NSTA-ASTC EAGER Project: Resource for STEM Education Practitioners

Front-End Evaluation Report

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Prepared by:
Kelly Riedinger, Ph.D.
Director of Research and Evaluation
David Heil & Associates, Inc.

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DAVID HEIL & ASSOCIATES, INC.
Innovations in Science Learning

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Executive Summary

The National Science Teachers Association (NSTA) and the Association for Science-Technology Centers (ASTC), with support from the National Science Foundation (NSF), has launched an initiative to develop and distribute two pilot issues of a new resource for STEM education practitioners in both formal and informal (out-of-school) settings. An aim of the new resource is to better connect practitioners across education settings and the research and knowledge base about STEM learning. David Heil & Associates, Inc. (DHA) is serving in a co-PI role on the grant to provide NSTA and ASTC with research and evaluation services to inform the development of the pilot issues of the resource through front-end, formative, and summative evaluation. This report summarizes the front-end evaluation study conducted from 2014-2015 that included focus group discussions and a national survey administered to members of the target audiences. Our goal in this front-end study was to explore the landscape of resources available in the STEM education community to identify areas where the new resource could strategically contribute. Additionally, the front-end study sought to gather data regarding the interests, needs and expectations of the target audiences to provide the NSTA and ASTC with data-driven recommendations for the development and iterative refinement of the proposed new resource.

Key Findings

While there is a wealth of resources available to STEM education professionals, there is agreement across the target audiences that there is a need for a resource that connects researchers and practitioners as well as educators across a variety of settings. This was coupled with a high level of interest in the proposed new resource among members of the target audiences.

The input provided by STEM education professionals on the national survey and during the focus group discussions offered specific suggestions regarding the following aspects of the new resource: format, publication factors, topics of interest, recommended authors and contributors, and distribution.

Focus group and survey respondents across the country also identified a number of potential challenges to the success of the proposed resource, and offered the following suggestions:

- Identify strategies for making research accessible and applicable to STEM education practitioners;
- Consider how to make the new resource stand out against the landscape of resources already available to STEM education professionals;
- Ensure that the pilot study is of high quality, aesthetically pleasing and features notable professionals from the STEM education field;
- Include articles, features and resources that are inclusive of all STEM educators, including those from small and rural museums as well as informal educators from non-museums settings (e.g., afterschool programs, environmental education centers, field stations, science camps, media).

Collectively, findings from the front-end study offer strong evidence that there is a need for and high level of interest in the proposed resource. Through the national survey and focus group discussions, members of the target audiences provided clear expectations and input regarding the resource. Based on compilation and analysis of the evaluation data collected, DHA offers the following recommendations:

Recommendations

1. The NSTA and ASTC should continue to pursue development of the proposed new resource to connect educators across settings and to the research and knowledge base in STEM learning.
2. To align with current and appropriate terminology, the project leadership at NSTA and ASTC should engage in discussions with the advisory board around definitions and terms associated with informal science education.
3. The NSTA and ASTC should begin identifying and convening editorial board members who have expertise in the STEM education field as well as with the editorial process.
4. The NSTA and ASTC should consider interviewing editors from related STEM education journals and consider important "lessons learned" regarding aspects of publishing such as article submission and the peer review process.
5. The NSTA and ASTC should begin developing protocols for vetting content materials and resources as well as rubrics for the peer review process of articles.
6. The new resource should be designed with the input provided by the target audiences in mind including their suggestions for aspects such as: format, publication factors, topics of interest, recommended authors and contributors, and distribution.
7. The NSTA and ASTC should consider a theme-based approach in which each issue explores a particular topic or issue from a variety of perspectives (e.g., researcher, classroom-based educator, museum educator, other informal/out-of-school educator).
8. The new resource should provide opportunities for researchers and practitioners as well as formal and informal educators to interact with one another.
9. The NSTA and ASTC should consider strategies in order to make the resource accessible to all STEM educators across a range of settings.
10. The NSTA and ASTC should consult related resources to inform the development and features of the proposed resource.

Introduction

While there is a wealth of research-based knowledge in STEM education, there is currently no easily accessible, user-friendly resource for practitioners that connects formal and informal (i.e., out-of-school) settings. With this need in mind, the National Science Teachers Association (NSTA), in collaboration with the Association of Science-Technology Centers (ASTC), applied for and was awarded a National Science Foundation (NSF) Early-concept Grant for Exploratory Research (EAGER). The purpose of this funded project was two-fold; first, the project aimed to conduct a needs assessment to identify what STEM education resources were currently available to practitioners in both formal and informal (out-of-school) settings for learning. Second, the project proposed to develop, pilot and evaluate a new resource that sought to better connect practitioners in these settings with each other, and the rapidly growing research and knowledge base about STEM learning. The proposed resource would highlight successful curricula and programs based on STEM education research across formal and informal, out-of-school STEM education communities.

Grant related activities to date included the assembly of an advisory board as well as initiation of Phase I of the project which primarily focused on implementing the front-end study. As a co-principal investigator (PI) on the grant funded project, David Heil and Associates, Inc. (DHA) was contracted as a research and evaluation partner to conduct front-end, formative and summative evaluation for the project. This report focuses on the front-end research conducted by DHA for the first phase of the grant-funded project. The front-end research was designed specifically to inform content development and delivery of the proposed resource through both a landscape and needs assessment.

Goals of the Evaluation

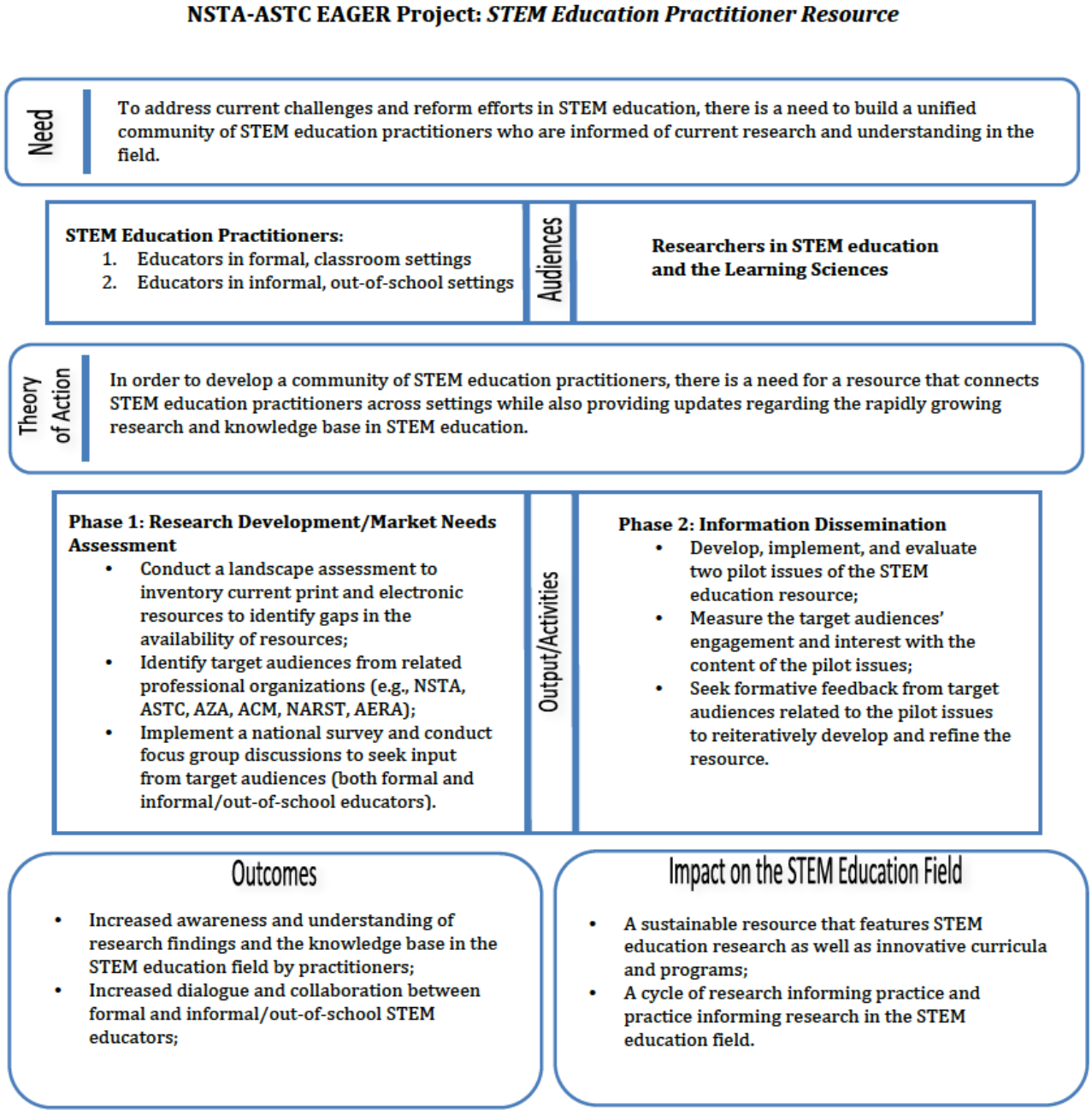
The aim of the front-end research was to gain an understanding of existing resources in the STEM education field as well as provide strategic input from the targeted audiences in order to assist the project leadership in making informed decisions regarding the development and implementation of the resource. In particular, the front-end study was conducted to:

- Inventory and document current print and electronic resources available to practitioners in the field of STEM education;
- Gain a baseline understanding of how STEM education practitioners access and use research;
- Identify gaps in the availability of existing resources in the field;
- Identify target audiences from partner organizations (e.g., NSTA, ASTC) and other related professional organizations (e.g., NARST, the American Alliance of Museums, Afterschool Alliance, Visitor Studies Association, Association of Children's Museums);
- Gather input from the target audiences to inform the development and design of the proposed resource.

Project Logic Model

The logic model presented in Figure 1 visually depicts the theory of action for the *STEM Education Practitioner Resource* grant initiative and highlights specific ways in which the output and activities lead to project outcomes and strategic impacts. Visually representing the theory of action and causal chain allowed DHA to identify appropriate evaluation goals and methodologies to guide the study.

Figure 1. Logic Model for *STEM Education Practitioner Resource* Project



Methodology

As part of this front-end study, DHA implemented the following two strategies to inform Phase I of the project: a landscape assessment and a needs assessment. The landscape assessment was designed specifically to inventory existing resources in the STEM field while the needs assessment focused on identifying the interests, needs, and expectations of the targeted audiences[i].

For each of the two aspects of the front-end study, DHA used a complementary, mixed-methods approach to collect data and insights related to the stated evaluation goals and project objectives. A complementary methods approach was warranted as it explores a question or problem from multiple perspectives and incorporates both quantitative and qualitative data (Creswell, 2008). Each type of data is viewed as complementary; the quantitative data provide a broad overview while the qualitative data allow for a nuanced, in-depth understanding of the needs and input from the target audiences.

The data collection strategies employed for the landscape assessment included web-based research, review of materials, survey methods, and focus group discussions. As part of the needs assessment, DHA conducted focus group discussions with formal and informal (out-of-school)[ii] educators and administered a national survey to the targeted audiences. Table 1 provides an overview of the data collection strategies used for the two approaches implemented during the front-end research study.

Table 1. Overview of Data Collection Strategies

Evaluation Stage	Approach	Methods
Front-end Study	Landscape Assessment	• Web-based research • Review of materials • National survey • Focus group discussions
	Needs Assessment	• National Survey • Focus group discussions

STEM Resource Inventory and Review

STEM education resources available to practitioners were compiled, reviewed and inventoried by DHA. To initiate this review and inventorying of existing resources, DHA conducted both web-based research and review of materials from professional organizations and groups affiliated with STEM education research and practice. In addition, resources identified by survey and focus group respondents were also used as sources of data for creating the inventory of resources in the field. Members of the DHA evaluation team used an inventory spreadsheet to document and compile a list of existing resources available to STEM education practitioners. The spreadsheet included details such as type of resource, sponsoring organization, target audience, and content topics. An aim of the documentation and inventorying was to illustrate existing resources that are currently available in the STEM education field while also highlighting any gaps or needs in the resource base. The data was also used to indicate whether or not there is a need for a new resource in the STEM education field and in particular, where there are gaps in the knowledge base that the new resource could help address.

National Survey

Creswell (2008) explained that surveys are suitable for quantifying variables to identify broad trends. Similarly, Berends (2006) posited that survey methods describe characteristics of a sample or population, providing information that can add to a methodological approach. Particularly with regard to evaluation in education, Pattison, Cohn, and Kollman (2013) explained that surveys are useful to gather input and feedback from a broad audience in a short amount of time and allows for respondents to provide input confidentially or anonymously.

A national survey was administered electronically through SurveyMonkey for both the landscape and needs assessment. The national survey was initially developed by the DHA evaluation team with input from the project co-PIs (i.e., NSTA and ASTC). The survey instrument was then reiteratively refined based on input provided by members of the project advisory board. Survey items were primarily focused on gathering data related to the interests, needs and expectations of the target audiences. In addition, the survey aimed at documenting the resources available to members of the target audiences and how the targeted audiences use these STEM education resources. The national survey was anonymous and included open-ended items as well as Likert-scale, close-ended items.

Members of the project advisory board assisted in administering the national survey to a broad audience that included education researchers and practitioners in both formal and informal education settings. In most cases, the entire membership of an organization was sampled for data collection; however, where appropriate, the survey was targeted to specific subpopulations. For example, the Association of Zoos and Aquariums (AZA) organization includes members working in a range of areas not necessarily associated with education (e.g., animal management and welfare, public relations, business operations). Only members in the "educator" track were targeted from this organization for survey administration. Table 2 highlights the organizations identified for the survey as well as the population targeted from each for input on the national survey.

Table 2. Targeted Audiences for National Survey

Organization	Targeted Population
National Science Teachers Association (**NSTA**)	All members who identified as informal educators + 10% sample from broader membership
Association for Science-Technology Centers (**ASTC**)	Entire membership
Afterschool Alliance	Entire membership
Association of Children's Museums (**ACM**)	Entire membership
Materials Research Society	All members who identified as interested in materials education
The American Alliance of Museums (**AAM**)	Entire membership
Visitors Studies Association (**VSA**)	Entire membership
National Science Education Leadership Association (**NSELA**)	Entire membership

American Chemical Society	Entire membership
American Association for the Advancement of Science (**AAAS**)	Entire membership
American Educational Research Association (**AERA**)	Informal Learning Environments Research & Science Teaching and Learning Special Interest Groups
North American Association for Environment Education (**NAAEE**)	Entire membership
National Association for Interpretation (**NAI**)	Entire membership
Astronomical Society of the Pacific	Entire membership
Association for Zoos and Aquariums (**AZA**)	Members who identified as educators
American Association of Physics Teachers (**AAPT**)	Entire membership
American Society for Engineering Education (**ASEE**)	Members in the K-12 division
National Association of Biology Teachers (**NABT**)	Entire membership

In total, 1202 professionals responded to the national survey to provide input. Of these respondents, 440 (**36.6%**) identified as formal, school-based educators, 646 (**53.7%**) identified as informal science educators and 116 (**9.7%**) identified as researchers or from higher education.

A question on the survey prompted respondents to indicate their professional affiliations. Results from this question suggest that there was representation on the national survey from a broad range of professional organizations or groups (Table 3).

Table 3. Professional Organizations or Groups

Afterschool Alliance	11.4%
American Association for the Advancement of Science (AAAS)	11.6%
American Association of Physics Teachers (AAPT)	3.6%
American Educational Research Association (AERA)	5.3%
American Society for Engineering Education (ASEE)	2.6%
Association for Science-Technology Centers (ASTC)	30.5%
Association for the Education of Teachers of Science (AETS)	1.6%
Association of Children's Museums (ACM)	6.5%
Association of Zoos and Aquariums (AZA)	5.4%
Center for the Advancement of Informal Science Education (CAISE)	14.4%
Materials Research Society	2.5%
NARST	6.7%
National Afterschool Association (NAA)	4.3%
National Association of Biology Teachers (NABT)	5.0%
National Earth Science Teachers Association (NESTA)	3.4%
National Marine Educators Association (NMEA)	4.1%
National Middle School Association (NMSA)	1.1%
National Science Teachers Association (NSTA)	59.0%
North American Association for Environmental Education (NAAEE)	9.4%
The American Alliance of Museums (AAM)	13.8%

The American Chemical Society (ACS)	5.4%
The Association for Science Teacher Education (ASTE)	4.6%
Visitors Studies Association (VSA)	4.8%

Figures 2 and 3 provide additional demographic details for the formal and informal science education practitioners who responded to the national survey. As Figure 2 illustrates, the respondents from formal, classroom-based settings represented diversity in terms of professional role, school setting, as well as grade level. Likewise, the respondents from informal science education also represented diversity in terms of characteristics such as type of institution, setting, and organization offerings (Figure 3).

Figure 2: Characteristics of Formal Educators

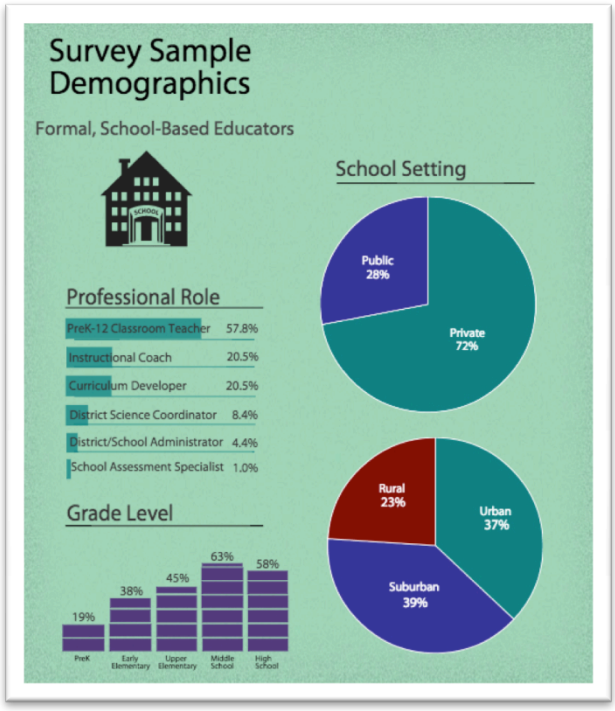
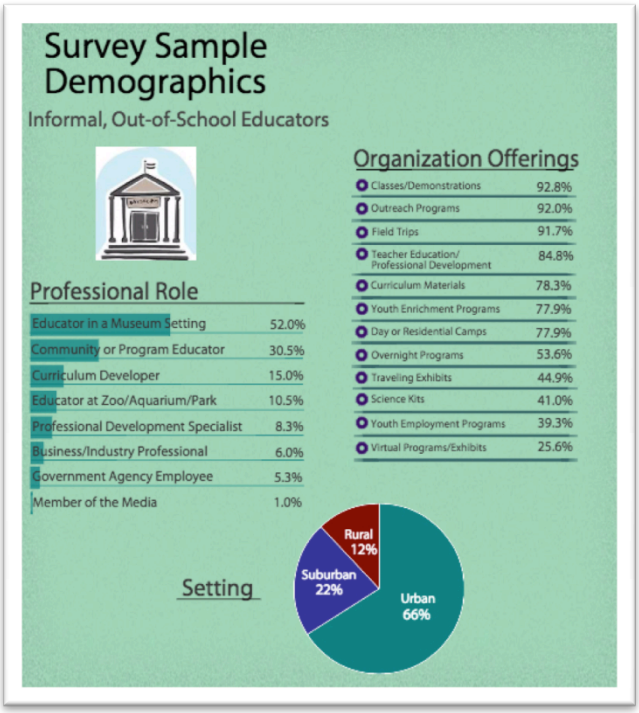


Figure 3: Characteristics of Informal Educators



Focus Group Discussions

DHA also facilitated a series of focus group discussions during the spring and fall of 2014 with a total of 62 STEM education professionals. Focus group discussions were conducted in conjunction with several conferences including the NARST Annual International Conference in April 2014, the National NSTA Conference in April 2014, the NSF AISL PI Meeting in August 2014, and the ASTC Annual Conference in October 2014. For each of the discussions, DHA provided a focus group specification guide to the associated organization to ensure that participants represented diversity across a variety of criteria including (but not limited to): professional role, gender, race/ethnicity, years in education, and setting. A sample focus group specification guide used for this front-end study can be found in Appendix A. Each organization then provided a list of potential focus group participants to DHA. The DHA evaluator then sent out email invitations to each individual on the list provided and all of the respondents who consented to participate were included in the focus group

discussions. The sample consisted of 10 researchers, 2 retired educators (formerly informal science educators), 15 educators from formal, school-based settings, and 35 educators from informal science education settings. A discussion guide was used to facilitate the conversation during each of the focus groups. A sample of the questions from the focus group discussion guide is presented in Table 4.

Table 4. Sample Focus Group Questions

	Sample Items
Focus Group Discussion Guide	➢ Where do you typically get information that translates research to practice in the STEM education field? ➢ Where do you think there are gaps in the current pool of resources in STEM education where a new resource could contribute? ➢ What topics would you be interested in reading about or exploring in a resource focused on translating research to practice in STEM education? Why are these topics of interest to you? ➢ Are there any authors/contributors you would like to see published in this potential resource? Why?

Data Analysis

The data from the national survey and focus group discussions were analyzed using quantitative and qualitative methods. Quantitative data were analyzed using the analysis tools in SurveyMonkey as well as with the statistics software, SPSS. Both analysis tools were used to compute descriptive statistics (e.g., frequencies, percentages, measures of central tendency) as well as to make comparisons by field (i.e., formal practitioner, informal practitioner, researcher). Responses to several of the open-ended questions were categorized and crosstabulated using Dedoose, a web application for mixed methods research. The descriptive statistics are summarized and displayed throughout the report using tables and graphs.

Focus group discussion data were transcribed and analyzed within the rigors of qualitative research. Methods of analytical induction were employed to identify emergent themes from the data collected. Members of the DHA team individually coded the qualitative data to identify patterns and themes and then met to negotiate the codes, reconcile any differences between codes developed, collapse categories, and identify relationships between categories. Through this iterative process, DHA was able to continually refine codes and identify the meaningful patterns and trends from the corpus of data collected. The qualitative data are descriptive and provide an in-depth, nuanced understanding of the input provided by the target audiences. Qualitative findings are presented in narrative form and where appropriate, participants' quotes are reported to further elucidate findings.

Findings

This section provides an overview of the findings from the landscape and needs assessments that were implemented as part of the front-end study. By inventorying the current resources available to STEM education professionals, DHA was able to identify areas where a new resource could contribute. Further, through the needs assessment, DHA was able to collect input from the target audiences to inform the development of a new resource. This section highlights the key findings from the front-end study.

Landscape Assessment

As a means to address the objectives of the front-end study, DHA explored the "landscape" of print and electronic resources available to STEM education professionals. In particular, we were interested in not only documenting and inventorying the current resources available in the STEM education field, but also to understand how practitioners access and use these resources. We sought to gain insight related to this evaluation objective through analysis of participants' responses to the following survey and focus group questions:

- Where do you currently find and access STEM-based information and resources for teaching?
- What journals in science education do you currently read/consult or have you read/consulted in the past?
- What are the top five websites and/or blogs that you regularly follow or use to access STEM information, resources or ideas?
- How do you typically access articles/resources from the STEM education field?
- Where do you typically get information that translates research to practice in the STEM education field?
- Where do you think there are gaps in the current pool of resources in STEM education where a new resource could contribute?

The evaluation team coded participants' responses and identified several patterns that emerged from the data. We also inventoried the current resources available to STEM education practitioners and conducted a gap analysis to identify potential needs where a new resource could contribute.

Practitioners used a variety of outlets for accessing research and information in STEM education. In particular, practitioners indicated that they most commonly used the following resources to obtain information and learn of research in the field:

NSTA practitioner journals (e.g., Science & Children, Science Scope, and The Science Teacher);
NRC texts (e.g., Surrounded by Science & Ready, Set, Science);
AAAS texts (e.g., Project 2061 publications);
Conferences and Professional Development Workshops
Administrator or supervisor (e.g., district science coordinator, principal, department chair)
Online websites (e.g., Google Scholar)
Research Journals (e.g., Science Education, JRST)
Professor/Instructor

Survey and focus group respondents suggested that they typically accessed STEM information and research through practitioner-based journals such as the journals offered through the NSTA. Respondents also indicated that they consulted texts such as those available through the National Research Council (NRC) and the Association for the Advancement of Science (AAAS) to learn about research in STEM education. Other sources of information that respondents cited included learning of research during professional development workshops and at professional conferences (e.g., NSTA regional and national conferences). Similarly, the respondents explained that they received resources and readings from supervisors and/or administrators responsible for facilitating

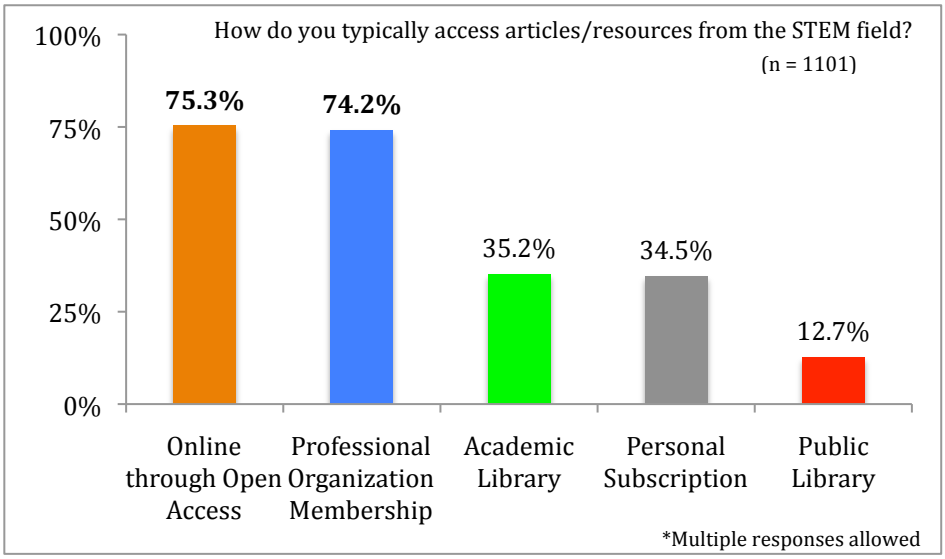
professional development within their district, school, or organization. For instance, teachers explained that they received readings from a science department chair or district science coordinator that aimed at providing information about best practices and research in the field. Some of the respondents indicated they consulted research directly by reading articles from research journals such as *Science Education* and *Journal of Research in Science Teaching* while others explained that they usually used Google Scholar to search for topics of immediate importance to their work. Learning of research through coursework such as science methods course and graduate studies was an additional way that respondents suggested they learned about STEM information and research.

Some typical responses that support these assertions were:

> *"I think the NSTA peer reviewed [journals], what I would characterize as practitioner journals, have a nice mix of here's the research but here is the practical opportunities. It's a short on ramp to give teachers ideas to work with tomorrow or with slight modification next week."*
>
> *"I attended a summer workshop at [university name removed] from their different departments, trying to reach teachers. It was a nanotechnology one, and astrobiology one, a couple of those. It was a nice mix of research presentations and then trying to say what can you do in your classroom with it being not just for information's sake. So it was science research and how could you bring that to your middle school or high school classroom."*
>
> *"I try to sprinkle in research [in the science methods course] when I can. But I don't alert them, that here's the research behind what we're doing. I just sprinkle it throughout the course so they're getting it...What I have also done is with seminars and workshops, professional workshops that I have done is using practitioner-based ideas from the research, things that they can do in their classrooms."*
>
> *"The Project 2061 Books: Benchmarks for Scientific Literacy, the Atlas maps… Basically in the curriculum studies that we set we use those [texts] in the professional development that we provide to teachers for the curriculum topics studies. I also sometimes refer to those books just to see what misconceptions and understandings that students might have."*
>
> *"I don't really go through the paper journals that often. It's usually just Googling what I am interested in and looking to see where it came from before passing it on [to colleagues.] Occasionally using Google Scholar to find the pieces of information I need fast."*
>
> *"I'm thinking of my role as an informal science educator. I didn't always have opportunities to go to conferences. But my supervisors did, like the people who were directors of education. I think at those venues they were exposed to new research ideas which then they would bring back to us and share."*

STEM education professionals primarily access STEM education resources through open access and professional organization memberships. As Figure 4 illustrates, nearly three quarters of the respondents accessed articles and resources online through open access and through their membership in professional organizations (e.g., NSTA, ASTC, NARST). Other avenues for accessing resources included through an academic library (**35.2%**) and personal subscription (**34.5%**). Accessing resources through a public library was the least common strategy identified by survey respondents.

Figure 4. Accessing Resources and Articles



Ease of access, article topics, free access, scope and electronic availability were identified by respondents as the most influential factors for selecting a resource to read/consult. These were identified as more important than other criteria such as the resource's impact factor, format/layout, availability in print and authors/contributors.

Figure 5. Factors for Resource Selection

What factors influence how you select a resource for reading or to consult for your research/teaching? (n = 1021)

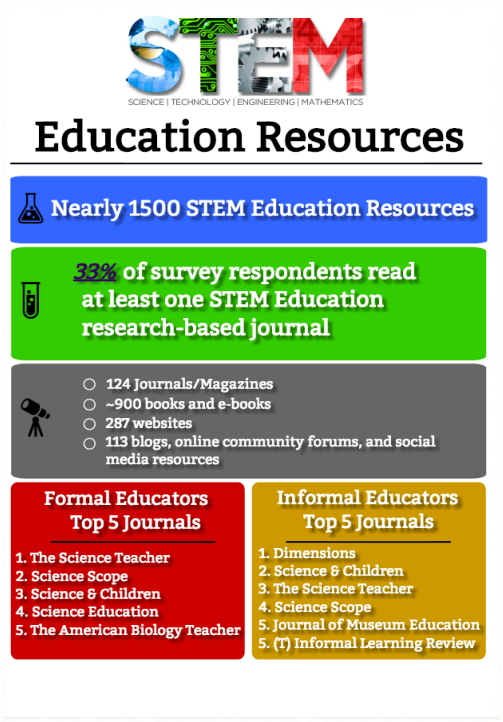
Factor	Very Important	Somewhat Important
1. Ease of Access	76%	21%
2. Article Topics	67%	29%
3. Free Access	63%	27%
4. Scope	57%	32%
5. Available Electronically	49%	34%
6. Impact Factor	18%	38%
7. Format/Layout	9%	34%
8. Available in Print	9%	24%
9. Article Authors	6%	21%

Practitioners assume that the information and resources they receive are based on best practices and research in the field. A notable finding was that practitioners assume that the information they receive through the outlets identified are based on research and best practices in the field. That is, they do not necessarily critically evaluate or identify the sources of information from which practitioner-based articles, conference offerings, and professional development workshop are based. Rather, they assume that through the top-down dissemination of information and research, they are receiving the most current and vetted information. For example, a focus group respondent explained,

> *"Through the COSIA and Reflecting on Practice Network, in that network there are a lot of publications that are offered or accessible through the website that have been vetted and the [project leadership] said these are important. That is generally where I get [information.]"*

Responses such as the example highlighted here point to the current ways in which research is disseminated to practitioners in the STEM education field.

There is a wealth of resources available to STEM education practitioners. Through DHA's efforts to inventory the resources currently available to STEM education professionals, we were able to identify nearly **1500** resources. Of these resources, approximately **60%** of the resources were books or e-books available through professional organizations such as the NSTA, ASTC, AAAS, and the NRC. Nearly **20%** of the resources were websites that addressed STEM education topics. Other resources available to educators, though less prevalent, were journals, magazines, newsletters, blogs, community forums, and social media resources. The most commonly read journals by formal educators included practitioners-based journals such as those offered through the NSTA as well as a research-based journal, Science *Education*. Likewise, informal educators most commonly read NSTA practitioner-based journals such as *Science and Children, The Science Teacher*, and *Science Scope*. However, they also read journals specific to their field such as *Dimensions, Journal of Museum Education* and the *Informal Learning Review*.



Only a few resources were identified that specifically seek to connect research and practice for STEM education professionals. Of the resources identified through the landscape assessment, there were only a few examples of resources that specifically address the research to practice cycle. These resources included the Relating Research to Practice project (http://relatingresearchtopractice.org/) led by the Exploratorium, the Research + Practice Collaboratory (http://researchandpractice.org/) led by the Exploratorium, the Successful STEM Education website (http://successfulstemeducation.org/) hosted by the Education Development Center, Inc. (EDC) and the STEMdex website (http://stemdex.ipac.caltech.edu/) hosted by the California Institute of Technology. This suggests the need for additional resources, such as the proposed initiative, that build on what is currently available to STEM educators.

While there are many resources available to STEM education professionals, there are several gaps where a new resource could contribute. After inventorying and analyzing the resources available, DHA identified the following needs:

- There are few resources that specifically aim at connecting education professionals across settings (e.g., connecting formal and informal educators; connecting researchers and practitioners);
- Many of the current resources that are available for informal educators are targeted for museum educators. Still lacking are resources that specifically address the needs of educators in non-museum settings (e.g., botanical gardens, parks, afterschool programs, science camps, field station, environmental education centers, media). Also lacking are resources for educators in small, rural museum settings;
- Although there were resources for supporting learners who have been historically under-represented in STEM (e.g., girls, racial minorities, linguistic minorities), more resources are needed for supporting other under-represented populations such as learners with disabilities, economically disadvantaged youth, and other racial minorities (e.g., American Indians, Alaskan Natives, Native Hawaiians).

Key findings from the landscape assessment included learning how STEM education professionals access and use research in the field as well as understanding factors that influence their selection of such resources. Further, the inventorying of resources as part of the landscape assessment suggested that while there are numerous resources available to professionals in STEM education, there are still several gaps that a new resource could address.

Needs Assessment

The primary purpose of the needs assessment as part of the front-end study was to collect input from the target audiences to guide the development of the potential new resource. In particular, DHA sought to determine and prioritize the interests, needs and expectations of the targeted audiences. The data collection strategies aimed to determine the level of interest in the proposed resource, gather input regarding issues and topics important to members of the target audiences, and identify potential challenges or constraints.

Similar to the landscape assessment and gap analysis, we used the national survey and focus group discussions as a primary component of the needs assessment to gather input from STEM education professionals. Survey and focus group questions focused on the following areas:

- Interest in and need for a resource that connects practitioners in a variety of settings with each other, and with the research and knowledge base in STEM teaching and learning;
- The strengths and weakness of currently available STEM education resources;
- Common topics of interest to members of each of the unique target audiences;
- Recommended authors, contributors, supplemental materials and editors;
- Preferred delivery methods and format.

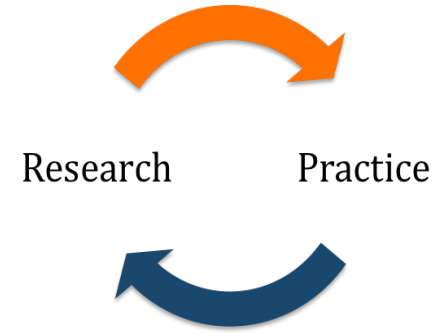
Through quantitative and qualitative analysis of the survey and focus group data collected, DHA was able to identify several emergent themes regarding the interests, needs and expectations of the target audiences.

Respondents felt there was a need in the field for the proposed new resource. Further, members of each of the target audiences expressed interest in the resource. In response to the survey questions and focus group prompts, STEM education professionals felt there was a need for such a resource in the field and expressed interest in such a resource. These sample responses from focus group and survey participants highlight the need for and interest in the proposed resource:

> *"[I think there is a need for a resource] that speaks to both formal and informal science education, building bridges between different education venues."*
>
> *"There really is nothing in informal science education. There is not a single journal that I know dedicated to informal science education."*[iii]
>
> *"The formal and informal [science education] communities are very separate. [A] journal would help to weaken these barriers."*
>
> *"A journal that is open to practitioners and researchers is needed."*
>
> *"A journal focused on informal-formal STEM is a fantastic idea! I would be interested in reading and contributing to [the proposed] journal."*
>
> *"[I] would love to have a publication such as the proposed resource that focuses on informal/formal STEM education topics."*

These comments provided by focus group and survey respondents underscore the need for and interest in a resource such as a journal to bridge researchers and practitioners across education settings.

Both researchers and practitioners identified a need for better connecting research and practice. For instance, one focus group respondent — a researcher from a higher education institution — explained, "*From the research end, there are no ways for us to connect to the teachers. There's a gap on both ends, a rift, really. And so teachers and educators don't touch the research. And the researchers don't really get to the teachers. So there's this big gap…something [such as the resource] that creates connectivity would be nice."* Similarly, practitioners felt there was a need for connecting research and practice but identified several challenges to the process including lack of access to research, lack of applicability of the research, and lack of time. A focus group participant described, "*I was in the classroom for nine years before starting my master's degree. I never knew anything about research. I think I speak for most teachers… it's like, 'Who has time for research?' If they do have time, they don't really know where to go. Or what does it mean for them? Or how does it translate into what we do in the classroom?"* Practitioners explained that often the academic jargon inherent in research information was difficult to read and interpret, thus making the writing inaccessible. One focus group participant, for instance, commented: "*The most difficult thing for me as an informal educator with no formal training is the jargon. If you have not been trained in the field sometimes it is a little difficult to get up to speed with some of that information and really be able to get through an article or a book without having to reference back to something because you are just not familiar with the term."* Focus group participants believed there was a need in the field for a resource that connects research and practice. However, practitioners cautioned that the resource needed to be accessibly written,



relevant to their work and brief enough to read quickly (e.g., 1-2 page research summaries). Both researchers and practitioners advocated for a research-practice cycle rather than a linear approach. Additional quotes related to this notion included:

> *"As a person that does research I think one of the things that I would find useful would be something that provides a forum for teachers to say exactly what they are finding a problem with, feedback from the teachers."*

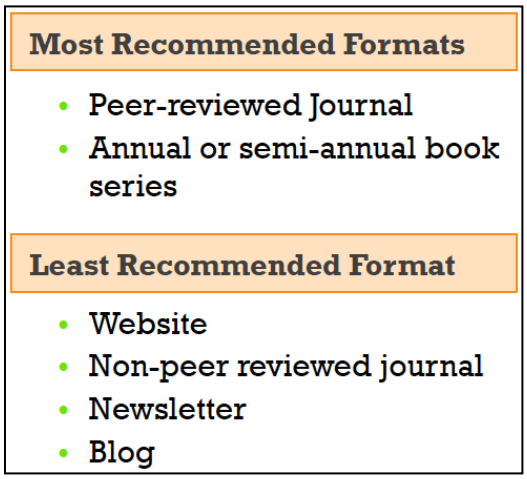
> *"If teachers are doing something in the classroom they see as an inquiry approach and they are finding it's not working and they are implementing things the way research describes it but they are running into these problems. As a researcher, it is helpful knowing the problems that people are encountering because it allows us to reexamine the types of suggestions that we are making and the things we are doing research on…that recursive loop."*

Target Audience Input

Focus group and survey questions also aimed to collect input from the target audiences regarding aspects of the resource such as format, publication factors, topics of interest, recommended authors and contributors, and distribution.

Overall, most respondents were in favor of a peer-reviewed journal or book series. Approximately **92%** of respondents were "very interested" or "interested" in a peer-reviewed journal and **78%** of respondents were "very interested" or "interested" in a book or book series. On the other hand, the least recommended formats were a website[iv], non-peer reviewed journal, newsletter or blog (Figure 6). Less than **50%** of respondents were interested in each of these formats.

Figure 6. Most and Least Recommended Resource Formats



Regarding delivery method, most focus group and survey respondents preferred an electronic resource. STEM education professionals preferred a resource they could read online coupled with articles that could be downloaded and printed for those who preferred to read hard copies. Some focus group participants expressed a preference for reading journals in hard copies and as such, recommended a resource in both print and digital format. However, participants

explained that having a resource with materials that could be printed could address this concern. Illustrative quotes that relate to this recommendation include:

> *"There are journals that are online mostly but they have a PDF button you can click on it. Those are the ones I find most useful."*
>
> *"Digital. It needs to be digital. It is much easier for me to access that way."*
>
> *"Most people don't have time to track down [a hard copy], drive to the library, hope that the one copy that they have is available at the time, make a photo copy and then take it home and read it. It is much easier to just go home and Google it when you need it. And maybe if you want you can print off a copy for yourself."*
>
> *"It is good to have a digital format. Science & Children, I like getting a hard copy. But if there is something good and I know someone that could use it, I would like be able to send a digital file."*

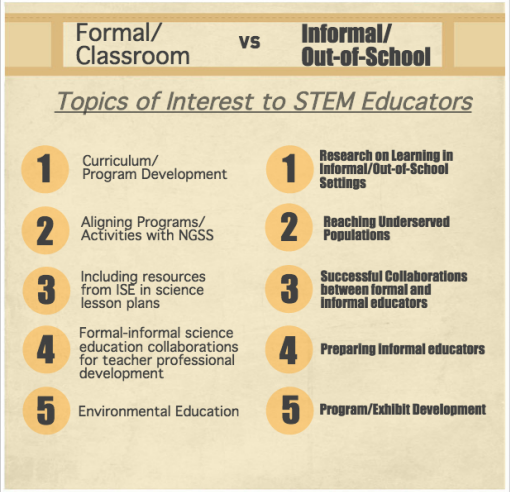
Educators across a variety of settings expressed strong interest in several topics related to STEM education. A focus group question specifically probed participants to indicate topics they were interested in reading about in the proposed resource. DHA compiled the list of topics generated by focus group participants and included a question on the national survey to better understand broader interest in these topics. Table 5 displays findings related to this survey question.

Table 5. STEM Education Topics of Interest

	High Interest or Some Interest	Neutral	Low Interest or No Interest
Maker education initiative	60.3%	23.4%	16.2%
Environmental education	**80.2%**	12.8%	7.0%
Citizen science	74.5%	18.5%	7.1%
Culturally relevant science education	55.3%	28.4%	16.3%
Curriculum/Program development	**85.6%**	10.3%	4.1%
Aligning program/activities with NGSS	71.1%	18.1%	10.8%
Successful collaborations between formal and informal educators	**82.2%**	13.6%	4.1%
Including informal science education resources in classroom science lessons	**81.1%**	12.8%	6.1%
Research on learning in informal science education contexts	**80.1%**	14.6%	5.3%
Museum-school partnerships	62.4%	25.4%	12.2%
Reaching underserved populations in informal science education	77.6%	16.2%	6.2%
Preparing informal science educators	70.7%	17.1%	12.3%
Formal-informal science education collaborations for professional development	79.8%	13.2%	7.0%

Overall, educators were the most interested in the following topics: curriculum and program development, successful collaborations between formal and informal science education, including informal science education resources in classroom science lessons, research on learning, and environmental education. In order to understand the specific needs and interests of the different educators, DHA used the analytic tools in SurveyMonkey to filter by formal and informal educators. Figure 7 identifies the top five topics of interest for each of the target audiences.

Figure 7. Topics of Interest for Formal and Informal Science Educators



Similarly, the focus group participants suggested exploring a particular theme in each issue and having contributors with different perspectives provide content. Figure 8 lists themes that respondents suggested for exploration in the pilot issues:

Figure 8. Potential Pilot Issue Themes

1. Examples of Successful Programs/Exhibits (ISE) and Activities/Lessons (Classrooms)
2. Cognitive Sciences & Theories of Learning
3. Assessment & Evaluation
4. Issues of Equity & Science for All
5. Successful Formal-Informal Science Education Partnerships
5. Professional Development Models
5. Addressing Standards
8. Examples of Research to Practice/Implications of Research
8. Misconceptions/Alternative Conceptions
Citizen Science
Making & Tinkering
Teaching Controversial Topics
Nature of Science
Inquiry-Based Science
Citizen Science
Teaching Outdoors/Outdoor Classrooms
Preparing Future Educators of STEM
Digital Learning Tools
Engineering Education

The themes numbered and highlighted at the top of the list were mentioned more than once and ranked by the frequency with which the focus group participants suggested them. All of the themes at the bottom of the list were mentioned only once and are in no particular order. The list is inclusive of all of the themes suggested by respondents.

STEM Education Professionals also expressed interest in specific authors and contributors they would like to see featured in the pilot issues of the resource. Figure 9 lists the authors and contributors that were recommended by more than one STEM educator. The lists are divided by education setting; with the exception of Neil deGrasse Tyson, the authors of interest were distinct for educators in each setting. However, the recommendation of the Exploratorium by multiple educators in formal settings points to other potential contributors who likely are of mutual interest to professionals in both settings.

Figure 9. Recommended Authors and Contributors

Educators in Informal Settings	Educators in Formal Settings
• John Falk	• Page Keeley
• Lynn Dierking	• Bill Nye
• James Bell	• Neil deGrasse Tyson
• Kevin Crowley	• Roger Bybee
• Kirsten Ellenbogen	• Neil Shubin
• Shawn Rowe	• Robert Ballard
• Margaret Honey	• Ohkee Lee
• Neil deGrasse Tyson	• Exploratorium
• Sue Allen	• Karen Ansberry and Emily Morgan (Picture Perfect Science)
• Angela Calabrese Barton	• Arthur Eisenkraft
• Jrene Rahm	• David Sobel
• Sue Dale Tunnicliffe	• Erica Halverson
• Christine Cunningham	• Joe Krajcik
• Philip Bell	• Brian Reiser

When prompted to indicate potential resource features, survey and focus group participants indicated the following as preferences:

- Short (1-2 pages) research summaries including practical implications for practitioners;
- Featured educators, programs, exhibits, and partnerships;
- Interviews (transcripts, videos or podcasts) with researchers;
- Roundtable or panel discussions with a variety of professionals in the STEM education field;
- Articles that feature ideas, strategies, activities, programs/exhibits from a variety of learning settings;
- Videos of exemplary science education (e.g., activities, exhibits, program implementation) and examples of practical implications of research.

Some examples of comments related to resource features included:

> *"I would like to see articles that digest research and just spell out what [researchers] are trying to say without all the jargon…some sort of summary, a more detailed abstract, that says this is what I was talking about in layman's terms…something that is a little bit different than an abstract…because sometimes [in the abstract] they just take the same sentences from the article."*

> *"Another [suggested feature] would be an interview format. Where you interview people that have recently done seminal research in the field or leaders in the field."*
>
> *"The interview format is also useful. Present an article as an interview where they pose a question. Like the last chapter [in Community Connections for Science Education] was a conversation between a woman who eventually became the head of science for [name removed] county and a fellow out of the Midwest who was working with a 4H program. And they had a conversation and it was transcribed and became the last chapter in the book."*
>
> *"One way to translate research to practice is through a podcast. A colleague of mine at [university name removed] has a podcast called voice of literacy. She shares the top research in literacy journals. She actually interviews the researchers but it is more of a conversation about 'How did you get interested studying this.' 'Why is this important?' 'What does this mean for teachers listening?' She has a lot of subscribers for that."*
>
> *"A lot of times I read articles and people will have these wonderful ideas. And I think, 'That sounds brilliant. But what does it look like?'... And not just videos, I also found the most useful were sample lessons…And somebody that is collecting student work or has video of research in action in classrooms."*
>
> *"[Video] would be helpful for practitioners. That model of seeing it. There's so much that you lose when it's transcribed on the page. It's flat versus seeing the kids doing the interaction."*

Similarly, the survey and focus group participants offered recommendations regarding supplemental materials to include as part of the new resource. Social media outlets such as Pinterest, YouTube, Facebook and Twitter were the most often suggested supplemental materials by respondents (Figure 10).

Figure 10. Supplemental Materials

Typical responses related to social media included:

> *"With Twitter, I primarily use it as a news source. So all of these professional organizations, they are on my Twitter newsfeed and they create a sort of digest with a link to the resources."*

> *"If there was multimedia possibly that could be, I was imagining [videos], with case studies. Short, three minutes max, of demonstrations, implementing ideas in a program or exhibit, tours of new or existing exhibits, examples of how visitors engage with the 'thing' at an exhibit. Or how a classroom is using a technology."*
>
> *"For example, [researcher's name removed] does Google Hangouts and just answers questions."*

Though all of these features and supplemental materials were suggested by respondents, it will be necessary for the NSTA and ASTC to determine which of these are the most important to incorporate in the pilot issues and which will be sustainable after the grant funding ends. This was also echoed by focus group respondents who cautioned against too many supplemental materials to avoid inundating readers.

And finally, STEM education professionals offered guidance and recommendations regarding the publication and editorial process. In particular, questions on the national survey and focus group discussion guide probed participants to suggest members for the editorial board as well as identify factors that influenced their selection of a journal for publication (if they had previously attempted to publish details of their work).

Many of the respondents were not able to identify specific individuals with editorial experience to serve on the board. Therefore, only a limited number of suggestions were offered and are listed below. With the exception of John Falk, Lynn Dierking, Dennis Schatz and Bronwyn Bevan — who were recommended by multiple STEM education professionals — all of the individuals were named only once and are listed in alphabetic order.

- Bronwyn Bevan, *Exploratorium*
- Lynn Dierking, *Oregon State University*
- John Falk, *Oregon State University*
- Dennis Schatz, *Pacific Science Center*

- Elsa Bailey, *Elsa Bailey Consulting*
- James Bell, *Center for the Advancement of Informal Science Education*
- Philip Bell, *University of Washington*
- Anita Krishnamurthi, *Afterschool Alliance*
- Christine Cunningham, *Museum of Science Boston*
- Kirsten Ellenbogen, *Great Lakes Science Center*
- Stacy Klein, *Vanderbilt University*
- Krishna Medulla, *Brooklyn College*
- Shawn Rowe, *Oregon State University*

Journal scope and content, target audience, and journal reputation were identified by respondents as the most influential factors for selecting a journal for publication. These were identified as more important than other criteria such as ease of submission, journal impact factor, peer review process, cost of publishing, options for open access, publisher and manuscript acceptance rate.

Figure 11. Factors for Publication

If you have tried to publish details about your work in the past, which of the following factors influenced your selection of a journal for publication? (n = 718)

Factor	Very Important	Somewhat Important
1. Journal Scope/Content	54.8%	38.2%
2. Journal Target Audience	52.6%	38.1%
3. Journal Reputation	48.6%	41.3%
4. Ease of Submission	28.5%	42.7%
5. Impact Factor	22.5%	45.7%
6. Peer Review Process	21.2%	45.8%
7. Cost of Publishing	29.3%	30.3%
8. Open Access Option	20.8%	27.1%
9. Publisher	11.4%	36.9%
10. Acceptance Rate	10.6%	35.1%

Overall, the data collected as part of DHA's front-end evaluation efforts offer guidance regarding the target audiences' interests, needs and expectations to guide the development of the proposed resource. In addition, the study provided insights regarding potential challenges and barriers that respondents believed could limit the success of the proposed resource. These challenges are compiled in the following list:

- Identify strategies for making research accessible and applicable to STEM education practitioners;
- Consider how to make the new resource stand out against the landscape of resources already available to STEM education professionals;
- Ensure that the pilot study is of high quality, aesthetically pleasing and features notable professionals from the STEM education field;
- Include articles, features and resources that are inclusive of all STEM educators, including those from small and rural museums as well as informal educators from non-museums settings (e.g., afterschool programs, environmental education center, field stations, science camps, media).

As is often the case with any new initiative, there will be challenges and barriers to launching the proposed new resource. By compiling and identifying the key challenges, the data will help focus the project leadership and advisory board on the critical issues early on so that they may be addressed throughout the planning and development of the pilot issues.

Conclusions and Recommendations

By exploring the landscape of resources in the STEM education field, DHA was able to document a need for the proposed resource. Input from members of the target audiences provided further evidence that there is a need for and interest in a resource that connects STEM educators across settings and with the growing research and knowledge base. Further, through the front-end study, DHA was able to gather input from the target audiences to provide data driven recommendations to the NSTA and ASTC to guide the development and implementation of the pilot issues of the resource. The specific recommendations include the following:

Recommendation 1. The NSTA and ASTC should continue to pursue the development of the proposed new resource to connect educators across settings and to the growing research and knowledge base in STEM learning.

National survey and focus group respondents broadly believed that there was a need for a resource that seeks to connect practitioners across settings. Further, they were interested in a journal or similar resource to connect research and practice while also building on related resources (e.g., websites) already available in the field.

Recommendation 2. To align with current and appropriate terminology, the project leadership at NSTA and ASTC should engage in discussions with the advisory board around definitions and terms associated with informal science education.

Currently, there are a range of terms used to describe learning in non-school settings. While organizations such as the NSF, NSTA, and NARST currently use the phrase informal science education, other terms have been advocated such as free-choice science learning, lifelong learning, non-formal science education and out-of-school learning. Though DHA strategically used the term informal science education on the national survey to align with the term used by lead organizations in the field, several survey respondents indicated that the project was using inappropriate terminology. It will be important for NSTA and ASTC to discuss which terminology would be best to align with for the proposed resource as well as how to define informal science education. That is, consider whether it will be necessary to set boundaries around the term or how broadly the resource intends to reach (e.g., families learning science at home). While DHA advocates for an inclusive definition to ensure a broad reach, it is an important discussion to have within the project team and with the advisory board.

Recommendation 3: The NSTA and ASTC should begin identifying and convening editorial board members who have expertise in the STEM education field as well as with the editorial process.

The next step for the project is to identify professionals in the field who have expertise in STEM education as well as the editorial process. It will be important to identify professionals who can create connections between researchers and practitioners as well as across education settings. The editorial board can also assist in inviting potential contributors as well as provide guidance regarding the article submission and peer review process. Therefore, it will be important to ensure that members of the editorial board are well known in STEM education to ensure they have professional relationships with the notable professionals in the field and can solicit contributions and articles from these individuals.

Recommendation 4: The NSTA and ASTC should consider interviewing editors from related STEM education resources.

As survey and focus group respondents pointed out, there are many resources currently available to STEM educators and it will be important to ensure that the proposed new resource stands out in the already crowded landscape. To develop a following and create a valuable and sustainable resource, it would be helpful for NSTA and ASTC to talk to professionals who manage and edit similar resources to consider their "lessons learned." Further, information from editors of related journals could provide guidance regarding submission and peer review of contributions that are outside the normal scope of NSTA and ASTC journals (e.g., research summaries, multimedia contributions).

Recommendation 5: The NSTA and ASTC should begin developing protocols for vetting content materials and resources as well as rubrics for the peer review process of article submissions.

Across multiple categories of potential audiences, STEM education professionals were interested in resources and contributions that had been vetted by some type of review process. While the target audiences expressed that the process did not need to be as rigorous or lengthy as a research manuscript review process, they did want to know that resource features were vetted by experts or other professionals with experience in the field.

Recommendation 6: The new resource should be designed with the input provided by the target audiences in mind.

An objective of this front-end study was to gather input from the target audiences to ensure that the new resource aligns with their interests, needs and expectations. Members from the target audiences provided specific input with regard to the resource format, publication factors, topics of interest, recommended authors and contributors, and distribution mechanisms. This input should be used to guide the development of the pilot issues.

Recommendation 7: The NSTA and ASTC should consider a theme-based approach for the pilot issues.

Focus group participants cautioned that meeting the needs of the unique target audiences might be a difficult task to accomplish. As a means to meet the needs of each audience, they suggested a theme-based approach in which each issue explores a particular topic from a variety of perspectives (e.g., researcher, classroom-based educator, museum educator, other informal/out-of-school educator). Themes that were suggested by respondents with some frequency included:

- Examples of successful programs, exhibits, activities or lessons;
- Theories of learning;
- Issues of equity and science for all;
- Successful partnerships between formal and informal science education;
- Educator professional development.

Recommendation 8: The new resource should provide opportunities for researchers and practitioners as well as formal and informal educators to interact with one another.

A key need identified in the field was a resource that helped to connect researchers with practitioners as well as a resource that fosters interactions between educators in different settings. The focus group participants and survey respondents offered several suggestions for accomplishing this including Google hangouts, interviews with researchers, and panel discussions or roundtables with educators across learning settings that are featured either through video links or by including transcripts in the resource.

Recommendation 9: The NSTA and ASTC should consider strategies in order to make the resource accessible to all STEM educators across a range of settings.

Practitioners, in particular, were concerned about having access to the resource, particularly given that they may not have access to an academic library. Another concern was ensuring that the educators from rural and smaller informal science education settings would also have access. The following suggestions were offered to make the resource broadly accessible:

- Offer the resource in print and electronic formats. If only one format can be implemented, the respondents expressed the most interest in an electronic resource with downloadable pdf files that can be printed;
- Ensure that the resource is reasonably priced and provide some open access articles;
- Consider tying subscription to membership with NSTA and ASTC as well as other potential related organizations while also offering individual subscriptions.

Recommendation 10: The NSTA and ASTC should consult related resources to inform the development and features of the proposed resource.

There are already several initiatives that have demonstrated success in connecting research and practice (e.g., NRC texts, Relating research to practice website, Research + practice collaboratory website). It will be important for the NSTA and ASTC to review these related resources to consider ways that the new resource can add to or build on the prior work in the field. Further, consulting these texts and websites will assist the NSTA and ASTC in identifying successful strategies, strengths and weaknesses of the resources, and potential features for the new resource.

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Appendix A: Focus Group Specification Guide

DAVID HEIL & ASSOCIATES, INC.
Innovations in Science Learning

NSTA-ASTC NSF Eager Project
ASTC meeting Focus Group Specifications

Date: Monday, October 20th, 2014
Time: 9-10 am & 10:30-11:30am
Location: Marriott Raleigh

Specifications

- Reach out to 20-25 respondents for 12-15 to show and participate in the discussion
- Include a diversity of participants, to the extent possible:
  - Include educators from a range of institutions (e.g., museums, science centers, aquaria, zoos, botanical gardens, youth programs, historic sites, etc.)
  - Include educators from both non-profit and for profit institutions
  - Include educators from a variety of settings (e.g., large institutions, small institutions, rural museums)
  - Include a mix of race/ethnicities
  - Include a mix of gender

Honoraria

- Focus group participants will be provided an honorarium in the form of a $25 Amazon gift card at the completion of the focus group (provided by DHA)

Registration and Refreshments

- Participants should arrive at least 10 minutes early to sign in and prepare to begin the discussion
- Refreshments will be provided

Contact

Kelly Riedinger, PhD, Director of Research and Evaluation
David Heil & Associates, Inc.
kriedinger@davidheil.com
(503) 245-2102 (office phone)

Endnotes

[i] In this report, the term target audience refers to STEM education professionals including researchers, educators in formal, school-based settings as well as educators from informal science education/out-of-school settings.

[ii] For the purposes of this study and evaluation report, the term "informal science educator" will refer to practitioners working in out-of-school settings including (but not limited to): museums, science centers, aquaria, zoos, botanical gardens, parks, youth serving programs, environmental education centers, field stations and media.

[iii] While there are some journals in the field of museum education, the respondent who provided this quote was pointing to the lack of a journal specifically focused on science learning in informal environments.

[iv] Though most respondents indicated they often consulted websites for their work, they believed there were an overwhelming number of websites and as such, were not in favor of a website as a delivery format.