expected to use these resources in a classroom or afterschool setting, and the largest groups expected to use them in elementary or middle school programming. Thirteen (13) Film only attendees estimated that they would use the *Mysteries of the Unseen World* resources to reach 894 students. From those who provided estimates, responses ranged from a low of 7 to a high of 150, averaging 69 per Film only attendee.

### **3.3 What challenges or obstacles did educators encounter or think they might encounter in implementing the resources?**

Workshop attendees: When asked what challenges or obstacles they thought they might face in implementing the *Mysteries of the Unseen World* resources, Workshop attendees shared a range of comments. Of those who pointed to a specific challenge or obstacle, about a fifth commented on time constraints and scheduling challenges (21%). Less than one-tenth each said they might face challenges with the technology (6%), find



that the content isn't the right level for their students (6%), face financial obstacles (6%), and/or have trouble adapting the resources (5%). Nearly a third declined to answer the question (30%), more than a tenth said they didn't think they would face any challenges (13%), and about a sixth shared miscellaneous responses (17%), including a few who said they weren't sure what obstacles they might face.

Film only attendees: When asked what challenges or obstacles they had encountered or thought they might face in implementing the *Mysteries of the Unseen World* resources, the largest groups of Film only attendees declined to answer the question (69%) or said they hadn't encountered or didn't think they would face any challenges (10%). A handful each explained that the content might be too advanced (7%), said they wouldn't be using the resources (3%), or pointed to financial obstacles (3%) or trouble with challenges with technology (3%).

### **3.4 Did educators expect to use the film and/or educational resources to encourage students' interest in STEM or STEM careers?**

Workshop attendees: Workshop attendees were asked if they expected to use the film and/or its educational resources to encourage students' interest in STEM or STEM careers. Nearly half said *Yes* (49%), about a third said they were *Not sure* (32%), and less than a tenth each said *No* (2%) or noted that the question was *Not Applicable* to their setting (8%). Next, the Workshop attendees were invited to explain how they might use the film and/or its educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. One-sixth each described how they would use the resources to encourage interest in STEM (16%) and/or STEM careers (16%), and less than a tenth talked about the value of the film (8%). More than half declined to answer the question (54%), a handful explained that the resources weren't applicable to their teaching field or students (3%), and just over a tenth provided miscellaneous responses (10%).

Film only attendees: Film only attendees were asked if they had used or expected to use the film and/or educational resources to encourage students' interest in STEM or STEM careers. None of the Film only attendees indicated that they had used the resources in this way. More than a third said they planned to use the resources to encourage students' interest in STEM or STEM careers (38%), while one-seventh said they did not plan to use the resources in this manner (14%). A tenth said they were *Not sure* (10%), and more than a quarter noted that the question was *Not Applicable* to their setting (28%). Next, the Film only attendees were invited to explain how they might use the film and/or educational resources to encourage students' interest in STEM or STEM careers, or why they didn't expect to pursue this goal. More than a fifth said they would or might use the resources in their program or curriculum (21%), while less than a tenth each said they were planning to show the film (7%) or said they would share the resources with other educators (3%). Just under half declined to answer the question (45%), one-sixth explained that the resources weren't applicable to their teaching field or students (17%), and one-seventh shared miscellaneous responses (14%).

### **3.5 Did educators think their use of the film and/or educational resources had or would help facilitate outreach among underserved students?**

Workshop attendees: When asked if and how their work with the film and its resources might contribute to the project goal of facilitating outreach among underserved students, about a third said they would (or would like to) be working with underserved youth (30%) and just over a tenth said they would not (13%). A sixth shared miscellaneous responses (16%), less than a tenth said they were unsure (6%), and more than a third declined to answer the question (35%). Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources.

Film only attendees: Film only attendees were asked if and how their work with the film and its resources had or might contribute to the project goal of facilitating outreach among underserved students. About a third said they would (or would like to) be working with underserved youth (31%) and just over one-sixth said they would not (17%). Nearly half declined to answer the question (48%) and a tenth shared miscellaneous responses (10%). Those who indicated that they would or would like to work with underserved students shared a ranged of comments about the students they work with and how they might use the film and its resources.

#### **Question 4: What feedback did Film only attendees share about future workshops related to *Mysteries of the Unseen World*?**

**4.1 Why didn't Film only attendees participate in local workshops in their areas?** The Film only attendees were asked why they didn't attend the *Mysteries of the Unseen World* local workshop held in their area earlier in the year. More than three-quarters said they didn't know about the workshop (76%). A tenth pointed a timing issue (10%) and less than a tenth noted that they don't teach the topics in the film (7%). One said s/he did attend (3%), though the workshop this educator planned to attend was shortened to just a film screening when a local sports team made national playoffs the same evening and the workshop coordinator received a "rash of cancellations." Finally, one-seventh of Film only attendees declined to answer the question (14%).

**4.2 How did Film only attendees rate aspects of the opportunity to attend a local workshop?** Overall, the Film only attendees somewhat agreed that: *they would like (or would have liked) the opportunity to attend a local workshop that spends time going over the resources, they would find (or would have found) a workshop on the film and resources to be a good use of my time, and they would like (or would have liked) to attend a workshop that showed me ways to use the resources in my local setting.* They also fell between being neutral and somewhat agreeing that *they would like (or would have liked) to attend a workshop that explained the educational goals of the film and resources and that they would likely obtain knowledge about the film and resources at a workshop that would be difficult to obtain without being there in person.*

**4.3 How likely were Film only attendees to participate in a future *Mysteries of the Unseen World* workshop, what would they hope to gain from the experience, and what topics would they want to have covered?** When Film only attendees were asked about their likelihood of participating in a future *Mysteries of the Unseen World* workshop, if it were offered again in their area, nearly two-fifths each said they would be moderately likely (38%) or very likely (38%) to participate. One-tenth indicated that they were not at all likely (10%), and less than a tenth each were slightly likely (7%) or extremely likely (3%).

Film only attendees were then asked, if they were to participate in a future workshop on the *Mysteries of the Unseen World* film and resources, what they would hope to gain. About a third each pointed to teaching ideas (31%) and/or resources, including information about where to find them and how to use them (31%). A tenth said they would hope to gain more information about the topics featured in the film (10%), and less than one-tenth each explained that they would like to gain information about STEM careers (7%) or shared miscellaneous responses (7%). More than a quarter declined to answer the question (28%).

When asked what topics they would want covered, more than a quarter of Film only attendees explained that, if they were to attend a workshop in the future, they would want to be sure that it would cover STEM content in sufficient depth (28%). About a sixth pointed to information about the resources (17%), and a tenth identified teaching ideas (10%). One said s/he would want to be sure the workshop would cover information about "STEM careers in nanotechnology" (3%), while another was "unsure" (3%). More than half of the Film only attendees declined to answer the question (52%).

#### **4.4 In the future, would Film only attendees prefer to participate in a local workshop or a webinar?**

When Film only attendees were asked if they would prefer a local workshop or a webinar, if National Geographic could offer one or the other, the largest group of nearly two-fifths pointed to a preference for the local workshop (38%). Just under a third said they had no preference and that either option would be fine (31%). About one-seventh explained that they would prefer a webinar (14%), and a tenth said neither, they would prefer to review the resources and plan on their own (10%). None said that they were not sufficiently interested in the topic (0%).

#### **4.5 Without having attended a local workshop or webinar, how did Film only attendees think they would determine which resources to use?**

When asked how they would or had determined which *Mysteries of the Unseen World* resources to use in their educational settings, without the benefit of having attended a local workshop or webinar, more than a quarter said they would review the resources to determine the best use for their classroom or students (28%), while a tenth pointed to specific resources they would use (10%). Less than a tenth each said they were not sure (7%) or that they wouldn't use the resources (7%), and one-seventh shared miscellaneous responses (14%). Nearly two-fifths declined to answer the question (38%).

### **Phase 3: Museum educator post report findings**

As part of the awardee reporting requirement, educators from the awardee sites that participated in the Museum Educator National Workshop were asked to complete a post report at the end of their award about their: experience participating in the awardee program, use of the *Mysteries of the Unseen World* materials to engage visitors and students, satisfaction with the materials, perception of the effectiveness of the film and activities in meeting the project's learning objectives, efforts to disseminate and promote the materials to local educators, and efforts to draw underserved audiences to see the film and engage in outreach.

The evaluation team edited a draft version of the *Outreach Award Post Report* initially developed by National Geographic for this purpose and then collaborated with the outreach coordinator from National Geographic to ensure the partners had access to the report forms well in advance of the completion of their awards. A total of 11 of the 17 museum partners that attended the Museum Educator National Workshop activated the outreach award. These 11 partners all completed the follow-up "post report," for a response rate of 100% of those sites that activated an award.

Basic descriptive statistics were provided on the quantitative data generated from the report forms. Content analyses were performed on the qualitative data generated in the open-ended questions. For total values from the partners of 1000 or greater, the reported total values were rounded to three significant figures in the text for ease of interpretation. The qualitative analysis was both deductive, drawing on the outreach award objectives, and inductive, by looking for overall themes, keywords, and key phrases. The educator responses were coded by two independent coders and any differences that emerged in coding were resolved with the assistance of a third coder.

#### **Question 1: What was the overall reach of *Mysteries of the Unseen World*, as facilitated by partner organizations?**

To assess the overall reach of the project, the 11 partner organizations estimated the number of educators and students reached by their marketing and outreach efforts. They reported reaching approximately 42,200 educators and 998,000 students. The reported number of educators reached ranged from 29 to 25,915 per organization, the reported number of students reached ranged from 122 to 647,875, and the partners averaged reaching 3,837 educators and 90,678 students each. When invited to elaborate, a number of

museum educators shared feedback on their educator-focused marketing and outreach efforts related to *Mysteries of the Unseen World* (including emails, letters, preview passes, conferences, and distribution of the project materials, among other methods) and/or how they estimated the number of educators and students reached.

## **Question 2: What was the reach of the *Mysteries of the Unseen World* field trips to partner organizations?**

Nine (9) of the 11 partners estimated the number of field trips groups that attended screenings of *Mysteries of the Unseen World* at their organizations, for a total approximation of 852 groups. The number of field trips hosted by each partner ranged from 1 to 297 and averaged 95 per partner that provided information. One partner declined to answer the question and another explained that, although they did not track the number of groups, they could provide information about individual attendees.

Ten (10) of the 11 partner organizations estimated the number of educators and students reached through field trips, for a total approximation of 7,740 educators (and chaperones) and 41,800 students. The number of educators reached by the 10 partners ranged from 2 to 3,329 and averaged 774 per partner that provided information, and the number of students reached by the 10 partners ranged from 20 to 10,987 and averaged 4,177 per partner that provided information.

Three (3) of the partner organizations were able to specify the grade range of the students who attended field trip screenings. Together, these 3 organizations estimated reaching 761 students in grades K-4, 4,050 students in grades 5-8, 31 students in grades 9-12, and 545 other students.

## **Question 3: How did the partner organizations reach out to underserved communities?**

**3.1 How did partner organizations use the Underserved Community Outreach funding to support underserved students?** When asked how they used the \$1,000 Underserved Community Outreach grant to support underserved students, 9 of the 10 partner organizations noted that the funding was used to pay for tickets to see *Mysteries of the Unseen World*, with many partners also providing the students admission to their science center or museum. Additionally, a number described having used some of the funding to coordinate the students' transportation to and from their site and/or to reach underserved students through the film's other educational materials. One of the grantees explained that they weren't able to use the funding and another described some of the challenges they faced in working with the grant, including liability and the timing of their showings.

**3.2 How many educators and students were reached through the Underserved Community Outreach funding?** Together, the 10 organizations that indicated they used the Underserved Community Outreach grant reported having reached approximately 692 educators and 7,450 students through activities supported by this funding. The number of educators reached by these 10 partners ranged from 2 to 400 and averaged 69, and the number of students reached by the 10 partners ranged from 20 to 4,000 and averaged 745. One grantee elaborated, "*While not all 4000 students received the funding, the vast majority of the groups were supported at least in part by subsidized access. Our survey responses from teachers tell us that, without the funding for students in need, none of their students would be able to take the trip.*"

**3.3 How many students saw the film with assistance from the Underserved Community Outreach funding?** Together, the 10 organizations that indicated they used the Underserved Community Outreach

grant reported that approximately 5,570 students saw *Mysteries of the Unseen World* with assistance through this funding. The number of students who saw the film with assistance from this funding ranged from 20 to 4,000 and averaged 557 per partner.

**3.4 Did partners have additional feedback about the value of the Underserved Community Outreach funding?** When invited to share additional feedback about the value of the Underserved Community Outreach funding to their organizations, comments from the partners were entirely positive. The majority described how the funding helped them subsidize film tickets, museum tickets, and/or transportation costs, benefitting the students, the schools, and the partner organizations.

#### **Question 4: How many local workshops were coordinated by the partners, and how many educators attended?**

The 11 partner organizations coordinated 11 educator workshops dedicated solely to *Mysteries of the Unseen World*, reaching a total of 758 educators. The number of educators reached ranged per workshop ranged from 3 to 230 and averaged 69 per workshop. At the same time, the partners coordinated an additional 23 educator workshops that included *Mysteries of the Unseen World* in addition to other programming, reaching 1,280 educators. The number of educators reached ranged per workshop ranged from 43 to 364 and averaged 55 per workshop.

#### **Question 5: What other events were coordinated by the partner organizations, what content and resources were used, and how many educators and students were reached?**

**Number of events and event types:** Ten (10) of the 11 partner organizations coordinated other educator and student events that featured *Mysteries of the Unseen World* in some way. Together, they planned a total of 24 other events (that is, events other than the educator workshops considered in the previous section) for the general public, students, educators, board members, and/or policy makers.

**Content featured:** Three-quarters of the 24 events planned by the partners featured the subject of nanotechnology (75%). Two (2) partners noted that their events featured “all” of the *Mysteries of the Unseen World* content (8%), and 1 event each focused on the following subjects: biology (4%), electron microscopy (4%), and infrared light (4%).

**Resources used:** The partners described using a range of the *Mysteries of the Unseen World* resources at the 24 events. Nearly three-quarters of the events featured the film on giant screen and/or DVD (71%), while just under three-fifths made use of the Museum Educator Guide and activities (58%). A third of the events used the poster (33%), a fifth used online videos and/or the film’s trailer (21%), and about one-sixth used the “fun facts” handout (17%). Just over a tenth used other materials (13%), including “*NatGeo Kids and other NatGeo giveaways*,” the “*FEI Guide*,” and “*materials from NISE network Nano day*.”

**Number of educators and students in attendance:** The partners were able to estimate educator attendance at 20 of the 24 events, for an approximate total of 1,820 educators. The number of educators per event ranged from a low of 2 to a high of 700, with an average of 91 per event. The partners were also able to estimate student attendance at 8 of the 24 events, for an approximate total of 2,380. The number of students per event ranged from a low of 20 to a high of 900, with an average of 297 per event. Finally, though the information was unsolicited, one partner noted that their public Nano Days event drew 100 members of the general public.

## **Question 6: What feedback did partners share about the value, distribution, and use the *Mysteries of the Unseen World* media and materials?**

### **6.1 How were the DVD, Museum Educator Guide, poster, and “fun facts” handout valued by the partners, distributed, and used?**

**Educator DVD:** Overall, the partners found the educator DVD to be very valuable. Ten (10) of the 11 partner organizations were able to detail the number of educator DVDs they distributed, for an approximate total of 4,040. Responses ranged from a low of 29 to a high of 2,000, and averaged 404. The partners noted that they shared the DVDs primarily with educators.

**Museum Educator Guide:** Overall, the partners found the Museum Educator Guide to be very valuable. Six (6) of the 11 partner organizations were able to detail the number of Museum Educator Guides they distributed, for an approximate total of 3,080. Responses ranged from a low of 29 to a high of 2,000, and averaged 513. The partners noted that they only shared the resource with educators.

**Poster:** Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of posters they distributed, for an approximate total of 2,680. Responses ranged from a low of 29 to a high of 1,000, and averaged 298. The partners noted that the posters were primarily shared with educators.

**“Fun facts” handout:** Overall, the partners found the poster to be very valuable. Nine (9) of the 11 partner organizations were able to detail the number of “fun facts” handouts they distributed, for an approximate total of 3,760. Responses ranged from a low of 29 to a high of 1,500, and averaged 417. The partners noted that they were primarily shared with educators.

**6.2 How did partners use and value the lobby kiosk?** When partners were asked if their organization chose to host the kiosk, 10 said *Yes*, while the remaining partner said *No*. Those who used it explained that they put in their lobbies to promote the film, entertain audiences while they waited to enter the theater, and connect the film to other exhibits, among other responses. In general, the partners found the kiosk to be very valuable to their organizations. When invited to comment on the value that the kiosk brought (or did not bring), some partners described its value in terms of use by potential film viewers, museum visitors, and members, while other described liking previous National Geographic materials more than the kiosk and having trouble with the kiosk’s iPads.

**6.3 How did partners rate the value of the other *Mysteries of the Unseen World* media and materials?** The partners generally thought the giant screen film was extremely valuable to their organizations. Additionally, they indicated that each of the following materials was very valuable: the standards sheet, the website, the online videos, and the online activities and lessons. Finally, they generally found the iPad app/game to be between slightly and moderately valuable.

## **Question 7: How did partners use the informal activities in the Museum Educator Guide, how many educators and students did the activities reach, and what value did the activities bring?**

**7.1 Did partners use the activities?** All but two of the partner organizations used activities from the Museum Educator Guide. Those who utilized the activities in the Museum Educator Guide described using them in a variety of ways (for example, with field trips and in curriculums) and finding them “*useful*,” “*simple*,”

and “*easy to implement.*” One partner noted that some of the activities “*took too much time.*” Those who didn’t use the activities said they either adapted some of the concepts or hadn’t found the right group to share them with.

**7.2 Which activities did the partners use, how many educators and students were reached, and what value did the activities bring?** Electron Microscope Image Scavenger Hunt was used by 9 of the partners, and Zoom and Too Slow were each used by 5 of the partners. Playing with Perspective was used by 4 of the partners, while Faster, Slower and Playing with Light were each used by 3 of the partners. Two (2) of the partners used the Too Fast activity, and 1 of the partners used each of the following activities: Making Waves, Too Small, Invisible, Mosquito Maze, and Perspective. None of the partners used the Careers activity.

When asked to comment on the value that the activities did (or did not) bring to the educators and/or students they reached, some of the partners described how the educators and students really enjoyed and were engaged by the activities. At the same time, other partners described how they used the activities in their exhibits and their trainings, and how they modified or were inspired by them. Finally, one of the partners expressed dissatisfaction with the activities, saying, “*Some just took too much time. I really like the Robot ones so much better. Better variety of time requirements and can easily be modified to all ages. Kit will help immensely!*”

## **Question 8: What feedback did partners have about the outreach award requirements and the project overall?**

**8.1 How reasonable did partners find the outreach award requirements?** When asked how reasonable they thought the outreach award requirements were, 6 partners said they were very reasonable. Three (3) of the partners thought they were somewhat reasonable, and 2 thought they were somewhat unreasonable. None of the partners thought the requirements were not at all reasonable or neither reasonable or unreasonable.

**8.2 How did partners rate the ease of accomplishing the outreach award deliverables?** The partners generally felt that it was very easy to share their outreach plan with National Geographic and that it was easy to utilize \$1000 for underserved students, disseminate and promote materials, and integrate *Mysteries of the Unseen World* into existing workshops. Overall, the partners indicated that it was *neither easy nor difficult* to host dedicated educator workshops and complete the post report. Finally, the partners noted that it was generally very difficult to ensure response to the educator survey. Those who rated this element lowest conducted their programs early in the grant period when they were asked to complete an online survey form developed internally by National Geographic. When the independent evaluation for the NSF grant began several weeks later, they were then asked to use an updated version of the form that would be sent to the independent evaluator instead of National Geographic. This shift in strategy likely caused some initial confusion and additional burden to the survey requirement that did not affect partners that commenced their outreach later in the grant period and were only instructed to use the independent evaluation form.

**8.3 Did the partners think they would be likely to participate in this award program again?** When asked if they would participate in this National Geographic award program again, 9 of the 11 partners said Yes, while 2 explained that *It would depend.* Those who said Yes praised the resources, the support from National Geographic, and the value of the opportunity for local educators. Those who said *It would depend* commented on the challenges of meeting some of the requirements and the amount of time they invested.

**8.4 Did the partners have suggestions for future programs?** When asked what changes they thought National Geographic should make the program moving forward, the partners shared a range of suggestions, including: altering the educator survey component, disconnecting activities from the kiosk, facilitating discussions among the partners, developing more activities, connecting to the Next Generation Science Standards, particularly cross cutting concepts, and making the project more interdisciplinary.

**8.5 Did the partners have additional feedback to share about the project?** When invited to share additional feedback about their experience conducting outreach on behalf of *Mysteries of the Unseen World*, many partners shared positive comments about the opportunity and their experience in with the project. Additionally, one reiterated that their organization had trouble using the funding and another suggested working with shorter films.

## Discussion

The evaluation findings indicate that the *Mysteries of the Unseen World* educational program was well received by the educator audiences who shared feedback for the Study 3 summative evaluation. Below, we briefly summarize aspects of the project that stood out to educators in this study, looking across the findings and at themes that emerged in numerous places, not just in response to specific questions.

First, we consider feedback about the film shared by the educators, including museum educators who attended the Museum Educator National Workshop, educators who saw the film at their local workshop (Workshop attendees), and educators who saw the film at their local science center or museum but did not attend a local workshop (Film only attendees). Second, we examine themes that emerged from the feedback shared by museum educators about the Museum Educator National Workshop and the *Mysteries of the Unseen World* educational resources, as detailed in Phase 1 of this report. Third, we discuss themes that emerged in the feedback from Workshop attendees and Film only attendees about the local workshops, educators' interest in similar workshops and webinars, and their thoughts about and plans for the educational resources, as detailed in Phase 2. Fourth and finally, we look at themes that emerged in partner organizations' responses to questions about their outreach and marketing efforts, use of the resources, and thoughts about the outreach award program, as detailed in Phase 3. Though feedback from the educators is generally separated by educator group in these last 3 parts of our discussion, where possible their comments and suggestions are considered concurrently for ease of review.

### Educator feedback about the film

Overall, the *Mysteries of the Unseen World* film was consistently praised by the educators, including museum educators who attended the Museum Educator National Workshop, educators who saw the film at a local workshop (Workshop attendees), and educators who saw the film at their local science center or museum but did not attend a workshop (Film only attendees).

- ➡ In general, all three groups of educators indicated that they liked the film, found it visually exciting, and thought its presentation was clear. Overall, they also thought it had high learning and engagement values for their students, and that they would recommend it to their colleagues. Feedback from educators included comments like: "*Perfect for a science center*" and "*[The filmmakers did a] great job...this is a tough subject for such a large format.*"
- ➡ The three groups of educators pointed to a number of elements that they particularly liked about the film including the accessibility of the film content (as in, "*Made abstract content concrete. Covered a*



range of content aligned with standards- how eye works, light, waves, nano”) and the film’s visuals and imagery (as in, “Visually stimulating photos and videos keep [students’] attention”).

- Additionally, almost all of the partners who completed the post reports at the conclusion of the outreach award period indicated that they thought the film had been extremely valuable to their organizations. As one partner noted, commenting on the film and its educational resources, “*The material package (promotional and educational) for this film was incredibly compelling and exceptionally valuable. It was one of the strongest packages we’ve seen for any film.*”

### Feedback from museum educators

In general, the 20 museum educators who attended the Museum Educator National Workshop greatly valued the opportunity to participate in and learn from the experience. Their responses also point to a few issues that may be worth considering when planning future workshops and related educational programming, outreach, and educator networking.

- Though the museum educators generally indicated that the workshop was well run and organized, their feedback also suggests small logistical changes that could be implemented in the planning of future workshops. For example:
  - A few museum educators indicated that the schedule could have benefitted from some tweaking and, perhaps, a tighter agenda (as in “*maybe reorganizing*” and “*better-dedicated time to actually running through the majority of the activities without saying, ‘now go ahead and flip through the rest of the materials’*”).
  - When asked to comment on the workshop’s programming, one participant wrote, “*I wish the award had been explained earlier in the workshop; it would have given me a framework through which to view information given on the first day.*” Though the workshop organizers likely assumed that participants would come to the workshop with knowledge of the outreach awards (which were available to all participating institutions), this museum educator’s response indicates otherwise. An overview at the beginning of the workshop, if it wasn’t provided, would have been useful for this particular participant, and may have also helped others who could have benefitted from a quick refresher.
- In general, the museum educators valued the opportunity to network and brainstorm with their peers, and many also felt they would have benefitted from additional time to learn from other workshop attendees. Future workshop efforts might explore additional ways to strengthen this community of museum educators, who seemed receptive to further networking. For example:
  - Setting aside more time for formal and informal networking during the workshop and encouraging post-workshop networking could help fulfill the educators’ desire to learn even more from the other workshop attendees. One of the partners echoed this feedback about learning from the other museums and science centers in a post report submitted at the conclusion of the project, saying “*It would be great to hear from other institutions about what they did with their award.*” Post-workshop networking could be facilitated by, for example, hosting a follow up event or online forum or distributing a shared contact list. These types of in-person or remote follow-up extensions could serve to strengthen the educators’ relationships with one another and with National Geographic,

and, in turn, help National Geographic generate even more useful ideas and resources in the future.

- The museum educators often requested additional ideas and resources.
  - Though the museum educators generally indicated that the amount of material covered in the workshop, the amount of formal presentations and lectures, and the amount of time for discussions and sharing with others were all just right, two-fifths (40%) also expressed a desire to have done *more* at the workshop – more activities, more discussion sessions, and a longer workshop overall – indicating that they are open to gaining as much as possible from these types of workshops.
  - The museum educators pointed to a wide range of useful teaching strategies shared over the course of the workshop, indicating that each market is likely to value and use the content in a slightly different way. Some mentioned the importance of “*low budget activities*” that can be conducted without special equipment, others stressed the need for “*shareable tools and resources*,” and a few pointed to the value of resources, like the kiosk, with components that can be rotated in and out, depending on a museum’s preferences and capabilities. In general, it seems that the greater the range of ideas and resources provided, the more likely it is that museum educators will be able to make use of one or more of them.
- The outreach team might want to find additional ways to incorporate unanswered questions from the *Mysteries of the Unseen World* film into the accompanying educational resources.
  - When asked what they disliked about the film, more than a third (35%) of museum educators indicated that the film’s examination and imagery of the science behind “seeing the unseen world” could have been stronger. Though directed at the film, the educators’ feedback points to the opportunity for this topic to be examined more fully, not only in the Museum Educator Guide and other film-related resources, but also in the local programming designed to reinforce and extend the film’s STEM content.
- It seems that some museum educators might appreciate additional support in implementing their outreach awards.
  - A handful of museum educators indicated that they felt “*unprepared*” to use the *Mysteries of the Unseen World* educational resources and/or to implement the outreach award. When given the opportunity to elaborate, all those who responded (20% of all museum educators) pointed to internal institutional challenges, indicating that the outreach team may want to follow up with museum educators individually to answer questions or help strategize or customize implementation ideas.
  - When asked if there was anything missing from the workshop nearly a third (30%) of museum educators expressed an interest in receiving additional information about marketing to and training educational professionals. This may be another area where the workshop and outreach teams may want to provide guidance.

## Feedback from Workshop attendees and Film only attendees

In general, the Workshop attendees indicated that the local workshops were well-run, a good use of their time, and that they allowed them to gain knowledge that would have been difficult to obtain without being there in person (as in, *"I liked the hands on activities afterward. I couldn't have gained the same depth of knowledge by reading about them"*). Said one of the Workshop attendees, speaking about the overall experience, *"It was an awesome workshop. I have been to many (over 35 years in education) and it was one of the best ran workshops I have attended."*

Below, we highlight some of the feedback from the Workshop attendees and Film only attendees that National Geographic may want to consider if and when they coordinate similar projects in the future.

- Given the educators' consistent enthusiasm for the workshops and their general willingness to attend them either in person or virtually, with some also observing the added value that comes with *seeing* the resources in terms of feeling prepared to use them, future workshop organizers might want to look into taping one of the workshops and sharing it as a webinar to reach a broader network of educators. Though this will require taking into account the technological capabilities of the partner organizations and the attendance and scheduling of their local workshops, the educators surveyed in the evaluation would support National Geographic's efforts to explore additional workshop options.
  - When asked how they would determine which resources to use in their educational settings without the benefit of having attended a workshop, the largest groups of Film only attendees who answered the question knew which resources they wanted to use and/or thought they would be able to research the best materials for their educational settings without assistance. However, those who attended a local workshop agreed that they felt adequately prepared to begin using the resources, while those who did not only somewhat agreed that this was the case. Reflecting on the value of actually seeing how the resources might be implemented, one Workshop attendee observed that the workshop provided the extra 'nudge' needed to feel confident with the information covered, as in, *"It is like I have been told a child needs to be introduced to a vegetable 5-7 times before they will eat it sometimes I feel like I have to be exposed to new teaching techniques a number of times to feel competent to teach it."*
  - When asked if they would prefer a local workshop or a webinar in the future, the largest group of Film only attendees expressed a preference for in-person workshops (as in, *"I learn better by seeing and hearing in person. I would feel like I couldn't ask questions at a webinar"* and *"I focus better in person"*). However, some of the Film only attendees pointed out that a webinar might be *"more convenient"* as *"scheduling to be out of the office can be difficult."* Given this interest – and depending on the technological capabilities of the partners and the attendance and scheduling of their local workshops – if National Geographic were to coordinate a similar project, they might want to look into taping one of the workshops and sharing it as a webinar. Future evaluations might also look into the educators' interest in and familiarity with webinars, as well as the benefits and challenges of sharing workshop material in this manner.
  - As an informal comparison only, there were small apparent differences in how the two groups of educators rated the value of the educational resources, among those who indicated the resources were applicable to their settings. Where the Workshop attendee group generally found the online activities/lessons and the iPad app/game to be extremely valuable, the Film only attendees thought both resources were very valuable. Additionally, while the Film only attendees generally rated the educator DVD, website, and online videos as more valuable than the other resources

(between very and extremely valuable each), the Workshop attendees thought all three resources were very valuable. Finally, the Film only attendees gave one of the lowest ratings to the “fun facts” handout (finding it moderately valuable), while the Workshop attendees felt the resources was very valuable. The extent to which these apparent differences are meaningful and point to recommendations on how to communicate information about the handout, for example, to educators who don’t attend a workshop, is beyond the scope of the evaluation, but the issue may be worth exploring prior to developing and promoting film-related materials in the future that are to be accessed by those not having the benefit of attending a workshop and seeing the materials demonstrated in person or remotely via webinar.

- Future workshop organizers might consider providing partner organizations with an outreach toolkit or other support to help them reach a broader network of educators in their areas when they are recruiting participants for their local workshops.
  - When asked why they did not attend the local workshop in their area, the largest group of Film only attendees indicated that they didn’t know about it. The group as a whole also somewhat agreed that they would have been interested in the opportunity, and the majority indicated that if another workshop were to take place in their area they would be moderately to extremely likely to attend. Though it is unknown how many of these interested Film only attendees would have come to their local workshop if they had known about it, it’s possible that the partners could have done more outreach to local educators. In the future, the outreach team might consider assisting with this effort by providing partners with an outreach toolkit containing templates for a mass email, flyer, and press release, among other resources, with the goal of making it easier for partners to promote the workshop among educators in their areas.
- The largest groups of Workshop attendees and Film only attendees that participated in the evaluation noted that they were elementary educators and that they planned to use the resources with elementary students, indicating that many educators were willing to adapt resources targeted at middle school students for use in their elementary-level classrooms. As one educator explained, *“All the activities presented can be easily adapted to different grade levels and to different learning styles.”* Future film efforts may want to consider sharing such recommendations with educators for adapting the materials for different ages.
  - It is not known whether the teaching levels of the educators who participated in the two different surveys (Workshop attendees vs. Film attendees) were representative of the full group of educators that attended the local workshops or saw the film across the partner sites. Balancing against the additional burdens this may place on partner organizations, future outreach and evaluation efforts might aim to track and report on this information by, for example, requesting that partners request teacher grade level in their workshop registration forms and provide a breakdown of the same information from the list of educators (who only saw the film) to whom they sent a survey requests.
- Many of the elementary school educators that participated in the evaluation did not, however, seem to recognize that the Museum Educator Guide contains activities specifically designed for the elementary school level. To help connect such educators to these activities, it may be worth brainstorming ways to help ensure educators can be easily directed to the resources designed for their students. As one possibility, it might be worth encouraging the partner organizations to reach out to targeted educators (if possible) when planning their local workshops, to help direct them to the age-appropriate resources and share ideas for implementation or modification.

- Throughout their surveys, a number of Workshop and Film only attendees indicated that the film and its resources weren't at the ideal level for their students, with many finding them *"too advanced"* and a smaller group saying that they had hoped to gain *"activities for use in the upper levels."*
- However, even though the targeted age range of the project wasn't ideal for all of their students, some educators pointed out that *Mysteries of the Unseen World* could still be a positive educational experience, as in, *"The younger the students, the less they are likely to become engaged by some of the details, since they don't have the background to understand the nature of light and color. Nonetheless, the film could get them questioning and wondering if the teacher follows up on the ideas."*
- Overall, Workshop attendees and Film only attendees valued the resources and had specific plans for their use, particularly in regards to influencing students' interest in STEM or STEM careers. However, the outreach team will likely want to investigate why a number of educators had trouble playing the educator DVD.
  - In general, both groups of educators explained that they would use or had used the resources to influence students' interest in STEM and/or STEM careers in 4 main ways:
    - by preparing students to see the film (as in, *"Will be using many of the DVD activities/online activities to prepare students to watch MUW"*);
    - supplementing the information in the film through hands-on activities (as in, *"The videos will be used to help explain what students are experiencing in the hands-on activities, either before or after the activity"*);
    - adding to other lessons (as in, *"We are studying plants and I plan to use the time lapse app to record beans sprouting"*); and/or
    - using the resources to enhance their career days (as in, *"Our 'career day' will happen in January at school, and these resources will be implemented into our forensics presentation, so thank you"* and *"We have already had community day in which they met several people in various careers. I will build on that prior knowledge by adding these types of careers"*).
  - Some of the most frequently cited resources among Workshop attendees who planned to use the resources and Film only attendees who planned to use them or already had were, in no particular order: the Museum Educator Guide, poster, "fun facts" handout, the website, the online videos, and the educator DVD. However, a number of educators reported having difficulty playing the DVD, which the outreach team will likely want to look into, if they haven't done so already.
- Future film-related media projects might want to gather metadata about the use of the iPad app/game when considering the creation of similar resources for future projects.
  - Though those who used the iPad app/game generally found it valuable, large groups of Workshop attendees and Film only attendees indicated that they had not used or did not plan to use the iPad app/game. Additionally, some of the educators expressed confusion about how to access to the resource (as in, *"Where is the iPad app/game? Do I need to download that? Is an iPad required? Can a Chromebook, or other technological tool be used instead?"*) or explained that their classrooms didn't use iPads (as in, *"I do not have access to iPads where I teach"*). Given the likely availability of metadata about the downloads and use of the iPad app, National Geographic might

want to review this information when considering the creation of similar resources on future projects.

## Feedback from the partner organizations

In general, the 11 partner organizations that “activated” the outreach award and completed the post report felt that their involvement in the project was a positive experience. Below, we highlight some of their accomplishments, comments, and suggestions that National Geographic might want to consider if and when similar projects are coordinated in the future.

- If resources allow, future outreach teams might work more closely with partners to coordinate the timing of the outreach award, consider the best way to gather data from the partners’ reservation systems, and determine the extent of the impact of the Museum Educator National Workshop on the partners’ outreach and marketing efforts.
  - Overall, the partner organizations estimated reaching approximately 42,200 educators and 998,000 students with their marketing and outreach efforts (which included emails, letters, preview passes, conferences, and distribution of the project materials, among other methods). Additionally, of those who were able to provide estimates, the group as a whole hosted an estimated 852 field trip groups, reaching approximately 7,740 educators or chaperones and 41,800 students. A few of the partners were able to estimate grade ranges reached with the field trip screenings (approximately 761 students in grades K-4, 4,050 students in grades 5-8, 31 students in grades 9-12, and 545 other students). Some of the partners described that their numbers weren’t final or that they could have done more if they had more time after the Museum Educator National Workshop (as in, *“To date, this is the number of attendees to the film”* and *“Unfortunately, I did not have enough time to plan and implement some of the outreach award deliverables. In my case, the film was being released about 2 weeks after I attended the [national] workshop”*). In light of this feedback, outreach teams on future projects might want to look for ways to give partners more time to complete the post report and/or more time to ramp up their outreach activities after the National Workshop.
  - Other partners noted that their reservation systems didn’t capture all of the information asked for on the post report (as in, *“We do not have a way of knowing how many trips there were, but we can tell you how many students and teachers/chaperones saw the film on a field trip”* and *“Grade levels are not listed in our current reservation detail”*). If capturing this information is a high priority for future projects, the outreach team might consider working with each partner to determine the kinds of information their reservation systems can collect, as well as if and how additional data might be gathered.
  - Though responses from museum educators considered in Phase 1 indicate that the group as a whole valued the opportunity to participate in and learn from the Museum Educator National Workshop, further evaluation efforts might examine how much of the partners’ outreach was done through channels established prior to attending the National Workshop and how much was directly influenced by ideas, resources, and/or motivation gained at the workshop.
- Future outreach teams might consider working with each partner to set organizational goals for outreach to underserved communities, such as targeted numbers of students and educators to reach and/or how the resources might be best used with these audiences.

- The partners described how the Underserved Community Outreach grant benefited students, schools, and the partner organizations, and said it helped them reach new audiences, as in, *“Funding for underserved audience is something that we get increasing requests from schools every year...Programs like this allow students to participate in activities and enrichment that they would not normally get to.”*
  - As a group, the partners indicated that they reached approximately 692 educators and 7,450 students through the project’s Underserved Community Outreach grant, and that approximately 5,570 students saw the film with assistance through this funding. In general, the partners described using the funding to pay for or subsidize ticket costs and to fund transportation, with some reaching underserved students through the film’s other educational materials (as in, *“Spent \$1020 on field trips and classroom supplies for 2 Title One schools”*).
  - The numbers of underserved students and educators reached ranged widely by partner – for example, the number of students reached and the number of students who saw the film both ranged from a low of 20 to a high of 4,000 per partner, and the number of educators reached ranged from 2 to 400. Though theoretical best use of the funding cannot be determined in this evaluation (particularly when considering both the number of students reached and the impact(s) of said outreach), some of the partners indicated that they found ways to make the most of the funding that worked especially well for their organizations. These partners observed that the funding helped them reach more students (for example, *“For most, we were able to just cover the movie cost for the students. If we were to cover museum and movie admission, we would only be able to have served 71 individuals, but because we found other ways to cover their admission costs, we were able to serve more than 3 times that amount,”*) and/or build on content featured in the film (as in, *“I also did a post-visit and follow-up [with students who saw the film] with some of the educator activities provided by Nat Geo”*).
- ➡ The partners generally shared positive feedback about and made use of the resources and activities. However, some of the resources and activities were more highly valued than others. Thus, the outreach team might consider gathering formative feedback about the materials being developed for future projects to get a sense of what may be especially valuable to partners and educators.
- In general, the partners found the giant screen film to be extremely valuable and the DVD and Museum Educator Guide to be very valuable, and also indicated that they used these resources often. The partners thought the least valuable resource was the iPad app/game, which they rated between slightly and moderately valuable, with one partner explaining, *“I don’t think there is a need for the app in a school setting, but should be geared more towards the general public.”* If considering the development of an iPad app for another project, future developers might consider gathering formative feedback on the development of future apps and/or reviewing the metadata from the *Mysteries of the Unseen World* app to better understand how these kinds of resources are used by partners and educators (as also noted earlier in this discussion).
  - As a group, the partners indicated that they used almost all of the activities in the Museum Educator Guide, with the Careers activity being the only one that wasn’t utilized. Electron Microscope Image Scavenger Hunt, which was used by 9 of the 11 partners, was the most-used activity, followed by Zoom and Too Slow, which were each used by 5 of the partners. Though the reasons for their preferences are unknown, and are beyond the scope of this evaluation, the outreach team might consider gathering formative informal feedback about activities they develop around future giant screen films.

- The outreach team might consider gathering informal feedback from Museum Educator National Workshop attendees whose organizations declined the outreach award. Additionally, they may want to request more detailed outreach plans from potential partners in order to minimize the likelihood that a partner would not be able to use the funding, as happened with one of the 11 *Mysteries of the Unseen World* partners.
  - Of the 17 organizations that attended the Museum Educators National Workshop, 11 went on to activate the outreach award. Though the reasons why six potential partners declined the award are unknown, the project team might consider gathering informal feedback from these organizations with the goal of creating a program that appeals to (and is feasible for) as many museums and science centers as possible.
  - Additionally, one of the partners that accepted the outreach award explained that they were unable to use the funding because of internal issues. Depending on future project priorities, a similar outreach grant might benefit from a more detailed screening of potential partners, for example requesting more fully developed outreach plans, and/or working with each partner to identify ways that the outreach grant could be of use to their organizations and to the students in their communities.
- Some of the partners indicated that they had difficulty registering educators for their local workshops and gathering surveys from Workshop and Film only attendees. To the first point, future outreach teams may want to set personalized educator attendance goals for each partner, based on the size of their educator network and their experience hosting professional development programs. To the second point, one partner suggested that future outreach teams provide incentives for local educators.
  - Though the partners that activated the outreach award generally found the award requirements reasonable, a few explained that they had trouble registering educators for their local workshop (as in, “*We found it difficult to get educators to register for dedicated workshops for the movie and the associated educational material*”). Future outreach teams, therefore, might want to set different goals for each partner, so that every organization can strive to use the resources to the best of their ability (as in, “*It would be great to have something geared towards museums that are new to teacher/professional development and may not be able to meet the numbers you’ve requested for educators, but could complement those numbers with outreach to the public*”).
  - Some of the partners indicated that they found it difficult to produce enough educator surveys, both from Workshop attendees (as in, “*We had to have them fill out the survey onsite- which can be difficult to convince people to stay and do- or we had to trust that teachers would fill them out offsite, which was not possible for us to track.*”) and from Film only attendees (as in, “*It is difficult to make educators that are just coming to see the movie participate in the evaluation piece in the end*”). One partner suggested that National Geographic provide incentives for educators (for example, “*bags, caps, classroom resources*”), in order to increase the likelihood of a higher response rate to these surveys.
- Finally, future outreach teams might take into account that projects like *Mysteries of the Unseen World* are likely to continue to foster the development of the partners’ educational networks, and in some cases help to establish these networks.
  - Though many of the partners seem to have gone into the project with established educator networks, this was not the case for all of the organizations. As one partner noted, *Mysteries of the*



*Unseen World's impact was larger than the project itself, as in, "Our biggest challenge was that we don't have an established educator base of our own yet and are working to develop that...However, having the opportunity to host a dedicated Mysteries workshop has really helped us to jumpstart that and we've made some very important steps in developing our educator network that would not have happened otherwise." At the same time, another partner pointed to the larger benefits for educators (and, tangentially, students), saying, "We'll need to 'teach' our educational community what to do with these opportunities but it is well worth the effort."*

# Appendix 1: *Mysteries of the Unseen World* Museum Educator National Workshop Agenda



Present:

## ***Mysteries of the Unseen World* Museum Educators Workshop Washington, D.C. October 23-25, 2013**

### **DRAFT AGENDA**

#### **Wednesday, October 23rd**

##### **Evening Event at The Beacon Hotel**

5:30- 7:00 p.m. Welcome Reception, Cabinet Room at the Beacon Hotel  
Cocktails and appetizers will be served.

#### **Thursday, October 24th**

##### **Breakfast in the National Geographic Dining Hall**

8:00- 8:45 a.m. Breakfast vouchers will be provided

##### **Morning Session in Grosvenor Auditorium (*M Street Building, Main Floor*)**

8:55 a.m. Attendees gather in the Grosvenor Auditorium

9:00-9:15 a.m. Welcome and staff introduction

9:15- 9:55 a.m. *Mysteries of the Unseen World* 3D film screening

9:55-10:00 a.m. Quick break

10:00-10:15 a.m. Making STEM connections

10:15-10:45 a.m. Hands on activity: Understanding Why We See What We See: Exploring the Lens of the Human Eye

10:45-11:00 a.m. Coffee Break – Refreshments available in M Street Lobby

##### **Activity in National Geographic Library (*16th Street Building, Main Floor*)**

11:00-11:15 a.m. Introduction to Museum Educator's Guide (MEG) contents – Meet in 16<sup>th</sup> Street Building Lobby outside of the Library

11:15-12:00 p.m. Exploration of kiosk and MEG activity: Electron Microscope Image Scavenger Hunt

Special thanks to our partners:

1



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**Lunch in the Control Center (17<sup>th</sup> Street Building, 9<sup>th</sup> Floor)**

12:00-1:00 p.m. Catered lunch in the Control Center

**Afternoon Session in the Control Center (17<sup>th</sup> Street Building, 9<sup>th</sup> Floor)**

- 1:00-1:30 p.m. Engaging Children with the Nano World  
Special Guest: Alyssa Calabro, Research teacher of Electron Microscopy,  
Bergen County Academies
- 1:30-1:45 p.m. Question and Answer session with Alyssa Calabro
- 1:45-2:15 p.m. Introduction of extended activities from the MEG: Too Slow
- 2:15-2:45 p.m. Breakout session- Participants will break into groups to augment, modify and  
brainstorm activities that can be used from the MEGs in their museum setting.
- 2:45-3:00 p.m. Groups share ideas from planning session
- 3:00-3:15 p.m. Afternoon Coffee Break: Explore others' ideas from the planning session gallery  
walk. Refreshments will be served.
- 3:15-3:30 p.m. Scientist career profile videos are presented
- 4:00-4:15 p.m. Engineers in the Classroom program is introduced
- 4:15-4:50 p.m. Engineering activity
- 4:50-5:00 p.m. Question and Answers from the day
- 5:00-6:00 p.m. National Geographic Museum Exhibit open for viewing
- 6:20 p.m. Meet "Under the Stars" in the M Street Building Lobby to walk to dinner

**Dinner in Hubbard Hall Board Room (16<sup>th</sup> Street Building, 2<sup>nd</sup> Floor)**

6:30 p.m. Seated dinner  
Guest speaker: Brendan Mullan, Science Educator and Astrobiologist,  
National Geographic Emerging Explorer 2013

Special thanks to our partners:



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2

## Friday, October 25th

### Morning Session in North End of Cafeteria (*M Street Building, Main Floor*)

- 8:30- 9:00 a.m. Catered Breakfast in the North End of the Cafeteria
- 9:00-9:30 a.m. Explanation of Outreach Awards
- 9:30-9:45 a.m. Question and Answer session about Outreach Awards
- 9:45-10:15 a.m. Free educational materials from NatGeoEd.org
- 10:15-10:45 a.m. How to effectively use media in the classroom: Best practices of how to use video and photography in educational settings
- 10:45-11:15 a.m. Introduction of short informal activities, including museum “cart” activities
- 11:15- 11:45 a.m. Working groups: sharing ideas of historically effective strategies to engage public with films. Discussion of engagement activities with assets provided.
- 11:45-12:00 p.m. Gallery walk to share ideas from working groups
- 12:00-12:15 p.m. Closing remarks, evaluations  
Boxed lunch provided

Special thanks to our partners:



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3

# Appendix 2: *Mysteries of the Unseen World* outreach award fact sheet

National Geographic presents  
**MYSTERIES OF THE UNSEEN WORLD**

Opening worldwide on November 1, 2013

## Launch Partner Package

### 1. **WHAT: EDUCATION SEMINAR AT NGS HEADQUARTERS IN WASHINGTON, DC**

**DETAILS: September 26 & 27, 2013, All expenses paid, 25 spaces available.**

Join us in Washington, D.C. for a “Train the Trainer” seminar where you will learn all about (and get a preview screening of) *Mysteries of the Unseen World* and the comprehensive education materials accompanying the film. Space available for 25 attendees only; both formal and informal learning activities will be presented so you will have all the tools you will need to reach out to local educators or host a learning event at your museum. *Made possible by a grant from NSF.*

### 2. **WHAT: OUTREACH SUPPORT AWARDS**

**DETAILS: \$2,600 awards each to be used for educational outreach (25 awards)**

Attendees at the Education Seminar will also receive a small award to put toward their theater’s education outreach efforts. NG will be asking that in return for both the Education Seminar and this award, your education staff will commit to a plan to do the following:

- Utilize a minimum of \$1000 of this award to support students from underserved communities to attend the film. We prefer that you use these funds to support as many kids as possible; The funds can be put towards any associated expense, such as tickets or busses (If the funds go towards tickets, these must be at a discounted rate). The remaining \$1600 can be spent on any other part of your film outreach campaign, as long as it supports the objective of maximizing the teacher/student outreach of your educational campaign.
- Disseminate and promote *Mysteries of the Unseen World* education materials to your local educators and use the informal material to engage kids and families at your venue.
- Commit to teacher workshops, and/or integration into your existing teacher workshops. NG will work with you to determine an agreed-upon number of teachers reached via these workshops.
- Reporting to National Geographic:
  - Complete an NG-provided post report that includes quantified data on your outreach to educators, students, and families over the run of the

film. NG requests that the completed form is submitted to NG within 30 days of the close of the film run at your venue.

- Distribute an NG-provided online survey to your network of educators so we can gather and analyze data about their use of the materials and the film. We also ask that you encourage your teachers to participate in the survey as much as possible. We will provide an incentive for educators to complete the survey, (such as 20% off the NG Store), and we are also happy to share the results with you for your own business purposes.

We will give you the tools and materials to implement these activities, and we will be happy to share all resulting information with you, with an eye towards better quantifying all of our efforts. *Made possible by a grant from Lockheed Martin.*

### **3. WHAT: MYSTERIES OF THE UNSEEN WORLD LOBBY KIOSKS**

**DETAILS: 15 kiosks available, theaters/museums pay for shipping only. Easy assembly and tear down.**

Extend the learning from *Mysteries of the Unseen World* and enhance your audience's film experience by having an interactive "kiosk" in your lobby or museum. With three activity stations, kids and adults alike can scan images taken with an electron microscope and try to guess what they are looking at. NOTHING looks the same magnified a million times! Each kiosk has three stations, 2 with ipads and the scanning software, and one with "old fashioned" magnifying glasses so kids can see how science has allowed us over time to see more and more of our world. *Fabricated by the Carnegie Science Center, with a grant from FEI, a manufacturer of electron microscopes.*



#### **4. ADDITIONAL EDUCATION OUTREACH**

Resources will include a full suite of education activities tied to the film, including videos of scientists and engineers talking about STEM careers, plus a poster and DVD with all education activities on it for giveaway to local educators.

#### **5. MYSTERIES OF THE UNSEEN WORLD GAME/APP FOR THE IPAD**

We are also creating an App/Game for the ipad that will allow players to view electron microscopy images and guess what they are seeing, as well as create puzzles of these amazing images.