

ARTICLE

Flexible Interventions to Increase Family Engagement at Natural History Museum Dioramas

KAREN KNUTSON, MANDELA LYON, KEVIN CROWLEY, AND LAUREN GIARRATANI

Abstract A research/practice collaboration designed, implemented, and tested strategies to facilitate family engagement with natural history dioramas. Across a series of design studies, 295 family groups with at least one adult and one child aged 4–18 were observed at a wildlife diorama of deer in their natural habitat. Each mini-study tested a different intervention intended to encourage families to engage more deeply with the diorama. Compared to a baseline condition where families used the original diorama with no intervention, findings suggested that all interventions supported increased engagement, but that some interventions were more successful at engaging younger children, increasing conversations about biodiversity and ecosystems issues, or in developing science skills such as observation and classification. We make recommendations for supporting family learning at dioramas and also reflect upon how our research/practice partnership was vital to the work.

INTRODUCTION

By presenting realistic flora and fauna in their natural context, dioramas provide a rich way for visitors to understand biodiversity and ecosystems. Early dioramas were first created for scientific or taxonomic purposes; however, in the United States dioramas have always had the primary goal of public education (Reiss and Tunnicliffe 2011; Kamcke and Hutterer 2014). Eye-catching dioramas often included dramatic active scenes of animals hunting, eating, or caring for young. While dioramas continue to be much-loved exhibits in natural history museums, there is a sense that they are old-fashioned and not as engaging as newer, technologically advanced exhibit styles (Wonders 2003). Many dioramas are now historical artifacts in themselves, with a level of craftsmanship and detail that would be impossible to replicate. Natural

history museums are feeling pressure to provide scientific information in more compelling ways to their audiences (Watson and Werb 2013), and in recent years, museums have attempted to retool dioramas to make them more engaging and compelling for visitors (Davidson et al. 1991; Loveland et al. 2014).

The Hall of North American Wildlife at Carnegie Museum of Natural History (CM) includes 26 large dioramas that depict animals from diverse biomes. Dioramas focus on specimens posed in simple narratives that suggest caring for young, or walking through a landscape, but there are also more dramatic scenes that include, for example, hierarchy conflict or predator and prey relations. Most of the dioramas in the Hall are traditional glass-fronted scenes with painted landscapes, but several popular dioramas feature scenes that extend beyond the frame into the gallery space, where visitors can

Karen Knutson, Associate Director, University of Pittsburgh Center for Learning in Out of School Environments
Mandela Lyon, Program Development Coordinator, Carnegie Museum of Natural History
Kevin Crowley, Professor of Learning Sciences and Policy, University of Pittsburgh
Lauren Giarratani, Director of Education, Carnegie Museum of Natural History.

walk entirely around specimens in their simulated landscapes. A paragraph of text explains key features of each scene and in some cases a digital touchscreen next to the diorama provides visitors the opportunity to scroll through text and images that provide additional information on the flora and fauna visible in the scene.

In spite of the wealth of information available in these richly detailed environments, and even though the animals in the dioramas can be a popular draw for families, visitor engagement is often rather low. In a timing and tracking study we conducted as a pilot for the current research, we observed families viewing dioramas in the main path through the Hall of North American Wildlife – an area that includes 13 large-scale dioramas. We observed that 20% of families spent less than 1 minute, 40% spent 2–5 minutes, 33% spent 6–9 minutes, and only 6% spent 10 minutes or longer. Furthermore, researchers rarely noted close observation, pointing, or talking – behaviors that might be associated with deeper family engagement with the dioramas. Most commonly, families were observed to traverse the hall in a slow, steady stroll; maybe stopping here and there to point something out, but rarely stopping to explore the dioramas more closely.

As in many natural history museums, these dioramas are an iconic and historic permanent exhibit at CM and replacing these displays with more contemporary hands-on experiences is not desirable, practical or feasible. While the museum had already installed interactive stations in the wildlife hall (two that included question/answer flap labels, two short videos, a touchable furs area, and a thematic display of taxidermy from the local region), with low visitor learning engagement outcomes and the constraints of the historic exhibits, the museum was interested to explore the kinds of low-cost

interventions that might invigorate the visitor experience in Wildlife Hall.

In this article we describe a design-based research study where museum educators partnered with University of Pittsburgh Center for Learning in Out of School Environments (UPCLOSE) researchers to create, test, and evaluate a series of low-cost interventions designed to improve visitor engagement with existing dioramas. Our partnership focused on iteratively developing questions and interventions with the goal of providing quick-turn-around data to inform further design of activities. The project provided a useful mechanism for educators to prototype ideas about family learning and engagement without having to commit to full-scale program development. Interventions included new signage, hands-on activities, and human facilitation designed to encourage conversations and support families in making scientific observations. We brainstormed ideas for the interventions within the constraints that they should be cost-effective and easy to replicate, so that they could be easily spread to other dioramas in the museum and shared with the field.

METHODS

The project team (museum educators and researchers) selected a focal diorama to be used for testing. The chosen diorama portrayed white-tailed deer in a natural setting that included flora, fauna, and evidence of human presence in nature. The team selected this regionally familiar habitat and animal, postulating that it would draw on museum visitors' possible prior knowledge and familiarity with relevant local issues, such as deer overpopulation. And the diorama was not one of the hall's signature attractions. Our studies of the wildlife hall confirmed findings at other diorama



Figure 1. Deer diorama Carnegie Museum of Natural History showing pre-existing label copy and digital screen (Leaf litter intervention stationed in front). Photo: Mandela Lyon. [Color figure can be viewed at wileyonlinelibrary.com]

halls (Davidson et al. 1991), the deer diorama was neither exotic nor dramatic; did not have the attracting power of megafauna such as moose and bear; and, at the CM, the deer diorama is also situated in the middle of a long run of wildlife dioramas and not at an important vista location. We chose it to provide a good test of what it takes to increase engagement around an “average” natural history museum diorama. Prior to beginning the project, the deer diorama had an existing traditional label panel and a digital touchscreen embedded in the wall to the right of the diorama that provided more information about the location, flora, and fauna on display (see Figure 1).

For each of eight interventions, the project team created and supplemented the diorama with a variety of low-cost materials (signage and activities) that were geared to encourage different kinds of exploration and conversation in

targeted content areas for this particular diorama (Figure 2).

Researchers then conducted unobtrusive observation studies to assess how families engaged with and utilized the diorama with each intervention. Observers were stationed off to the side of the diorama, so that families could use the exhibit without undue interference. Observers were looking for family groups where the children appeared to be between the ages of 4–18. If a member of the family spent more than 5-seconds at the diorama, the group was included in the study. Behaviors such as looking, pointing, sitting, bending, touching, doing an activity, and reading were noted on an observation sheet that had checkboxes for each behavior. After the last family member in the targeted group moved away from the diorama, observers stopped the timer and made notes about the family’s interactions at the diorama,



Figure 2. Bioblitz intervention set up below diorama. Photo: Mandela Lyon. [Color figure can be viewed at wileyonlinelibrary.com]

including who initiated and who terminated the experience, as well as any conversations or questions that could be overheard. A series of prompts on the data collection sheet further directed observers to note whether families looked or talked together, if they seemed interested in the diorama, whether they appeared to look at multiple elements of the diorama, if they connected the intervention activity to subsequent observation at the diorama, or if they used the touchscreen or took photos.

All methods have trade-offs. In this case, we might have elected to audio or video record family interactions. By then doing line-by-line analysis back at the university research lab, we would have more reliable and accurate data, especially with respect to family talk. This would have been our preferred method if the primary purpose of this study was to build theory about family learning. But the point of this study, and

an important purpose of our larger research/practice partnership, was to work in ways that would intentionally increase the museum's capacity to use data from practical measurement to support local improvement (Bryk et al. 2011). We developed our data collection sheets and observation methods so that they could be used independently by museum staff or student interns with no more than a few hours of training. And more importantly, our results could be quickly turned around to be utilized in the next round of intervention development. Practical measurements should, above all, be usable and informative in terms of decision making (Knutson and Crowley 2005; Penuel et al. 2011).

White Tailed Deer Baseline Condition

To establish a baseline for comparison, we observed 35 families at the white-tailed deer

diorama in an unmodified state (which included a 200 word text panel and a touchscreen extended label). Families spent a median time of 16 seconds, with 38% spending 10 seconds or less, 18% spending 11–30 seconds, 12% spending 31–60 seconds, and 15% spending more than 1 minute. The maximum time was around 3 minutes. Eighty seven percent of families said “look at that” (or the equivalent) at least once during their stop at the diorama. Sixty seven percent of families pointed at objects or touched the glass of the diorama. Twenty five percent of families were observed to use the touchscreen next to the diorama, and this ranged from one child paging through and reading each possible page of text, to another who merely tapped the screen and didn’t seem to read the text. In most cases the partner of the screen user was looking at the diorama while the other used the screen.

The baseline study suggested that most families were quick to breeze past the deer diorama without too much focused attention. A typical interaction like this sounded like:

“Look at the deer”. One family member would notice the deer and call the rest of the family’s attention to it. In some cases, the family slowed down briefly, but glanced over in the deer’s direction. In other groups this comment was a sign for the rest of the group to stop and acknowledge the initiating family member’s interest. These families spent some time looking at the diorama and tried to find something to say in response to the interested party’s call for the group’s attention.

For many visiting families, deer are a familiar sight and one that is not worthy of a second glance. The deer population is rapidly growing in suburban areas and deer are seen as a nuisance. We heard some families say: “We see them all the time.” Or, sometimes, “well, we don’t see that every day” (*with sarcasm*). However, in a couple of cases, with this familiarity

came deeper knowledge. The diorama could also sometimes support meaningful conversations for those with knowledge or interest in deer. For example, one family used the deer diorama as an opportunity to discuss the grading system for buck points and deer hunting more generally.

The Interventions

Each intervention was implemented in the space immediately adjacent to the deer diorama. As part of the iterative process of testing and evaluation, the project team met to review findings after each round of testing. Discussion of results from each implementation cycle helped shape the next intervention. In some cases, a single intervention was tested in several implementation cycles in order to ascertain whether or not an outcome could be further improved or changed.

The primary objective was to find ways to help visitors attend to, and learn from, details they might overlook. The team was hoping to see parents engaged in the activities, and to see family members looking and talking about the diorama together. Ideas for each intervention were brainstormed by the team, sometimes reflecting ideas from the educators, or adapted from educational materials developed for use with school groups or for tabled programs. Sometimes interventions reflected ideas from the research literature, and sometimes they were inspired by programming we had seen at other museums, or wished we had been able to try in this context. Large content-related goals focused on supporting families engaging in at least one of three ‘big ideas’ in natural history: identifying and grouping organisms (taxonomy); how organisms are adapted to an environment (form and function); and the importance of sharing observations with other people in the process of identifying and answering questions (process of science). Additional skills

appropriate for the families with school-aged children were also considered in the development of modifications, including counting, sorting, measuring, and comparing.

In the end, we developed and tested eight interventions. Five of the interventions represented different approaches, with modifications that involved the use of tools, labels and different kinds of sorting activities. Three interventions involved iterations of activities that focused on authentic objects and specimens that visitors could touch.

- *Human Impact.* In this intervention, graphical displays with imagery and text were mounted on a series of rotating cubes that, when pushed, could spin on a PVC pipe frame and align to reveal one of four stories exploring different impacts of human activity on the ecosystem. Three different stories about deer overpopulation were explored: the effect of habitat loss on local bird populations due to deer browsing, the loss of top-level predators and resulting increase of deer populations, and the relationship between deer over-browsing and invasive species. One additional story about logging drew visitor attention to direct evidence of human activity observable within the deer diorama. A feedback board and related signage placed in front of the diorama prompted visitors to share their thoughts on local issues of deer population management.
- *Bioblitz worksheet.* This intervention focused on helping families to notice the biodiversity depicted in the diorama by noting and classifying species on a worksheet. The activity also took advantage of some “hidden” or at least less noticeable specimens in the diorama – it promised that with careful looking, visitors might find things they didn’t see at first glance. A worksheet and clipboard were stationed on a table in front of the diorama. Family groups worked together to find all of the animals and plants exhibited in the diorama. The worksheet provided spaces for participants to count the numbers of different kinds of organisms present in high-level groupings (plants, mammals, birds, etc.). A later modification used laminated cards on a ring to ask families to locate the different kinds of organisms.
- *Puppet Play:* Realistic hand puppets of a fox, raccoon, and skunk, three animals absent from the diorama but likely to be found in that habitat, were provided with a prompt requesting that families act out the puppet animals’ different behaviors and how they might interact with the animals in the diorama, then share the story they developed on a feedback board placed next to the diorama.
- *Leaf Litter Sorting:* Realistic leaves, laminated organism cards, and bins for sorting cards by taxonomic group were used to create a leaf litter ecosystem sorting activity in an empty child’s play sand table. Placed in front of the diorama, the table extended the foreground of the diorama to show the ecosystem at soil level that is only slightly visible in the diorama. Images of organisms typically found in the leaf litter of an eastern deciduous forest were laminated and hidden in realistic leaves that corresponded to tree species in the diorama. Participants dug through the leaves to find the cards. Participants could then sort them into bins representing major taxonomic groups (fungi, insects, snails, etc.).
- *Naturalist’s Tools:* This intervention modeled the naturalist’s toolkit. A box containing binoculars, tools, and a notebook

for recording and sharing observations, modeled after a biologist's field notebook, were placed in front of the diorama along with a sign that encouraged visitors to "Look and Share," prompting use of the binoculars and sketching or writing in the notebook. Families were challenged to connect their observations of birds in the diorama to objects placed on an activity table. Bird skulls, a microscope, a bird call player, and challenge cards on the table prompted visitors to connect clues from each observation and to identify the two bird skulls.

The final three interventions were a linked series of interventions that all involved authentic objects.

- *Objects*: Based on an earlier joint exhibit development project, called Exploration Basecamp, this intervention provided a set of specimens and tools related to the topic of the deer diorama. A large toolbox containing authentic materials and books and tools from the CM educational collection was placed in front of the diorama. The exterior of the box was painted with animals and plants, offering visitors a hint to its contents. Inside the toolbox, prompts on each specimen encouraged visitors to look in the diorama for connections between objects outside of and within the diorama. Biofact objects included white-tailed deer antlers, white-tailed deer tooth growth series, Riker mounts of scat from eastern forest mammals, a red squirrel study skin, a blue jay skull, magnifying glasses, and books on eastern deciduous forest ecosystems.
- *Object and Tools*. The toolbox described above was augmented with measuring

tools and comparison prompts and the materials were spread out on an activity table placed in front of the diorama.

Objects on the table included deer antlers and lower jaws, a measuring tape, information prompts, and comparison prompts to help participants determine that tooth wear is a better determinant of animal age than antler complexity, which can be used to compare animal health and nutrition.

- *Object and Facilitation*: A museum educator was stationed near the deer diorama at a table with touchable specimens and measurement and observation tools used in the other box interventions. The educator was instructed to engage families in conversation and activities around the diorama, and used prompts and activities from the self-guided Box and Binocular interventions to facilitate these interactions.

FINDINGS

We had a target of collecting about 30 family units for each intervention, with an understanding that the sample size would be large enough to capture a good range of families who attend the museum. If however, initial data collected for an intervention revealed that the intervention was not working at all, as in the case of Puppet Play, we terminated data collection early. Two hundred and ninety-five families were included in our overall sample. The average family group size was three. Forty-five percent of groups included one adult, 49% had two adults, and 6% had three or more adults. The sample included 242 adult women and 192 men.

Dwell time is used in visitor studies to provide an objective, easy to use measurement of the use of exhibit features (Bitgood et al. 1988). In addition to collecting behavioral observations

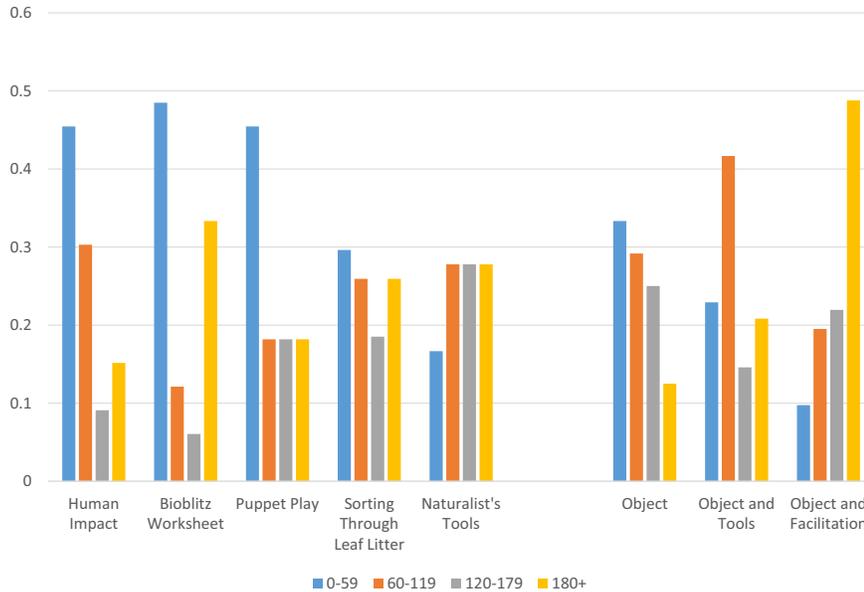


Figure 3. Median dwell time in seconds by intervention. [Color figure can be viewed at wileyonlinelibrary.com]

we calculated family dwell time. As shown in Figure 3, every intervention was successful in increasing dwell time at least three times over baseline, with the most successful intervention, Objects and Facilitator, supporting a median dwell time almost eight times above baseline.

Figure 3 shows how dwell time data were distributed within each intervention. The first thing to notice is that Human Impact and BioBlitz Worksheet show distinctive “U” shaped distributions. Most families stayed for less than 60 seconds, which is not enough time to engage fully in either activity as designed. So, families came up to the exhibit, looked at the intervention, perhaps spun a few cubes on the Human Impact intervention or picked up the BioBlitz Worksheet, but ultimately did not really get involved in the activity. However, for these interventions, when visitors did engage (particularly for BioBlitz Worksheet), they tended to stay a longer time. These interventions

appeared to share a high bar for engagement. Most families chose not to get involved in the intervention, however, for the slightly more than 50% of families who did engage, the interventions did a decent job extending families’ time spent.

In contrast, Leaf Litter and Naturalists’ Tools show relatively even distributions. Families using these interventions could simply walk up and start doing things like picking up a magnify glass or rummaging around in the leaf litter box. Although there were more structured aspects to the interventions (i.e., the sorting bins at Leaf Litter and the sketch book in Naturalists’ Tools), these could be integrated into activity on the fly. Families did not need to figure out (and agree) how to do the activity before they began interacting. Both interventions supported extended engagement, with around half of the interactions exceeding 2 minutes.

Now consider the iterative development of the Authentic Object interventions. Figure 3 shows that the median interaction times increased steadily between Objects, Objects and Tools, and Objects and Facilitator. But the really interesting findings are in the distributions plotted in Figure 3. In the Object condition, the proportions decrease steadily as time increases. This is a pattern consistent with a low bar to entry, but a limited engagement potential for the longer term. In the Object and Tool condition, we see more potential for extended engagement, with more than 40% of families staying between 1 and 2 minutes. This makes sense as, now that there are objects and tools, there is more to explore, and 20% of families will extend that exploration beyond 3 minutes.

It is in the final intervention, Object and Facilitator, that we find the longest engagement of any of the eight interventions – only 10% of families stayed less than a minute and almost 50% stayed for more than 3 minutes. Families were interacting with a human who had a planned introduction to the diorama, could answer their questions, and could draw their attention explicitly to targeted concepts related to the diorama. Museum professionals may not be surprised that a live human facilitation promotes longer engagement, but it is interesting to see the incremental increases we got compared to the non-staffed interventions. Although the best in terms of median dwell time, human facilitation times were not twice as long as the next closest interventions.

THEMATIC DISCUSSION OF RESULTS

While dwell time gives us an overall sense of how each intervention might be working, it does not tell a complete story. For example,

when we looked at how the Puppet Play intervention was working, we found that many people were choosing not to engage with the activity, and also that there was some confusion about the structure of the activity we had suggested. Next, we provide an overview of issues that emerged through our analysis of the qualitative observation data, which documented conversations, behaviors, use of labels and intervention materials. We created a table that provides highlights of some of the more important findings from these behavioral data. Below we break down the outcomes across interventions and point out how different interventions worked or did not work to support the design (Table 1).

Observation Skills

Encouraging visitors to spend more time observing the diorama was a top-level goal for interventions. Interventions sometimes involved a trade-off between privileging the observation of details in the diorama versus completing an activity stationed in front of it. Bioblitz did an excellent job of focusing families' attention on locating details in the diorama, while Human Impact produced a low amount of focused attention on details within the diorama. Human Impact however, was more likely to support visitors having great conversations about the conflict of man and nature and in-depth content explorations of ecosystems issues. Families also shared their views on a feedback board for other visitors.

Observing and Comparing

Several interventions helped visitors to focus on specific nuances of specimens and artifacts. Providing real bones to handle, turn, see, and feel helped visitors to notice the scale of

Table 1.
Overview of key findings

Intervention	Activity	Key focus area	Median time spent in seconds	Also attended to diorama	Key points
Human impact	Flip signage and public feedback	Ecosystems/ climate change	60	83%	Efficient. Participation and content talk. Local, relevant.
Bioblitz worksheet	Worksheet tally and classify	Observation and classification skills	66	95%	Focused attention on diorama. Really attractive for middle-schoolers. Some parents avoid
Puppet play	Puppets and prompts	Animal behavior	98	73%	Not very popular. Fun but no content talk.
Sorting through leaf litter	Sorting and classification game	Biodiversity, classification	106	19%	Good for young children plus modifications for older. Limited connection to diorama.
Naturalist's tools	Binoculars, bird calls, specimens	Observation and identification skills	121	70%	Binoculars popular with children. Additional identification activity for structure and attention to diorama.
Authentic objects/ objects and tools	Specimen, reading materials, and tool kit	Form and function, measurement, analysis	75	48%	Individual exploration and discovery. Lots of information available in specimens and materials.
Objects and facilitator	Museum educator plus specimens and tool kit	Form and function, measurement, analysis	163	63%	Personalized attention, in depth content. Connection to diorama if facilitator encouraged.

details; while short informative captions explained key factors scientists use to distinguish age or gender characteristics. The three authentic object interventions included multiple examples of scat or bones from different related species that helped visitors to compare and contrast specimens and discern the key characteristics that identify animals.

Classification

Leaf Litter and BioBlitz worksheet interventions specifically asked visitors to make judgments about the kinds of items that are related species. Leaf Litter had small bins to help sort found objects, while Bioblitz asked visitors to classify each element of the

diorama into its proper category. Leaf Litter was open-ended, but Bioblitz had a clear “right” answer and families who engaged were often driven to see the activity through to the end. These activities did not foster the same level of conversations about classification as some of the Box activities where several different specimens were compared.

Ecosystems Understanding

A big challenge for engaging families around dioramas was to turn attention beyond the focal fauna to a consideration of the other details depicted—the details that highlight the ecosystem in which these animals live. The Leaf Litter activity helped to focus attention on

aspects of the diorama that were most often missed by visitors, such as the flora in the scene and the ground level insects depicted. To a similar degree, activities like Bioblitz also helped families to think about different categories of organisms within the ecosystem displayed in the diorama. The Human Impact intervention explicitly engaged families in discussing the ways in which humans and deer are in conflict in local suburban settings.

Local Connections

Like the Human Impact intervention, some interventions were particularly good at helping visitors to explore local connections. In some cases this talk came naturally to those who hunted, even if no intervention was placed at the diorama. Interventions like the Box activities provided the support for families to slow down, handle specimens, notice details, and talk, and these conversations (often/sometimes) led to discussions of local examples. For example, we observed that plasticized animal scat samples were compelling for children and adults—in one case, a grandfather talked about how he used scat to track animals after being presented with a set of scat replicas by his grandson. Deer antlers were another popular aspect of the Box activity. While some parents who were deer hunters spontaneously began a conversation about how points on deer are calculated just by looking at the diorama, when presented with a specimen and notes about antlers, these conversations became more frequent.

In addition to the exploration of content-related outcomes, the research team was also interested in tracking aspects of visitor use related to the engagement strategy employed by the different interventions. Below we outline some findings that are applicable across a number of intervention strategies.

Worksheets

These are a familiar format for school-aged children and they really help to structure an activity, giving a purpose to an exploration of a diorama. In our interventions that used a worksheet, we found that children (especially in the age range 7–12), often enjoyed completing them. For parents who took a teacherly approach to the museum visit, worksheets were a useful guide especially for parents for whom the museum visit was seen as a great educational activity. These parents called children over if they hadn't seen the activity and helped to encourage and direct children to complete the task. For other parents worksheets represented a perceived level of time effort that was a barrier to becoming engaged.

Perceived Effort and Parent Disengagement

Relatedly, across our observations we noticed a common trend of parents choosing to direct their families either towards, or away from, interventions. For example, while those who did use the Bioblitz activity tended to spend a long time working on it, a full half of our sample participants at the Bioblitz did not use the intervention. We heard many parents directing their children away from the activity; "This is not for us, come along," said one mother. We postulate that with its worksheet and clipboard, the activity had a high perceived effort. We also note that while the facilitation intervention resulted in a long dwell time and interesting interactions, social norms might play a role in encouraging families to linger longer than they might actually wish to. We noticed parental modeling of polite interaction techniques in this intervention, as parents

encouraged children to ask questions and get involved in the experience.

Facilitation

From prior work with facilitators in the museum, the research team knew that engagement outcomes would be much improved if a manned table was situated in front of the deer diorama. Facilitators at the museum are enthusiastic and knowledgeable, and with the addition of deer diorama related specimens, we thought that this intervention would be our best. Facilitators engaged families in questions about blue jays and deer in activities related to diorama content. Results show that families indeed spent time and engaged in the structured conversations set up by facilitators. Families did engage in content, learning about the environmental features and factors covered by the facilitator. However, we did notice that the facilitated interventions could be one-sided or closed-ended, with the facilitator taking the lead and not always allowing the family to follow their own lines of inquiry. Also, although facilitation was associated with longer interactions, some parents had to strongly encourage their children to participate, and to ask questions or provide answers to the facilitator on behalf of their children. There are real differences in what it costs to have floor staff assigned to a diorama versus the other non-staffed interventions we tested. We think data like these would be a nice jumping off point for educators who want to do cost/benefit analyses so that they can use their existing resources (material and human) to maximize learning on the floor.

Open-ended Exploration

One of the strengths of the authentic object interventions was the extent to which they provided an open-ended and non-

threatening way to spend more time at the deer diorama. These activities helped families to delve deeper into content related to the diorama, and children experienced a sense of wonder and excitement at finding and sharing different specimens in the boxes, well beyond the expected excitement of the comparative tray of animal scat specimens.

Appealing to Different Audiences

All of the interventions worked well for young children, except perhaps the human impact label experience. Leaf litter was a great activity for the youngest toddlers, and slightly older siblings were able to assist with sorting the found items into category bins labeled by species. The appeal of tools, such as binoculars, and bird calls, were also compelling for young children. In some cases, young visitors walked away with binoculars wanting to use them throughout the dioramas on the floor. Slightly older children enjoyed Bioblitz and the sense of completing a specific task. Puppet Play, somewhat surprisingly, attracted teens who were interested in role-playing and writing on the white board. Adults seemed to enjoy the facilitated conversations best, but also enjoyed helping children with goal-oriented tasks and using tools.

CONCLUSIONS

Dioramas are a signature historic and permanent exhibit type in natural history museums. While dioramas include often much loved displays, many are not well-utilised by visitors. They are expensive to replace, and renovations that feature more contemporary hands-on experiences may not always be feasible. The process of creating and evaluating a series of prototype interventions around the deer diorama was extremely gratifying for the project team.

Museum staff were able to rapidly test and iterate on long-standing questions. For instance, the team wondered whether or not certain types of prompts or activity starters would actually work. This iterative process supplied rapid answers to questions like these, and even more in depth information, e.g. if they worked, researchers could help to facilitate a conversation about why and which learning outcomes were specifically met. In this, staff were able to prioritize the kinds of outcomes they most wanted to see, and to think about the trade-offs of supporting one audience or another.

Having the mandate of this specific project to design and test learning, education staff did not have to follow typical exhibit design processes and protocols for on the floor activities at the museum. Being freed of the investment into lengthy design and approval processes from other departments in the museum allowed the team to experiment with many ideas in a short time frame. Additionally the team was able to test, and to learn from, strategies that they might never have selected for full-scale development. The process of iterating weekly and re-implementing and evaluating ideas stretched staff, and forced both researchers and practitioners to let go of the desire to have all aspects of the design perfected. Getting the team into a system of weekly or bi-weekly reporting and implementing helped to keep up the project's momentum.

During the course of the project, education staff were working closely with researchers, looking at data and learning about the observation protocols. Program staff were also trained in designing observations and collecting data, developing institutional capacity for evaluation in the museum. The deep learning gained throughout the iterative design process has increased the museum education staff's

capabilities in program design and is enhancing their collaboration with the museum's exhibition design team. Project outcomes are finding immediate application in "In the Field," a new exhibition renovation within the Hall of North American Wildlife. Situated among the wildlife dioramas, the space is outfitted as a field research station with authentic science activities that visitors can use to explore neighboring dioramas. Success with iterative activity development influenced the overall exhibit design of "In the Field". With the expectation that activities will need to be improved based on visitor feedback, the design of the field station exhibit infrastructure allows for activities to be updated on a regular basis. Specifically, one wall in the field stations contains hooks and a feedback board where activities can be updated on a regular basis. The inaugural activity in this space uses the hooks to present a Bioblitz activity on a clipboard that visitors take away to explore the dioramas, and the feedback board invites visitors to record and compare their Bioblitz data. Future iterations may swap the clipboards for satchels with binoculars or other tools and prompts modified from prototypes piloted in this study. Another area of the field station includes lab cabinets that contain specimens, prompts and tools tested in the Box interventions. Visitors can open cabinet drawers to explore specimens of their choice and compare touchable furs, skulls, and herbarium specimens to the specimens observed in dioramas. Museum staff continue to experiment with a variety of tools, specimens and prompts to optimize the experience for visitors. **END**

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REFERENCES

- Bitgood, S., D. Patterson, and A. Benefield. 1988. "Exhibit Design and Visitor Behavior: Empirical Relationships." *Environment and Behavior* 20(4): 474–491.
- Bryk, A. S., L. M. Gomez, and A. Grunow. 2011. "Getting ideas into action: Building networked improvement communities in education." In *Frontiers in sociology of education*, edited by M. Hallinan, 127–162. Netherlands: Springer.
- Davidson, B., C. Heald, and G. Hein. 1991. "Increased Exhibit Accessibility Through Multisensory Interaction." *Curator* 34(4): 273–290.
- Kamcke, C. and R. Hutterer. 2014. "History of dioramas." In *Natural History Dioramas*, edited by S. Tunnicliffe and A. Scheersoi, 7–21. New York: Springer.
- Knutson, K. and K. Crowley. 2005. "Museum as Learning Laboratory: Developing and Using a Practical Theory of Informal Learning." *Hand to Hand. (Part 1 of 2)* 18(4): 4–5.
- Loveland, M., B. Buckley, and E. Quellmalz. 2014. "Using technology to deepen and extend visitors' interactions with dioramas." In *Natural History Dioramas*, edited by S. Tunnicliffe and A. Scheersoi, 87–104. New York: Springer.
- Penuel, W. R., B. J. Fishman, B. H. Cheng, and N. Sabelli. 2011. "Organizing Research and Development at the Intersection of Learning, Implementation, and Design." *Educational Researcher* 40: 331–337.
- Reiss, M. J. and S. Tunnicliffe. 2011. "Dioramas as Depictions of Reality and Opportunities for Learning in Biology." *Curator*, 54(4): 447–459.
- Watson, B. and S. Werb. 2013. "One Hundred Strong: A Colloquium on Transforming Natural History Museums in the Twenty-first Century." *Curator: The Museum Journal*, 56: 255–265.
- Wonders, K. 2003. "Habitat Dioramas and the Issue of Nativeness." *Landscape Research* 28: 89–100.