

STEPS Summative Evaluation Report

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Executive Summary

User Experience Research Consulting (UXR) conducted a summative evaluation of the NSF-ISE funded project, STEPS (Science Theater Education Programming System). The STEPS project brought together a network of informal science educators and contractors to create an interactive museum theater authoring and presentation system to increase educational capacity for small and large museums across the country. The software package includes an authoring tool for the creation of multimedia science theater productions; a presentation player for displaying the shows to audiences in museum theaters, planetariums, and in outreach facilities; a web-based tutorial for the astrobiology content and STEPS software; and three pre-packaged shows varying in length and dramatic effects to showcase the potential uses of STEPS for informal science learners ages 7-12. The professional development of the of informal science educators in the network was the primary goal of the project with all other tangible deliverables stemming from that collaborative effort.

This evaluation report synthesizes key analysis and findings from data based on longitudinal surveys, diary studies, and post-project interviews with the network partners; usability surveys with other museums professionals; and a quasi-experimental pre/post-show survey with students viewing one of the completed astrobiology shows.

Throughout the evaluation, STEPS was shown to be effective in achieving the goals set forth in the original proposal, particularly with respect to the professional development of the informal science educators in the network. Year 4 research will build on these findings and identify the long-lasting impacts of a project like STEPS on the professional identity and self-efficacy of informal science educators. The following is a list of the most salient findings with respect to the associated audiences and evaluation questions addressed by this summative evaluation:

Primary audience: the museum network that created STEPS

- To what extent is the STEPS product used by individuals in the STEPS network at their institutions?

STEPS participants found a unique way to use STEPS to connect with their visitors to support the sustainability of the project beyond the grant. For example, a large museum is working with its teen program to provide the STEPS shows to audiences of all ages. A small museum took the opportunity to reach out to its local theater company to solicit actor volunteers who will sustain the STEPS program.

- To what extent was the process of developing these products recommendable for creating a collaboration/network?

The use of Team Leadership Theory, which was used to develop and maintain a bottom-up distributed leadership structure, was particularly effective for achieving the professional development and self-efficacy goals of the project. STEPS provided opportunities for every individual to learn a new skill, try something outside of his/her comfort zone, and take leadership roles based on individual self-interests. These benefits were exchanged for challenges with decision-making throughout the project and some project members who wanted more top-down structure, particularly at major milestone points. See section 5.0 for a detailed reflection on the benefits and challenges of the Team Leadership Theory framework.

Secondary audience: other science museum educators that will use STEPS and its associated products

- Was the process for developing these products recommendable for creating a more usable final product for science museum educators outside of the STEPS project?

Results from the system usability survey and diary study suggest that with the addition of the finalized software tutorial, the STEPS software will serve the unique needs of science museum educators in performing science theater in their institutions. Unique features, like timeline forking, which allows for multiple endings to a story, and the use of museum theater language in the labeling of buttons (e.g. “cues” and “scenes”), are a direct result of museum educator input.

Tertiary audience: museum visitors who will experience a STEPS show while visiting a museum institution

- To what extent are the show's learning goals and experiential outcomes with respect to museum theater achieved?

The results of the evaluation of the shortest and least theatrical of the three museum educator-developed astrobology shows produced significant differences with large statistical effect sizes in a pre/post-unmatched pairs study. The target audience of 5th-7th graders who participated in the evaluation of the shortest and least theatrical of the three museum educator-developed astrobology shows performed approximately 20% better on a test covering the shows content than a comparable group of 5th-7th graders who had not participated in the show. Similar results were obtained for 3rd graders. These findings demonstrate the accessibility of the show's content to these audiences and the broad appeal of this science content area through a digital and theatrical approach.

- To what extent is the STEPS software system and associated storylines and components a successful product?

The content and delivery of the show used for evaluation (*Planet Hunter*) was appropriate for the full age range of the intended target audience of upper elementary and middle school students (7-12 years old). The three key features of the STEPS show that were cited as the things that students liked best were: the live actors, the multimedia elements, and the addition of multimedia characters. It is noteworthy that students in each group provided unsolicited positive feedback about the pre-recorded digital actors and asked about the pre-recorded digital actors; which speaks to the fact that presenting science content in a theatrical way is engaging and convincing.

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1.0 Introduction

1.1 Background

The Science Theater Education Programming System, or STEPS, is a four-year informal science education project (three years of project development plus one year for research) funded by the National Science Foundation, Informal Science Education division (award #1043060). The STEPS project, led by Principle Investigator Brad McLain of the University of Colorado, Denver (formerly with the Space Science Institute in Boulder, CO) established five main deliverables:

1. Museum Partnership Network – a community of informal science educators working towards a common goal; small museums and large museums¹ were paired together for mentorship opportunities
2. STEPS – a unique and innovative software tool for science theater programming
3. Astrobiology Theater Shows – a set of three performance shows with the STEM content focus of astrobiology
4. Professional Development – products for informal science educators, including in-person workshops, online tutorials, and inter-museum interactions
5. Research – focused on understanding informal science educators’ sense of professional identity, capacity building within their institutions, and informing the field about the relationship between professional identity and multi-institution collaborative networks

Astrobiology was chosen as the STEM content for the shows because it was popular with the public and multi-disciplinary in its science content that gave the team room for theatrical creativity. The three astrobiology theater shows varied in purpose, length, and theatrical components:

- Planet Hunter is a short (15-20 minutes) piece about the search for extra-solar planets, designed for both in-museum presentation (including small theaters and multi-use spaces) and for outreach activities. It is performed by a single live actor in concert with two pre-filmed multimedia actors. The show includes an optional audience participation orrery activity at the end of the theatrical component.
- Extremo-WHAT? is a medium-length show (20-30 minutes) about the search for extreme life on Earth, with the premise of a late night talk show gone wrong. The audience is invited to make choices about the story’s direction. A Disney animator created four digital characters for the show who interact with a single live actor.
- Mars Interrupted is the longest and most theatrical production of the three shows (30-40 minutes) about the possibilities of finding life on Mars versus Europa. It includes two live actors and several digital characters who are on a spacecraft on mission to Mars. The crew is thrown into crisis when they must struggle with the on-board computer (also a digital character) for control of the spacecraft (similar to the premise of 2001 A Space Odyssey).

¹ Museum size was determined by an institution’s annual operating budget, visitorship, and/or their staff size.

1.2 Project Team

To accomplish this, the PI brought together a geographically distributed and multi-disciplinary team including:

Science Museums²

- Bishop Museum (Honolulu, HI)
- Chabot Space and Science Center (Oakland, CA)
- Farmington Museum (Farmington, NM)
- Montshire Museum of Science (Norwich, VT)
- North Museum of Science and Natural History (Lancaster, PA)
- Space Center Houston (Houston, TX)

Professional Organizations

- Association of Science-Technology Centers (Washington, DC)
- Astronomical Society of the Pacific (San Francisco, CA)

Advisory Institutions

- Challenger Learning Center of Colorado (Colorado Springs, CO)
- Children's Museum of Indianapolis (Indianapolis, IN)
- Colorado School of Mines (Golden, CO)
- NASA Astrobiology Institute (a virtual, distributed organization)
- National Optical Astronomy Observatory (Tucson, AZ)
- SETI Institute (Mountain View, CA)

External Contractors

- Del Padre Visual Productions (East Longmeadow, MA) – software development
- Institute for Learning Innovation (Edgewater, MD) – front-end and formative evaluation
- UXR Consulting (Baltimore, MD) – summative evaluation
- University of Colorado at Denver (Denver, CO) – research

The team used the following tools to support the collaboration across geographic distances and time zones:

- Basecamp (<http://basecamphq.com/>), a web-based project management platform
- Webex (<http://www.webex.com/>) for video and voice conference calls as well as desktop sharing
- face-to-face professional development workshops related to astrobiology, museum theater, and evaluation
- annual full team meetings at ASTC
- individual and team phone calls and emails

1.3 Team Structure

To facilitate the achievement of creating an effective museum network and, by extension, all other project deliverables, the PI applied Team Leadership Theory (TLT), as described by Hackman & Walton (1986), Larson & LaFasto (2001, 1989), Northhouse (2004), and others, as an organizational framework, combined with the characteristics and goals of a “community of practice.” Communities

² Two other science museums started but did not complete the project: the Kansas Cosmosphere and Space Center (Hutchinson, KS) and the Science Museum of Virginia (Richmond, VA).

of practice are “groups of people who share a common concern or passion for something they do and learn how to do it better as they interact regularly” (Wenger 2006).

LaFasto and Larson (2001) studied 6,000 work teams in organizations worldwide and developed the TLT framework. Their research indicated that team leadership lends itself to greater productivity, more effective resource use, better decisions and problem solving, higher quality products and services, and increased innovation and creativity. Most of the projects and organizations they studied were groups that worked in a single organization, often the same building, with the ability to have regular face-to-face interactions and shorter time frames for projects (i.e. 1 year as opposed to 3). STEPS is one of the first studied examples of TLT applied across a geographically distributed team mediated my technology developing a set of products over a three year period.

LaFasto and Larson articulated eight characteristics for excellence. In the table below, each characteristic is listed below with a brief description of how it was actualized in the STEPS project.

Table 1: Team Leadership Theory framework adapted for the STEPS project

LaFasto and Larson TLT	STEPS TLT
1) A clear and elevating goal	The team was tasked with the creation deliverables that were challenging and required a multi-disciplinary team. The software and shows were novel and out of the comfort zone of the educators, but the project overall was perceived as valuable to the group with the inclusion of professional development opportunities, the STEPS software system, the three astrobiology shows, astrobiology tutorial, and associated evaluation and research products.
2) Results-driven structure	Application of TLT through subteams and a network whip working across multiple, parallel timelines. Each subteam had a timeline and set of milestones to achieve. This framework was the nuts and bolts of the collaborative structure.
3) Competent team members	The project required and brought together informal science educators, software developers and multimedia professionals, scientists knowledgeable about astrobiology, a leadership and management team, and theatrical expertise.
4) Unified commitment	At the individual level, the team established a unified commitment to the project at the kickoff meeting by drafting and signing three governing documents: a Declaration of Collaborative Excellence, a Collaborative Framework, and a Collaborative Agreement (see Appendix A, B, and C). At the institutional level, the PI obtained buy-in from the leadership (e.g. Museum Director) as well as the informal science educator who would participate in the project.
5) Collaborative climate	A collaborative climate was created through the use of web-based communication tools (Basecamp and Webex); a schedule for communication to happen face-to-face and online; shared leadership so that there was room for multiple voices to be heard; and ongoing encouragement for subteam leaders to take control of the project rather than a top-down structure.

6) Standards of excellence	The standards of excellence were set forth in the Declaration of Collaborative Excellence and carried out in practice through the process of collaboration and the creation of products that would be disseminated to the broader ISE community.
7) Principled leadership	On the part of the PI, there was an explicit commitment to TLT, announced at the kickoff meeting and reinforced through monthly teleconference meetings. On the part of the participants, they agreed to the shared leadership model and the responsibilities and assigned tasks that came with it.
8) External support	External resources were in the form of financial support from the National Science Foundation, scientific review from a team of advisors, and product development support from technology and media, and evaluation and research consultants.

The team adopted the framework on January 18, 2008, when they first met in Boulder, CO, for the project kick off meeting. They enacted the framework throughout Year 1 (2008) with the following activities:

- Developed an on-line project Web site through Basecamp for messages, milestones, to-do lists, contact info, and write-boards
- Created a public Web site to communicate the project externally (<http://stepsproject.org/>)
- Learned more about the project’s science content, astrobiology, through invited talks, Basecamp posts, Adler planetarium workshops, and newsflash updates
- Learned more about theater by attending Tessa Bridal's museum theater workshop at the Children’s Museum of Indianapolis
- Conducted the STEPS front-end evaluation and baseline research and evaluation on the collaborative
- Formed specific subteams and assigned their leaders (story team, asset production team, audience participation team, professional development team, software team, and research and evaluation team)
- Established a features and functionality list for the STEPS software
- Attended the STEPS ASTC Year 1 workshop and meeting (Philadelphia, PA)

During Year 2 (2009), the team focused heavily on project development and continued professional development. They:

- Participated in three small-group evaluation workshops bringing together one small museum and one large museum along with any other network partners in the area (held at the Science Museum of Virginia, Chabot Space and Science Center, and pre-ASTC meeting in Ft. Worth, TX)
- Attended a museum theater workshop led by Larry Gard (a STEPS team member) from the Science Museum of Virginia in Richmond
- Completed four process-evaluation, web-based surveys called “pulse checks”
- Participated in monthly “all-hands” team web conferences
- Participated in sub-team teleconferences as leaders, full participants, and “lurkers”
- Attended the STEPS ASTC Year 2 workshop and meeting (Ft. Worth, TX)

During Year 3 (2010), the team completed the development phase and moved into production. They:

- Developed web-based tutorials based on the astrobiology content and software
- Collected multimedia assets for creating the shows

- Completed all three shows
- Beta-tested performances and software in multiple institutions
- Strategized marketing and advertisement
- Presented papers and workshops at the Museums and the Web and ASTC annual conferences
- Attended the STEPS ASTC Year 3 workshop and meeting (Honolulu, HI)

Year 4 (2011) was dedicated to the research deliverables associated with the project. A team of researchers from the University of Colorado will conduct longitudinal studies of the project participants to understand better the impact of STEPS on the evolving professional identities of the Museum partners and the ongoing sustainability of the museum network. In addition, various members of the STEPS team will:

- Continue marketing and distribution of the STEPS products
- Complete the final summative evaluation report
- Engage museum visitors across the country in STEPS-created shows

This report provides a summative evaluation of the STEPS project after the completion of Year 3. As described above, a research team from the University of Colorado, Denver will complete the research plan in Year 4. The next section outlines the evaluation questions for each of STEPS's three target audiences and the associated methods for data collection.

2.0 Evaluation Questions and Methods

The summative evaluation examined three target audiences with overarching research and evaluation questions related to each. These questions address both the processes and products of the STEPS project.

- Primary audience: the museum network that created STEPS
 - To what extent is the STEPS product used by individuals in the STEPS network at their institutions?
 - To what extent was the process of developing these products recommendable for creating a collaboration/network?
- Secondary audience: other science museum educators that will use STEPS and its associated products
 - Was the process for developing these products recommendable for creating a more usable final product for science museum educators outside of the STEPS project?
- Tertiary audience: museum visitors who will experience a STEPS show while visiting a museum institution
 - To what extent are the show's learning goals and experiential outcomes with respect to museum theater achieved?
 - To what extent is the STEPS software system and associated storylines and components a successful product?

We used multiple methods to answer the overarching evaluation questions. Each audience type and associated evaluation questions called for a different set of complementary methods.

Table 2, below, maps the chosen methods to the evaluation questions for each audience:

Table 2: Evaluation questions and associated methods

Research Question	Method	Sample
STEPS Network		
To what extent is the STEPS product used by the collaboration?	Diary Study	3 participants from different institution types, completing 5-15 entries over six-week period leading up to the ASTC meeting in Honolulu, HI
	Interviews	Face-to-face and phone interviews with 12 STEPS partners including (4 professional organization members, 2 museum directors, and 6 museum educators)
To what extent was the process of developing these products recommendable for creating a collaboration/network?	Pulse Checks	Summary review of the 5 formative pulse checks conducted with network partners during Year 2 and the early part of Year 3
	Post-project questionnaire	Final web-based questionnaire distributed to all museum network participants currently on the project, n=11
	Interviews	Face-to-face and phone interviews with STEPS partners including (4 service organization members, and 6 STEPS network partners)
Other Museum Professionals		
Was the process for developing these products recommendable for creating a more usable final product for science museum educators?	SUS surveys	System Usability Scale surveys with first-time users of the software, n=12
Museum Visitors		
To what extent are the show's learning goals and experiential outcomes with respect to museum theater achieved?	Pre-/Post-Show paper questionnaires (quasi-experimental, pre/post unmatched pairs)	n=83 pre-show questionnaires from 3rd-7th graders and n=83 post-show questionnaires from 3rd-7th graders
To what extent is the STEPS software system and associated storylines and components a successful product?	Post-show paper questionnaires (open-ended questions from post-show questionnaire)	n=83 post-show questionnaires from 3rd-7th graders

3.0 Results

3.1 Primary audience: the museum network that created STEPS

3.1.1 Evaluation question: To what extent is the STEPS product used by individuals in the STEPS network at their institutions?

Method: Diary Study

Timelines shifted in Year 3, and the software and complete set of shows were not ready for all network partners to incorporate the shows into their educational programming as originally intended in the grant (<http://informal.science.org/project/show/1845>). A few individuals were able to work with the nearly final versions of the software and astrobiology shows, documenting their range of experiences in a diary study. Three STEPS network members participated in the diary study over a period of six weeks from the time a nearly final version of the software was released in mid-August up through the ASTC meeting in Honolulu, HI in early October.

Participants completed a web-based diary entry form created in Google Forms (see Appendix A). The entry form included check boxes to mark specific activities and closed ended scales for participants to report their overall confidence with the software, performing outreach shows, and performing museum theater. We instructed participants to fill out an entry form each day that they used a part of the STEPS system outside of their typical STEPS project work. The goal was to capture participant experiences “in the wild” without direct support from the software team or other network members. These three participants represented a range of institution types, prior experience with the software, theater and science backgrounds, and familiarity with the STEPS shows. Below are a series of brief case studies that describe the experiences of each individual.

▪ Participant A: Large museum testing all three shows

Participant A was from a large science museum with access to a full-scale museum theater. Participant A had a background in theater and was able to test all three astrobiology shows during the study period, providing four diary entries (8/13-9/27, 2010). Participant A used all components of the STEPS software system (the show planner, presentation player, and asset manager), made editorial adjustments to the scripts, and performed all three shows. The primary focus of this individual’s activities was putting together the Extreme-O What show and memorizing lines for all three shows. The Extreme-O What show was an opportunity for this participant to work directly with the software and successfully put together a STEPS show using the show planner. Participant A was able to troubleshoot the software and report system bugs to the software team.

This individual’s initial self-reported confidence using the STEPS software was a score of 5 on a scale from 1 to 7, where 1 was not at all confident and 7 was extremely confident. In the first diary entry Participant A commented, “I am very comfortable with it but there are some aspects of it that I still do not know how they work”. At the end of the study, Participant A reported a confidence score of 6, self-described as a “power user”: “[I’m] a power user since I have worked with it so much. I have built the Extreme-O What show up from just the assets...” Due to the participant’s background in theater, the confidence scores for performing outreach shows and museum theater both started and remained a 7, the highest score on the scale.

▪ Participant B: Small museum testing the Planet Hunter show

Participant B was from a small museum without a dedicated theater space. Participant B had experience with traditional outreach activities (e.g. hands-on science activities) but no theater experience. This individual worked with all components of the STEPS software system (the show

planner, presentation player, and asset manager), and performed the Planet Hunter show in a retrofitted theater space during the study period, providing five diary entries (9/15-9/29, 2010). The experiences of this individual ranged from initial frustrations learning the software to increased enthusiasm for learning the script and performing a show.

This individual's self-reported confidence in using the STEPS software started out at a 3 in the first diary entry, self-describing as a truly novice user and providing this follow-up comment: "Other than loading it in and hitting the play button for one play (PlanetHunter), I do not know how to edit plays, build my own, or move around in Planet Hunter more efficiently...". After just two weeks of use, the participant's final entry described a confidence level of 5 with enthusiasm for creating new shows in the STEPS system: "Can't wait to start building [a] new show with [my museum's] content in the show planner." Participant B's confidence scores for performing museum theater also grew with practice and experience. The theater confidence score started at a 1, with the participant citing no theater experience, and increased to a 5, commenting that acting classes would be a good professional development opportunity in the future to expand her skills further. The confidence scores for performing outreach went from a 5 to a 6 as the participant became familiar with the show and optimistic about taking it out into the community: "Now I am ready for the challenge of taking it on the road and setting up in new spaces."

- Participant C: Small museum experimenting with props and collaborating with local groups
During the study period, Participant C focused on planning and marketing for the future use of STEPS shows and spent time learning the Planet Hunter script – the first show to be debuted at this participant's institution in a planetarium. Participant C had a background in planetarium shows, but no background in theater or script writing prior to the STEPS project. This individual used all components of the STEPS software system (the show planner, presentation player, and asset manager), modified the scripts, and practiced the Planet Hunter show and associated audience participation activities. Participant C provided eleven diary entries during the study period (8/17-10/4, 2010).

Participant C described meeting with a lighting technician from a local community theater to discuss best practices for lighting to provide an authentic theater experience in a planetarium setting. Participant C also chronicled the process of learning Planet Hunter across several diary entries, which highlighted the rewards and challenges of learning a new set of skills and the benefits of having access to a network of partners to turn to for advice. The following selection of entries describes the participant's personal growth from novice performer to camera ready:

Take 1

First real attempt with Planet Hunter...First had problems getting situated. Too many items to carry at once (remote, net, and script). Had to restart Planet Hunter several times as I kept forgetting something I needed...I couldn't figure out how to exit the STEPS software prematurely and still forget as I know there's a way as I did it before. Had to spend time thinking how I would hold everything, which hand should the remote be in etc. Also, there [are many] items to remember. For example, I used the Stethoscope but forgot to actually put them in my ears. I was even trying to figure out should I be holding the net the entire time? I have to put it down to do the scale demo with the balls...Definitely need to work on timing.

Take 2

Had an extremely hard time getting out the stethoscope, placing it in ears and using it. Had hard time passing the net to the other hand to make whip motion. Realized our projection showed the bottom of the desktop, not correct format. ... Took time to record the lines correct[ly] so I can listen to them later – [a network partner's] suggestion via [Basecamp] post.

...

Take 5

Still messed up a few lines and timing. Impressed how much I did remember. Feel better in performing Planet Hunter in the regards to me being ready to perform for small groups come October.

...

Take 7

Had major memory lapse! A very bad rehearsal. Ended recordings and rehearsal early.

Take 8 (performed for Museum Staff)

Felt it was my best performance yet. Maybe because I had an audience for the first time. Unfortunately I had forgotten to record it which I regret. ...

This individual's self-reported confidence with the software remained a 5 from beginning to end explaining that "...there is still a lot more to try out". This individual had limited experience performing outreach, but after performing one live show felt very confident and went from a starting score of 4 up to a score of 6, with the following comment: "If I can do winging it with a[n] [impromptu] audience with technical difficulties mixed in, I can do it. [I] still would want the presentation to be polished more, [and] me to have more practice before we start asking schools to pay for it." Participant C described a similar experience with regard to confidence performing museum theater as Participant B. This individual described an initial confidence level of 4 with, "I don't have theater experience other than doing science demonstrations in the past. So this is new territory." The final confidence score of 5 identified guarded optimism: "Definitely know I can work my way through it, but [I] don't really have a sense of how my performance is viewed. Was my lack of theater acting skills important or obvious to the audience?"

These three case studies highlight the range of experiences that exist among the broader informal science education community in terms of comfort with technology, performing outreach, and performing museum theater. Each future STEPS user will approach the system with a variety of skills and institutional support. Key elements of the learning process as exhibited by the three diary study participants are (1) practice using the software and (2) test performances in front of live audiences.

Method: Post-project Web-based Questionnaire

In a post-project web-based questionnaire (described in detail in Section 3.1.2) all participants, including the three listed above, indicated their confidence with the STEPS software (n=11, 7 science museum educators and 4 professional organization employees³). Table 3 includes the descriptive statistics for items related to the use of the STEPS software. Overall, science museum educators somewhat agreed that they could confidently use the STEPS software (M = 5.14) and that they could develop a show with it (M = 5.00). Additionally, science museum educators indicated that they were generally satisfied with the STEPS software. Scores for the professional organization employees were lower than the informal science educators. This was expected because they will be less likely to use the STEPS software in their future work, and because the software was designed *by* informal science educators for use *by other* informal science educators.

³ One of the Professional Organization Employees did not respond to the specific set of items related to performing outreach with the software, because s/he felt it did not apply to her/his situation.

Table 3: Descriptive Statistics for Software Related Items

	Group	N	Min	Max	Mean	SD
Rate your level of confidence with regards to using the STEPS software	1	7	4.00	7.00	5.14	1.07
	2	3	1.00	4.00	3.00	1.73
I can use the STEPS software to develop a show	1	7	3.00	7.00	5.00	1.29
	2	3	2.00	5.00	3.67	1.53
Satisfactions using the STEPS software	1	7	4.00	6.00	5.43	.79
	2	3	3.00	4.00	3.67	.58

Note: Mean values range from 1 to 7. Group 1 = Science Museum Educators, Group 2 = Professional Organization Employees, SD = standard deviation

Method: Interviews

We conducted semi-structured interviews with 12 network members including 2 museum directors, 4 professional organization members, and 6 science museum educators, to determine to what extent the STEPS products were intended for future use by the collaboration members and affiliated institutions. In order to preserve anonymity of the participants, we reported the results in aggregate.

Interviews were open-ended and semi-structured, meaning the interviewer guided the conversation using overarching topics and questions, but the participants' own narratives and experiences determined the direction of the conversations. Open coding of the interview transcripts by one researcher led to the identification of emergent themes among participants (see the complete interview instrument in Appendix E, note themes C and D).

Institutional Impact

Increasing institutional capacity for science museum theater was a key component of the project and the primary concept described by participants when asked to speak about their thoughts regarding the end products. Participants described the ways in which the software and shows enabled their institution to provide new shows or enhance existing programs. The following quotes capture the range of participant responses in this category:

"It's been challenging...and it is going to fundamentally change what we do at our museum – I know that. The results that I've just seen with [my staff] presenting Planet Hunter at [my] museum, people get excited about it. [Visitors] are like, 'Wow, this is cool! How much are you going to charge for it?' And I'm like 'Well, it's free.'"

"It was the first time I had ever had the thought that we would even get a grant. That the project is about theater is a total stretch for me – I hadn't ever had any direct contact with theater."

"STEPS gave us the opportunity to create a new experience in a planetarium that we couldn't before. We have equipment that we didn't have before. We have a reason now to collaborate with the [local] theater community. This is the first time we really have a reason to bring something to them – that's planted the seed for some opportunities to work together, even if it might just mean [my staff] and an intern from the theater company could come and sit down and write a script together."

"We've got the big screens and the projectors and all of that stuff but we didn't have the software to do that stuff. Just Power Point... Our combustion show is a stand-alone, but it doesn't have any multimedia in it. And [another staff member] does a mad scientist show with Power Point, but not for long!"

“We never did theater before and it’s allowed us to broaden our horizons and see where this goes.”

Future

At the time of the post-project interviews, the project leaders and individual institutions were still determining the future of STEPS, from marketing and dissemination plans to internal programming. For some, new grant opportunities and community partnerships were already in the works to support STEPS programming in 2011 and beyond. The following comments highlight these points:

“You know I really want to take the ball now and see where we can go within our institution and really that’s what excited me about it the whole time – the opportunity to do that and kind of put our own spin on it.”

“We’re going to go through a whole series of the three programs dealing with the challenges of non-trained people who are not under the control of a paid position. I will be looking for money for it – as I have two or three possibilities that will work... I think we need another year or two to work on it and make it a really polished product.”

“I want to convert [an existing show] into a STEPS show because I want to add music, you know, and stuff to go along with it. [My colleague is] so animated and dynamic - I want to wow it even more. I think STEPS will really be able to help with that.”

“We do have a plan on the table for how we’ll roll out with STEPS which will come up in the springtime when we get our next crop of teen volunteers. That’s how we’ve decided to use it. We’re looking at two of the scripts using different groups based on ages. Whatever makes the most sense for the story audiences.”

“We’ve partnered with [another STEPS network institution] to use the framework of STEPS [the software] to develop three more shows that are mostly talking about earth science [with a grant from NASA]. I know that next year is the primary year for the development [of that project] so by the end of year I would expect some sort of product to be done. I know it’s in the 2011/2012 timeframe.”

Other partners indicated they still had questions about the sustainability of the STEPS products in their institutions and the extent to which the package would have widespread appeal to institutions outside of the network:

“You’d have to keep writing scripts to make this sustainable – new programs. But if we can get to the point that there are certain programs that we [give to certain age groups]... I still don’t know if people will pay for it yet [as an extra public program]. I’m a little nervous about whether or not people will pay for it.”

“...I don’t really have a sense if this is something that people want...so it might not be going anywhere honestly besides 10 or 15 museums. ...I think it’ll be a grassroots kind of getting it out there. I don’t think it’s going to be a big revolutionary ‘Hey, look at this thing’, but I think that when people see the shows that can be made it’s going to be a real grassroots effort.”

3.1.2 Evaluation question: To what extent was the process of developing these products recommendable for creating a collaboration/network?

Method: Review of Formative Evaluation Pulse Checks Complemented by Post-Project Interviews

As described in the Introduction, STEPS used Team Leadership Theory (TLT) and elements of Communities of Practice to support professional development opportunities for informal science educators. During the formative evaluation phase in 2009, a web-based questionnaire called a

“Pulse Check” was used to gauge the mood of the STEPS collaboration with regard to issues of decision making, capacity building, support, and workflow. The Pulse Check (see Appendix C) was comprised of 20 rating-based items on a seven-point scale from 1 (strongly disagree) to 7 (strongly agree), and 3 open-ended questions that aimed to reveal current states in the collaborative network.

As a formative evaluation (Year 2, 2009-early 2010) tool, we analyzed and interpreted each Pulse Check at the group level as it was administered (i.e. we aggregated and summarized the data from whomever participated in the survey at that point in time). The PI used that information to make strategic changes during the project. A total of 5 Pulse Checks were administered (February, May, August, November 2009, and February 2010). A detailed analysis of the results from each point-in-time Pulse Check during formative evaluation was presented as a conference paper at the Museums and the Web 2010 Annual Meeting in Denver, Colorado (please see, Koepfler, J.A., McLain, B., & Sala, S. (2010), Web-Supported Collaborations: Building, Evaluating, and Sustaining a Museum Partnership Network, <http://www.archimuse.com/mw2010/papers/koepfler/koepfler.html>, for more details).

For the purposes of the summative evaluation (Year 3, 2010), we wanted something that would give us a general sense of the process the group went through leading up to the final face-to-face meeting at ASTC 2010, and then use a set of post-project interviews to obtain participant reflections on the process overall (rather than the point-in-time data from the Pulse Checks). To do this, we combined the Pulse Check questionnaire items into five (5) main categories loosely conceptualized as: capacity building/growth, decision making/leadership, communication, inter-team support, and expectations (see Appendix C for the items that we combined to create these loose conceptualizations). Averaging across groups of items in this way provided for a more practical interpretation of these high-level concepts, although unique information from each individual item is lost due to averaging (for information on individual items as assessed during the formative evaluation phase please refer to the Museums and the Web paper: <http://www.archimuse.com/mw2010/papers/koepfler/koepfler.html>).

The total sample of science museum educators who completed at least one pulse check out of the five Pulse Checks was n=22. However, attrition occurred at the project level with participants leaving the project and new ones entering it, and at the survey participation level with some participants completing one month and then missing a consecutive month and responding again in the third month. This reduced the number of science museum educators who completed all 5 pulse checks to n=7. Due to the interest in the summative evaluation for looking at development across the STEPS project, only these 7 individuals were included in the analyses. To ensure the validity of our interpretation, we conducted a comparison of means with (n=7) and without (n=22) the complete time series data. This comparison yielded no significant differences (i.e. the patterns in the curves are very similar and in many cases overlapping) and therefore we do not appear to ‘lose’ anything in the analysis, despite the small sample size.

Category average scores for each of the 5 pulse checks are provided in Table 4. Overall, respondents reported generally positive attitudes towards each of these components across the STEPS project. Although there was not consistent growth across each time point for any of the components, there was a noticeable peak at Pulse Check 4. These scores were likely influenced by face-to-face meetings in Fort Worth, Texas, at the ASTC 2009 conference in which the first prototypes of the software and shows were presented, and a pre-meeting evaluation workshop held for three partner institutions, which occurred close to the pulse check deployment. The lowest overall values for any of the components occurred at Pulse Check 2. This is likely due to the uncertainty of the project during the early development phases and an adjustment to the new sub-team leadership structure.

Similarly the reduction in scores from Pulse Check 4 to Pulse Check 5 can be attributed to a tumultuous period in the project in which the PI transitioned from one institution (SSI) to another (University of Colorado, Denver) and the project timelines and deliverables were shuffled to support the administrative process necessary for this change.

Table 4: Means for Each Component for Each Pulse Check

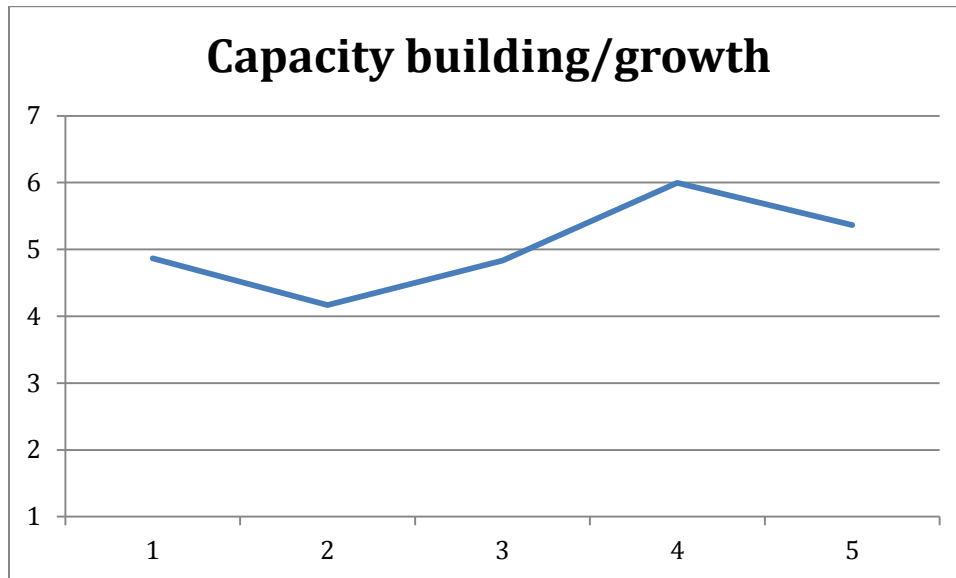
	Pulse Check 1 (Feb. '09)	Pulse Check 2 (May '09)	Pulse Check 3 (Aug. '09)	Pulse Check 4 (Nov. '09)	Pulse Check 5 (Feb. '10)
Capacity building/growth	4.87	4.17	4.83	6.00	5.37
Decision Making/Leadership	4.77	4.50	5.00	5.66	5.00
Communication	5.06	4.67	5.06	5.61	5.17
Inter-Team Support	5.06	4.67	5.28	5.67	4.78
Expectations	4.61	4.26	4.75	4.86	4.63

Note: Values can range from 1 to 7.

Separate graphs are provided for each of the 5 categories in the sections that follow with additional reflections from the post-project interviews, which occurred during the two weeks during and after the final face-to-face meeting at ASTC 2010. Post-project interviews were conducted in person or over the phone (based on participant availability). All six out of the seven participants that make up the Pulse Check summary in Table 4 above (one participant left the project before the completion of the final interviews), plus three other STEPS partners and two museum directors make up the range of comments that complement the quantitative data below. It is important to keep in mind that the final pulse checks were administered at a different point in the project (February 2010) than the final reflective interviews (October 2010).

Capacity Building/Growth

Capacity building/Growth saw the largest increase across the project (M = 4.17 at PC2 vs. M = 6.00 at PC4). Overall project members appeared to support strongly the professional development that came as a part of working on the STEPS project.



Note: The x-axis represents each pulse check (PC1-PC5). The y-axis represents the mean score from 1 to 7.

Qualitative comments suggest that this category was a success of the project. Participants cite growth at the professional development level and institutional level. Due to the unique leadership structure, each participant's growth context was individualized. For some, the key learning experiences were content based and for others they were related more towards transferable skills. The examples provided in the interviews were extensive and we list them here to provide the full breadth of participant experiences in this project.

Professional Development

"The opportunity to just stretch in a different way, and knowing that there was no one else that was doing it [in our area] and struggling deeply to differentiate the museum from the competition in the area."

"It helped me be able to showcase what I know, like stuff people [at my institution] didn't really know everything that I could already do and that helped bring it out and people say 'Oh, wow! She's good at that' Now I've gotten more projects to do and things like that."

"I mean, I definitely learned a lot from it. I think dealing with these different teams and having to run team meetings helped me in a way, for a while I was leading [a subteam] and I felt like I developed professionally from that. I learned about running a team, and trying to be efficient about it, and being able to report back to a larger group – so I think that actually did help me somewhat."

"...I've done some things on the project that I wouldn't have done otherwise... Like making that video in Camtasia. I wouldn't have done that before but I already have ideas for how I can use that in other parts of my work and just working with the STEPS system, that's a departure from my typical work."

"Definitely an acquisition of some skills that I didn't have before. My only theater experience had been behind the scenes on the tech side. Being able to get out in front of people and try that out, knowing that I'd eventually be having others in my institution perform the shows – that was an opportunity that was really welcomed. It was something I hadn't really thought about before."

"In the actual project, I was put in such a leadership position, out of necessity really [for the project], I think what it did for me, I was given the opportunity to demonstrate my leadership – to manage stuff. That's something that I had [at my previous job] and you know I've never really been able to do [it at my

current job]. This project gave me the opportunity to prove myself. I was really lucky. I was given a promotion when we were doing two layoffs.”

“Working with the audience participation was a little bit outside of my comfort zone because most of the people on the team were more accustomed to working directly with visitors in a presenter/educator role as opposed to what I usually do which is work on exhibits and other types of experiences that visitors are going to participate in but not necessarily facilitate. So, you develop the experience and then you send it out there and you’re not there actually facilitating the experience. So thinking about how to design that facilitated interaction was something that was a little bit outside of my immediate area of experience.”

Institutional

“It seems to me that those places that have had the ability to devote the energy and resources to it have been able to get the most out of it so far. I’m thinking of [one institution in particular] – they were already doing some sort of science theater and they were able to integrate that easily into that work stream. A different example would be [another institution], which has more flexibility with what they offer their audiences. At [my institution] it’s hard – if you weren’t already doing something it is hard to get legs on it and get [institutional buy-in].”

“It made me think a little bit more about what makes a good story. Some of the stuff we talked about early on is stuff that I still think about when we develop new programs and whatnot. It was useful for us to hear about the role of story, or storytelling, as one of our ways of looking at science education.”

“I did something that wasn’t expected of me. I scripted the astrobiology part of the tutorial. I did a lot of research and learned quite a bit. I’m much more knowledgeable about the astronomy part. I did learn something about a new content area and it was really fun. It was also a different delivery method... This was a real challenge to think ‘what is a self-paced tutorial’ and what needs to go in there that would allow it to be self-paced that isn’t just reading page after page with weird facts interlaced. ...it got me thinking about the different methods of professional development that we could use...this gave us insight into actually being able to do that.”

“I think it served the project in that it did give people an opportunity to develop new skills, develop their leadership, develop their leadership experience and to get involved in a project that was new territory to them. I think it was a real challenge though in that you bring together a bunch of people representing a bunch of museums with a bunch of different cultures and priorities and try to develop a project that is going to meet all of their needs both institutionally and personally – I think that’s a very hard thing to do.”

“I think for a lot of people this was really a great opportunity. I think...if the director was on board that people really got the opportunities and really enjoyed the experience. So that was cool.”

In addition, the distributed leadership and shared ownership encouraged individuals to step outside their comfort zones, share their skills, and consider each other’s point of view. This process proved particularly effective for professional development and created a sustainable network of informal science educators.⁴ The following comments highlight the overall positive impact of the network on the STEPS participants:

“Just the time spent working with the other partners developed some new relationships that have carried over into other things. That aspect of it definitely had an impact.”

“I think the high point for all of us was getting to know everybody and getting to know a tool...”

⁴ The research team will investigate the impact of this process on the participant’s professional identities in greater detail throughout Year 4 (2011).

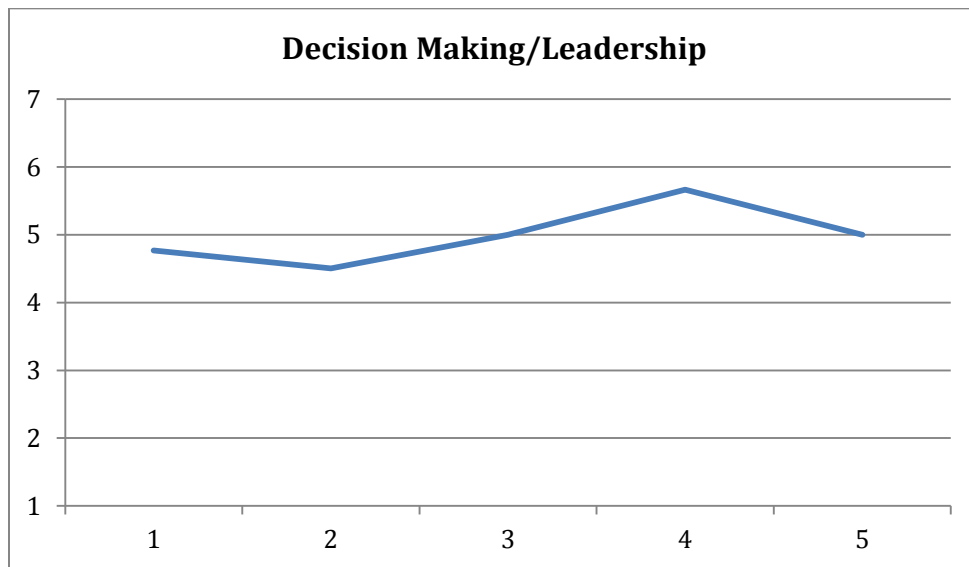
“It was really great for networking. I think the trips – the face-to-face – going to other museums was really important. I think that’s really what I got the most out of it – the networks. Because of all the layoffs at work, I’ve really lost any type of mentor even to learn off of, but through the project I’ve actually been able to learn and expand my knowledge beyond what [my institution] has. I think that’s really what I got out of it – there’s much more out there than what we just do.”

“Expanded my professional network – people I know through the project are people I would want to work with [again].”

“[STEPS] was one the things we were finding valuable – having a collaboration with some of the other science centers for things that may not even have anything to do with STEPS. So, [despite lack of time and resources] there was an impetus to press on. For example, being able to bounce ideas off of others, ‘here’s something that I’m thinking about doing, what are your experiences like with your community?’”

Decision Making/Leadership

Decision making and leadership showed minor but steady growth across the STEPS project with the peak (M = 5.66) at Pulse Check 4.



The decision making and leadership structure were two intertwined components of the collaborative process. The use of TLT required a bottom-up, distributed leadership framework, which led to the creation of subteams to accomplish specific milestones and the introduction of parallel timelines for specific deliverables. Early in the project, some subteams found themselves with little to do (e.g. the professional development team), required to wait on the deliverables of another group (e.g. the story team). During the formative evaluation, participants identified that at times the process for making final decisions was ambiguous and slowed because of this approach. During post-project interviews, participants reflected on the challenges of this process, while recognizing the purpose and value of the TLT framework. Several participants commented on the need for more structure and more top-down leadership than the TLT framework calls for, particularly at critical milestones along the process.

Comments related to ambiguity and the speed of the process included:

“For the distributed leadership I thought it was really cool. ...but I felt like the production team leader really should have been [the PI] since he had what the objectives truly were and he really did have the

leadership in helping the software team help the production team figure out what it was trying to do. And that was particularly challenging.”

“In terms of how things worked, there were so many things that were running parallel [e.g. timelines] that really needed a project [manager] – I think [the project leaders] needed to make more of the executive decisions, not decision by committee, something probably needed to be decided early on – like the look. So people would know and we’d all be on the same page. People wouldn’t be repeating themselves in terms of work.”

“...this distributed leadership model is admirable but you need someone to put their foot down and say ‘I need it now’. ...I think that timelines thing important. It’s all so complicated you know, there’s personalities coming in – it’s hard to say this is what you should change [regarding some of the logistics].”

“[TLT] was nice in theory. It was a good experiment. I think a lot of people gained a lot from it, and I hope that for the institutions the products will be worth the effort, but I also think it could have been done a lot more efficiently.”

“We spent a lot of time writing the scripts and that delayed everybody. I don’t know if there’s a better way of going about that. I know one of the frustrations early on, was the fact that we would try to decide on what the story would focus on and then later down the road someone would say, ‘oh no, we have to go in this direction’ so then we’d have to rewrite the story...”

“I think that was sort of a dance that came up a number of times as to where the boundaries were with respect to the distributed leadership and the consensus-based process versus a little bit more of a top-down approach to some of the decisions that sometimes was needed.”

“I think the bottom-up in general is really good if all of the voices can really be heard and that is a real time consuming process. ...I’m still an advocate for having strong leadership. So you want all of the voices to be heard but then someone has to be responsible for it and I think that’s where the bumps were – no one was sure who was going to say ‘OK, I’m going to make that happen’. Not everything can be done by committee. It’s very hard to be a strong leader who leads based on what everyone wants incorporating all the other ideas that people have.”

Comments related to an appreciation for the process despite its challenges include:

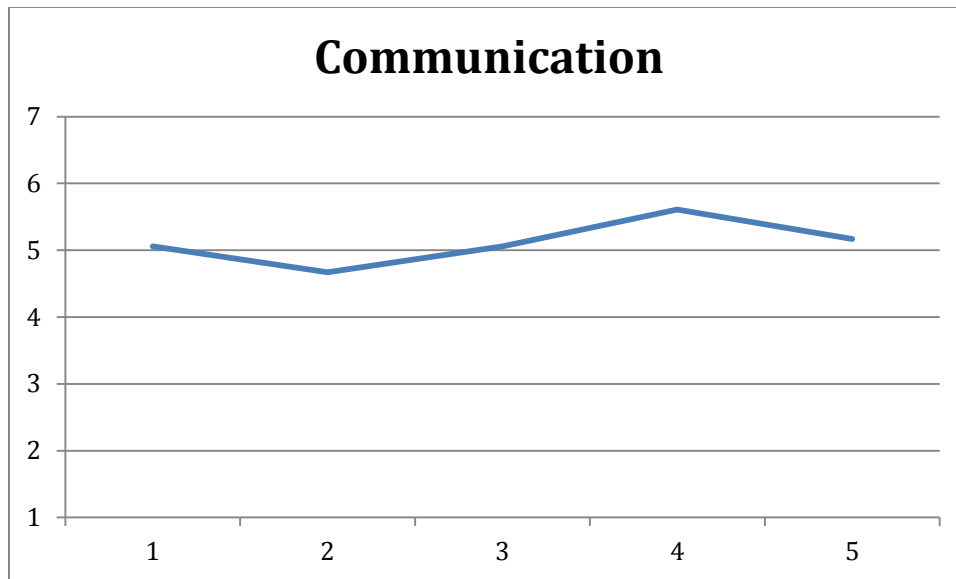
“As a whole the ownership shift from being [the PI’s] baby out to it being shared among all of us really worked quite well actually, unlike a lot of projects I’ve done like this. It was fostered well, you could take an area and go with it and you weren’t second-guessed along the way. You were really given complete ownership. That I thought worked really well. The flip side of that is that at times I think there was probably need for more clarity in communication as far as expectations and what parameters we were working within. I know [the project leaders] tried to do that little dance that you have to do of not over- or under-stepping boundaries. Ultimately it worked but it probably could have been more clear.”

“I definitely liked the idea of giving everyone the opportunity to be a leader. You know, I never expected to be the leader of the [sub]team, but it was a great experience.... The challenge was trying to get everyone involved and to get on the telecons.”

“I think that seeing how the project was managed and how the collaborations were structured in the early phases of the project was helpful and I think was somewhat instructive in terms of how a distributed collaborative project like this can work and where some of the pitfalls are.”

Communication

Overall, project members were moderately positive about communication throughout the STEPS project. Like other areas, the highest support for communication items occurred at Pulse Check 4 (M = 5.61).



As a by-product of the decision-making and leadership process as well as the distributed nature of the team across the country, communication also had its ups and downs. Throughout the course of the project, two to three face-to-face interactions (in the form of workshops related to theater, astrobiology, and evaluation) occurred each year with the annual ASTC meetings serving as a culminating point. Monthly full-team teleconferences and weekly subteam conferences were held via the Webex web conferencing system. The team used Basecamp for electronic communication and information management, which became unwieldy over three years of information gathering (a problem that all collaboration platforms suffer from in this context). Without these systems, project communication would have been extremely difficult; however, the challenges of at-a-distance communication remained. Participants described frustration with communicating in large groups over the phone, and challenges related to participant commitment and scheduling conflicts. The following comments reflect these themes:

“I don’t know if everyone was given equal voice. I think some people were louder and crankier than others and it came out in the final product...”

“I was always confused about who was doing what. It seemed like we had just started to gel with [one member] on the team and then [that person] was gone [to lead another subteam].”

“The challenge was trying to get everyone involved and to get on the telecons. ...even though I couldn’t dedicate as much time as I wanted, to me it was a surprise that these other partners were not trying to make a stronger effort to be a part of these telecons. Or maybe they were...and I’m just not aware of other people participating on other teams instead. There’s all these different scheduling conflicts from everyone else that prevented them in participating in telecons – so maybe that’s a big difference between a small institution and a large institution. ...so that was just a bit of a surprise to me.”

“...there were definitely instances where it was hard to know when to wade into a discussion and when not to. I think a lot of that is because when you’re working with people who you haven’t worked very closely with or you don’t know that well and a discussion gets a little bit inflamed and you’re dealing with the whole thing remotely, it’s just hard to know how to negotiate that.”

Suggestions for improvements in communication included creating even more opportunities for face-to-face interactions and re-evaluating the parallel timelines approach to streamline better the workflow process and provide more fluid communication.

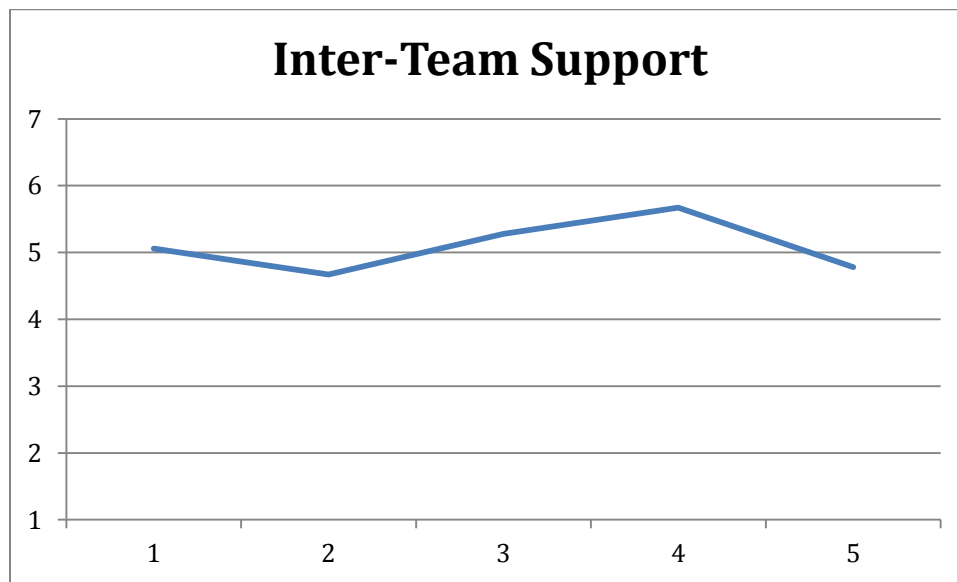
“Communication wasn’t always clear because there wasn’t always one person in charge saying ‘this is what I need from you’. I felt like what came out of my work after three years doesn’t feel like three years’ worth of work, because a lot of time went into working with teams ...and I always tried to keep it in mind that this is what they were doing [Team Leadership Theory], but it was at a lot of times frustrating for me.”

“I feel like we needed more face time – that becomes real cash. Or face time with smaller working groups with tasks assigned to them.”

“We were just constantly waiting. We’d listen in and try to keep up with what was going on, but there was nothing for us to be actively contributing to until those scripts were written...and then we could come in. This has happened in other projects.”

Inter-Team Support

During the middle of the project, team members were positive about their support from fellow STEPS partners on this project. Two low points in the project occurred at Pulse Check 2 (M = 4.67) and at Pulse Check 5 (M = 4.78), during times of project ambiguity as mentioned earlier.



In any collaboration, a diverse set of personalities can be challenging for a group, particularly one dispersed across the country and using technology as a primary means of communication. In addition, attrition contributed to the loss of members and the gaining of new ones, which periodically changed the group dynamic. The project had a series of five different evaluators and at least 20 informal science educators touch the project at one point or another. These factors contributed to some participants feeling that the team support was not always as high as it should have been, and others admitted to the lack of support that they were able to provide:

“We weren’t able to support the project as much as we should have – but I’m glad we were a part of it”

“One of the things that always stuck with me, my director said, I need to make STEPS a priority, even though I couldn’t dedicate as much time as I wanted, to me it was a surprise that these other partners were not trying to make a stronger effort to be a part of these telecons.”

“...it seemed like the focus really was the shows and so when it came to the professional development piece [the astrobiology tutorial], we had a lot of trouble getting buy-in and contributions from other people. ...It was a challenge because the showy piece – the most creative piece and the part that people are going to interact with – is the show. I understand the need to get that right, but it was frustrating because I see the [tutorial piece] as part of the sustainability of the product.”

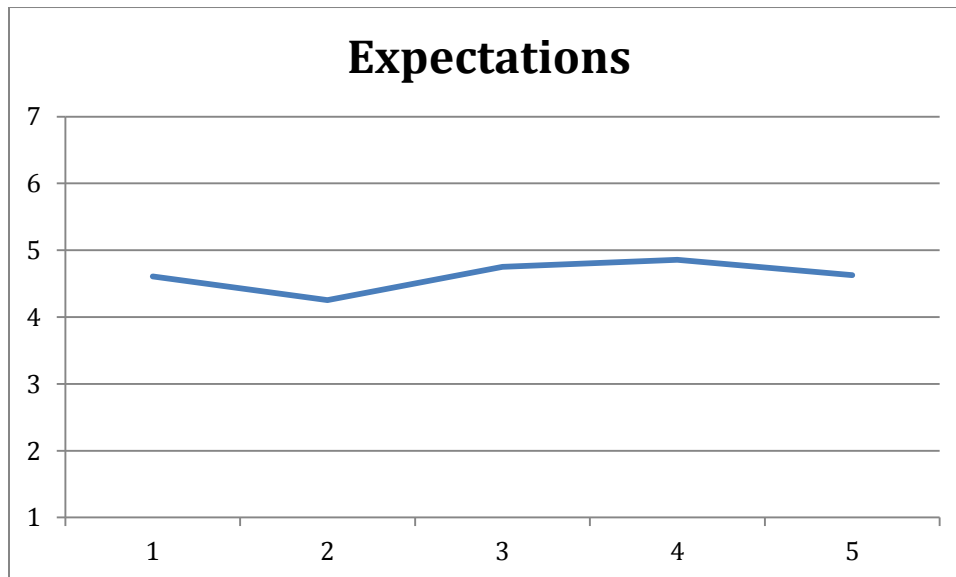
“I would want to have some way of standardizing the level of participation – not to say that everyone has to have the same exact amount, but the fluctuations and the general approach being that if you can’t take something on, let us know you can’t take it on and the rest of the team has to figure out how to adjust and cover everything. I don’t think that worked well in practical terms. The nature of who was on the project and the jobs that we all have is that we were all juggling lots of different projects and weren’t always communicating clearly about what else we were juggling and what our availability was for STEPS... I think that makes it challenging to stay connected to the project, make it a priority, and know that the other people on the project are doing the same thing.”

Despite these frustrations, one individual noted that without the existing structure, integrating into a new collaboration partway through the project would have been far more difficult:

“I did feel a little lost because I hadn’t been in it the whole time and trying to figure out what everything was, but it was so easy with everybody saying ‘oh, this is this’ and [the project leaders] and everybody, and I talked to [the software team] a lot, and would email [the project leaders], and it was really nice having that there. And then being able to jump into the production team – they were like ‘the production team is starting’ and I was like ‘Oo! That sounds like the perfect fit for me. [laughing] I’d love to do that.’”

Expectations

Expectations during the STEPS project remained generally flat across the project. The only deviation occurred at Pulse Check 2 where there was a slight decrease in questionnaire items about project goals ($M = 4.26$).



Questions regarding expectations during the formative evaluation considered whether or not the project seemed on track and achieving the goals it set out to achieve. During post-project interviews participants reflected on both the products and the process of STEPS with a new understanding of what the complete STEPS package would contain. Participants provided a broad range of reflections on their expectations for the project:

“I don’t really think I’ve seen the best of what the project has to offer. I’ve only seen Planet Hunter performed and that may be my fault, but [my colleague] saw it for the first time in Houston a few weeks ago, so I haven’t seen the other two which are much more theatrical.”

“I had an idea that it would be more improvisational – that the assets and the software would be more easily accessible, that you could serendipitously bring down things based on questions from the audience, and the product that we have does not seem to have that capability. Everything seems to have to be very much performed.”

“It seemed like the original point was that people would be able to pull together different shows and I wish I had seen them at ASTC, but it seemed like it was really difficult to create those shows and that you’re going to need internal dedicated resources to pull together more shows for it... The scripting process is very involved, even with the branching [timelines] – every branch doubles the amount of work. It’s cool, but it’s not quite what I thought it would be...”

“I thought it was a really neat project. I loved the concepts and the idea of it. The theater and the science and tying multimedia into it – the technology, which people are all into these days. I started playing with the software and was like ‘ah, how am I going to figure this out’ but once I started playing with it I didn’t have any problems.”

“Maybe we each had our own vision of it. I still have my own vision of how we will use this thing in some of our programs. Even if I don’t use the STEPS system [as it is], I will use concepts of the STEPS system and concepts of a good story in developing [other] systems here [at my institution].”

Method: STEPS Network Final Survey

The STEPS network final survey was a web-based questionnaire developed to assess professional identity and professional development of STEPS partners upon completion of the project (see Appendix G). The final survey was deployed on October 25, 2010, two weeks after the completion of the collaborative work at the ASTC2010 conference in Honolulu, Hawaii, and after the post-project interviews had been completed. Since the purpose of the Pulse Checks was to provide actionable feedback to the PI throughout the project, we used item-level data, which was not as useful for understanding the constructs of professional identity and development *at the end* of the project. For that we selected a series of rigorously tested scales and asked STEPS participants to rate items related to professional identity development on a seven-point Likert-type scale from 1 (strongly disagree) to 7 (strongly agree). Items were summed and averaged to obtain overall values for each construct, which can be interpreted also on a 1 (strongly disagree) to 7 (strongly agree) metric. Four developed or modified scales were included in the survey from existing scales in research literature to assess constructs including perceived cohesion, professional development, clarity of professional identity, and overall professional identity.

The Perceived Cohesion Scale (PCS) is a 6-item scale modified from Bollen and Hoyle’s (1990) Perceived Cohesion Scale. Bollen & Hoyle (1990) defined perceived cohesion as, “an individual’s sense of belonging to a particular group and his or her feelings of morale associated with members in the group” (p.482). The scale was modified to focus on a project member’s perceived cohesion toward the informal science educator community. As explained in the original grant proposal, “informal educators often feel isolated from the larger community and lack the necessary opportunities to grow as education professionals (Sutterfield, Middlebrooks, 2000). Research on

similar issues facing formal educators has linked quality professional development to an enhanced sense of professional identity” (McLain, 2007). Cronbach’s alpha, an indicator of scale reliability, has been found to be in the .90’s for the Perceived Cohesion Scale when used with other samples (Bollen & Hoyle, 1990; Chin, Salisbury, Pearson, & Stollak, 1999). Cronbach’s alpha ranges from 0 to 1 and indicates the internal-consistency of items. Values greater than .70 indicate that a scale has adequate reliability.

We assessed professional development using a 4-item scale developed specifically for use on this survey. Professional development was broadly conceptualized as how informal science educators have grown in their careers through involvement in the STEPS project. Due to the small sample, reliability metrics were not computed for this scale.

Clarity of professional identity was assessed using a 4-item scale modified from Dobrow & Higgins (2005). Dobrow and Higgins (2005) conceptualized professional identity using Ibarra’s (1999) definition: “the relatively stable and enduring constellation of attributes, beliefs, values, motives, and experiences in terms of which people define themselves in a professional role.” This scale was modified to address the impact of STEPS on a museum educator’s perceived professional identity. Cronbach’s alpha has been found to be in the .90’s when used with other samples (Dobrow & Higgins, 2005).

General perceptions of professional identity were assessed using a modified version of Brewer, Van Raalte, & Linder’s (1993) professional identity measure. This scale was selected because studies have found it to have good construct validity, consistent factor structure, and good reliability (Brewer, Van Raalte, & Linder, 1991, 1993; Martin, Eklund, & Mushett, 1997). Brewer et al. (1993) conceptualized professional identity more generally as the degree to which people identify with their professional role. The scale was modified to directly address professional identity in the context of an informal science educator role. Cronbach’s alpha has been found to be in the .90’s when used with other samples (Hales & Waalks, 1994 as cited in Martin, Eklund, and Mushett, 1997).

The sample size for the STEPS final survey was 11. This included 7 science museum educators and 4 professional organization employees from a combination of small and large institutions spread across the country. Each partner institution had at least one representative complete the final survey. Due to the unique difference between the role and context of science museum educators in places like Space Center Houston and the North Museum, and professional organization employees in organizations like ASTC and ASP, we reported the results separately for each of these groups.

Results for the STEPS Final Survey are provided in Descriptive statistics were examined for science museum educators (Group 1) and professional organization employees (Group 2). Overall, science museum educators reported higher levels of professional development and identity after the STEPS project than the professional organization employees. This is important (and expected) because the science museum educators were the primary population identified to grow as result of working collaboratively on the STEPS project.

Table 5. Descriptive statistics were examined for science museum educators (Group 1) and professional organization employees (Group 2). Overall, science museum educators reported higher levels of professional development and identity after the STEPS project than the professional organization employees. This is important (and expected) because the science museum educators were the primary population identified to grow as result of working collaboratively on the STEPS project.

Table 5: Descriptive Statistics for Professional Development and Identity Scales

	Group	N	Min	Max	Mean	SD
Perceived Cohesion Scale	1	7	4.50	6.83	6.12	.79
	2	4	4.33	6.50	5.63	1.07
Professional Development	1	7	5.25	7.00	6.07	.69
	2	4	3.00	5.50	4.69	1.14
Clarity of Professional Identity	1	7	4.25	5.25	4.82	.35
	2	4	3.00	4.00	3.56	.43
Overall Professional Identity	1	7	5.67	6.17	5.91	.16
	2	4	3.00	5.33	4.42	1.00

Note: Mean values range from 1 to 7. Group 1 = Science Museum Educators, Group 2 = Professional Organization Employees, SD = standard deviation

Despite differences, science museum educators and professional organization employees both reported high levels of perceived cohesion. This indicates that in general the team felt that they were part of a larger network of informal science museum educators more broadly.

The groups differed noticeably with respect to professional development. Science museum educators (M = 6.07) reported higher levels of professional development from participating in the STEPS project compared to professional organization employees (M = 4.69). Although some growth was expected for all participants, including contractors and project leaders who were not included in this evaluation, the STEPS project was designed primarily to help museum educators grow professionally at their institutions. As one science museum educator reported: “It’s been a huge benefit for me as far as the professional development. I’ve been exposed to things that I probably wouldn’t have been able to do without STEPS.”

Scores on overall professional identity were moderately high for science museum educators (M = 5.91) and lower for professional organization employees (M = 4.42). These scores indicate that science museum educators identified with their role as an informal science educator and that they valued this role. Scores for clarity of professional identity were slightly lower. It is not clear why this is the case, but the differences in the wording of the two scales shows that clarity of professional identity referred to the STEPS project’s impact on professional identity whereas the other scale was more generic. Research in Year 4 may shed light on this finding.

3.2 Secondary audience: other science museum educators that will use STEPS and its associated products

3.2.1 Evaluation Question: Was the process for developing these products recommendable for creating a more usable final product for science museum educators?

Method: System Usability Scale Paper Questionnaire

The STEPS software was not yet complete at the time of the ASTC meeting and thus measuring usability through task-based scenarios or think aloud protocols would have been inappropriate. Instead, we chose to use the SUS instrument, which measures an individual’s perception of the usability of a system. It is particularly helpful for testing a system that does not have its full set of

functions and features in operation, but has a complete user interface, which was the case with STEPS.

John Brooke developed the System Usability Scale (SUS) in 1986 to serve as a “simple, ten-item scale giving a global view of subjective assessments of usability” while employed at the Digital Equipment Corporation. It was originally constructed using a large pool of statements and then reduced to 10 items that produced the most extreme responses, which alternate positively and negatively to decrease response bias, (see Appendix E for the 10 statements). The SUS is a non-proprietary survey and covers a variety of aspects from need for support and training to use the tool and interface complexity and therefore has been found to have high face validity for measuring the usability of a system (Brooke, 1996). Cronbach’s alpha has been found to be in the .90’s when used with other samples (Bangor, Kortum, and Miller, 2008).

A completed SUS instrument yields a single number representing a composite score for the overall usability of STEPS. Scores for individual items are not meaningful on their own. SUS scores range from 0 to 100.

Surveys were completed by a small number (n=12) of first-time STEPS users from the project network and also with other informal science educators in the Exhibit Hall at the STEPS exhibit booth during the 2010 ASTC annual meeting in Honolulu, HI (total sample: n=12). Due to low attendance in the exhibit hall in general, the sample size is very low for this portion of the study. These results are descriptive and provide a limited understanding of the perceived usability of the system. First-time users spent 5-10 minutes exploring the software interface for the first time.

The aggregate SUS score for the STEPS software with this sample was 68.125 (SD=12.71, Median=73.75). Bangor, Kortum, and Miller (2008) studied how a set of adjectives correlate to SUS scores or order to aid interpretation for practitioners. This score is considered “good” on their scale which associates adjectives with SUS scores in the following hierarchy: best imaginable, excellent, good, OK, poor, awful, and worst imaginable. Given that the system requires some form of tutorial, training, or user’s manual to operate it, like many specialized software applications (e.g. FinalCut Pro, Adobe Illustrator), and participant’s were on their own to explore the system for this study, this score is particularly promising. Although this sample size is small, the STEPS interface provides enough built-in support for users to perceive that they will be able to use the system.

3.3 Tertiary audience: museum visitors who will experience a STEPS show while visiting a museum institution

3.3.1 Evaluation Question: To what extent are the show's learning goals and experiential outcomes with respect to museum theater achieved?

Method: Pre/Post-Show Paper Questionnaire

One of the shows created by the network partners was Planet Hunter. This was the first show completed and the only show being performed by an institution during the evaluation period. The STEPS Planet Hunter questionnaire was designed to assess to what extent the show's learning goals were achieved for its intended audience of 7-13 year olds. Four learning objectives were developed for the Planet Hunter show by the story subteam.

After experiencing the Planet Hunter show the audience will understand:

1. The difference between stars and planets
2. The differences between solar systems and galaxies

3. That extra-solar planets have been discovered and explore the transit method of discovery
4. That the search for life on extra-solar planets begins with finding Earth-like planets – rocky and water-supporting.

We administered the Planet Hunter survey as a pre/post between-subjects measurement tool at the North Museum of Science and Natural History in Lancaster, Pennsylvania. Three groups of students from the museum’s “Science Around the Corner” program came to see the show throughout the day. “Science Around the Corner” attracts a demographically diverse group of students from local private and public schools within walking distance of the museum. Group 1 was composed of 50 fifth, sixth, and seventh graders, 66% of which were males and 34% of which were females, with an average age of 11.12 years (SD = .98, i.e. 10, 11, and 12 year olds). Group 2 was composed of 69 fourth graders, 47% of which were males and 53% of which were females, with an average age of 9.18 years (SD = .38). Group 3 was composed of 57 third graders, 39% of which were males and 61% of which were females, with an average age of 8.28 years (SD = .57).

Upon entering the planetarium for the show students filled in rows of seats on each side of the theater alternating between the two sides to distribute the classes within the pre- and post-test groups randomly and evenly on both sides of the room. Clipboards with paper questionnaires and a pencil were provided face down underneath each seat. Prior to the show, a researcher asked students on the left side of the planetarium to complete pre-show questionnaires. Once the show was completed, a researcher then asked the right side of the room to complete post-show questionnaires. Volunteers collected the questionnaires from students upon completion. As a thank you gift, we gave each classroom teacher a bag of small finger puppets or pencils to distribute to his/her students back at school. The post-show audience participation activity, the orrery activity, was not performed due to time restraints. Each performance lasted between 15-18 minutes with a follow-up question and answer period with the “Planet Hunter” once all surveys had been turned in.

We developed a five-item, multiple-choice and true/false quiz to cover the breadth of the learning objectives (see Appendix F). Scores for the quiz ranged from 0 to 5, with a 5 representing a perfect score. We used a between-subjects design to assess the impact of the Planet Hunter show on the three groups of students. Descriptive statistics for each of the groups are provided in Table 6.

We conducted a two-way, between-subjects ANOVA for the pre-survey and post-survey knowledge scores. Overall we found statistically significant differences among the groups, $F(5, 170) = 7.929$, $p < .001$. Specifically, we saw a statistically significant main effect between all students who filled out the pre-show questionnaires versus the post-show questionnaires, $F(1, 170) = 7.36$, $p < .001$. In addition, we found a statistically significant main effect between each of the three groups overall, $F(2, 170) = 12.76$, $p < .001$. We conducted post hoc analyses using a Bonferroni adjustment⁵ to identify specifically which groups were statistically different. Overall, Group 1 (the 3rd grade students) scored statistically significantly higher ($p < .05$) before and after the Planet Hunter show compared to the other two groups. In addition, students in Groups 1 and 3 who completed the post-show questionnaire scored statistically significantly higher ($p < .05$) than those who completed the pre-show questionnaire. Unexpectedly, Group 2 (4th grade students) had slightly higher scores before the Planet Hunter show compared to Group 2 students who filled it out after the show (although this difference was not statistically significant and is therefore not concerning to the interpretation of the results). The mean score drop for this group was primarily due to the large

⁵ The purpose of the Bonferroni adjustment is to control for finding statistically significant difference due to chance from running multiple comparisons. The adjustment keeps the overall alpha level at .05.

number of incorrect responses on item 2 (see Table 8 below). Because of the between-subjects design, which was necessary to prevent test effect which results from taking a pre/post test in a short period of time, we attribute this difference in Group 2 to chance and factors beyond the control of this study. These scores do not indicate that students lost knowledge as a result of seeing Planet Hunter (since the groups are different), simply that the second group did not gain more knowledge than the first group had (for whatever reasons) entering the museum that day.

Cohen’s D was computed for the differences between pre-show and post-show scores for each of the groups. Cohen’s D is a measure of effect size that represents the standard deviation difference between the groups. Cohen’s D is considered to be useful for assessing the practical difference between groups because it takes into account group variability, whereas mean differences do not. As a general rule of thumb values around .30 are considered “small effects”, values around .50 are considered “medium/moderate effects”, and values at or greater than .80 are considered “large effects” (Cohen, 1988). Overall, Group 1 (5th, 6th, and 7th grade students) showed large positive differences between pre-show and post-show questionnaires, Group 2 showed negligible differences between pre-show and post-show questionnaires, and Group 3 showed moderate positive differences between pre-show and post-show scores (see Table X, below).

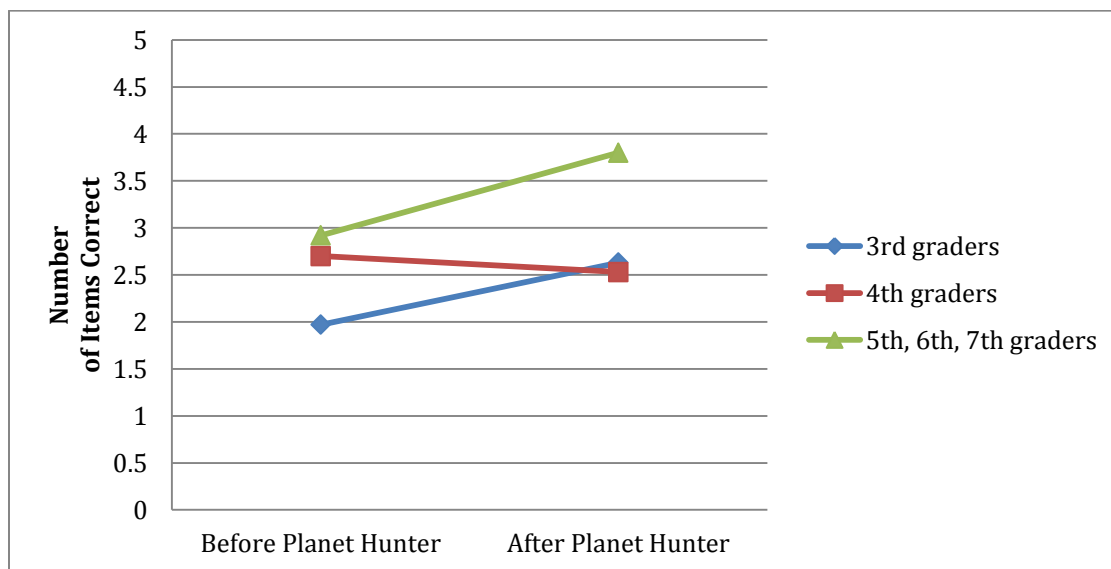
Table 6: Descriptive Statistics for Scores on the Planet Hunter Knowledge Quiz

	Before/After	N	Mean	SD	Effect Size (Cohen’s D)
Group 1: 5 th , 6 th , and 7 th Graders	Before	25	2.92	1.12	.80
	After	25	3.80	1.08	
Group 2: 4 th Graders	Before	33	2.69	1.24	-.13
	After	36	2.53*	1.11	
Group 3: 3 rd Graders	Before	30	1.97	1.07	.64
	After	27	2.63	1.00	

Note: Although not a statistically significant difference, the majority of the decrease from pre to post for 4th graders was related to Question 2.

Overall, these findings provide evidence that students attended to and learned some of the pertinent information identified in the learning objectives for the Planet Hunter show. Figure 1 provides a graphical representation of each of the groups pre-show compared to post-show.

Figure 1: Average Number of Items Correct for Each Group on the Planet Hunter Knowledge Quiz



Results for Each of the Planet Hunter Quiz Items

Results for the percentages of students who correctly and incorrectly answered the individual questions are in Tables Table 7, Table 8, Table 9, Table 10, and Table 11. An asterisk (*) is placed to the right of the correct response for each item. Overall, students who filled out the quiz after experiencing the Planet Hunter show answered more individual items correctly than students filling out the questionnaire before the show. As mentioned earlier, an unexpected larger proportion of students in Group 2 (4th graders) correctly answered item 2 before the show (73%) when compared to Group 2 students who answered item 2 after the show (47% correct). This trend did not hold for either of the other groups and we attribute this result to random error (i.e. chance).

Table 7: Item 1. What is the name of a star with planets orbiting it?

- A. Universe
- B. Galaxy
- C. Solar System*
- D. Asteroid

	Incorrect/Correct	Group 1: 5 th , 6 th , and 7 th Graders	Group 2: 4 th Graders	Group 3: 3 rd Graders
Before	I	60%	48%	63%
	C	40%	52%	37%
After	I	44%	47%	48%
	C	56%	53%	52%

Table 8: Item 2. Scientists think the best chance of finding life on other planets is to find planets similar to Earth.

- A. True*

B. False

	Incorrect/Correct	Group 1: 5 th , 6 th , and 7 th Graders	Group 2: 4 th Graders	Group 3: 3 rd Graders
Before	I	28%	27%	17%
	C	72%	73%	83%
After	I	8%	47%	15%
	C	92%	53%	85%

Table 9: Item 3. Our Sun is classified as a ____.

- A. Planet
- B. Star*
- C. Giant
- D. Nova

	Incorrect/Correct	Group 1: 5 th , 6 th , and 7 th Graders	Group 2: 4 th Graders	Group 3: 3 rd Graders
Before	I	8%	15%	63%
	C	92%	85%	37%
After	I	4%	19%	33%
	C	96%	81%	67%

Table 10: Item 4. Scientists use a method called ____ to find extra-solar planets.

- A. TRANSIT*
- B. OBSERV
- C. SCOPE
- D. BINO

	Incorrect/Correct	Group 1: 5 th , 6 th , and 7 th Graders	Group 2: 4 th Graders	Group 3: 3 rd Graders
Before	I	48%	70%	80%
	C	52%	30%	20%
After	I	36%	67%	70%
	C	64%	33%	30%

Table 11: Item 5. A solar system is composed of many galaxies.

- A. True
- B. False*

	Incorrect/Correct	Group 1: 5 th , 6 th , and 7 th Graders	Group 2: 4 th Graders	Group 3: 3 rd Graders
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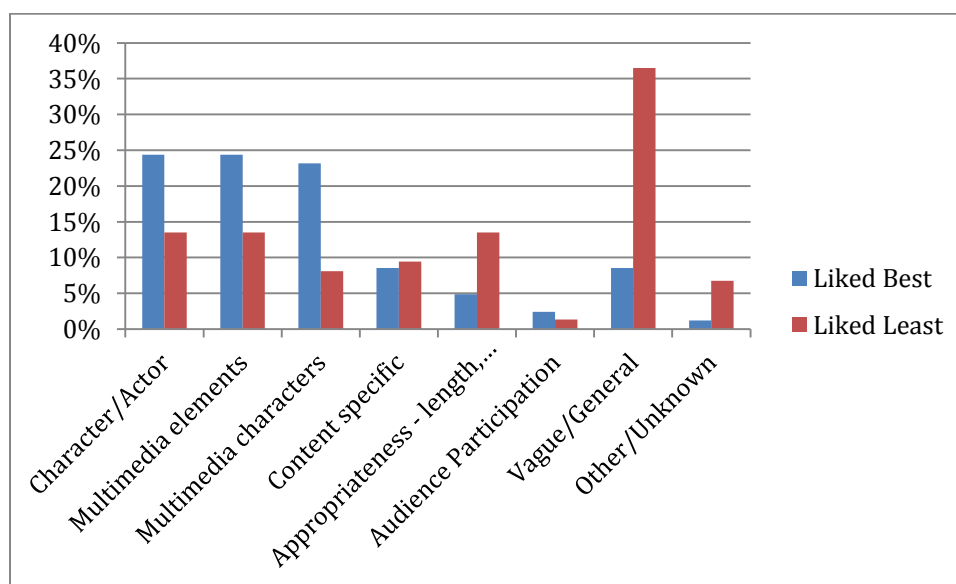
Before	I	64%	70%	80%
	C	36%	30%	20%
After	I	28%	67%	70%
	C	72%	33%	30%

3.3.2 Evaluation Question: To what extent is the STEPS software system and associated storylines and components a successful product?

Method: Open-Ended Questions from Post-Show Paper Questionnaire

The Planet Hunter post-show questionnaire had an additional set of two open-ended questions about what students liked best about the show and what they liked least. Open coding of the qualitative responses by one researcher led to the identification of emergent categories. No preconceived categories were used. Overall, the responses were positive with participants citing specific examples of things they liked best about the show (e.g. character/Actor, multimedia elements, multimedia characters categories) and stating that there was “nothing” that they did not like about the show most often (Vague/General category) (see Figure X).

Figure 2: Comparison of categories for what students liked best and least about the Planet Hunter show



Of the 82 participants who responded to the first question about what they liked best about the show, 26% (n=21) cited the live actor as what they liked best. Students enjoyed the character, some of his reactions to the sound effects in the show (notably, a whip crack), his role as a “Planet Hunter”, and his general demeanor. Representative comments from this category included:

- “when the shot came and he jumped.” (group 2)
- “the Planet Hunter” (group 1)
- “when PH tur[n]ed [into] Aph” (group 1)
- “I liked the weird, not very smart guy.” (group 3)
- “H[im] being a Planet Hunter” (group 1)

“he was fu[n]ny” (group 2)

A novel component of the STEPS theater system was to include multimedia features along with live acting and storytelling to engage audiences. The students in this study particularly enjoyed the multimedia elements. Twenty-four percent (n=20) of the respondents mentioned that they liked one of the multimedia elements best. Nearly all of these responses related to high-resolution images of the planets that were shown and a few participants noted the Kepler video.

Another 23% (n=19) of respondents indicated that they liked the multimedia characters, Sarah and Javier, the best. The inclusion of these characters into the show was strategic for a number of reasons. The young, science-savvy high school-aged characters were chosen to appeal to the younger audiences as role models, particularly by comparison to the humorous and slightly dopey Planet Hunter character. In addition, creating pre-filmed characters to interact with a live actor required only one museum staff member’s time, while enabling dramatic tensions between the characters – a key goal of the system. The software was designed to be most effective with high-quality, high-definition images and the use of such images when projected onto the ceiling of a planetarium dome had the effect of students wondering whether or not Sarah and Javier were real and connecting with the Planet Hunter through a live feed of some kind. At least one student from each group raised his/her hand to ask whether or not those characters were “real” at the end of each presentation on the day of testing.

The remaining comments fell into the content category (9%, n=7), in which students mentioned that they specifically liked learning about the planets and solar system; the appropriateness category (5%, n=4), mentioning that they found the show funny or an appropriate time length; and the audience participation category (2%, n=2), e.g. “[What] I like[d] about the show is when he picked two girls” (Group 2). Due to the time availability of each of the student groups that day, the optional post-show orrery activity was not incorporated. Audience participation was intended to be one of the three key components of a STEPS show (along with live actors and multimedia). Future research is needed to determine the effectiveness of this component of the STEPS shows.

Participant responses to the question about what they liked least about the show also fell into the same categories as those they liked best, however, more than one-third (36%, n=27) of the 74 responses to this question were vague or general comments stating that there was “nothing” they did not like about the show, or similarly: “I liked everything about the show”.

The 14% (n=10) of participants who indicated that they did not like something about the character/actor, provided a range of comments about specific actions the actor made (n=6) (e.g. “how dramatic the guy was”, “the man talking at the same time people were talking”, “when he uses a net”) or that they did not like the Planet Hunter character (5%, n=4). Another 14% (n=10) of responses identified things they did not like as much about the multimedia components (e.g. the planets), and a final 14% (n=10) of responses fell into the “appropriateness” category suggesting that the show was too short, which can be interpreted positively (students wished they could have seen more). The remaining responses fell into the content category (9%, n=7), multimedia characters (8%, n=6), and audience participation (1%, n=1), and other/unknown (5%, n=5).

4.0 Discussion

The STEPS project kicked off in January 2008 targeting three audiences with associated key deliverables:

(1) Primary Audience: create a network of informal science educators and other professionals through collaboration and increase personal and institutional capacity with the development of the

STEPS system, (2) Secondary Audience: other sciences museum educators who will use the STEPS software as a science communication tool in other institutions across the country, and (3) Tertiary Audience: a suite of theatrical shows that would engage and educate audiences in science museums from 7-13 years of age. In this section, we reflect on each of these primary deliverables in light of the evaluation results.

4.1 Primary audience: the museum network that created STEPS

- To what extent is the STEPS product used by individuals in the STEPS network at their institutions?

The sustainability of producing and performing STEPS shows remains a question for some institutions, particularly the smaller museums, as they think through their 2011 budgets and staffing capabilities. For some, this unanswered question is leading to creativity with the formation or extension of community partnerships. Several museums have engaged their local communities for performers. A large museum is working with its teen program to provide the STEPS shows to audiences of all ages. Older teen members will serve as show directors and producers, while the younger teens take on acting parts. A small museum found its *Planet Hunter* program so successful with its younger audiences that their makeshift theater will now become a permanent installation. One museum took the opportunity to reach out to its local theater company to solicit actor volunteers who will sustain the STEPS program in its first months with a debut of *Mars Interrupted* in the first months of 2011.

- To what extent was the process of developing these products recommendable for creating a collaboration/network?

The use of TLT was particularly effective for achieving the professional development and self-efficacy goals of the project. STEPS provided opportunities for every individual to learn a new skill, try something outside of his/her comfort zone, and take leadership roles based on their own self-interests. The project was successful in creating a network, or networks, of individuals who used their relationship in the project to forge new opportunities beyond STEPS. One small and large museum worked together on a NASA grant, which will use STEPS to create new shows about global climate change. A small museum continues to consult with another large museum on theatrical techniques and script writing. Two museum educators from the more geographically isolated partner institutions have found new a network of individuals to share ideas and best practices. Outside of the project, one museum has used STEPS to build a new partnership with a local theater group.

These benefits came at some costs. Decision-making proved difficult throughout the project and there were project members who wanted more top-down structure, particularly at major milestone points.

4.2 Secondary audience: other science museum educators that will use STEPS and its associated products

- Was the process for developing these products recommendable for creating a more usable final product for science museum educators outside of the STEPS project?

Time and marketing efforts will determine the extent to which the STEPS system will be adopted by museums across the country. However, results from the system usability survey and diary study suggest that with the addition of the finalized software tutorial, the STEPS software will serve the unique needs of science museum educators in performing science theater in their institutions. The learning curve for creating and performing shows with the STEPS software was about one month

for participants who helped create the shows from which the software design and attributes were modeled. Future research and evaluation from STEPS partners or out-of-network museums creating new shows with STEPS may shed light on additional features and functionality that will be useful in future iterations of the software if funding becomes available. Unique features like timeline forking, which allows for multiple endings to a story, and the use of museum theater language in the labeling of buttons (e.g. “cues” and “scenes”), are a direct result of museum educator input.

4.3 Tertiary audience: museum visitors who will experience a STEPS show while visiting a museum institution

- To what extent are the show's learning goals and experiential outcomes with respect to museum theater achieved?

The results of the evaluation of the *Planet Hunter* show, which is the shortest and least theatrical of the three shows, provides evidence for success in reaching the target audience with key STEM-learning objectives. Throughout 2011, institutions will use modified versions of the instruments created for the evaluation of *Planet Hunter* to measure the effectiveness of the other two shows across different institution types.

The large statistical effect sizes are particularly encouraging highlighting the differences between pre and post-show groups as not just statistically significant, but practically significant. For example, the target audience, 5th-7th graders who participated in the Planet Hunter Show, performed approximately 20% better on a test covering the shows content than a comparable group of 5th-7th graders who had not participated in the show. Similar results were obtained for 3rd graders. These encouraging findings demonstrate the accessibility of the show’s content to these audiences and the broad appeal of this science content area through a digital and theatrical approach. It is also noteworthy that students in each group provided unsolicited positive feedback about the pre-recorded digital actors and asked about the pre-recorded digital actors; which speaks to the fact that presenting science content in a theatrical way is engaging and convincing.

Opportunities for future research exist to test experimentally which elements of the theatrical shows are most engaging and effective for audience learning (media elements vs. audience participation activities vs. digital characters), which mechanism of delivery is most effective (museum theater vs. documentary vs. exhibit), and what effect different levels of theatrical shows have on learning and engagement (Planet Hunter vs. Extrem-O What vs. Mars Interrupted).

- To what extent is the STEPS software system and associated storylines and components a successful product?

The content and delivery of Planet Hunter was appropriate for the full age range of the intended target audience of upper elementary and middle school students (7-12 years old). The three key features of the STEPS show that were cited as the things that students liked best were the live actors, the multimedia elements, and the addition of multimedia characters. The inclusion of high-quality multimedia characters and components was particularly successful for the 5th-7th graders and was successful at creating a “suspension of disbelief,” which is critically important for lending credibility to theatrical performances.

4.4 Study Limitations

The small sample sizes and the sample irregularity due to attrition prevented us from being able to make stronger inferences about what specific characteristics of individuals or institutions related

to variability in qualitative and quantitative responses. For example, we could only identify overall effects of the impact of TLT on an individual's professional identity, but we could not infer whether the effect is consistent after taking into account other variables (e.g., size of institution, position, etc.).

This report was also limited by the timing of the summative evaluation. We did not have the ability to compare between institutions or test multiple shows by multiple museum educators because the shows were not yet implemented by all members of the partnership at the time of the study.

5.0 Lessons Learned about Team Leadership Theory

Note: This section was written in direct consultation with the PI regarding his reflections on Team Leadership Theory.

The evaluation results point to the successes and challenges of the process used to enhance professional identity and professional development in the STEPS project. Although the Year 4 research report will shed more light on this topic with regards to individual outcomes for the museum educators, the summative evaluation provides an opportunity to reflect on the process and project management components of the use of the Team Leadership Theory framework.

The STEPS project expanded the horizons for the application of TLT beyond other studies and projects related to the framework. In several ways, STEPS pushed TLT to its limits. Perhaps the two most significant aspects came in: (1) Applying TLT to a project team with no previous experience working together and who did not previously know each other and; (2) applying TLT to a wide-ranging geographically-distributed team, resulting in challenges such as coordinating face-to-face meeting opportunities, establishing telecon times across seven time zones, increased reliance on online communication technology (project management wikis, videocons, and Google Docs), and addressing the needs of widely diverse educators, museums, and their audiences.

Therefore, at times, decision making and task management proved difficult for both the project leaders and individual subteam leaders who rotated in and out of leadership roles. This was an identified challenge by nearly every individual involved from the PI, the network partners, and down to the contractors. The tension between a bottom-up leadership style and the need to "get the job done" within the constraints of time, budgets, and other project realities provides interesting opportunities for future research. Such opportunities would include the augmentation of TLT with elements of other leadership strategies that maintains the positive elements of professional development enjoyed especially by the network partners while supporting more transparent and timely decision making to achieve critical project milestones.

Additional findings about TLT as it was applied in STEPS that may be of significant use to future projects include:

1. Institutional buy-in for a project like STEPS is critical, and strong efforts were made throughout the project to connect the project directors with both the museum educators as well as their museum CEOs and directors as partners for success. For the institutions who had directors actively participate in the project, the institutional impact and opportunities for individual growth were high. For institutions that lacked that level of participation and commitment, the project was more of a struggle for their educators. Two institutions ended up leaving the project due, in some part, to this issue. Regular personal phone calls from the PI to the institutional directors and a periodic executive summary sent to all of the partners helped facilitate part of this process. However, this

evaluation stresses the continued need for that level of support for other projects that may take on this form of collaboration.

2. Process or collaboration evaluation, like a pulse check, is highly recommended by the PI for measuring the impressions and attitudes of the project team over time. This allows the project management team to reflect systematically and holistically with quantitative and qualitative data, and then make time-sensitive decisions, changes to their approach and project structure, and other interventions as necessary.
3. Collaborative and multi-disciplinary projects that demand the development of new skills and require participants to venture out of their “comfort zones” have a wealth of benefits particularly in the area of participant growth and self-efficacy.
4. Face-to-face interactions were very important and an assumed component of the LaFasto & Larson studies. The pulse checks showed that face-to-face meetings had a positive impact on team morale and group cohesion as well as on pushing the project’s timelines forward. This point cannot be overstated. Like STEPS, future projects that adopt TLT should: (1) Provide ample travel funds for planned meetings with high frequency that will allow geographically dispersed participants to meet and to reinforce a shared vision for the project goals, and; (2) Build in a flexible travel fund for unplanned meeting requirements when it becomes clear that the project could benefit from it. Often these opportunities and needs cannot be forecasted and may not occur even at the milestones when one might expect.
5. If the primary deliverables for the project had simply been the software and the associated astrobiology shows rather than the more complex and subtle goals of professional development and professional identity enhancement for the participants, a more traditional top-down management structure might have been less expensive and more efficient. However, the original intent for using the TLT framework was two-fold: (1) To promote the development of deliverables that would be grounded in the experience and expertise of museum professionals and, therefore, more usable/desirable by others in the field by project completion and; (2) the growth and development of informal science education professionals through their active participation in TLT within the broader context of a working community of practice. In light of these priorities, TLT within the context of a community of practice is highly recommended for personal and institutional growth through unique and challenging professional development experiences and opportunities.

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In Boulder, January 18, 2008
The Unanimous
Declaration of Collaborative Excellence
of the STEPS Project Team

When in the course of educational efforts it becomes possible for science communicators to push their field forward and to assume strident advances in theory and practice among the professional advocates of science literacy on the earth, a decent respect to the opinions of their colleagues requires that they should declare the causes which impel them and the details of their aspirations.

We hold these assertions to be supported by research and experience, that science communicators operate in a world of difficult challenges, that they strive for enhancements of their professional identities and circumstances through certain laudable efforts, that among these are increased impact, innovation, and the pursuit of collaboration.

To secure these efforts, the STEPS network is hereby established -- deriving its powers from the participation of its constituents -- to provide an enriching community of practice and laying its foundation on such principles and organizing its powers in such form, as to the STEPS team seems most likely to effect achievement of goals and professional development opportunities.

We, therefore, the representatives of the STEPS project, in general congress, assembled, appealing to the highest motivations of science communicators everywhere for the rectitude of our intentions, do, in the name, and by authority of the good people of these united institutions, solemnly publish and declare, that the STEPS project is now officially in active pursuit of collaborative excellence in accordance with the goals, processes, and products laid out herein. And for the support of this Declaration, we mutually pledge to each other our time, our resources, and our respectful honor.

STEPS Collaborative Framework

The STEPS project team puts forth the following as clear and elevating goals for both the process and products of the work to be done: The *STEPS* project will advance the theory and practice of informal education with innovations in professional development through a unique collaborative network, combining small and large science centers, and the creation of a flexible theater presentation system. With the inaugural *STEPS* astrobiology shows, it will also develop and implement an informal learning experience for science center visitors designed to increase interest in, engagement with, entertainment from, and understanding of science. The *STEPS* project will also include an extensive and pervasive evaluation and research component to examine the process and results of the project in order to generate valuable learning for the field of informal science education.

The central framework, which all components of this project support, is professional development of informal educators with the intent of enhancing their sense of professional identity, building the capacities of their home institutions, and informing the field about the relationship between professional identity and multi-institution collaborative networks.

To enact and ensure the achievement of these lofty aspirations, we, the STEPS project team, assert the following Guiding Principles (based on the eight characteristics for excellence identified in Lafasto and Larson’s Team Leadership Theory) to serve as a compass for our collaborations:

1. We shall endeavor to define, evolve and participate in a shared vision of collaboration as the solution through the shared project (*STEPS*) and provide the means for partners to identify relevant needs through participation in the front-end evaluation.
2. We recognize and support the leadership structure of the project, identifying the Space Science Institute as the primary leader, and the creation of several sub-groups as well as rotating leadership positions to distribute leadership responsibilities as appropriate throughout the duration of the project.
3. We recognize the need and importance of Committed Members to the project, both individually and institutionally, and define such commitments in the Collaborative Agreement document.
4. We shall endeavor to constrain work on this project to what we deem as Realistic Time Commitments, recognizing that collaborative processes often require more time and effort, but also garner more benefits.
5. We shall strive to create In-Person Communication opportunities among collaborators whenever possible through multiple meetings, partner site visits, and annual ASTC workshops.

6. We shall endeavor to eliminate any ambiguity in funding support for the project to support the work to be done.
7. We shall strive to ensure that the Benefits of Participation Outweigh the Investment for each partner in each element of the project, with the goal that seek partners accomplish more together than they could have done separately.

Amendments

To be generated as needed as the project evolves.

STEPS Collaborative Agreement

We the Team Members of the STEPS project, in order to form a powerfully capable, mutually enriching, and highly successful collaboration, commit to engage in and contribute to the best efforts of this newly formed and unique network of science communicators, writers, artists, scientists, and media professionals in achieving the worthy goals established for and by it within the STEPS concept.

To this end, and in the spirit of defining a unified commitment to a results-driven structure and collaborative climate, the STEPS team members agree to the following roles, expectations, and responsibilities:

--We commit to work with the project director, project manager, and other participants to contribute to the collaborative work described in the proposal.

--As one of the project partners, one or more of our team will attend required in-person and virtual meetings including representative sessions during the workshops, partner meetings, and monthly meetings with the project staff.

--We agree to work with other collaborative members on task teams, identified as Development Emphasis Areas (DEAs) and in other smaller group efforts working toward successful completion of the project.

--We will work with other collaborative members in the development and delivery of both the *STEPS* system and the inaugural astrobiology presentations during the three-year project development term of the grant.

--During the development term, we agree to support prototyping of the project deliverables and, upon completion, we agree to install the presentation system that comes with the grant project and will deliver *STEPS* programs on a regular basis for at least up to one year post-participation, allowing for customizations as needed.

--We agree to provide access and information to the project's research team as described in the proposal throughout the three year project development term and for one additional year post-participation.

--We commit to use the agreed-upon protocols and tools of communication, including: necessary in-person meetings with the larger group, with smaller task-oriented groups, and with specific partners; participation in regular telecons with the same, as needed;

electronic communication via the tools provided in the project website as posting messages, to-do items, milestones, writeboards, and file-sharing.

--We commit to the identification and constructive communication of dissenting opinions and ideas regarding both the processes and products of the STEPS project, recognizing that discourse upon dissent may or may not lead to changes and/or amendments to the collaborative governing documents and practice.

--We agree to work together to decide how much time each partner shall spend on various activities to ensure reasonable commitments. This shall occur through regular communication during the project.

--We commit to honor formative evaluation results to ensure usability of the project deliverables.

--In the event of staff changes, we commit to clear and expedient "passings of the torch" to minimize negative project impact.

--We commit to communication with the rest of our institution staffs and leaders about STEPS development and use activities.

--We agree to a hierarchy of collaboration that includes cooperation, collegiality, and responsibility, moving from the more general to the more specific and individual commitment to the project and its team.

Signatures

Amendments

Appendix D – Diary Study Entry Form

STEPS Diary Study – created in Google Forms

Please Read Before Starting

Thank you for participating in our ongoing evaluation and research efforts for the STEPS project. For the duration of this diary study, we would like you to use the STEPS software and its associated scripts, audience participation activities, and props as often as you normally would in line with your institution's programming plans. Your thoughts and experiences are invaluable to the research and evaluation components of this grant.

For the next month or so you will receive reminders to complete diary entries by accessing the link to this form. We ask that you go to this link and complete a diary entry each day that you use STEPS 3-5 times a week as appropriate. We estimate that it will take 10-20 minutes to fill out completely the first time, and only about 10 minutes in subsequent entries. Here are some things to keep in mind while you are filling out the form:

- Relate as much as you can about your experiences, positive and negative, big and small. We are interested in all of it, no matter how minor it may seem at the time. We are especially interested in experiences that were surprising or unexpected.
- Our goal is to make STEPS work better for you and other museum professionals. If you can't get some feature to work, or are having trouble understanding portions of a script or content on the tutorial, it is not your fault. Please describe any such situations in detail.
- Whenever you try something in STEPS that you had not used or explored before, please tell us about it, whether or not you were able to get it to work. Describe the situation in which you used it in detail.
- If you're not sure about whether to put something in the diary or not, please put it in.

If you ever have any questions, please don't hesitate to contact Jes Koepfler at jes@uxrconsulting.com, (###) ###-####.

STEPS Diary Study

* Required

Let's Get Started!

Your answers to these questions help us better understand the extent to which members of the collaboration are using STEPS. This is an exploratory study and there are no right or wrong answers. Your candid feedback will be the most useful to us as we continue the research and evaluation components of the STEPS NSF-funded project. Your responses will be kept confidential and your data will be reported in aggregate. In short, your secrets are safe with us, so don't be shy.

Here's a few easy questions to get started. You'll only have to answer a couple of them in future entries.

Your Name: *

Your Institution:

Today's Date: *Please use mm/dd/yyyy format

Time at Start of this Diary Entry: *Please use hh:mm format and include whether it's AM or PM

Approximately when did you join the STEPS team? Please use mm/yyyy format

Approximately when was the first time you used a version of the STEPS software? Please use mm/yyyy format

Have you already completed this form AT LEAST once? If yes, you'll skip the first set of scaled questions.

- No
 Yes

Before Using STEPS Today...

(This will be the only time you have to answer these questions.)

Before using STEPS today, please rate your confidence level with regards to using the STEPS software. *

_____ 1 2 3 4 5 6 7 _____
Not at all confident Extremely confident

Please describe your reasoning for your rating:

Before using STEPS today, please rate your confidence level with regard to performing outreach shows. *

1 2 3 4 5 6 7

Not at all confident Extremely confident

Please describe your reasoning for your rating:

Before using STEPS today, please rate your confidence level with regard to performing museum theater. *

1 2 3 4 5 6 7

Not at all confident Extremely confident

Please describe your reasoning for your rating:

Tell Us What You Did with STEPS Today

Which STEPS shows did you work with today (if any)? *Check all that apply.

- Planet Hunter
- Extremo-What
- Mars Interrupted (formerly MISTY)
- Unique show(s) at my institution (Please describe)
- None
- Other:

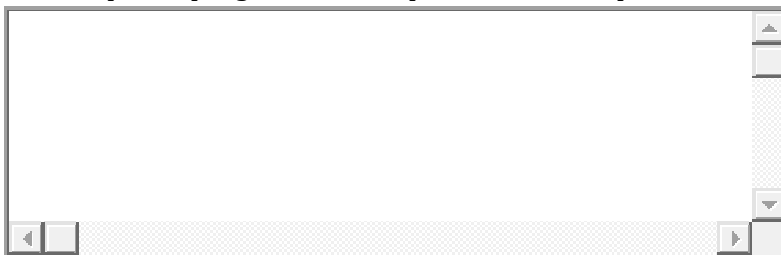
If you selected "Unique show(s)..." above, please describe the shows you are doing at your institution. Include a brief description of the content, where you are in the process of creating the show, and its title.

A large, empty rectangular text box with a light gray border and a vertical scrollbar on the right side, intended for the user to describe their shows.

Which component(s) of STEPS did you work with today? *

- Asset Manager
- Show Planner
- Presentation Player
- Astrobiology Tutorial
- Working with the script(s) for the show(s)
- Working with assets for the show(s)
- Working on audience participation activities
- Working with another STEPS member on the project
- Working with another staff member at your institution on the project
- Working with props for the show(s)
- Other:

Who else, if anyone at your institution, was involved in your work with STEPS today? Please indicate their role(s) and how you are working with them on STEPS: Consider folks in marketing, interns, public programs, development, fellow departmental colleagues, etc.

A large, empty rectangular text box with a light gray border and a vertical scrollbar on the right side, intended for the user to list other people involved in their work.

Approximately how much time did you spend working with STEPS today? *Include time for preparation, planning, rehearsing, presenting, troubleshooting, training others, etc for TODAY only.

Please use hh:mm format.

Describe the experience you had with STEPS today. Feel free to include as much detail as you want, thinking about challenges, successes, surprises both good and bad... *



Did you use anything new in STEPS today? A new feature of the software? A new storyline? A new audience participation activity, etc.? *

- No
- Yes

[« Back](#) [Continue »](#)

Now That You Have Used STEPS...

Now that you have used STEPS a bit more, please rate your confidence level with regards to using the STEPS software. *

_____ 1 2 3 4 5 6 7 _____

Not at all confident Extremely confident

Please describe your reasoning for your rating:

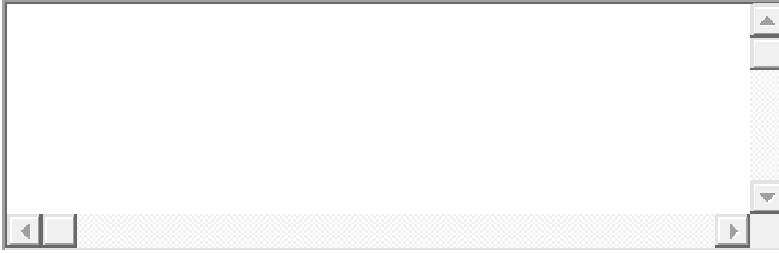


Now that you have used STEPS a bit more, please rate your confidence level with regards to performing outreach shows. *

_____ 1 2 3 4 5 6 7 _____

Not at all confident Extremely confident

Please describe your reasoning for your rating:



Now that you have used STEPS a bit more, please rate your confidence level with regards to performing museum theater. *

1 2 3 4 5 6 7

Not at all confident Extremely confident

Please describe your reasoning for your rating:



If you have any additional questions, comments, or concerns, please note them here.



Thank You Very Much for Your Time

Your feedback during this process is truly invaluable to the research and evaluation components of this study.

What time is it now that you are submitting this diary entry? This information simply helps us know how long certain types of instruments take people to complete on average. It is not used for

analysis. Please use format hh:mm and include whether it's AM or PM

Appendix E – Interview Themes and Questions

A. Individual – Self-efficacy, professional development, individual learning

- How do you feel about your contributions to the team/project?
- Do you feel like you held up your end of the deal?
- How did working on a project of this magnitude and complexity affect your performance at your institution?
- What are your impressions of this project as a professional development opportunity?
- To what extent did you learn new things?
- ...apply old skills to a new problem?
- ...share your skills/expertise?
- To what extent did you feel your institution valued the work you were doing on the project?
- In what ways were you brought out of your comfort zones? Was it beneficial?
- If you hadn't done STEPS would you have developed these skills?
- Having participated as an individual, do you think it has helped you in other areas at your institution?

B. Process – Overall project, management, time and logistics – value

- Team leadership approach – not a top-down structure, dependent on other people to stand up and take a turn at leadership, defined by setting their own agendas and tasks and setting their own deadlines and milestones and moving those around as needed to get the job done.
- Did you appreciate that approach? For the process and for the product
- In terms of doing the work on teams, or participating in the community that was built, how did the notions of Team Leadership Theory work for you, or not?
- How do you think the leadership framework for this project impacted the results? (both for you and for the product)
- Given that this was run with distributed leadership what were some of the gains, that you got from that?
- What were the difficulties or challenges that came about because of it?
- How much did you feel that you captured and embodied these goals?

C. Product – How do you feel about the overall product that you created?

- Several deliverables came out of this project:
 - A front-end evaluation
 - Stories
 - Software
 - Shows (combo of stories with the software and assets)
 - Astrobiology tutorial
- How do you feel about the products that you've created?
- If you had to do it all over again what would you do the same way?
- What would you change?

D. Future – where will we all take this as a group? As institutions? As individuals?

- How will you implement your experience with STEPS within your own organization or wherever you're going next?
- How will you take advantage of the network that has been created, if at all?
- How will you use STEPS as a tool to reach existing or potential audiences?

Appendix F – Pulse Check Statements and Categories

Decision Making/Leadership:

Q2 I feel empowered to take a leadership role in advancing my area of responsibility on the STEPS project.

Q5 I can provide input into decision-making.

Q16 STEPS provides opportunities for people to take leadership roles.

Q19 Decision-making is fair and equitably distributed among the partners.

Q20 Decisions are made effectively and efficiently.

Capacity building/growth:

Q3 I can contribute outside my primary area of expertise.

Q10 I have grown in my professional capacity through collaborating on this project.

Q11 I can use what I learn in STEPS in other areas of my professional life.

Q17 People can contribute outside their primary area of expertise.

Q18 The project allows participants to grow.

Communication:

Q1 I feel that I can discuss issues freely and openly with STEPS partners.

Q14 People are discussing issues openly and fairly.

Q22 Coordination between the various subteams works well.

Inter-team Support:

Q6 My input and ideas are valued by others in the collaboration.

Q13 I feel sufficiently supported in my project participation.

Q15 People's perspectives are valued in this collaboration.

Expectations:

Q8 From my perspective, the project is achieving the goals I anticipated.

Q9 The project takes up too much of my time and attention.

Q12 I enjoy taking part in the STEPS project.

Q23 In general, the project seems to be on track and seems to achieve its intermediate goals.

Additional items tested formatively, but not included in the summative evaluation:

Q7 I can participate in efforts to use evaluation to monitor progress and document achievements.

Q21 The collaboration uses research and evaluation effectively to measure achievement.

Q4 I can contribute equally and fairly.

Appendix G – STEPS Network Final Survey

Scale 1-7: 1=Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree. 7=Strongly Agree
Negative items were reverse-scored

Professional Development Items

- I feel that I have developed professionally through my involvement with the STEPS project.
- The STEPS project has helped me grow in my career.
- Being a part of the STEPS project has taught me new things about my career.
- Working with other informal science educators has helped me develop as a professional.

Perceived Cohesion Scale

- I feel a sense of belonging to the informal science educator community.
- I am happy to be at my institution.
- I see myself as part of the informal science education community.
- I am enthusiastic about the institution I work for.
- My institution is one of the best in the field.
- I feel that I am a member of the informal science education community.

Consider the following definition of professional identity as you respond to the next set of statements.

Professional Identity is “the relatively stable and enduring constellation of attributes, beliefs, values, motives, and experiences in terms of which people define themselves in a professional role.”

Clarity of Professional Identity

- Working on the STEPS project has helped me develop a professional identity.
- I am still searching for my professional identity.
- The STEPS project has helped me better understand who I am professionally in my career.
- I do not yet know what my professional identity is.

Professional Identity (General)

- I consider myself an informal science educator.
- I have many goals related to being an informal science educator.
- Many of my friends are informal science educators.
- My job is an important part of my life.
- Other people see me as an informal science educator.
- I would be disappointed if I could not continue being an informal science educator.

Performing shows

Rate your level of confidence: 1=Not at all confident, 7=Extremely confident

- ...with regard to performing outreach shows
- ...with regard to performing museum theater

Software

- Rate your level of confidence: 1=Not at all confident, 7=Extremely confident...with regards to using the STEPS software.
- I can use the STEPS software to develop a show.
- Rate your level of satisfaction using the STEPS software.

Appendix H – System Usability Scale Statements

Created by John Brooke in 1986, validated and published in 1996.

Scale: 1-Strongly disagree to 5-Strongly Agree

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.
- I think that I would need the support of a technical person to be able to use this system.
- I found the various functions in this system were well integrated.
- I thought there was too much inconsistency in this system.
- I would imagine that most people would learn to use this system very quickly.
- I found the system very cumbersome to use.
- I felt very confident using the system.
- I needed to learn a lot of things before I could get going with this system.

Appendix I – Planet Hunter Survey

Pre-Show Questionnaire

Test Your Knowledge

Take a quick quiz to test your knowledge on questions related to astrobiology!

Please *check the box* next to your answer for each question.

1) What is the name of a star with planets orbiting it?

- Universe
- Galaxy
- Solar System
- Asteroid

3) Our Sun is classified as a _____.

- Planet
- Star
- Giant
- Nova

2) Scientists think the best chance of finding life on other planets is to find planets similar to Earth.

- True
- False

4) Scientists use a method called - _____ to find extra-solar planets.

- TRANSIT
- OBSERV
- SCOPE
- BINO

5) A solar system is composed of many galaxies.

- True
- False

★Are you...

- Female
- Male

★What is your age in years? (e.g. 35)
_____ years

★With whom are you visiting the museum today?

- Alone
- With other adults only
- With other kids only
- With other adults and kids

★Did anyone help you complete this survey?

- No
- Yes
- If yes, how old was that person in years?
_____ (years)

~Thank you for your help!~

Planet Hunter Survey for Youth – We Need Your Feedback!

Post-Show Questionnaire

Your Thoughts on Astrobiology

★ In general, how **interested** are you in topics related to astrobiology?

(Please, circle your answer)

Not very interested				Very interested		
1	2	3	4	5	6	7

★ In general, how **knowledgeable** are you about topics related to astrobiology?

(Please, circle your answer)

Not very knowledgeable				Very knowledgeable		
1	2	3	4	5	6	7

★ What did you like BEST about the show? _____

★ What did you like LEAST about the show? _____

Test Your Knowledge

Please **check the box** next to your answer to each question below.

1) What is the name of a star with planets orbiting it?

- Universe
- Galaxy
- Solar System
- Asteroid

2) Scientists think the best chance of finding life on other planets is to find planets similar to Earth.

- True
- False

3) Our Sun is classified as a _____.

- Planet
- Star
- Giant
- Nova

4) Scientists use a method called _____ to find extra-solar planets.

- TRANSIT
- OBSERV
- SCOPE
- BINO

5) A solar system is composed of many galaxies.

- True
- False

A Bit About You

★ Are you...

- Female
- Male

★ How old are you? _____ (years old)

~Thank you for your help!~