**To be more inquisitive in the natural world:**

**Evaluation of the *Interpreters and Scientists Working on Our Parks***

**(iSWOOP) pathways project**

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*Interpreters and Scientists Working on Our Parks* (iSWOOP) is a Pathways project funded by the National Science Foundation (DRL #1323030) that brings together educators, scientists, and National Park Service (NPS) interpreters to incorporate site-based science into programs for the public. Beginning in October 2013, the two-year iSWOOP project (PI: Martha Merson, TERC) has engaged park ranger interpreters from New Mexico’s Carlsbad Caverns National Park (CAVE) in a new model of professional development featuring on-site scientific research, visual data and inquiry-oriented techniques for increasing STEM learning opportunities for visitors. Co-PI Nickolay Hristov and Senior Scientist Louise Allen of Winston-Salem State University have conducted scientific research at CAVE since 2004. Their research on the hundreds of thousands of Brazilian free-tailed bats that roost at CAVE formed the centerpiece for the professional development and visual library in this pilot project.

The key components of iSWOOP included: *on-site professional development*, with field-based and seminar-style experiences; interpreters becoming conversant in *technologies used for scientific research* (thermal imaging; laser scanning, high-speed imaging, spectrographs for bio-acoustics); a *library of* *visualizations*, including still images, video footage, animations and graphs; *display options*, including a mobile cart with laptop and 60” screen, and iPads; and *ongoing contact* with scientists and project leaders via e-mail, blogs, follow-up visits, and conference calls. Fourteen interpreters participated in the first two rounds of training, held at CAVE in January and June 2014. As a result of training, interpreters each crafted a unique program using a subset of the material in the visual library that they could incorporate into their work with visitors.

Dr. Cynthia Char of Char Associates, an independent consulting firm specializing in program evaluation, led the program evaluation with assistance from Sara Morales, research associate at New Mexico State University’s Institute for Mathematics and Science Education, and TERC staff. The evaluation assessed iSWOOP’s impact on interpreters’ knowledge and practice.

Addressing the pathway project’s primary objectives, the evaluation examined the extent to which iSWOOP was successful in: a) Increasing interpreters’ knowledge and understanding of on-site scientific research; and b) Enhancing interpreters’ strategies for engaging the public through visual media with on-site scientific research and technological tools. The evaluation also investigated participants’ reactions to the program, as to what aspects of the program interpreters valued most, obstacles to implementation and types of needed support, and recommendations for program improvement.

Sample and Methods: The sample consisted of 14 interpreters who had participated in multiple sessions of iSWOOP professional development. Interpreters had participated in one of two rounds of on-site training, held in January and June 2014. A mixed methods approach was used, with data sources including interpreters’ applications to participate in iSWOOP, pre- and post-project interpreter surveys, observations of visitor programs, and forms interpreters submitted that described visitor learning occurring during programs.

The 14 interpreters (100% return rate) completed pre-project surveys online prior to the first day of training, and post-project surveys after interpreters had at least ten weeks in which to implement iSWOOP visitor programs.

Observers took ethnographic field notes during 26 iSWOOP programs for visitors beginning in Summer 2014. Nine of the ten iSWOOP interpreters working at the park that summer were observed. (Four of the nine interpreters participating in the January training had already moved onto other summer placements.) Observers (one member of the external evaluation team and one project staff member from TERC) conducted observations on ten different days at four points in time throughout the summer and early fall.

Using their field notes, observers scored the interpreters’ programs on four major dimensions central to the project: 1) park-based research questions and findings; 2) scientific content related to bat behavior; 3) use of technology and images; and 4) visitor interaction techniques.

Scoring was on a 3-point scale (0 = not evident, 1 = evident, and 2 = exemplary). The set of specific behaviors scored (total of 21 behavioral items) closely corresponded to those that interpreters were asked to self-assess in the surveys. Thus, observational rating forms provided an additional source of evidence with which to triangulate findings from the self-report surveys. Interpreters were also rated on their overall visitor engagement and visitor interactivity (low, medium, high).

Interpreters played a key role in helping gather information to help gauge visitors’ learning from the iSWOOP programs, through an *interpreter form on visitor learning*. Comment boxes and questions on the forms interpreters completed after delivering their programs asked specifically for impressions and quotes related to visitor learning. Interpreters recorded visitor responses to variations of two questions that they posed towards the end of a visitor program: “Did you see something in a new way?” and “Who found out something new about scientists’ work?”

For each question, the interpreter first received a show of hands from members of their visitor group, which s/he then recorded, and then asked for a few volunteers to share their thoughts on what new things they had seen or found out. After the session, interpreters recorded these comments in an on-line feedback form created by project staff to capture visitors’ reactions and interpreters’ observations.

The interpreters submitted comments on 104 program sessions with a total of 1067 visitors in the project’s first nine months of programming (January through September 2014. Winter/Spring: 404 people, on 49 forms; Summer/Fall: 663 people, on 55 forms.)

These comments were coded by three members of the evaluation/project team, using categories that emerged from the comments and that were naturally in alignment with the main features of the project, project goals, and reactions in blog posts from interpreters. All comments were reviewed by all three team members, and scored by consensus.

**Background Profile of Interpreters**: To capture the working knowledge and prior experience that interpreters might draw on to explicate science processes or to build visual literacy with visitors, several items on the program application forms and pre-program surveys asked participants about their backgrounds along a variety of dimensions. Results revealed that the majority of interpreters were generally in their twenties and thirties and early in their careers with the National Park System, had some background in the sciences, and were a largely transient and fluid work population, working across a variety of different park sites.

All 14 interpreters were currently working full-time at CAVE (31-40 hours (11), or more than 40 hours (3)) at the time of their iSWOOP participation. All nine interpreters in Cohort I (trained in January) were year-round NPS employees. They, however, were about evenly split between those who continued to work at CAVE following their iSWOOP training for five months or more into the summer (5 people), versus those who left CAVE after the winter season was over (4 people). For Cohort II (trained in June), all five interpreters were seasonal employees working at CAVE for the summer.

Most (11 of 14) of the interpreters were in their twenties or thirties (five being in their twenties), and thus relatively early in their careers; two were in their fifties.

As a group, the iSWOOP interpreters constituted a relatively young work force in their time at the NPS. Over half (8 out of 14) had worked in the national parks for five or fewer years. Four had worked at parks over a 6-10 year period, while two had worked in the parks for a 11+ year time period. Moreover, a number of the positions held were highly seasonal, with some staff working only summers, possibly coupled with fall or winter seasons. Thus, one may have worked in the National Park System across a multi-year period, but only during the summers.

Many interpreters came with experience working at a number of different National Parks. Most (9 out of 14) reported working in four or more different parks across the country, with six of them indicating six different parks in their work history. Only four mentioned working at only one or two parks to date. Even including the permanent staff participating in iSWOOP, only four of the 14 had been working at CAVE continuously for four or more years. Several of the participants, while seasonal, have returned to CAVE to work at different points in time.

Most (10 out of 14) described their work responsibilities at the parks in which they have worked as dealing with interpretation and programming for visitors for “most” or “almost all of the time”. Four described how interpretation had been a more minor focus in some of their earlier NPS positions, but were now ones that they viewed as primarily involving interpretation. Thus, it appeared that all the participants were serious in park interpretation as a career focus and path.

Regarding their formal educational training, almost two-thirds (9 of the 14) had degrees in the sciences, with the majority of B.S. degrees in the area of conservation science, forestry and resource management. One third had non-STEM backgrounds, such as in history and anthropology.

Asked to describe how they spent their time during off-hours from work, many (12 of the 14) continued to pursue activities related to their park work. Activities included: volunteering at other parks, trail restoration, gathering data for scientific projects, doing talks and interpretive work with school groups, scouts, amateur photography, hiking and exploring back country, caving, and reading magazines and books about science and nature. Thus, individuals’ choice of work at the NPS appears to reflect some core personal interests, lifestyle choices, and values.

Regarding program design implications of the interpreters’ backgrounds, the interpreters engaging in the program were receptive professionals, dedicated to interpretation as a major part of their job responsibilities, and engaged in leisure pursuits related to their jobs, with a number having some formal training in science. Given the somewhat transient nature of the NPS interpreter workforce (with its mix of seasonal and longer-term employees), there is a clear need for an efficient and streamlined professional development process for interpreters becoming knowledgeable and connected to their specific local park site. At the same time, it seems worthwhile also to have professional development that helps equip them with broader scientific concepts, interpretive skills and approaches that can be generalizable across a variety of park sites in which they might work.

**II. FINDINGS OF PROGRAM IMPACT**

Findings of the iSWOOP program impact are organized into two major sections, pertaining to the primary goals regarding: a) Increasing interpreters’ knowledge and understanding of on-site scientific research; and b) Enhancing interpreters’ pedagogical strategies for engaging the public through more interactive styles of engaging visitors, featuring visual media on on-site scientific research and technological tools.

**A. iSWOOP increased interpreters’ knowledge and understanding of park-based scientific research**

Greater Access to Pertinent Scientific Research and Scientists.

***Summary: Information needs are significant for park interpreters, who often search for park-related scientific information weekly. They tend to rely most on the Internet and on materials prepared by others for use in the park, and to a slightly lesser extent, journal articles. They generally viewed their information searches as successful.***

***Another way to learn about park-based science is through direct contact with scientists. In the experience of these interpreters, such opportunities were quite rare, with low frequency of various kinds of contact (e.g., public lecture; briefing sessions; guided tours; participating in actual data collection; regular ongoing exchanges with scientists.) Thus, iSWOOP offered a rarely utilized form of contact and collaboration between park interpreters and scientists conducting on-site research. By delivering direct contact with scientists, iSWOOP project activities increased interpreters’ understanding, first-hand experience, and enthusiasm about on-site scientific research happening at their parks.***

**Access to Pertinent Scientific Research and Scientists**. In pre-program surveys, interpreters described their pressing needs for scientific information about park phenomena, often engaging in information searches at least weekly. They most commonly relied on the Internet and on materials prepared by others for use in the park, and to some degree, journal articles. Direct contact with scientists was rare.

The vast majority of interpreters reported quite frequent searches for scientific information about park phenomena. Almost all (12 out of 14) indicated that they searched out scientific information as part of their jobs on a weekly basis (7 reported “several times a week”, while 5 report “almost weekly”). Only two said that they searched for information only twice a month. None indicated “monthly”, “every few months”, or “rarely or never”. This might be as expected, given that for many interpreters, their park position at a specific park may only last for 3-6 months. Thus, staff are expected to “hit the ground running” shortly after arriving at a park site, and competently handle their interpretation responsibilities with visitors.

Interpreters indicated in their pre-program surveys that they were generally successful in finding information they were seeking. As one interpreter voiced, “Sometimes it feels like a wild good chase, but I usually find what I’m looking for.” Five interpreters offered additional comments regarding factors that seemed to significantly heighten their success: being helped out by co-workers; having a good on-site library and library staff; having strong research skills, and knowing how to reach out to the right scientist or expert.

Regarding the kinds of information sources they utilized for scientific research related to park phenomena, interpreters tended to rely on most frequently (either “some” or “a lot”) the *Internet* (14; with 12 reporting using it “a lot”), followed by *materials prepared by others for use in the park* (13; with 9 reporting “a lot), and then, *scientific journal articles* *related to science in the park* (13; with 6 reporting “a lot”).

One interpreter described some of the challenges in obtaining pertinent and useable scientific research:

*The greatest challenge is getting the research-based information and publications to the staff and translating that scientific information into a language that is easily understandable to a person without the science background (park guides). We do not have much time in our daily jobs to research topics extensively. Also, there is so much information available that sorting through it can be difficult for some. We need science-based information available to staff that is easy to read/understand and is in a condensed version with the main ideas and scientific findings. Reading scientific journal articles can be confusing and intimidating for some.*

For most interpreters, direct contact with scientists was rare. When asked about specific ways they had interacted with scientists for the purpose of learning about their park-based research, most interpreters reported “a little” to “none” for most forms of interpreter-scientist interactions. These included *public lectures given by scientists in the park in which I’m working* (11; with 5 reporting “none”); *participating in actual data collection as part of scientific research at the park* (10; with 7 reporting “none”); and *regular ongoing exchanges (in person or by e-mail) with scientists* (10; with 4 reporting “none”). *Scientist-guided tour of the park* (9, with 5 reporting “none”); and *briefings by scientists, as part of the job* (9, with 4 reporting “none”) were also quite rare.

When describing the kinds of professional contact with scientists interpreters have had prior to iSWOOP, many indicated that contact was quite limited, and was very park-specific and varied depending on the park. Contact was typically limited to a few lectures several times a year, and scientists responding to interpreters’ questions, if approached.

*The amount is minimal, usually limited to an hour or so presentation a few times a year. Researchers…will usually do a presentation to the Interpretation staff at the end of their visit to the park. The park's resources staff also present hour-long presentations a few times a year.*

*In the initial training, there is lots of contact with researchers, and then future contact only ever seems to occur when I am seeking answers to questions or in attempt to understand a phenomenon.*

*I have found that there is a disconnect between the park interpreters and the scientific researchers. It seems that often research being done is being kept for the scientists while the interpreters are being left with the public domain information.*

*Depends on the park. In some parks I've worked, I've had little to no contact with in-park resource personnel. I feel that CAVE is on the higher end of accessibility. A few natural and cultural resource personnel presented during my two-week introductory training. I know who to contact and feel comfortable doing so. I'm usually informed as to what research groups are in the park at any time. Sometimes I even run into researchers. I must admit, though, I would love it if short talks and briefings with park staff would be built into research permits...*

A few interpreters did describe some notable exceptions in which they were able to assume a more active role assisting researchers with scientific data collection.

*Very little overall [contact], however there have been exceptions at some of the parks I have worked. At [one park] there was a great deal of informal contact between resource management and other park employees and I would credit those individuals with keeping people informed of projects and offering opportunities for off-duty employees to assist. Those opportunities included assisting with wildlife surveys on multiple occasions, actively surveying cave passageways and helping with scientific cave studies (collecting data).*

*While working at [one park], I worked closely with the chief of resources to obtain and use collection permits for macro-invertebrates within the caves. In addition to the collection, I assisted with species monitoring within the cave on a monthly basis. Also while at [the park], I helped with a 5-year monitoring of seasonal pools of water within the cave on a weekly basis.*

All of the interpreters reported that they found participating in iSWOOP valuable. When asked how iSWOOP had benefitted them, either personally or professionally, interpreters most frequently mentioned access to scientific research being conducted at the park. All but one indicated that their understanding of scientific research had increased due to iSWOOP, particularly their understanding of the kinds and extent of on-site research being conducted at the park, and of the scientific techniques and technological tools used to conduct that research.

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| Greater knowledge of On-site Scientific Research |
| *Now I know more of the how, the why, the discoveries. And I just want to know more. There's so much other research to access. How??? I want all visitors to see their parks as hotbeds of active research!**I did not know the extent of bat research happening at CAVE, so yes my understanding has changed. There is much more being studied and much more to be learned about these bats that people have been watching for decades.**I have a greater awareness of and appreciation for the scientific research here. My participation in iSWOOP and some of my own reading has shown me that there is a great variety of fascinating research going on here, from bats to cave microbes.**Yes, my understanding has increased due to iSWOOP. I didn't know the nature of some of the studies that have taken place here. I learned a lot of details and new information about bats and how scientists use technology to study them*. |
| Scientific Techniques and Technology |
| *My understanding of scientific method was not very deep. Being part of iSWOOP definitely added to my knowledge of how scientific research is being done and the details that go along with it, as well as the scientist's personal experience in the research.**I have a greater understanding of the tools used by researchers to study the bats. I knew the results of the research but now I have a better understanding of the data that was gathered to come to that understanding.**Having participated first-hand with LiDAR scanning and also working with the biologists, I have a better idea of the techniques and strategies used to learn about research being conducted about bats. It would be helpful to be exposed to a broader spectrum of research outside the realm of bat biology. There is much more to science in this park than we are exposed to in the iSWOOP training.**The 3-D mapping is an awesome tool. How do you count bats? With thermal imaging camera. I can watch the bat in flight all day, that high speed high def. camera is awesome. Thermal imaging of bats is a great tool, both during flight and bats in roost.* |

As one interpreter expressed, “We [already] understand and know there is a variety of research being done here at CAVE as in all our parks. What has changed for me is the understanding of the specifics being done... i.e.: here is the specific technology and results of research. It's more in depth now as to the specifics, the challenges, and I have a greater appreciation for the process that helps me translate what is happening for the general public.”

**Increased Scientific Knowledge**

***At the beginning of iSWOOP, interpreters rated their ability to convey scientific content knowledge related to the bats of Carlsbad Caverns. The specific areas in which they saw themselves as least adept were the scientific bat research conducted at CAVE, bat behavior patterns, and fluctuations in bat body temperature related to bat activities. Interpreters also described modest levels of being able to make sense of images from technology (e.g., thermal cameras, laser scans and high speed videography). Following iSWOOP training, interpreters reported improvements in their ability to convey a variety of scientific topics to visitors. Some of the areas in which interpreters reported improvements were ones that they had earlier indicated already having high levels of prior knowledge. The greatest gains were for making sense of images from technology, and the sense of 3D spaces of the caverns - both major emphases in the iSWOOP training.***

***Interpreters also reported sizeable improvements in their understanding of the scientific bat research being conducted at CAVE and the ways Brazilian free-tailed bats interact with their habitat. Observations and interpreters’ visitor learning forms corroborated that interpreters were putting new knowledge into practice: conveying to visitors scientific content pertaining to bats and park-based research, the science process, and the technology used to study bats.***

Interpreters were asked in the pre-program surveys to self-assess their skill level in conveying to visitors (by explaining or involving visitors in activities or conversation) eight different areas of scientific content knowledge pertaining to their park site. Given the scientists’ expertise and the charismatic species dwelling in Carlsbad Caverns, these areas largely concerned scientific topics about bats. Respondents rated their abilities in each content area using a four-point rating scale (weak; not particularly strong; strong but room for improvement, and definitely strong.)

Interpreters rated their ability to convey scientific content knowledge in a critically varied manner, as strong in some areas and less so in others. While most interpreters rated themselves as reasonably able to convey information regarding the *ways Brazilian free-tailed bats interact with their habitat* (11 out of 14; 2 “definitely strong”) and the *sense of 3D spaces of the caverns* (10 out of 14; 4 “definitely strong”); they expressed more moderate levels regarding *bat anatomy that relate to feeding or flight* (9 out of 14; 3 “definitely strong”); and of the *scientific bat research being conducted at CAVE* (8 out of 14; 2 “definitely strong”).

Modest levels of conveying specific content knowledge were expressed for *bat behavior patterns while bats are in the cave* (5 out of 14; all 5 “strong but room for improvement”), *making sense of images* *from thermal cameras, laser scans and high speed videography* (5 out of 14; only 1 “definitely strong”), and *fluctuations in bat body temperature related to bat activities* (3 out of 14, none “definitely strong.”)

Following the iSWOOP training and being able to try out iSWOOP in their visitor programs, interpreters were asked in post-program surveys to assess the extent to which participating in iSWOOP had improved their ability to convey each of these same eight scientific content areas to CAVE visitors. Ratings were along a 4-point scale (not changed; improved a little; improved a fair amount, and led to major improvement.)

Many of the interpreters reported improvements (either improving a fair amount, or major improvements) in almost all of the eight content areas. The greatest gains were reported for *making sense of images* *from thermal cameras, laser scans and high speed videography* (11 out of 14; 7 “major improvements”) and the *sense of 3D spaces of the caverns* (11 out of 14; 7 “major improvements”). Both were major emphases in the iSWOOP training’s fieldwork and classroom components. Interpreters in Cohort II were also asked about gains in their understanding of bat sounds (a special technology feature in Cohort II training), and all five interpreters indicated improvements (2 reported “major improvements.)

Eleven out of 14 interpreters also reported improvements in *scientific bat research being conducted at CAVE* (11 out of 14; 5 “major improvements”), and the ways *Brazilian free-tailed bats interact with their habitat* (11 out of 14; 6 “major improvements”). It should be noted that of these four areas in which 11 out of 14 interpreters rated improvements, two were ones in which interpreters had previously indicated already having fairly high levels of prior knowledge (how bats interact in their habitat, and sense of 3D spaces of the caverns.)

Most interpreters also reported improvements in utilizing two other areas of science content knowledge. They indicated that they were now able to convey information concerning *bat anatomy that relate to feeding or flight* (10 out of 14; 6 “major improvements”) and *fluctuations in bat body temperature related to bat activities* (8 out of 14, 4 “major improvements”).

As hoped, interpreters were able to integrate content from iSWOOP PD into programs for visitors. Interpreters described their engaging visitors with information about bats and on-site scientific research in the following ways:

*I used several slides, showing the bat in flight in slow-motion, as well as the [bats] exiting the cave in slow-motion. Visitors learned how a bat flies, that they aren’t as scary as they thought, and that there are many more bats in our cave than they thought.*

*I gave a program one afternoon to a group of visitors that included two adult couples and a family with several children. We started off by talking about bats in general and how their nocturnal behavior makes them a mysterious and scary animal. We then went into how these misconceptions arise from a lack of understanding and appreciation of this incredible beneficial group of animals…The children were quite interested and developed some of their own questions about things they were curious to know about bats. Before I showed the video and computer programs used to estimate bats I asked the group to observe the flight in real time and try to estimate how many bats they were observing.*

*A very successful program I’ve had with visitors focused on how scientists seek answers to questions. I focused on a very commonly asked question, how many bats are there? I first asked the visitors how they would go about trying to answer this question and then followed up by comparing their ideas to what was actually done to count the bats. The take-home message of this program was the importance of critically thinking not only about cool facts, but HOW we know what we know. I want visitors to leave that program thinking about how the scientific process works, especially within our park.*

Observations of iSWOOP Sessions: Observations corroborated the survey findings of interpreters’ conveying of scientific content emphasized in iSWOOP. Observations were conducted of 26 sessions in which a total of nine interpreters used iSWOOP with visitors. Interpreters were observed and later scored for the presence of interpretive behaviors pertaining to three major areas pertaining to iSWOOP’s programmatic priorities and desired behaviors by interpreters and visitors encouraged through the iSWOOP professional development: the conveying of science concepts (5 behavioral items), the use of technology and images (3 items), and the conveying of on-site scientific research (6 items). Thus, a total of 14 target behaviors were assessed.

Scoring was done using a 3-point scale (0 = not evident, 1 = evident, and 2 = exemplary). “Evident” was defined as observing the target behavior once during the session, while “exemplary” was defined as observing the behavior multiple times during the session, and/or with great skill and facility by the interpreter.

Upon review of the observational rating scores based on field notes, most of the 26 sessions observed yielded evident and/or exemplary levels of performance in the three major dimensions (science concepts, technology, on-site scientific research.)

Regarding science concepts, the vast majority of sessions scored at the evident and/or exemplary level regarding inclusion of descriptions of ways in which Brazilian free tailed bats interacted with their habitat (92%), of bat anatomy (92%), and of bat behavior (88%). High incidence in sessions also were found with concepts of trends and change over time (88%) and attending to scale (84%). All sessions (100%) were observed as having visitors attentive and interested in learning about science concepts.

**Science Concepts**

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| **Specific Behaviors** | **0 (Not evident)** | **1 (evident)** | **2 (exemplary)** |
| Describes ways in which Brazilian free tailed bats interact with their habitat (e.g., roosting, feeding) and how this is connected to evidence/how scientists know | 2 sessions (8%) | 14 sessions **(54%)** | 10 sessions (38%) |
| Describes bat behavior (e.g., what bats do in the cave, migration, reaction to light during bat flight, social, bumping) | 3 sessions (12%) | 11 sessions **(42%)** | 12 sessions **(46%)** |
| Describes bat anatomy (that relate to feeding or flight, reproduction and pup-rearing, fluctuations in bat body temperate related to bat activities) | 2 sessions (8%) | 11 sessions (**42%**) | 13 sessions **(50%)** |
| Explicitly attends to scale in ways that help visitors make sense of quantitative data (e.g., offers analogies to make scientific and mathematical concepts understandable to visitors) | 4 sessions (15%) | 12 sessions **(46%)** | 10 sessions **(38%)** |
| Incorporates the concept of trends, change over time, and related factors (e.g., drought and size of colony or number of births, seasonal differences, fluctuation in temperature) | 3 sessions (12%) | 12 sessions **(46%)** | 11 sessions **(42%)** |
| Visitors attentive and interested in learning about science concepts | 0 sessions | 16 sessions **(62%)** | 10 sessions (38%) |

(n = 26 sessions)

Regarding scientific technology, all (100%) of the observed sessions incorporated scientists’ graphs and high-tech visuals into their programs. Most sessions (85%) also had interpreters offering explanations or fielding questions to help visitor make sense of the technological images. About three-fourths of the sessions (73%) were observed as having visitors display interest and appreciation for the visual data collection strategies.

**Scientific Technology/Images**

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| **Specific Behaviors** | **0 (Not evident)** | **1 (evident)** | **2 (exemplary)** |
| Incorporates scientists’ graphs and hi-tech visuals into programs | 0 sessions | 4 sessions (15%) | 22 sessions (**85%)** |
| Explains/fields questions about these imaging techniques to help visitors make sense of images from thermal cameras, laser scans, and high speed videography | 4 sessions (15%) | 9 sessions (35%) | 13 sessions **(50%)** |
| Visitors display interest/appreciation for visual data collection strategies | 5 sessions (19%) | 9 sessions (35%) | 10 sessions (38%) |

(n = 26 sessions)

Regarding on-site bat research, almost all the sessions were observed as featuring interpreters establishing the relevance of the research and technology (92%), sharing details and purpose of the scientific research on bats conducted at CAVE (88%), and engaging visitors in learning about science research (85%). The one area observed at only moderate levels was eliciting from visitors the relevance of the research and the technology to solve problems (38%). All sessions (100%) were observed as having visitors interested and excited in the science research conducted on-site.

**On-Site Scientific Research**

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| **Specific Behaviors** | **0 (Not evident)** | **1 (evident)** | **2 (exemplary)** |
| Engages visitors in learning about science research, in general (e.g., role of questions) | 4 sessions (15%) | 14 sessions (**54%**) | 8 sessions (31%) |
| Shares details or broad purpose of the scientific research on bats conducted at CAVE (e.g., research questions, methods, findings, future research agendas from CAVE-based research) (n = 25 sessions) | 3 sessions (12%) | 11 sessions **(44%)** | 11 sessions **(44%)** |
| Establishes relevance (e.g., of research, study of colony population, use of technology (n = 25 sessions) | 2 sessions (8%) | 11 sessions (**44%)** | 12 sessions (**48%)** |
| Elicits from visitors relevance of research/study of bat colony/use of innovative tech to solve problem | 16 sessions **(62%)** | 5 sessions (19%) | 5 sessions(19%) |
| Visitors display interest/excitement for science research conducted on-site  | 0 sessions | 19 sessions **(73%)** | 7 sessions (27%) |

 (n = 26 sessions unless otherwise noted)

In addition to analyzing the extent to which each type of target behavior was observed in a session, a total score for each session was also calculated for each of the three areas (science concepts, technology and on-site bat research.). As before, each item could receive a score of 0 (not evident), 1 (evident) or 2 (exemplary). Maximum scores for the three areas varied depending on the number of items in the area (science concepts with six items, maximum score of 12; technology area with three items, maximum score of 6; on-site scientific research with five items, maximum score of 10.) Low, medium and high score ranges were determined for each of the three areas.

Most of the 26 sessions observed yielded medium to high levels of performance in each of the three major areas. Scoring at the medium and/or high level were: 21 sessions (81%) on *science concepts*, 22 sessions (84%) on the *use of technology and images* and 16 sessions (61%) on *conveying on-site scientific research*. All but one of the mean and median scores were at the “medium” level. (Median score for technology was “high.”)

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| **Science Concepts** |  |  |  |
| **Total Score Range** (6 items; Total Score Possible: 0 to 12) | **LOW** (0-5 Score) | **MEDIUM** (6-8 Score) | **HIGH** (9-12 Score)  |
| **Individual Session Total Scores** | Score of “4” (3 sessions); “5” (2) | “6” (1) “7” (2) “8” (9) | “9” (4) “10” (1) “12” (4) |
| **Total Sessions** (n = 26) | 5 (19%) | 12 (46%) | 9 (35%)  |

Observed Score Range: 4-12; median score = 8; mean score = 8.0

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| **Scientific Technology/Images** |  |  |  |
| **Total Score Range**(3 items; Total Score Possible: 0 to 6) | **LOW**(0-2 Score)  | **MEDIUM**(3-4 Score) | **HIGH**(5-6 Score)  |
| **Individual Session Total Scores** | Score of “1” (1 session); “2” (3)  | “3” (5) “4” (4)  | “5” (5); “6” (8);  |
| **Total Sessions** (n = 26) | 4 (15%) | 9 (35%) | 13 (50%) |

Observed Score Range: 1-6; median score = 5; mean score = 4.2

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| **On-Site Bat Research** |  |  |  |
| **Total Score Range**(5 items; Possible Scores – 0 – 10) | **LOW**(0-4 Score) | **MEDIUM**(5-7 Score) | **HIGH**(8-10 Score)  |
| **Individual Session Total Scores** | Score of “2” (2 sessions); “3” (4)“4” (4) | “5” (2) “6” (4)“7” (4) | “8” (1)“9” (3) “10” (2) |
| **Total Sessions** (n = 26) | 10 (38%) | 10 (38%) | 6 (23%)  |

Observed Score Range: 2-10; median score = 6, mean score = 5.7

Thus, the observational data on interpreters’ sessions largely corroborated the self-assessment findings from interpreters’ surveys, regarding their inclusion of scientific content, tools, and research emphasized in iSWOOP.

Interpreters’ Forms on Visitor Learning

During the final minutes of their visitor programs, interpreters were asked to pose to visitors variations of two different questions to help gauge visitors’ learning: “Who saw something in a new way?” and “Who found out something about scientists’ work they didn’t know before?” For each question, the interpreter received a show of hands from members of their visitor group, and then asked for a few volunteers to share their thoughts on what new things they had seen or found out. The interpreter also recorded the total number of individuals in the visitor group, for a “head count” of visitor participants.

A total of 104 interpreter forms (on 104 unique visitor programs) were submitted by 10 of the 14 interpreters, capturing reactions from a total of 1067 visitors.

For the question, “*Who saw something in a new way*?”, a total of 436 out of 575 visitors (76%), raised their hands to indicate that they had seen something in a new way.

Of the 85 forms for which interpreters had recorded specific examples of what visitors volunteered they had learned, each comment was coded as to whether it pertained to one of five key topics. The five topics, anticipated during the project’s professional development and instrument design phase, were:

1. bat content knowledge (regarding behavior, anatomy, population and species)
2. technology
3. science process
4. awareness of science at the park
5. information about the cave site

The first and last topics (bat content and information about the cave site) were ones that would normally be part of many CAVE programs, while the middle three (technology, science process, and awareness of science at the park) were topics that were especially emphasized through iSWOOP.

A sixth category, “other”, was used to capture other visitor comments, often about visitors’ more emotional reactions to the program. A comment that consisted of one or more sentences could be coded in multiple categories, depending on its content.

|  |  |
| --- | --- |
| ***Who saw something in a new way?*****Topic** | **Visitor comments on Interpreters’ forms** **(% of forms/sessions)** |
| Bat content knowledge  | 32 (41%) |
| Technology | 42 (54%) |
| Science process | 15 (19%) |
| Awareness of science at the park | 6 (8%) |
| Information about bat cave | 9 (12%) |
| Other | 8 (10%) |

(n = 85 forms with responses to this question; 78 forms that had codable responses)

The two most salient areas mentioned involved *technology,* arising in over half the sessions and *bat content knowledge* mentioned in about two-fifths of the sessions.

|  |
| --- |
| **Who saw something in a new way? Sample of Visitor Comments** |
| **Bat Content**3/23/2014. *(Bat Content)**They were surprised by the long lifespan of Brazillian free-tailed bats. They also had never heard about how mothers find their pups in the creche (the topic veered off of counting bats, as it tends to do).**3/5/2014 (Bat Content)* *One person mentioned that they were surprised to see how active the bats were during the day.**3/7/2014 (Bat Content)* *One visitor didn’t realize the population wasn’t constant. He had assumed that one colony size would remain pretty much the same.* *7/22/2014 (Bat Content, Technology)**The visitors noted that seeing thermal imaging of bats gave a new view of bats’ physical structure.**2/4/2014 (Bat Content, Technology)**One lady said she was surprised at how quickly the bats flying in the thermal video of the colony in the bat cave “warmed” up after landing within the colony.* |
| **Technology**4/14/2014. *(Technology)**All of the adults of course loved the slow motion bat flight, but they really loved learning how fancy technology can be used to study bats. They hadn't thought about that application.**3/4/2014 (Technology, Science Process)**The thermal imaging of the bats leaving the cave and the improved counting procedure to gain actual numbers of a bat colony at a cave and not just using estimations. This is especially beneficial now for all bat colonies given white-nose syndrome.* 7/30/2014 *(Technology, Bat Content)**Most of them had never even seen the bat flight, so just the video of bats exiting was new to them. The comparison slide of the free-tailed and the fruit bat flying showed them that not all bats fly the same or even look the same. Of course the slow motion video of the bats leaving the cave got lots of oohs and ahhs and people had never seen that before either.*8/12/2014. *(Technology, Bat Cave)**Several of the group mentioned that the computer mapping gave them a new understanding of the cave. The 3-D scans of cave, especially bat cave, gave an exciting perspective.* |

The third-most often mentioned topic was about the *process of doing science*, mentioned in roughly a fifth of the sessions.

|  |
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| **Science Process**9/6/2014. *(Science Process)**One visitor remarked that it was interesting to learn about the challenges that scientists face in trying to study bats with non-intrusive methods.*1/27/2014. *(Technology, Science Process)**He said he was surprised by the use of algorithms/computers to count and track the bats. He hadn't known that it could both be detecting and tracking them.*2/22/2014. *(Bat Content, Technology, Science Process)**The latter group was wondering if bats may return to CAVE earlier this year because of the seemingly early spring. This pondering led to a discussion about the greater picture that can be achieved through thermal imaging counts and climate data, etc. Those who have witnessed a bat flight before were all very excited about the added knowledge and the depth it's created in their experience.* |

For the question, “*Who found out something about scientists’ work they didn’t know before?*”, a total of 298 out of 501 visitors (60%), raised their hands to indicate that they had found out something new about scientists’ work.

Of the 80 forms for which interpreters had recorded specific examples of what visitors volunteered they had learned about scientists’ work, each comment was coded using the same five-topic coding schema adopted for the “who saw something in a new way?’ question.

|  |  |
| --- | --- |
| ***What kinds of things did you learn about scientists’ work?*****Topic** | **Visitor comments on feedback forms** **(% of forms/sessions)** |
| Bat content knowledge  | 15 (21%) |
| Technology | 32 (44%) |
| Science process | 35 (48%) |
| Awareness of science at the park | 18 (25%) |
| Other | 9 (12%) |

(n = 80 forms with responses to this question; 73 forms that had codable responses)

When describing what kinds of new things they had learn about scientists’ work, close to half the visitor sessions involved comments on the *process of doing science* (48% of sessions) and *technology* (44% of sessions).

|  |
| --- |
| **What kinds of things did you learn about scientists’ work? Sample Visitor Comments** |
| ***Science Process****2/12/2014 (Science Process)**In the course of the program, comments among the visitors indicated they realized that a lot of the obstacles to research are so obvious, that are overlooked--like darkness.**4/14/04 (Science Process)**They learned about the need to make observations first in order to generate good questions. They learned that questions are sometimes more important than answers.**3/11/2014 (Technology, Science Process)**Dad and Junior Ranger were impressed with the technology being used. Junior Ranger didn't realize that researchers could be in gross places (regarding the droppings hitting the camera microphone in the roost).**8/2/2014 (Science Process)**Learned about the need to study bats without bothering them. Now understands the need to quietly observe the bats.* |
| **Technology***3/4/2014 (Technology, Science Process)**I learned how the computer counts the bats as they fly through the sensor. It was amazing to watch the graph. Interesting to know that the “estimates” of bat numbers from years ago are so wrong, and the demonstration shows how they can’t possibly be accurate.**9/27/2014 (Technology, Science Process, Bat Content)**Learned about the uses of thermal imagery as a non-intrusive way to study bats' activity in the roost and to count bats.**8/1/2014 (Technology, Science Process)**For one group all the information was completely new. The other group stated that they didn't know of the non-invasive methods we used to study bats or the history of studying echolocation.* |

Visitors also mentioned their *awareness of scientific work being done at the park* (25% of sessions), and also continued to mention new *bat content knowledge* they had acquired (21% of sessions).

|  |
| --- |
| **What kinds of things did you learn about scientists’ work? Sample Visitor Comments** |
| **Awareness of Science at the Park***1/28/2014 (Awareness of Science at the Park)**They learned that scientists actually visited this park – they were not aware of that. They did not know that our bats were the subject of any research**8/13/2014 (Awareness of Science at the Park)**They were aware that there was possibly Science being done in National Parks, but unaware of the depth and breadth of research that actually goes on. They weren't aware that independent scientists came to National Parks to conduct research.**8/9/2014 (Technology, Science Process, Awareness of Science at the Park)**When I asked they all seemed to have learned about how scientists are using technologies they knew nothing about. They also told me that they didn't know that sometimes parks grant special permits to do research on things that visitors aren't allowed to do.* |
| **Bat Content***7/12/2014 (Bat Content, Science Process, Awareness of Science at the Park)**Learned about bats are counted accurately. How bats’ different physical structures influence their flight patterns, including the spiraling during emergence from Carlsbad Caverns.**6/11/2014 (Bat Content, Technology, Science Process)**They also didn't know that scientists could train bats to fly in wind tunnels. They did observe the differences in flight between the free-tailed and the fruit bat. They were able to deduce the reason why they flew differently, as well.**2/23/2014. (Bat Content, Technology, Science Process)**He learned about how scientists are breaking down our misconceptions on bats--his mind was really blown about them not being blind! He learned how technology has finally allowed us to learn more about bats. He also learned there is potential applications for us as they study the mechanics of bat flight, as opposed to birds.* |

**B. Enhancing Interpreters’ Pedagogical Strategies for Engaging the Public**

***Prior to iSWOOP, most interpreters felt their pedagogical skills were strong. They gave themselves high ratings in such areas as involving visitors in making observations, generating excitement, and providing opportunities for visitors to build on ideas. They also felt fairly confident in their ability to convey certain mathematical and scientific points, such as offering analogies about scale, and incorporating the idea of change over time. The main area that they deemed as weak was incorporating scientists’ graphs and high-tech visuals into programs.***

***Following iSWOOP professional development and an opportunity to try out the mobile cart and visual library with visitors, interpreters reported the greatest improvements in incorporating scientists’ graphs and high-tech visuals into their programs. They also noted improvements in their ability to generate excitement and involve visitors in making observations. Although these were skills on which they had earlier given themselves positive ratings, iSWOOP expanded their skillset.***

***Close to half the interpreters cited the inquiry-oriented and participatory visitor approach encouraged in iSWOOP as the greatest benefits of the program. Most interpreters also reported that iSWOOP had enabled them to look at visitor engagement differently, and that they are now more actively seeking to engage visitors in conversation, rather than delivering a more one-way exchange. Interpreters stated that iSWOOP had helped them better engage visitors in the ongoing research occurring at their park and for conveying the process of doing science, including researchers’ applications of cutting-edge technology.***

***Observations corroborated that interpreters were actively engaging visitors during their programs, eliciting visitor participation, involving visitors in making observations and predictions, and soliciting questions from visitors. Almost all sessions observed scored at medium or high levels of overall visitor engagement and visitor interactivity.***

In the pre-program survey, interpreters were asked to rate themselves on how strong they already felt they were on using eight pedagogical techniques in their work with visitors, using a four-point rating scale (weak; not particularly strong; strong but room for improvement, and definitely strong.)

Somewhat in contrast to their more critical self-assessment of content knowledge, interpreters had a very positive view of their pedagogical skills. Overall, the respondents rated themselves quite highly on all but one dimension. All or almost all rated themselves as already strong in: *involving visitors in making observations* (14 out of 14; 9 “definitely strong”); *offering analogies about scale* (14 out of 14; 7 “definitely strong”) and *incorporating idea of change over time* (13 out of 14; 10 “definitely strong”).

Self-assessment ratings were also high for *generating excitement* (11 out of 14; 5 “definitely strong”), *involving visitors in making predictions* (11 out of 14; 2 “definitely strong”) *leaving questions unanswered* (10 out of 14, 4 “definitely strong”), and *providing opportunities to build on ideas* (10 out of 14; 1 “definitely strong”.) The one area that interpreters did not feel they already had strong skills in was *incorporating scientists’ graphs and high-tech visuals into programs* (5 out of 14; all 5 “strong but room for improvement”).

Following iSWOOP training and an opportunity to try out iSWOOP with visitors, interpreters were asked in post-program surveys to assess the extent to which participating in iSWOOP had influenced their ability to incorporate any of the eight pedagogical techniques in their visitor programs. Ratings were along a 4-point scale: Not changed; improved a little; improved a fair amount, and led to major improvement*.*

Not surprisingly, the largest gain was expressed in the area in which interpreters previously indicated little skill: *incorporating scientists’ graphs and high-tech visuals into programs,* which moreover, was a major focus of the iSWOOP professional development.11 of the 14 interpreters indicated that their iSWOOP participation at led to improvements in this area (8 indicated “major improvements”.)

At the same time, most interpreters also reported improvements in several areas for which they had previously self-assessed themselves as having relatively strong interpretive skills. These were *generating excitement* (10 out of 14; 3 “major improvements), and *involving visitors in making observations* (9 out of 14; 4 “major improvement”).

Close to half of the interpreters also reported growth in *offering analogies about scale* (6 out of 14; 2 “major improvement”); providing *opportunities to build on ideas* (6 out of 14; 1 “major improvement”) and *involving visitors in making predictions* (5 out of 14; all “improve a fair amount”). More modest levels of improvement were reported for *leaving questions unanswered* (4 out of 14) and *incorporating idea of change over time* (1 out of 14).

When asked to describe an example of one of their more successful iSWOOP programs, two interpreters and one administrator expressed the fostering of visitors’ more active and inquisitive engagement in the following way:

*The programs that felt most successful were the ones in which the visitors would answer questions asked, ask their own questions, and respond to each other. There are times when visitors just won’t respond…and it gets awkward! I hoped visitors walked away with an appreciation of the scientific method, what it takes to answers questions that we all may share, insight into the world of bats, and perhaps to feel empowered to be more inquisitive in the natural world.*

*I did a program with several adults in their mid to late 50’s. They were very interested in learning about how technology can be used to study bats. One man was very excited about motion capture and started leading the discussion, explaining to the other two how many different applications there are for it. When I showed them the slide with two different species of bats flying in a wind tunnel, they were eager to point out all the differences they could observe, and were able to theorize why those differences existed. I really only facilitated their discussions, because they took so much initiative. I think they learned more about bats and their adaptations based on what food they eat, and how technology allows us to answer more questions about bats.*

*By far the best program I have seen was done in the theater as a formal interpretive talk. The interactions between the visitors and the interpreter were great: observation, questions, and critical thinking were all there. The visitors walked away with a new understanding of the challenges researchers face studying bats in the field. They also had an appreciation for how our National Parks are natural laboratories.*

Observations of iSWOOP Sessions: Observations corroborated survey findings on interpreters’ utilizing interactive pedagogical skills with visitors, as well as the challenges of incorporating such techniques into practice. Utilizing observational rating scores based on field notes, observations were scored for the presence of 7 different behaviors pertaining to specific pedagogical techniques. Scoring was on a 3-point scale (0 = not evident, 1 = evident, and 2 = exemplary).

Regarding specific interactive techniques, the strategies most often observed across the 26 sessions were ones that involved visitors in *making observations* (24 sessions, 92%), in *making a prediction or thinking through a challenge* (21 sessions, 81%) and interacting with visitors and *soliciting areas of interest and prior knowledge, and questions* (21 sessions, 81%).

The majority of sessions had interpreters encouraging visitors to *read, examine, and analyze visual data and images themselves* (19 sessions, 73%), and using a *variety of strategies for handling visitors’ questions* (17 sessions, 65%)

Much less frequently observed were strategies that involved eliciting from visitors *relevance of bat colony research /technology to solve problems* (10 sessions, 38%), and providing visitors *opportunities to build on each others’ ideas and respond to each others’ questions* (6 sessions, 23%).

**Visitor Interaction Techniques**: **Use of** **Specific Techniques**

|  |  |  |  |
| --- | --- | --- | --- |
| **Score Range** | **0 (Not evident)** | **1 (Evident)** | **2 (Exemplary)** |
| **Interact with visitors to solicit areas of interest and prior knowledge, and questions**  | 5 sessions (19%)  | 12 sessions **(46%)**  | 9 sessions **(35%)**  |
| **Involves visitor in making observations**  | 2 sessions (8%)  | 16 sessions **(61%)**  | 8 sessions (31%)  |
| **Encourage visitors to read, examine, and analyze visual data and images themselves** | 7 sessions (27%)  | 15 sessions **(58%)**  | 4 sessions (15%)  |
| **Involves visitors in making a prediction or thinking through a challenge**  | 5 sessions (19%)  | 13 sessions **(50%)**  | 8 sessions (31%)  |
| **Uses a variety of strategies for handling visitors’ questions** | 9 sessions **(34.5%**)  | 9 sessions (**34.5%)**  | 8 sessions (**31%)**  |
| **Provides visitors opportunities to build on each others’ ideas and respond to each others’ questions** | 20 sessions **(77%)**  | 5 sessions (19%)  | 1 session (4%)  |
| **Elicits from visitors relevance of bat colony research /technology to solve problems**  | 16 sessions **(62%)**  | 5 sessions (19%)  | 5 sessions (19%)  |

(n = 26 sessions)

In addition to analyzing how often each specific pedagogical technique was used across the 26 sessions, sessions were also scored as to the extent to which the seven techniques were observed in each session. Given that each of the seven techniques could receive a score of 0 (not evident), 1 (evident), or 2 (exemplary), a session could potentially receive a total score ranging from 0 (none of the seven techniques observed as evident) to 14 (all seven techniques observed at an exemplary level.)

A little over half the observed sessions (14 sessions; 54%) had interpreters using a range of interactive techniques of working with visitors at medium or high levels. Both the median (6.0) and mean (6.7) scores were at the medium/evident level.

**Visitor Interaction Techniques: Total Score Per Session**

|  |  |  |  |
| --- | --- | --- | --- |
| **Total Score Range** | **0-5 (Low)** | **6-9 (Medium)** | **10-14 (High)** |
| **Individual Session Total Scores**(7 items; Possible total scores – 0 – 14) | Score of “0” (1 session); 3 (3)4 (4)5 (3) | 6 (2)7 (1)8 (3)9 (3) | 10 (2)13 (3) |
| **Total Sessions** | 11 (42%) | 9 (35%) | 5 (19%) |

(n = 26 sessions)

Interpreters were also rated on overall levels of visitor engagement, visitor interactivity, and invitations for visitor participation (low, medium, high). The third rating of “interpreters’ invitations for participation” was added during the late summer and fall rounds of observations, when it was noted in earlier observations that interpreters could actively be soliciting visitors to interact and respond, but that they may have a quiet or subdued group of visitors (which would be scored as a low level of visitor interactivity.)

Almost all the sessions observed scored at medium to high levels of overall *visitor engagement* (22 sessions (88%)), *visitor interactivity* (20 sessions (80%)), and *interpreters’ eliciting visitor participation* (9 out of 9 sessions (100%)).

**Overall Session Scores** **on Visitor Engagement**

|  |  |  |  |
| --- | --- | --- | --- |
| **Score Range** | **1 (Low)** | **2 (Medium)** | **3 (Moderately High-High)** |
| **Overall Visitor Engagement**(n = 25 sessions) | 3 sessions (12%) | 5 sessions (20%) | 17 sessions (**68%)** |
| **Overall Visitor Interactivity/Responsiveness**(n = 25 sessions) | 5 (20%) | 14 **(56%)** | 6 (24%) |
| **Overall Interpreters’ Efforts for Participation** (scoring added in late summer/fall observations) (n = 9 sessions) | 0 | 2 (22%) | 7 (**78%)** |

As reported in an earlier section, a subset of observation items specifically looked at visitors’ reactions to major topics covered regarding on-site bat research, scientific technology and scientific concepts. The vast majority of visitor sessions were noted as receiving either medium or high levels of interest and engagement in all three areas.

**Visitor Reactions**

|  |  |  |  |
| --- | --- | --- | --- |
| **Score Range** | **0 (Low)** | **1 (Medium)** | **2 (High)** |
| **On-Site Bat Research:** Visitor display interest/ excitement for science research conducted on-site | 0 sessions | “**1**” - 17 sessions **(65%)** “**1.5**” – 2 sessions (8%)  | 7 sessions (27%)  |
| **Technology:** Visitors display interest/appreciation for visual data collection strategies | “**0**” - 4 sessions (17%)  “**0.5**” – 1 session  | 9 sessions **(37%)**  | 10 sessions **(42%)**  |
| **Science Concepts:** Visitors attentive and interested in learning about science concepts | 0 sessions | 16 sessions **(62%)**  | 10 sessions (38%)  |

(n = 26 sessions; For Technology: 24 sessions; 2 sessions with unreported ratings.)

**iSWOOP as fostering more interactive visitor engagement**

Most (9) of the 14 interpreters reported that iSWOOP had enabled them to look at visitor engagement differently. A number of interpreters commented on how they are now more actively seeking out visitors to participate in a facilitated conversation, rather than having a predominantly one-way exchange from interpreter to visitors.

*I've always thought of interpretation as conversation... I just now feel more driven to question, to strengthen my knowledge base and comfort level, to really get out there and start the conversation. Getting in front of group and talking at them is the easy way out... active engagement is the more challenging yet far more rewarding and beneficial style of interpretation...*

*I've realized that I should let the visitor define the parameters of the interaction more, especially in family settings. When I hear a question, instead of immediately swooping in to answer, let the adults in the group respond first, and let them invite me to participate. This has been richly rewarding, for both me and the visitors.*

*I let people do more of the observing rather than pointing stuff out and at time they shine light on something that perhaps I missed the first time around. I am more willing to answer questions with questions in order for the visitor to get to their own answer.*

*I use a lot of different techniques in my programs but I've used observation very little in the past. I've always felt when I've tried it, asking visitors to observe x,y or z was just a "filler". Now I understand how I can use observation to start a dialogue with the visitors about what they see - or don't see!*

Several interpreters commented on how they are now more aware of the potential to engage visitors in scientific research happening onsite.

*I have a better feeling for visitors' interest in emerging research, and for how the research may answer some remaining questions.*

*[I learned] that more visitors are interested in the hard science of things and the NPS interpretive staff isn't giving it to them.*

Of the five interpreters who reported no changes in looking at visitor engagement, a number felt that they already had good interpretive skills, while one indicated that she felt that there would be the opportunity for her to gain new insights on visitors, once she had more ample opportunity to try out iSWOOP with small groups during her roves using iSWOOP on an ipad.

Even those who reported no changes cited how iSWOOP had underscored the importance of inquiry and had provided them with a valuable visual library.

*[I don’t necessarily look at visitor engagement differently.] Our challenge is to be able to constantly adapt using a variety of tools and techniques based on a varied and diverse audience. iSWOOP and Interpretation are following the same path as both wish to incorporate more inquiry based methods, however the method of engagement is still the same... sometimes certain techniques work and don't work, and we engage the visitor by navigating through multiple methods to reach out. This has always been the case. But iSWOOP has brought inquiry to the forefront.*

*I am an interp ranger, whose job it is to know how to engage the public, the techniques available, how to read the audience, etc. Thanks to iSWOOP, we now have better imagery and media to show the public.*

**iSWOOP as a program to engage visitors in technology and the process of doing science.** One post-program survey item asked interpreters to imagine overhearing iSWOOP being described to a new interpreter mainly as a program about bats, and whether they would agree. All 14 interpreters indicated that they don’t consider iSWOOP as simply a bat program. They recognized that while the current content focus in their particular park was on bat research, the primary elements were about introducing visitors to the ongoing research occurring at their park, in ways involving technology and the process of doing science.

*Although iSWOOP programs are using bat research as a topic, iSWOOP programs are mainly geared toward the deficit of science literacy among park visitors. They introduce visitors to research in the park and scientific method, giving visitors a chance to step in the shoes of scientists.*

*The program is about learning what researchers are doing and discovering in our parks, and communicating that to visitors. The pilot revolved around bats here due to the fact it was started by bat researchers, but the iSWOOP program, as what the acronym stands for, can apply to any science being conducted in national parks.*

*iSWOOP is not just a bat program. Bats are just one aspect of the program. To me the process is what is important (the scientific process), the fact that we are all inquisitive and curious to learn makes us all scientists too. We have been given access to data in the form of images/video. I am helping visitors explore the possibilities and ways in which technology has advanced our understanding of bats (in this case) and how we interpret/process what we see.*

Several people interpreters also spoke about iSWOOP encouraging a different kind of visitor engagement.

*The images were of bats and the resource information we received was about bats, but I never think of iSWOOP as about bats. It’s about techniques and perspectives that can widen what interpreters have in their toolboxes. It’s about engaging visitors in scientific thinking, interpreting in a way that is not lecturing, and leaving some questions/thoughts open-ended.*

*Many of us initially felt it was a program to bring the scientific research to the public. However, so much emphasis was placed in changing our methods of delivery that it seemed the bat research was second to a goal of changing the way the public is engaged. I would now say that iSWOOP is an attempt to merge scientific research (of any type appropriate to the resource) with interpretive methods to invoke an appreciation and understanding of science through observation and inquiry.*

Thus, the iSWOOP training and approach appears to have been successful in enabling interpreters to strengthen and improve both pedagogical techniques in working with visitors and their ability to convey various areas of scientific content knowledge to visitors. As expressed by one interpreter:

*I honestly think that the methods we have been encouraged to use in our iSWOOP programs are the NPS future of interpretation. Inquiry-based learning is what interpreters need to practice in today's inquisitive and interactive world. Also, I have truly appreciated the improvement in my workplace. The interpretive conversations between coworkers, the feedback, seeing how my fellow interpreters work with the same resources... priceless. This is a craft we must learn together. Also, my own personal science literacy has been drastically improved. How are we to be good residents of this planet if we barely understand it and our impact?*

**III. PROGRAM FEEDBACK**

**iSWOOP Viewed as a Valuable Professional Development Experience by Interpreters**

***All of the interpreters reported that they had found participating in iSWOOP valuable. The benefits that interpreters most often mentioned concerned the access to scientific research being conducted at the park and the technology and data visualizations used by scientists, and the inquiry-oriented and participatory visitor approach encouraged in iSWOOP.***

***The elements of iSWOOP that interpreters reported as especially valuable were the on-site professional development, the suggested readings, and the e-mailing with project leaders. The two technology formats – large screen monitor and computers, and iPad – were positively received, and each seen as useful in different ways, depending on the format of visitor program and interaction. Interpreters recommended that the program needs to provide adequate time and support to enable interpreters to become sufficiently comfortable and adept at using the technology in their programs.***

***When discussing the biggest challenges of incorporating science research into their visitor programs, interpreters at first focused on their personal difficulties accessing scientific research as well as raised questions about appropriate techniques to foster visitor engagement and inquiry. Towards the end of iSWOOP professional development, interpreters expressed fewer concerns about their own access to information. Instead, their comments revealed a heightened awareness of techniques appropriate for engaging visitors with scientific research.***

**Value of iSWOOP**

When asked to rate how valuable an experience they had found participating in iSWOOP (4-point rating scale: not valuable; a little valuable; valuable; very valuable), all 14 interpreters reported that they had found participating in iSWOOP valuable. Six indicated that it had been “very valuable.”

When asked what they saw as the most beneficial things they gained from participating in iSWOOP personally or as a National Park Service professional, the area that was most frequently mentioned concerned the access to scientific research being conducted at the park. Ten of the 14 interpreters described this research knowledge and access as most beneficial. As two interpreters expressed:

*I find the opportunity to see the research most valuable. It is better to tell people how the research works if you know about the research. In many parks it happens behind the scenes and the interpreters are only told about the end result. We are asked to talk about something we are expected to take on faith.*

*I think the most beneficial thing from my experience is that it has led to take a step back and see this park not only as a precious resource and visitor attraction, but also as a site for research. This is a theme which can be exploited at a variety of NPS sites, including the historical parks. Not only scientists, but historians for example can utilize our parks to engage in rewarding study. This makes our parks seem more fresh and alive, if we can alert our visitors to the fact that many scholars use the NPS locations on a continuing basis for their work.*

A number of interpreters described the benefits in terms of several different areas, touching not only on the research, but also access to the technology and tools (mentioned by six interpreters), and how they could pass that onto visitors.

*The data and media files that researchers have shared with us are incredibly valuable. Visitors have an opportunity to see directly the researchers’ work. I was also very glad to have had the opportunity to talk to the researchers, ask questions and collect data. That experience is something I can share with visitors. This is something that visitors might be interested in volunteering to do (help with research projects) and inspire them to think about the world in a dynamic way (a place where things can change and we can ask why or how is it changing).*

*The most valuable part of iSWOOP is the face-to-face interaction with Drs. Nick and Louise, getting to know them personally, learning what they are discovering about our bats, learning about the equipment and getting to play with them, participating in the LIDAR survey, and getting to use some great video and pictures for our presentations.*

Close to half the interpreters (6 out of 14) cited the inquiry-oriented and participatory visitor approach encouraged in iSWOOP as the greatest benefits of the program.

*It helped me put some energy back into my programs and approach them a different way. Oftentimes the default for our programs is to do all the talking. This helped me step back from that.*

*I have said from the beginning the "bats" are taking the backstage for me. I have focused on tools and techniques that I can utilize at whatever park I happen to be working in. I feel participating in iSwoop has spurred me to look further into "facilitated dialogue" and how to incorporate other "visitor directed experiences" in my programs.*

One interpreter summed up the various benefits in this way:

*My understanding of bats and how we know what we know because of the research has increased immensely as well as gaining a stronger insight into methods and technology used to gain the knowledge. This has strengthened my ability to help connect the visitor to the same. The other value is to begin examining my own methods of program delivery and look for new ways of presenting the information. It has brought a new awareness to seek alternative methods based on the audience.*

**Challenges of Incorporating Science Research into Visitor Programs**

Interpreters were asked both on their pre-training and post-training surveys what they regarded as the biggest challenges to incorporating science research into programs with visitors. On the pre-training surveys, interpreters were about evenly split as to whether they spoke about the problems of interpreters having access to the actual scientific research (mentioned by 6 interpreters), versus making scientific information accessible and understandable by the public (7 interpreters).

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| Pre-Training Concerns with Interpreters’ Accessing of Research |
| *Knowing that research is going on in our park. There is a massive dividing line between outside research and our interp divisions, at most parks. Simply knowing that research is happening is the toughest hurdle to overcome.**Maintaining regular communication between researchers and interpreters, so we have the most up-to-date research to interpret.**My conversations with the scientists is always brief, as I am working at the time, and they are busy with their research, so the biggest challenge is to get as much information as I can in the short conversations, which means asking the right questions.*  |
| Pre-Training Concerns with Public Engagement with Scientific Research |
| *Accessibility and time-limitations and finding balance. Interpretive programming must effectively translate scientific research in a limited time frame to an audience with possibly little to no background in a topic or even the processes of research.**I think that the biggest challenge that I face is that visitors can be difficult to engage with the more in-depth science since they are in a vacation mindset.**One of the biggest challenges would be to arouse interest within the visitor. It has to be presented and packaged correctly in order to have that buy-in from the public. It can almost be seen as "marketing".**I would anticipate that the biggest challenges to incorporating science research would be making that information relevant and understandable to visitors. My expectation is that current research would be relatively specialized and complex, involving issues beyond the layperson's scientific knowledge. I think that once the research questions and problems are made comprehensible, that it will be an easier task to make that research meaningful to our visitors.* |

In contrast, in their post-training surveys, the majority of interpreters (11 out of 14 interpreters) commented on techniques for engaging the public, and fewer (2 interpreters) dwelled on issues surrounding interpreters’ access to scientific research. A number of the interpreters described the challenges of actively engaging visitors in the research in a more open-ended, inquiry manner, while being attentive to one’s audience and customizing programs to take into account the dynamics of the group.

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| Post-Training Concerns with Public Engagement in Scientific Research |
| *The biggest challenge is presenting research that can capture an audience's attention to begin with, to present it in a way that keeps the information in lay terms, and allows the visitor to understand the 'so what?' factor -- why it's meaningful to place and to themselves.**The biggest challenge is avoiding the trap of jargon! Science research can sound like a foreign language to many people, and I have to remind myself that while I may be familiar with certain concepts and vocabulary now, it is the visitor's first time hearing it.**I think visitors are used to being talked to and not involved in the scientific process. Children were more willing to answer questions but adults have a few more inhibitions. Getting visitors to participate was my biggest challenge.**Visitors are not the same as students. They come to national parks with different motivations and different objectives. We have to make research attractive to people who have recreation on their minds, not necessarily learning. That doesn't apply to everyone, but it applies to many visitors.**Science is inquiry. [Personally I think that the biggest challenge is having visitors or a group dynamic which is open and willing to volunteer their thoughts or questions with regard to inquiry based learning/programs. In my experience providing tour and programs here at the caverns sometime you have visitors that ask questions and sometimes you don’t. Having a program that places the responsibility on a visitor to do the “heavy lifting” (as was mentioned in the training) might not lead to a successful program in which you have connected the visitor to the resources.] Finding a balance that works is the most challenging for me. As a presenter we need to tailor our talk to our audience, but the audience can be inquisitive or not and you don’t want to expect them to do the lifting if they don’t want to. I think the science is exciting and I try to bring that excitement to my programs.* |

Two interpreters in both the pre- and post-training surveys (4 interpreters total) spoke about the importance of the interpreters themselves actually understanding the research, and how that was a necessary pre-requisite in a successful public program.

*The biggest challenge I think is communication and access to the research and science - knowing what is happening, who is doing it, and what is current to be prepared enough to then incorporate the science accurately. The second most challenge is in the ranger understanding the science enough themselves to make it relevant to the audience.*

*The biggest challenge for me is my ability to understand the science research so that I may incorporate it into programs. I find that science research now is very specialized and complicated. I like to know the context of ongoing research and how it fits with or changes our current understanding. I have confidence that once I understand the material, I can use my interpretive skills to get the information across to our visitors.*

**Feedback on Specific Program Components**

To gather feedback on specific program components, interpreters were asked to rate how valuable they found six different types of iSWOOP program activities and support that had been offered. Ratings were on a four-point scale: not valuable; a little valuable; valuable; very valuable, and also N/A.

The program component that received the highest rating was the *on-site professional development*, which 12 out of 14 rated as valuable (with 10 rating it as “very valuable.”). This was followed by positive ratings of the *suggested readings* (10 out of 14; 7 “very valuable”), the *e-mailing with project leaders* (9 out of 14; 2 “very valuable”), and *blogging with project leaders and peers* (8 out of 14; 1 “very valuable”). Rated as less valuable were receiving *written or in-person feedback on programs* offered by project staff (5 out of 14) and *conference calls* (3 out of 14).

Preferred Formats for Technology Use: During the June round of training for iSWOOP for Cohort II, interpreters were given not only a large screen monitor and computer with which to present iSWOOP images to the public, but also an I-pad version of iSWOOP, that they could take on roves, as interpreters moved about the CAVE park site and interacted with visitors.

Interpreters found that the two technology options were each useful in different ways, depending on the format of visitor program and interaction.

*iPad [is good] for roving and small groups, cart for large formal presentations and informal gatherings.*

*My favorite method of displaying the iSWOOP images is with the cart in the theater. I prefer this method because it gives the audience a large screen on which to view the images, the theater is relatively free of distractions, and it gives me the best means of manipulating the images and animation.*

*iPad in the cave is my favorite; it is easy to make an interpretive opportunity catered to their specific questions and needs.*

*Having the iPad with me while roving added a whole other dimension to my interaction with visitors. In a way it makes my roving easier. People are so visual and drawn to things they are familiar with...[like] visual media, so it was not difficult trying to generate the interest.*

Obstacles to Implementation: Ten of the fourteen interpreters reported that they had encountered some obstacles to implementation. The nature of these obstacles varied. Some interpreters described obstacles pertaining to the technology (4 interpreters), such as having more experience with PC’s rather than Macs, needing more time to become familiar with the technological tools, and figuring out what the best location would be to use the technology with visitors (in the exhibit space, vs. amphitheater or somewhere people can sit.) Three interpreters discussed the challenges of asking visitors for feedback, as had been requested by project staff as a way to provide additional data on visitors.

Two spoke specifically about the challenges of adopting a more interactive style of interacting with visitors, for themselves or what they observe with their colleagues.

*I am at a point where I like the selection of slides and flow. I am still having trouble with implementing the inquiry aspect of my program. I find myself answering my own questions. Visitors haven't provided me with useful feedback. They say, oh it was good or it was all interesting (no specifics).*

*One significant obstacle I've noticed with my peers: many interpreters have the Interpretive Development Program (IDP) so firmly drilled into their heads that they have trouble breaking the mold. Their iSWOOP programs aren't any different from any other ranger talk. They are doing all the work, and the visitors are more passive. A solution could be greater emphasis on learner involvement, engaging the audience, etc, and also back this up with their supervisors assuring them this doesn't have to be a "normal" ranger program. It can be hard to break out of the mold of what you think is the "right" way to give a program, but it can be done.*

Support Needed for New iSWOOP Interpreters: When asked what type of support they felt was critical for new interpreters involved in iSWOOP, interpreters expressed areas of need in a variety of areas. Half (7) of the interpreters voiced the need for having support offered by a various types of professionals, including project staff, scientists, technology experts and program supervisors.

Three additional areas of support, concerning time, technology and resources, were identified by four interpreters each. *Time* was discussed in terms of needing time to learn to use the technology, to become familiar with the scientific research, to develop their own program and to engage in co-worker conversations and feedback. Interpreters expressed needing *technology support* to learn how to use equipment, the Mac, and the keynote software. *Resources* on inquiry, images, and primary sources on science were also requested.

Regarding suggestions for improving iSWOOP, four interpreters discussed the focus on interpretive skills, with differences in opinion regarding how much the program needed to emphasize interpretive skills. Several said they are already skilled in this as interpreters, while others indicated that more work is needed in this area.

**CONCLUDING REMARKS**

In summary, as implemented at CAVE, the iSWOOP program offered a unique form of contact and collaboration between on-site park interpreters and scientists conducting on-site research rarely offered in National Parks. Through professional development experiences spanning both classroom seminars and field-based sessions with scientists, interpreters acquired a range of new visual tools (a library of scientific visualizations and images) and questioning strategies to encourage visitors to make sense of scientists’ visualizations. As a whole, they appeared to transform programming in so far as visitors learned about park-based research, had the opportunity to view rarely seen footage of bats in their roost, and in flight with high-speed cameras. These components were highly valued by interpreters, and offer a strong foundation of program elements that should continue to be included in future iSWOOP programs.

Moreover, the pilot study indicates that the iSWOOP training and approach were successful in increasing interpreters’ understanding, first-hand experience, and enthusiasm about on-site scientific research happening at their park, and also in increasing interpreters’ pedagogical awareness and skills to foster more active, inquisitive visitor engagement in science. Interpreters were seen putting knowledge into practice through their programs, and visitors reported acquiring new knowledge relating to bats, park-based research, the science process, and the technology used to study bats. The pilot study suggests that iSWOOP offers a promising and effective model for the National Park Service as it strives to encourage lifelong learning and science literacy among its park visitors.

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