

# *Astronomy from the Ground Up* Research and Evaluation: Executive Summary

**August 2010**

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**About the Institute for Learning Innovation:**

Established in 1986 as an independent non-governmental not-for-profit learning research and development organization, the Institute for Learning Innovation is dedicated to changing the world of education and learning by understanding, facilitating, advocating and communicating about free-choice learning across the life span. The Institute provides leadership in this area by collaborating with a variety of free-choice learning institutions such as museums, other cultural institutions, public television stations, libraries, community-based organizations such as scouts and the YWCA, scientific societies and humanities councils, as well as schools and universities. These collaborations strive to advance understanding, facilitate and improve the learning potential of these organizations by incorporating free-choice learning principles in their work.

## Introduction

This is synthesis summary of the five short summative reports on the Astronomy from the Ground up Project. The Institute for Learning Innovation (ILI) conducted front-end, formative, and summative evaluation for the AFGU project. The AFGU project team elected to break the summative analysis and findings into a series of five short reports, focusing on specific element of the AFGU project. Those five reports were: 1) Measuring Learning Outcomes; 2) Comparison of online and onsite workshops; 3) Participation in workshop follow-up online experiences; 4) Case studies of successful participants; and 5) Long-term impact of professional development experiences. This document serves a synthesis of those five reports, reviewing the overall impact of the project, contributions of the component parts, and implications for other related projects.

## Project Background

Astronomy from the Ground Up (AFGU) was a five year project directed by the Astronomical Society of the Pacific (ASP) and funded by the NSF Informal Science Education (ISE) division (DRL- 0451933). The primary partner institutions were the National Optical Astronomy Observatory (NOAO) and the Association of Science-Technology Centers (ASTC). Between 2006 and 2008, the AFGU project hosted 6 onsite and 6 online workshops. The project provided professional development for informal science educators in the area of astronomy educational programming. The project's primary goal was to encourage more astronomy-related programming to the public through participant institutions, with a target audience of educators from nature centers and small science centers. Previous ASP experience had revealed these centers do not typically provide much astronomy-related programming. AFGU was designed to address this need through training and support of the educators. Educators applied to the AFGU project, and if they were accepted, attended a core workshop, were given a kit of supplies to carry out activities, and received further support for implementation.

The main workshops were held in two different formats; one set was held during an intensive three day in-person workshop (onsite workshops) and the other was a three week online workshop experience (online workshops). Both workshops and the supplementary materials were offered free of charge to the participants. Participants took part in either the online or the onsite workshops, but not in both. While the experiences were different in duration and nature of contact, significant effort was made by the ASP team to match the workshops in terms of type of content, workshop activities, and level of support. The team promoted a cohort approach, so that participants became familiar with other individuals within their workshop, benefiting from other participants within the AFGU community. One of the goals of the summative evaluation of AFGU was to compare the relative benefits and affordances of the online and onsite formats, so as to inform the ISE community about future endeavors in professional development training.

After the main workshop, participants were asked to use the AFGU activities at their home institution and to train a minimum of one other educator in the AFGU content and activities. ASP developed an extensive AFGU community website which both sets of workshop

participants could use to access information about the AFGU activities and related astronomy and programming information. The website, called AFGUonline, also contained forums where individuals could comment on the activities, discuss current astronomical events such as meteor showers, and post questions for other community members to answer. ASP offered a series of follow-up mini-workshops on this site called Continuing Explorations, open to all workshop cohorts. Topics included: Globe at Night, Astronomy Behind the Headlines, and No Telescope, No Problem. Participation in the Continuing Explorations was optional. Educators from participant institutions who had not participated in a core workshop but who had received training were also encouraged to join the AFGUonline community.

The summative evaluation consisted of a lengthy web survey, site visits with selected sites from both online and onsite workshops, analysis of the AFGU online participation data and lengthy telephone interviews of long-term participants. Summative data was only collected from individuals participating in the final three online or three onsite workshops, as prior workshops were considered in a development phase.

## Project Impact

The main methodology was a lengthy web-based survey, conducted in 2009. Participants were asked to estimate the percentage of programming that was astronomy-related at their institution, both prior to participating in AFGU and at the time of the survey. As noted in the sample section, online and onsite groups offered significantly different amounts of programming prior to participating in AFGU. Before beginning AFGU, in institutions with online participants, 5% of their overall programming contained astronomy content. In institutions with onsite participants, 11% of their programming was related to astronomy prior to beginning AFGU. Both groups showed statistically significant increases in the amount of astronomy programming, with each group nearly doubling their proportional amount of astronomy programming. (See Table 1.)

**Table 1: Proportion of Educational Programming that is Astronomy Related**

	Prior to AFGU		Currently	
	Median	Median	Median	Std. Dev.
Online (n=54)	5	10	10	23.77
Onsite (n=52)	11	20	20	32.94
<b>Total<sup>a</sup></b>	<b>8</b>	<b>12.5</b>	<b>12.5</b>	<b>29.10</b>

<sup>a</sup> Statistically significant differences between online and onsite participants (ANOVA F=5.502, p<.05; Mann-Whitney U=966.0, p<.05)

## Individual Educator Outcomes

Through an intensive process during the project, project evaluators and team members determined that in order to deliver an increased amount of high-quality programming, participants would need to have knowledge and skills in a diverse set of areas. For example, they would need general astronomy knowledge, but also the practical knowledge and skills to find the resources needed to teach astronomy content. A suite of 11 learning outcomes were developed. The team then thoroughly examined both the online and the onsite AFGU

programmatic activities to determine if these activities would reasonably supported potential gain within these learning outcomes. Once the team was satisfied that the project activities had potential for causing change in these areas, these outcomes were used to gauge change in participants.

The 11 learning outcomes (both knowledge and skills) were:

1. General astronomy knowledge,
2. Teaching astronomy,
3. Organizing astronomy education events,
4. Finding resources to teach astronomy content,
5. Inquiry-based teaching,
6. Using hands-on activities to teach astronomy content,
7. Adapting AFGU toolkit activities to your own context and environment,
8. Conveying the meaning of astronomical scales (time and space),
9. Using models or analogies to teach astronomy,
10. Training or coaching someone else to teach astronomy,
11. Answering astronomy-related questions.

Participants were asked to reflect on each of these outcomes, self-rating their proficiency prior to taking part in the project, immediately after the main workshop, and months later, after implementing the activities. Prior to beginning AFGU, participants tended to rate themselves in the middle of the 5-scale. The lowest score was in adapting AFGU toolkit activities to their own environment. As many participants were not yet familiar with AFGU activities, it is logical that this would be a low scoring outcome prior to participants. The highest rating prior to beginning was in inquiry-based teaching. The greatest gains were seen in finding resources, adapting the AFGU toolkit, and conveying astronomical scales. (See Table 2.)

**Table 2: Self-Rated Proficiency on Learning Outcomes**

	<b>BEFORE</b> starting AFGU	<b>Right AFTER</b> main AFGU Workshop	<b>MONTHS AFTER</b> implementation
	Median Rating	Median Rating	Median Rating
General astronomy knowledge	2.5	3.7	3.7
Teaching astronomy	2.3	3.6	3.7
Organizing astronomy education events	2.3	3.4	3.4
Finding resources to teach astronomy content	2.4	3.9	4.0
Inquiry-based teaching	3.3	3.8	3.7
Using hands-on activities to teach astronomy content	2.5	3.9	3.9
Adapting AFGU toolkit activities to your own context and environment	1.8	3.7	3.8
Conveying the meaning of astronomical scales (time and space)	2.2	3.7	3.6
Using models or analogies to teach astronomy	2.4	3.8	3.7
Training or coaching someone else to teach astronomy	2.1	3.4	3.4
Answering astronomy-related questions	2.4	3.5	3.6

Scale is from 1 to 5, where 1=Not at all proficient and 5=Highly proficient.

Comparing these three rankings, participants showed statistically significant gains in every one of the outcomes categories measured immediately after the main workshop, and these gains were sustained over time. There were no additional gains during the post-workshop period, so while the Continuing Explorations and the other the resources may have contributed to sustaining workshop gains, they did not lead to additional increases in knowledge or skills.

The AFGU team also strongly felt that knowledge and skills were not enough to ensure greater high-quality astronomy programming, but that participants needed to feel excited about astronomy in general, and about teaching astronomy. Evaluators asked participants to assess their excitement in these areas during certain time frames. Participants showed both immediate and long-term gains in excitement in all three categories related to excitement. They did not show additional gains in excitement after the additional core workshop. While post-workshop supplementary activities may have help support the sustainment of long-term excitement, they did not foster further gains in excitement.

Participants did fulfill their commitment to training others and to implementing the activities back at home. AFGU participants trained on average just over 4 staff with 13 individuals training no staff. The maximum number of staff trained was 50. The majority of the participants felt that was easy to train other staff on the AFGU activities.

## Participation in the Follow-Up Online Community

The participant base for the site was quite large (636 at the time of the writing of this report), though not extremely visibly present in the site outside of the workshops. Posting comments to the forums comprised approximately 1% of the participant activity on the site. Most individuals participated in the AFGUonline community site to some extent. All individuals did at least one administrative action. The median number of days individuals signed in was 9 days post workshop. The range of number of times signed out was quite wide, with a standard deviation of 19 days. The maximum number of days during this period a participant signed in was 129 times. In the post-workshop period, there were no differences between the number of times online and onsite participants logged on. In total, 48 individuals (40% of the participants) did not make any forum postings, 23 (38%) from the onsite and 25 (41%) from the online. More than half of the individuals participated in at least one Continuing Exploration by the point this data was collected. The median number of Continuing Explorations per individual was three.

In the case study and long-term impact interviews, participants repeatedly expressed that even if they did not make extensive use of the site, they appreciated the existence of the site, feeling that it gave them a level of comfort for designing and implementing programming. Several interviewees identified the online community as a component of their successful implementation of AFGU.

## Comparison of Online and Onsite Workshops

In both online and onsite groups, individuals and their institutions experienced change during the AFGU project. At the onset of the project, there were few differences between the online and onsite groups in terms of experience or average institution visitorship and budget. Both groups eventually trained roughly equal number of individuals back at their home institution. Individuals from both groups experienced significant, lasting change on each of the main project outcome categories. Both groups sustained their gains in outcomes through the post online period. While the post online experience (i.e. Telling Science Like a Story, Globe at Night, etc.) may have helped maintain gains in the outcomes for the participants, those experiences did not contribute to an increase in outcomes over initial workshop experience.

While there were no significant differences between change scores from the two groups, overall total gain in online groups was trended slightly lower throughout the outcomes. Online participants (by their own perception) knew less specific deeper astronomy content (such as using models and analogies to teach astronomy and answering astronomy-related questions). Over the long term were online participants less likely to have high scores in teaching skills of astronomy. Nonetheless, both groups made significant gains in all areas.

Both groups of participants reported gaining excitement about astronomy, teaching astronomy and using hands-on experiences to teach astronomy due to the workshop. Post online activities may have helped sustain but did not increase excitement after the workshop. Online groups started out as less excited about using hands-on activities, but later showed no significant

difference from the face-to-face group. Over a longer period, online participants were slightly less excited about astronomy and teaching astronomy than were face-to-face groups.

### Key attributes of the AFGU project

The AFGU project was highly successful at both the institutional level and the individual participant level. Participant informal science institutions, including small science centers and nature centers, roughly doubled their astronomy programming due to the AFGU project. Individuals in both online and onsite groups made significant gains in each of the outcome categories, including gains in knowledge and skills. They also experienced an increase in their level of excitement about astronomy. Both the gains in excitement and in the outcome categories were sustained over time. In reflection, participants discussed what made this project successful for them. The case studies and long-term interviews revealed these key attributes of the AFGU program that contributed to success:

- Providing Resources: Participants had a variety of resources available to them, including the original toolkit with reference binder, forum, the downloadable activities, current astronomy news and Continuing Explorations workshops. In general, sites appreciated how easily the materials can be accessed and low cost of replacing kit items. The reference binder was particularly useful.
- Well-developed activities: Educators repeatedly refer to high quality of the activities design; they were clear, thorough, easy to learn and easy to implement. Participants appreciated the simplicity and hands-on nature of the activities. Many participants commented how well the activities fit their program and the audiences' positive reaction.
- Connection and support through the website and forum: A key component these effects are maintained, to a large degree, by the educators' perception of continued connection to each other and the instructors through the online forum. All interviewees used the forum in some capacity, whether casually scanning the emails that come to their inboxes or actively seeking advice from the online community. Without a comparison group that did not use the forum, we cannot conclude that the forum was the source of the retention of program effects, but it is clearly a strong contributor given how many respondents mentioned the forum as providing them a sense of belonging to a community and a never-failing source of information and support, especially from the AFGU staff when they need it. Interestingly, multiple individuals discussed how they were unable to spend much time contributing to the forum, or even reading the notices, but they took comfort in the concept that the forum was there if they needed it.
- Being free and online: More often than not, these small informal education settings did not have an extensive education staff. In multiple sites, the AFGU participant was the only full-time education staff or one of very few full time education staff. Budget for



education programming is usually small. A significant number of the online participants in the case studies and interviews stated that they would not be able to participate in the training had it not been online and free. Reasons for that included: a small budget; being the only staff on site and therefore not being able to leave; and county rules stating that employees are not allowed to take the time for professional development outside of state (would have to take personal time) or budget for out-of-state travel.

- Having opportunity to practice the activities: One of the onsite participants indicated that a great benefit of the workshop was the ability to practice the activities. This educator also found the opportunity to discuss adaptations and scenarios for using the activities very valuable.

Educators described certain qualities of AFGU that capitalized on their own interests and skills, which allowed AFGU to be implemented more easily. Those interests and skills were:

- Interest in astronomy: All educators had some level of interest in astronomy that prompted them to consider the topic as part of their programming. This interest varied from being opened to it all the way to one educator who is a long-time amateur astronomer. In many cases, the educators reported increasing their interests and knowledge related to astronomy after participating in AFGU. At least a couple of the educators less experienced with astronomy reported finding the atmosphere of the workshop non-threatening to learning what can be a very daunting subject for many.
- Teaching and learning styles: Most educators indicated valuing learning through interactive (hands-on) activities. They often found that AFGU activities also promoted that. In some cases, they also mentioned valuing interdisciplinary content. At least two of the educators who were least experienced with astronomy indicated having curiosity and a willingness to explore a wide range of topics; they valued being opened to learning new contents (“jack of all trades, master of none”).

Participants believed that AFGU fit with the values of their institution, and that fit enabled them to implement AFGU more easily. The characteristics that were particularly important at an institutional level were:

- Alignment with institution’s programs and interest to expand them: Astronomy fit with the institution’s missions, even if was not content area previously incorporated in programming. In some institutions, AFGU activities provided a way to expand existing or serve new audiences such as by complementing existing programs such as including star identification during a night hike. Especially for sites that have repeat audiences, the educators saw astronomy as a novelty capable of maintaining this audience interested and bringing the needed revenue to sustain the programs.

- Buy-in from key decision makers: The major decision makers embraced the program, both in cases where the educator was the main decision maker and in cases where an education director was present.

### *Long Term implementation*

Activities are still used by many respondents, who can describe their favorites with great detail and positive feeling. Given that they are still using the activities several years after the training may attest to the usability and quality of the materials. Multiple educators testified that the activities had become well-incorporated within their regular practice. Some educators found the activities difficult to adapt for other audiences, especially audiences of varying ages. Others found they need to vary their activities, either for their audiences or for themselves.

### **Barriers to implementation**

Participants also identified some factors which comprised their ability to implement the AFGU activities.

Adapting the activities: The bulk of the AFGU activities were designed originally for some form of classroom use, and nature center educators described their difficulties in adapting to outdoor or other settings. Some educators described difficulties with implementing with drop-in, younger or older audiences. While some individuals were able to adjust the activities to work with other audiences and setting, others struggled with this transition, ultimately causing them not to discontinue using the activities.

Having enough Astronomy content knowledge: As the workshops were relatively short, the AFGU team worked at achieving a balance between teaching participants astronomical concepts and demonstrating or practicing the AFGU activities. Since the target audience generally lacked a sophisticated understanding of astronomy, some of the individuals really struggled with understanding the background content for the activities they were to present. While data indicates that AFGU participants did learn general astronomy knowledge, participant comments during these interviews indicate that having enough content knowledge to effectively deliver the activities continue to be an issue for multiple AFGU participants.

### **Other Implications**

The AFGU project should serve as an exemplar for how to develop and disseminate professional development training to informal science institutions. Examining the results and components of this project, such as the key attributes described above, should inform future related projects. Similarly, there are some implications that other projects may wish to either capitalize on or consider when conducting professional development.

Adaptation: One of the few struggles that participants had in implementing AFGU was adaptation of the materials to different contexts and audiences. The participants were highly positive about the activities, stating the activities were well-designed, through and hands-on,

reflecting the extensive testing the activities had undergone in development prior to the AFGU project. Future expansions or similar projects should consider either testing the activities with novice educators in the target settings, or incorporating experienced educators from the target settings into the project team.

Balance in training and developing content knowledge: In both the 3-day onsite workshop and in the 3 week online workshop, participants struggled at times with the varying amounts of incoming content knowledge. In the short time frame of the workshop, it was difficult to teach enough content to give the participants a strong foundation of astronomy. Having individuals of varying incoming knowledge levels helped, as participants could support one another. The sense of connection participants felt with the ASP staff and the availability of the online community site also supported individuals, as they felt questions could be answered if they arose.

Advantages to online workshops: While online workshop participants had slightly lower overall gains the onsite workshops, in most cases there were no statistically significant differences between the two groups. Further, the online group had significant gains in every learning outcome. During the case studies and telephone interviews, online group participants commented on how without the online option, they would not have been able to participate in AFGU due to their small staff and budget size, even with funding for the travel being provided. One individual even noted that if she was to attend a workshop she would have to close her institution during that period. This finding emphasizes the need for online professional development opportunities. Future projects attempting to reach a target audience of informal science educators at small institutions should consider offering online professional development so as to better include this population.

Use of the online community: The ASP team has put significant effort into the AFGUonline site and Continuing Explorations workshops, and hundreds of informal science educators now have profiles on the community site. Reviewing the log files and interview commentary reveals an interesting dynamic. Participation in the online community outside of the workshops and Continuing Explorations was steady, but not extensive. The AFGU facilitators did most of the commenting on the site's non-workshop forums. Yet participants did continue to visit the site months and even years after their main workshop, even if they were not regularly contributing.

Participants frequently mentioned their appreciation of the AFGUonline resources and community even if they did not make frequent use of these features. Interview data supports the idea that participants see the online community as a form of "safety net", providing resources and support if needed. Future projects should not be discouraged by seemingly low active participation within an online community, as the existence of the community seemed to act as a positive support for individuals, whether or not they used it. The online community coupled with the Continuing Explorations workshops may have had a role in sustaining participant gains in the learning outcomes and excitement about astronomy over time.