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Foreword

What This Is The following report documents the Formative Evaluation findings for new exhibits at the Yavapai Observation Station, at Grand Canyon National Park.

Formative Evaluation is the second part of a two-part evaluation process. The body of this report summarizes the Formative Evaluation findings. The Office of Management and Budget approval number is #1024-0224 (NPS #03-010), Expiration Date: 09/30/2003.

What We Did Three representatives from The Sibbett Group facilitated the evaluation study on February 25 and 26, 2003. Four distinct visitors groups participated by interacting with exhibit prototypes and engaging in an exit interview; participants were recruited by National Park Service staff. Each session lasted thirty to forty-five minutes. After interacting with the prototypes, participants were asked a series of open-ended questions. Each session was documented with photographs. In appreciation of their time, pre-scheduled participants received a gift certificate to the Grand Canyon Association bookstore, and general visitors received a geology book.

The feedback and data from the Formative Evaluation was used to modify exhibit designs

for the new geology exhibits, which are included in this report.

What's Next In the remainder of the Design Development Phase, the exhibit design will continue to evolve. We will illustrate our vision of each learning environment with drawings and narrate the visitor's experience through written descriptions.

*Donald Sibbett
July 23, 2003
San Francisco*

Evaluation Overview

Evaluation Rationale The National Park Service Act of 1916, 38 Stat S35, 16 USC 1, et seq., requires that the National Park Service (NPS) preserve the national parks for the use and enjoyment of the present and future generations. At the field level, hallmarks of *use and enjoyment* include resource preservation, public education, facility maintenance and operation, and physical developments that are necessary for public use, health, and safety. The Government Performance and Results Act of 1993 (P.L 103-62) requires that the NPS develop goals to improve program effectiveness and public accountability, and to measure performance related to these goals.

Evaluation Background To more fully meet its charge to provide public education, Grand Canyon National Park staff requested that The Sibbett Group conduct front-end and formative evaluation studies as part of their exhibit design work for the Yavapai Observation Station. The Sibbett Group agreed to design and implement the studies that would document the needs, desires, and perceptions of Yavapai's principle user groups in order to develop the most effective interpretive exhibits.

Evaluation Process The process is ordinarily comprised of three evaluation phases: front-end, formative, and summative.

Implementation of the entire sequence ensures that the design team has real time data and analysis that informs design decisions prospectively and retrospectively builds a strong, well-documented foundation for future interpretive projects.

Front-End Evaluation Front-end evaluation is the first phase in the evaluation process. During the Preliminary Design Phase, front-end evaluation is employed to ensure that exhibit goals and objectives correspond to visitor expectations.

Formative Evaluation Formative evaluation is the second phase in the evaluation process. After assessing visitor interest through front-end evaluation, exhibit development is focused on designing exhibits that convey the concepts best suited to fulfilling visitor expectations. During the Design Development Phase, formative evaluation is utilized to help test the effectiveness of interactive and hands-on exhibit designs.

Summative Evaluation Ordinarily, summative evaluation is the final phase of the evaluation process, to test the success of installed exhibits. Summative evaluation is not part of this evaluation study.

Formative Evaluation Overview

Overview The Formative Evaluation study was conducted to assess the success of proposed geology exhibits and determine visitors' understanding of interpretive messages. Four prototypes were selected and built from the proposed interpretive exhibits.

It is important to note that these four exhibits were selected for their complexity, and therefore decontextualized from the proposed exhibit design in its entirety. Following this section is the Exhibit Content Outline, which provides an overview of all the proposed exhibits and highlights those selected for prototyping.

Format Four distinct groups were included in the Formative Evaluation study: 1) others who interpret the park; 2) middle school students; 3) educators / teachers; and 4) general visitors. Participants were asked to interact with the prototypes and then participate in an exit interview in order to assess their understanding of exhibit messages.

Conclusion The Formative Evaluation study provided a candid evaluation of the proposed design of interpretive exhibits for Yavapai Observation Station. Feedback from evaluation participants indicates that the proposed exhibit ideas, developed jointly by The Sibbett Group and the Grand Canyon interpretive staff, continue to support the project's overall interpretive themes, goals and objectives. However, design modifications are required to achieve the specific learning objectives for each interpretive exhibit. These modifications are included in the recommendation section in the Principle Findings for each prototype.

Study Goals & Methods

Study Goals The Formative Evaluation Study had the following goals:

- 1) Assist park managers and the Yavapai Observation Station design team (including The Sibbett Group and National Park Service interpreters) in assessing the success of proposed geology exhibits and determine visitors' understanding of interpretive messages.
- 2) Help ensure that exhibits support the interpretive themes, goals and objectives defined for Yavapai Observation Station and those articulated in the Grand Canyon National Park Interpretive Plan.
- 3) Support front-end evaluation study findings by ensuring that proposed exhibits correspond to exhibit recommendations about visitors' interests and favored modes of learning.
- 4) Determine visitors' interest in and understanding of:
 - Erosional forces of the Grand Canyon
 - Strata layers and rock environments
 - Geological processes
 - Geologic time

The Study's Perspective on Learning/ Understanding In this section, we briefly discuss how learning is least likely and most likely to occur and be measurable in a world of diverse learners and particularly in the context of informal education.

The following paragraphs are intended to assist the reader in understanding the

theoretical and methodological perspectives underlying the design, analysis, and conclusions of this study. We also include it here to provide a methodological rationale for our having considered a wide-range of responses as being indicative of participant-tester learning.

The traditional instruction/learning model is predicated on the assumption that one type of learning will fit all learners. This model does not usually take into consideration differences in how people learn. In this teaching-learning paradigm, the teacher 1) defines the universe of knowledge to be acquired; 2) presents information to the learner; and 3) tests to ascertain the degree to which the learner has acquired and retained the information presented by the teacher. Learning is measured by the learner's ability to make her learning conform to the presentation modalities and learning expectations of the teacher.

The implications of this model in the context of prototype evaluation are that the evaluator and design team will be likely only to assess the degree of each participant-testers' proficiency at reciting facts or understanding messages the designers embedded in the prototype. Such an assessment will be unlikely to measure the range or capture the richness of the learning process where a learner may report a level or type of learning much more elementary than the designers assumed or, on the other hand, far more advanced than the designers had built into the design.

For the purposes of the formative evaluation, we utilized another learning model, one that reflects how most people actually learn and also mirrors the reality of learning and measuring learning in informal education settings such as museum exhibits. This model assumes that different learners have different: 1) knowledge bases; 2) learning strengths and weaknesses; 3) learning styles, and 4) learning interests.

Given these assumptions, we consciously broadened our definition of learning to capture and document the experiences of participant-testers that might otherwise go over, under, or around our assessment net.

In this model of learning and, by implication, evaluation, teachers/designers and students/visitors are jointly responsible for: 1) defining the universe of knowledge to be acquired, and 2) manipulating the content and presentation modalities to increase possibilities for learning success. In addition, this model provides a rationale for employing a far wider spectrum of learning indicators. As a result, learners, evaluators, and designers can use these indicators as authentic and more accurate evidence of the formative evaluation study's participant-testers' learning and understanding.

Study Methods A formal protocol was written that called for:

- Participant interaction with prototypes
- Informal observation of participants

Administration and documentation of standardized follow-up interview protocol

The protocol sequence began with an explanation to participants of what was expected of them. Next, they interacted with one or more prototypes. During this interaction period, The Sibbett Group and Grand Canyon staff engaged in unstructured observation of participants. Finally, participants were engaged in either an individual or small-group exit interview utilizing open-ended questions designed to elicit their authentic responses.

Testing was conducted over a two day period. A participation incentive gift was provided for each participant-tester by the Grand Canyon Association.

Day One Participants were all members of three of the cohorts assembled by NPS staff:

- Tour operators/others who interpret the park
- Educators/teachers
- Middle school students

Day one participants interacted with all four prototypes.

Day Two Our fourth cohort, general visitors, was the focus of the second day's prototype testing and interviews. In order to assure a reasonably representative sample of all Grand Canyon visitors, participant-testers were selected using a visitor profile matrix, developed by The Sibbett Group, that considered factors including gender, age, and international region of origin.* Due to time constraints, Day Two participants generally were limited to interacting with a single prototype.

The sessions were documented using hand-written notes, audio recordings and photographs. The data were transcribed, aggregated and analyzed for use in this report.

Data Aggregation and Analysis Participant-tester responses were aggregated by extracting and transcribing them from both audio and written documentation. Subsequently, we sorted the raw data by cohort and specific protocol question into discrete cohort group matrices.

In analyzing these data, we employed both qualitative and quantitative methods including frequency tabulation (thematic and word-specific), response comparison (cross-age and cross-cohort), and macro data analysis. This combination of methods allowed us to capture unique perspectives and insights as well as identify trends and points of commonality within the data.

* Some Day Two participants did not fall under the general visitors category, as they were either GRCA employees or residents.

Formative Evaluation Study Overview

Background The formative evaluation study was conducted to assess the degree to which the proposed geology exhibit prototypes were successful in increasing participants' understanding of underlying interpretive messages as well as in supporting front-end evaluation study findings and ensuring that proposed exhibits corresponded to exhibit recommendations about visitors' interests and favored modes of learning.

From all the proposed interpretive exhibits, four were selected and built to be prototyped in the formative evaluation. It is important to note that the four exhibit prototypes were selected for their content complexity, and therefore decontextualized from the proposed exhibit design in its entirety. (Following this section is the Exhibit Content Outline, which provides an overview of all the proposed exhibits and highlights those selected for prototyping.)

Participants Four distinct cohorts were identified to represent the universe of visitors/users of Yavapai Observation Station. National Park Service staff recruited cohorts representative of:

- Tour operators/others who interpret the park
- Educators/teachers
- Middle school students
- General visitors (including non-English speaking)

Protocol The protocol specified that participants would interact with one or more of the prototypes and then participate in an exit interview that would assess the degree to which the prototypes enhanced their learning/understanding of: 1) the erosional forces of the Grand Canyon; 2) strata layers and rock environments; 3) geological processes; and 4) geologic time. Their reactions would be documented in writing and by audio recording for later aggregation and analysis.

What We Learned The formative evaluation study of the four prototypes provided a candid assessment of the proposed design of certain interpretive exhibits for Yavapai Observation Station. Feedback from evaluation participants indicated that the proposed exhibit ideas, developed jointly by The Sibbett Group and the Grand Canyon interpretive staff, continue to support the project's overall interpretive themes, goals and objectives.

Prototype testing, observation, follow-up participant-tester reaction assessment, and subsequent analysis also provided us with the opportunity to make certain generalizations regarding participants' interactions with the exhibits.

What worked well

- 1) Touch – opportunities to touch anything with particular interest in touching real items such as fossils and stones e.g., *Geology Column*, *Canyon Formation*, *Observation Station*, *Geologic Time*.
- 2) Sequencing – exhibit components that build on learning from participants' experience with one element to their experience with the next e.g., *Geology Column*.
- 3) Shapes – unusual physical design that visually compels visitors to approach and contemplate e.g., *Time Spiral*, *Geology Column*,
- 4) Movement – such as rotation or spinning that draws attention because it moves. May also encourage additional exploration and learning e.g., *Geology Column's* globes and trylons, *Observation Station's* rotating rock.
- 5) Sensory/cognitive linkages – words that match what is touched and seen e.g., *Canyon Formation's* layers, push-up box.
- 6) Contextual learning – stimulus to learn enhanced by the milieu e.g., view from Yavapai generates curiosity about Canyon formation and general principles of geology
- 7) "Real" things – seeing and/or touching authentic artifacts or replicas that foster cognitive or affective connections e.g. *Geology Column*, *Time Spiral*, etc.

8) Multiple learning modalities/perceptual abilities – using touch and sight (visual images and text), to communicate a single concept e.g., *Geology Column*, *Observation Station*.

9) Intentionality – design features that are consciously linked to learning goals such as "encouraging exploration" or "stimulating curiosity" e.g. *Observation Station's* rotating rock, *Canyon Formation's* trylons, and *Geologic Time's* "Time Line" slider and "Time Spiral's" rotation.

What requires re-examination/improvement

Participant-tester reactions also clearly indicated that design modifications are required in order to fully achieve each interpretive exhibit's learning objectives.

Challenges that remain include:

1) Thematic inclusion – interpretive themes that remain inadequately addressed i.e.:

- a) erosion
- b) geologic uplift
- c) geological uniqueness of Grand Canyon.

2) Concept clarity – do the exhibit components clearly address and illuminate the underlying concept for which they were designed? e.g., *Observation Station*, *Canyon Formation*.

3) Component linkages – lack of or inadequate explanations of how elements of an exhibit relate to one another, over-arching explanations e.g., *Canyon Formation*.

4) Multiple learning modalities – lack of learning opportunities using perceptual abilities other than sight and touch e.g., all prototypes

5) Intentionality – making sure that all design features and moveable elements can be clearly linked to project learning goals and that they reinforce the concept they are intended to teach e.g., *Observation Station*, *Canyon Formation*.

Principle Findings

Principle Findings The following findings document exit interviews with Formative Evaluation study participants, following their interaction with exhibit prototypes. The findings include: what participants felt they learned from the prototypes, what they wanted to learn more about, and their suggestions for improving the exhibit prototype.

Using the exit interview data from all participants, we formulated conclusions for each exhibit prototype. The conclusions and participant suggestions helped inform the recommendations.

Prototype 1 – Observation Station



Exhibit Goal To create an exhibit that promotes visitors' understanding of the erosional forces of Grand Canyon.

Prototype Description This prototype was modified slightly from its original design to include three main elements: a viewing scope, rock specimen and graphic panel. The original design included a magnifying glass, which was not used in the prototype, with the exhibit goal of focusing on erosional forces.



Prototype 1 – Observation Station

Overview This exhibit's goal was to promote visitors' understanding of the erosional forces of the Grand Canyon. The prototype's multi-modal learning design encouraged testers to focus on a particular geological layer while also offering opportunities to touch and read about what they were seeing. Overall, testers reacted positively to the experience with students and general visitors reporting the most learning from the exhibit. One student said, "It made me want to go over and look at it." However, references to erosional forces in participant responses were rare.

Indicators of learning/understanding Participants frequently commented that it was the combination of learning possibilities that they found particularly appealing e.g., to touch the same rock specimen they were looking at in the distance. Others reported that focusing on one feature through the viewing scope was a significant benefit. We also found that the exhibit fostered some testers' desire to know more about layers and the formation of Grand Canyon

Challenges to learning For nearly all participants, the exhibit did not promote understanding of erosional forces of Grand Canyon. Only two testers referred directly or indirectly to erosion in their interviews. Concern was also expressed by participant-testers regarding the lack of information and/or experience within the exhibit regarding the concept of slope.

What participants learned

Canyon layers, age of rocks. (Student)

The layers and colors, understanding basic makeup/staircase, changes take place over time. (U.S. Visitor)

Made me want to go over and look at it. (Student)

Touching sandstone. (Student)

Liked combination of modalities. (Educator)

The existence of layers, made a connection between different exhibit elements. (U.S. Visitor)

Looks right at a cliff. (Student)

Liked the focus that the tube brought. (U.S. Visitor)

Touching and seeing brings things together. (U.K. Visitor)

Very nice to touch with hands. (Japanese Visitor)

What did not foster learning

Doesn't explain how a cliff forms. (Interpreter)

Didn't get it. (Japanese GCA staff)

Didn't understand Lazy Susan ... implied there was something I wasn't getting. (Interpreter)

Which weather condition created which layer? (German Visitor)

Unclear that rock was from cliff. (U.S. Visitor)

Prototype 1 – Observation Station (continued)

Recommendations

- Provide more than one scope at each location and at different viewing heights.
- Focus on different features that illustrate erosional forces.
- Use graphics to describe the feature and erosional forces being highlighted.
- Use graphics to illustrate the comparison of a cliff being eroded over time.
- Provide a fixed rock sample that clearly shows erosion.

Participant ideas for improving the exhibit

More tubes. (Visitor)

A larger rock sample would be good to spin. (Educator)

Good if you show it changing over time – like a kaleidoscope. (Student)

Add explanation of “slope.” (Educator)

Find and compare through the tube. (Student)

Would be nice to have rocks from different layers. (German Visitor)

Bigger text. (Japanese Visitor)

Prototype 2 – Canyon Formation



Exhibit Goal To create an exhibit that promotes visitors' understanding of the strata layers, geological processes and erosional forces that formed the Grand Canyon.

Prototype Description This prototype represents only select elements that were proposed for this interpretive exhibit. Because of time and budget constraints, the final graphics and A/V component did not accompany this interactive.

Prototype 2 – Canyon Formation

Overview The prototype had three elements: 1) a stack of tiles representing canyon layers, each highlighting a fossil that participant-testers could see and touch; 2) a box-within-a-box, representing canyon layers, that could be pushed upwards to reenact the geologic uplift that set the stage for the Grand Canyon's formation; 3) two interlocking boxes, representing canyon layers and the Colorado River, the latter of which could be pushed downward to simulate erosional downcutting. The learning goal for this prototype was to foster visitors' understanding of the strata layers, geological processes, and erosional forces that formed the Grand Canyon.

Indicators of Learning/Understanding Nearly all participants understood that this exhibit was about layers and how the Grand Canyon was formed. One visitor from England said that exhibit elements prompted her to recall and finally synthesize geology lessons from her school days. Some participants reported that the exhibit called their attention to how many layers can be seen in the Canyon. Other testers reported that their interaction with the exhibit made them want to know more, especially the dates of the various layers. Overall testers were most enthusiastic about the "layer" component. It also evoked the most suggestions for ways to improve it.

Impediments to Learning A number of testers suggested that the exhibit lacked an overarching, cohesive explanation that would have provided a context for understanding the three prototype elements. A few reported their experience was confusing or that the exhibit was difficult to understand due to insufficient differentiation between and lack of clarity within prototype elements #2 and #3 (boxes).

What participants learned

[I learned] how water carved the Canyon; I was thinking it started from the bottom. (Student)

[Understanding about] different layers. (Chinese Visitor)

Rubber band element helped a lot, exposed different layers I didn't know. (Student)

Didn't know there were so many layers; [now I] understand why we won't have time to walk. (U.S. Visitor)

Lifting layers was good because you could see what was there. (Student)

Favorite was layers. (U.S. Visitor)

What did not foster learning

Would like to see three concepts tied together better. (Interpreter)

Found it confusing, hard to understand. (Educator)

Hard to hold things up to see underneath. (Educator)

Seemed like uplift was doing the same thing as river cutting. Uplift was confusing. (U.S. Visitor)

River was confusing because it pushed down an entire side instead of just down the middle. (Educator)

Prototype 2 – Canyon Formation (continued)

Recommendations

- Reconsider use of interactives to reinforce Grand Canyon formation. If interactives are used, employ the following:
- Use graphics to create an overarching connection between the three distinct factors that contributed to the Canyon's formation.
- Create even greater clarity in the visual layout and underlying principles for the "formation boxes."
- Include touchable, replica fossils with visible labels, in each layer.
- Instead of interactive "formation boxes," use animation to illustrate the formation of Grand Canyon.
- Illustrate with graphics the combination of geological, physical, and climatological factors that coalesced to create Grand Canyon.

Participant suggestions for improving the exhibit

A title with drawings of how three stages happened. (Interpreter)

Label layers on top, not on side. (Educator)

Real fossils attached to each layer with a few words to say it formed in a particular environment. (Interpreter)

Give dates about when they were formed and approximate time period. (Student)

Put more distance between the layers; they're hard to see and somebody's fingers could get squished. (Educator)

Tell why fossils are only on one side and why some don't have fossils. (Student)

[Boxes] hard to hold up or keep down, make push and pull very hard. (Educator)

Push river down through a cross-section. (Educator)

Prototype 3 – Canyon Column



Exhibit Goal To create an exhibit that promotes visitors' understanding of the strata layers and rock environments of the Grand Canyon.

Prototype Description This exhibit prototype represented all of the elements in the proposed exhibit, but only for select layers.



Prototype 3 – Canyon Column

Overview The Canyon Column prototype was designed to focus testers' attention on the strata layers and rock environments of the Canyon. Its four elements were: 1) a series of globes adjacent to each stratum to illustrate the location of the continents during the relevant periods and eras; 2) a rock sample of the same era or period; 3) a three-sided rotating graphic (trylon) with illustrations of the depositional environment associated with the stratum, and 4) a three-dimensional cross-section of the Canyon that identifies the name and age of the various canyon strata.

Indicators of learning/understanding Among the four prototypes, the *Geology Column* received the most positive comments and the most narrowly focused suggestions for improvement. Most participants reported their learning was enhanced by the juxtaposition of the globes, rock specimens, trylons, and column model. The sequence and relationship of elements was comprehensible and considered valuable by nearly all participants. The globes were especially popular as they stimulated thinking about geological change over geologic time, particularly the shifts in position and apparent quantity of land and water.

Challenges to learning Some reported the trylon feature to be problematical because of the subtle distinctions between creatures and their depositional environments. However, most participants seemed to perceive the trylons as an intrinsic part of their larger understanding of the exhibit. Students were especially attentive to the subtle changes in the kinds and quantities of creatures depicted.

What participants learned

[Saw] where Grand Canyon was so many years ago. (Student)

Layers helped most. Strong interactive display. (Educator)

Layers, how it's built up, how Earth was different, continents were apart. (Dutch Visitor)

Column was very clear, good. (Japanese Visitor)

Serves to push envelope about understanding time. When you turn the globe, you see so much ocean. (Interpreter)

Liked seeing animals in the water. (Student)

Gives an idea that layers are named and different. (U.S. Visitor)

Clarifying for kids that lower is older. (Educator)

Cross-referencing between elements. (Student)

Like comparing rock to real column, globes, touching rock. (U.S. Visitor)

What did not foster learning

Trylon confusing. (Japanese Visitor)

Trylon images were too much alike. (Student)

Didn't get triangle "flippers." (Interpreter)

Prototype 3 – Canyon Column (continued)

Recommendations

- Interpret at least seven layers of Grand Canyon.
- Use globes to show continent location, relative depth of oceans and seas, and latitude and longitude lines.
- Globes should have raised continents for tactile interest and to address ADA guidelines.
- Use animal images to visually hook visitors, particularly younger visitors.
- Reduce height of column model to provide greater tactile access for visitors.
- Condense some layers in the column e.g., Supai, in order to accommodate the inclusion of additional layers within the prototype format.
- Create more distinctions between illustrations that appear on rotating graphics, and incorporate a message that supports the illustrations.
- Consider a two-sided rotating graphic or a non-rotating graphic.

Participant suggestions for improving the exhibit

How do you make this ADA-compliant?
(Educator)

Would like age-reference on each layer, needs clear images, descriptions of fossils. (Japanese Visitor)

More trylons for comparison. (U.S. Visitor)

Canyon layers are really interesting to me because as you look across the Canyon, you can see it. The Supai layer was more detailed than what I needed. Would like one for each layer. Basalt is so different from the limestone, and if they're walking later in the Canyon, they'll know better what they're looking at. (Educator)

Good to have more layers. (U.S. Visitor)

Trylons with dry-land stories as well as what was happening in the water. (Educator)

Recommended readings for those who want more information. (Educator)

One globe per layer would be good to show relationship. (Interpreter)

Cross-reference with time spiral to see animals that lived there. (Student)

Especially with younger kids, they'd want to know more about dinosaurs. Seeing the fossils might make them more interested in looking at the rocks outside. (Educator)

Prototype 4 – Geologic Time Analogies: Time Spiral



Exhibit Goal To create an exhibit that promotes visitors' understanding of geologic time as it relates to Grand Canyon.

Prototype Description This exhibit prototype reflects an analogy that was proposed to explain geologic time.

Prototype 4 – Geologic Time Analogies: Timeline



Exhibit Goal To create an exhibit that promotes visitors' understanding of geologic time as it relates to Grand Canyon.

Prototype Description This exhibit prototype reflects an analogy that was proposed to explain geologic time.



Prototype 4 – Geologic Time Analogies: Time Clock



Exhibit Goal To create an exhibit that promotes visitors' understanding of geologic time as it relates to Grand Canyon.

Prototype Description This exhibit prototype reflects an analogy that was proposed to explain geologic time.

Prototype 4 – Geologic Time Analogies: Time Spiral, Timeline, Time Clock

Overview Three different time analogies were tested: a) 4.5 billion years illustrated in a three-dimensional spiral that pointed out significant elements, such as when the canyon's rock formed, the age of humans, and when the canyon was carved; b) a 12-foot long ruler that listed, from left to right, the epochs, periods and eras of the Earth's 4.5 billion-year history; and c) a 12-hour clock accompanied by an interpretive graphic panel that articulated how brief human existence is compared to a 12-hour span of time. A multi-modal approach that promotes visitor understanding of geologic time is both valuable and effective. Because of different learning styles and strengths, all three approaches appealed to at least some participants.

Indicators of learning/understanding Based on participant responses we concluded that a multi-modal approach that promotes visitor understanding of geologic time is both valuable and effective. Because of different learning styles and strengths, all three approaches appealed to at least some participants.

Time Spiral While participants suggested a variety of modifications to improve and refine this prototype, the Time Spiral received the most support from participants. The prototype inspired many – across age groups – to think about time. Visual accessibility was the key factor. Most positive comments were inspired by the spiral's shape, color, and three-dimensional figures – particularly animals.

Timeline Several participants found the literally *straight-ahead* linearity of the Timeline prototype to be helpful in conceptualizing time. The slider component was confusing to nearly all participants.

Time Clock A few participants reported that the Time Clock was significant in helping them better conceptualize geologic time. Overall, participants identified it as the least well-developed of the three time analogy prototypes.

What participants learned

Overall

Good to have multiple approaches; best I've ever seen. Good metaphors. Appropriate to have it here. (Educator)

We haven't been on Earth as long as the Earth has existed. (Student)

Humans are not old, rocks are. (U.S. Visitor)

We can experience how old Earth is and compare to history of living things. (Chinese Visitor)

How long ocean was on Earth, tells when, how many billion years ago land was formed and animals first created. (Student)

Time Spiral

Cool! Great visual. (Student)

Love the time spiral. (Educator)

Whoa! That's a long time ago. (Student)

Time spiral is more clear. See when life appeared. (French Visitor)

Like shape and allusion to how time is never-ending. (U.S. Visitor)

Reminded me of a giant hurricane that created Earth. (Student)

Timeline

Like length of ruler. (Educator)

Being able to touch and move things. (U.S. Visitor)

Time Clock

The clock helped me the most. (Student)

Most people can understand. (Student)

Prototype 4 – Geologic Time Analogies: Time Spiral, Timeline, Time Clock (continued)

Challenges to learning Most participant-testers wanted the analogies to more specifically and dramatically identify the time when the Grand Canyon appears in geologic time. Some participants also expressed a desire to have more detailed information within the prototypes regarding the vocabulary and definitions of geologic time.

The Timeline and Time Clock received the most criticism with some testers most commonly remarking that, in the case of the Timeline, they “didn’t get it” or, in the case of the Time Clock, that it had been done before and better previously at Yavapai.

Respondents who reacted favorably to the Time Spiral were most frequently critical of the other analogies. On the other hand, the relatively few testers who reacted positively to the Time Clock or Timeline, were less taken by the Spiral.

What did not foster learning

Overall

Need to tie more to the Canyon. (Interpreter)

Hard to visualize quantities of time. (U.S. Visitor)

Knew it already. (Student)

Make words bigger. (U.S. Visitor)

Want to know more about periods rather than just eras. (U.S. Visitor)

Time Spiral

Black and white with little words on the sides of the spiral don’t help. (Interpreter)

Timeline

Don’t understand the slider, why man was moving through time. (Educator)

Timeline didn’t help me much. (Student)

Ruler is so verbal. Putting on objects might make it clear. (U.S. Visitor)

Time Clock

This doesn’t do justice to what was here [the original time clock from earlier interpretive exhibits]; people would wait to see the whole “ticking” show. (Interpreter)

Didn’t see how it related to Earth. (Student)

Drop the clock! (Educator)

It’s the one we’ve seen before. (Student)

Prototype 4 – Geologic Time Analogies: Time Spiral, Timeline, Time Clock

(continued)

Recommendations

General

- Consider inclusion of all three elements or combining features of several into one.
- Make the Grand Canyon’s place in geologic time more obvious and dramatic in telling the geologic time story.
- Use consistent visuals (color, arrows, etc.) and language (larger-print signage, terminology, etc.) across exhibits to aid visitors in better understanding the exhibit and building cognitive connections between exhibits.
- Describe other time analogies, including Timeline and Time Clock, in a visitor handout.
- Include integral lighting to accentuate time periods.

Time Spiral

- Use the Time Spiral as primary geologic time analogy for exhibits.
- Make the Time Spiral’s references to geological eras and periods more apparent.
- Relate canyon layer colors from other exhibits to Time Spiral colors.

Timeline

- Remove slider panel referring to human history.

Time Clock

- Create a visual around the Time Clock that contextualizes the geology time periods.

Participant suggestions for improving the exhibit

Overall

- What is going to happen next?* (Student)
- Make words bigger.* (U.S. Visitor)
- Color code the layers on everything.* (Student)
- Combine line and spiral.* (U.S. Visitor)

Time Spiral

- Incorporate clock idea into time spiral with a sixty-second clock that lights up.* (Interpreter)
- Animals from top to bottom.* (U.S. Visitor)
- What is going to happen next? That question is a great conversation starter about the big important questions.* (Student)

Timeline

- Make two windows on the “slider.” One that tracks time as you slide it and the other that gives a visual of what it looked like.* (Educator)
- Linear was second best but instructions would have helped.* (U.S. Visitor)
- Timeline embedded in floor.* (Interpreter)

Time Clock

- Link periods to numbers on clock.* (U.S. Visitor)
- Maybe incorporate the clock idea into the spiral.* (Interpreter)

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