INTERGENERATIONAL GROUPS AND EMERGING SCIENCE: HOW CAN MUSEUMS FACILITATE LEARNING?

by

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Thesis directed by Dr. Cathy Regan

Abstract

New research in science and technology is emerging today at a faster pace than ever, and staying informed can be challenging for the public, especially families with younger children. Museums are already a resource to promote science literacy, and museum educators are trained to make all kinds of scientific ideas accessible to a variety of audiences. Unfortunately, because emerging science is fast-paced and ever-changing, many museums – especially smaller institutions – do not have the staff or budgetary resources to present this research to a wide audience. This study surveyed current literature in museum education and science learning, and current museum professionals from a range of institutions, to create a gallery guide that is flexible and easy to update for a museum, and that provides a fun and educational tool for family visitors. The study also includes a protocol to assist museum educators in collaborating with the researchers providing the science content.

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Introduction

In December 2010, Gallup released a poll showing that 40% of Americans believe that the wide variety of species living on the earth today is the result of creationism, as opposed to evolution (Gallup 2010). This is despite almost universal acceptance amongst scientists of Charles Darwin's theory of evolution by natural selection, first proposed 150 years earlier in his book, "On the Origin of Species" (National Academies Press 2008). That same poll also revealed a correlation between educational attainment and belief in creationism; participants with a college degree were more likely to understand and accept evolution than those with only a high school diploma. Since education levels can have an impact on science literacy, and considering that up to 95% of our science learning happens outside of the classroom, museums are poised to help the public better understand emerging science (Falk and Dierking 2010).

A similar Gallup Poll from 2010 indicates that just over half of Americans (53%) believe that global climate change is real and will affect them, down from a high point of 65% in 2008 (Gallup 2010). These are two examples of "emerging science," areas of scientific study where researchers are still answering questions and making new discoveries. While evolution by natural selection is a process accepted by nearly 100% of scientists, for example, research continues on the drivers, mechanisms, and results of that process. (This is as opposed to, for example, photosynthesis in plants. While still studied for various reasons, the basic mechanisms are understood and accepted.) And while a majority of scientists say that global climate change is real and problematic, the far-reaching effects are still unknown, making many members of the public wary of changing their lifestyle to counteract the problem (Yale Project on Climate Change Communication 2011). Emerging science issues can be considered challenging and

controversial in today's society, and can be difficult for the public to consume and understand because of this nature of scientific discovery and progress: changing, mutating, and even sometimes contradicting itself.

Understanding current science research is more important than ever, as the pace of scientific discovery increases – and it's not just the highly publicized "controversial" science that is growing and changing every day. A public that is scientifically literate is better-informed about their own health and wellbeing, their environmental impacts, and their decisions when it comes to voting on everything from education standards to science policy. Because museums can be so accessible and enjoyable for the public, they should be the perfect place to promote that kind of scientific literacy.

Museums are ideal learning environments because they allow visitors to build on their prior knowledge in the ways that interest them most, as well as provide new insights and knowledge for those visitors to build on in the future (Falk and Dierking 2002). They have access to rich collections, knowledgeable researchers, and skilled educators and exhibit developers that make information accessible to visitors in a variety of formats. Museums are also important places for families to learn together, as hands-on exhibits and real objects spark conversations and let parents help children to expand their skills and knowledge (Hein 1998).

However, there are a number of reasons why museums have difficulty presenting specifically emerging science, especially to family audiences. Staff time, budget resources, and difficulty keeping up-to-date while managing other day-to-day tasks are all strains on museums that might wish to present these kinds of programs (Chittenden et al 2004). Another common

problem for museums is making the connections between scientists and the educators or exhibit developers who want to present their research. And while smaller university museums can have especially exceptional access to scientists and their research, they are often understaffed and underfunded, with limited space and resources to update exhibits frequently.

Currently, most museums that offer emerging science present it in the form of web-based articles, in-house lectures, or special programming like family activity days, as opposed to consistent exhibit elements. Although these formats can still be a strain on budget and staff, they are easier to update than permanent exhibit elements and more flexible depending on audience. However, they are not necessarily using the real objects and interactive elements that make museums a unique learning environment. Additionally, most museums aim their emerging science content at adult or at least teenage audiences. The Koshland Science Museum in Washington, D.C., a museum that specializes in presenting current science issues, specifically states that their exhibits are intended for an audience aged 13 and up (Marian Koshland Science Museum of the National Academy of Sciences 2011). While this makes sense, due to the often complex nature of emerging science, museums are not fully realizing their potential ability to reach families and foster a lifelong interest in understanding and appreciating emerging science research.

The ability to think critically about emerging science is important for everyone, and museums can have an important role in helping the public, especially family groups, to exercise that ability. I propose to implement a system for the University of Colorado Museum of Natural History (UCMNH) to present emerging science to family groups, using its considerable resources

in collections, curator expertise, and location at the heart of a research institution. To target family audiences, I have focused on literature about how families learn together in museums, particularly about science. Taking into consideration best practices in label writing, exhibit design, and science curriculum standards, as well as a survey of institutions presenting emerging science, I decided that a low-tech gallery guide format would be the most successful tool for both museum staff and visiting groups to use. I have tested this guide in focus group and survey settings with parents and UCMNH staff, and used survey results collected from museum curators and collection managers to make the guide scientifically and educationally sound. Since creating gallery guides does require consultation with collection managers, curators, or researchers, I have also created and tested a protocol for collaboration to make this process smooth and practical. The end product is a gallery guide template and creation process that a museum's education staff can use to update the galleries with current science on a regular basis, overcoming staff time and budget restraints by connecting current static museum exhibits to dynamic emerging science topics.

Chapter 1: Objectives of Study, Scope, and Limitations

Objectives of Study

The main objective of this study is to create an avenue for science and natural history museums to be a resource to intergenerational groups of visitors who wish to engage with emerging science topics. The final product is the template for a gallery guide, aimed at intergenerational groups, that connects emerging science topics to exhibit elements currently in the galleries at the University of Colorado Museum of Natural History. Additionally, to make updating the guide sustainable for the museum, a protocol for collaboration with curators and collection managers was also designed.

Scope

The scope of the study is how museums, especially university museums, can overcome obstacles in presenting emerging science for intergenerational groups, particularly families with children age kindergarten to fifth grade.

I chose to concentrate on "current" or "emerging" science (i.e., scientific ideas that are still being researched by or debated amongst scientists), because it represents a gap in what museums currently present to families, and there is a dearth of research on how to fill that gap (Chittenden et al 2004). As developments in science move forward every day, it is crucial to promote science literacy for the general public: "the ideal situation where people are aware of, interested and involved in, form opinions about, and seek to understand science" (Van Dijk 2011, 4). Science literacy, when it comes to emerging science, is particularly challenging, because it is often "unfinished," still-changing, and being reported in the media as

"controversial." Therefore, becoming "interested and involved," "forming an opinion," and especially "seeking to understand" places more of a burden on members of the public to seek out current scientific news from credible sources. Emerging science literacy can also be particularly important, however, because it can have such an immediate influence on policy creation through voting, or even directly influence members of the public (Chittenden et al 2004).

I focused on intergenerational groups because there is a great deal of evidence to suggest that children learn especially well when they learn "in collaboration with more capable peers" (Vygotsky 1978, 86), as well as alongside people with whom they are familiar, such as family members (Ellenbogen et al 2004). In particular, there is evidence that museum settings encourage this type of learning, and that parents benefit from learning in museums alongside their children (Borun 2002).

The guide and its activities are age-appropriate, based on benchmarks for learning development (Wood 1997), national curriculum standards (National Science Teachers Association 2011), and my own experiences working with students in the UCMNH education department.

Limitations

There are several limitations on this study. First, because the research was carried out in the setting of a university museum, the recommendations will be most appropriate for that setting. This setting also influences the interactions between the museum's public section and its researchers, curators, and collection managers, and the protocol for collaboration will reflect

that influence. University museums also tend to have more limited resources, such as staff and money, to devote to projects outside of day-to-day functions.

A project that concerns emerging science will always be limited by the science that is currently emerging – science that is currently in the news or presently being researched at that institution. There is also a limit to what connections can be made between the emerging science topics a museum might wish to cover and the exhibits or objects currently on display in the gallery, as exhibits in most museums are fairly static.

Many exhibits involve front-end evaluation to determine what a community already knows about a particular topic, and what it is interested in knowing more about. Because of the nature of emerging science – "unfinished" and possibly still-changing, and because of the faster turnaround time to get this type of information onto the gallery floor, performing front-end evaluation on each topic may be more difficult, although evaluation of broader topics in emerging science could be useful.

Finally, a small sample size was a limiting factor in this research. I evaluated the initial gallery guide with a focus group of three family audience participants and a survey of nine UCMNH curators and collection managers, and I conducted interview surveys on a subsequent draft with seven family audience participants. Although the results I gleaned from these evaluations cannot be considered representative of the visiting population of UCHMN, the input was valuable to focus and revise the gallery guide tool.

Chapter 2: Literature Review

Americans today may gain as little as 5% of their total lifelong science knowledge in a formal school classroom setting, which means that up to 95% of our science learning is done in informal learning settings (Falk and Dierking 2010). An informal science learning environment is anywhere that a person might be exposed to science without a formal teaching agenda and without pre-set learning goals. Informal science learning can take place while reading a newspaper, watching television, engaging in outdoor activities, tending a garden, talking with friends or family, or any number of "designed spaces" like museums, zoos, aquariums, botanic gardens, or nature centers. Science learning is happening all around us all the time, and museums should be poised to take advantage of visitors' natural curiosity and help re-create the "moments of authentic curiosity and exploration seen in everyday science learning" to help create lasting connections to scientific ideas (National Academies Press 2009, 102).

I reviewed literature on best practices in museum education, family learning in museums, and science learning for children and families in order to decide on the best delivery method for a university museum to create those meaningful connections to emerging science. This literature review also informed the creation of the survey for museum professionals, discussed in the next chapter.

Foundations of Museum Education

Museum visitors – adults and children alike – respond to objects, ideas, and intended messages in museums in their own way, making their own meaning from all of those things, based on a number of factors that contribute to their experience (Hein 1998). Those are

summarized by Falk and Dierking as the "Contextual Model of Learning." The factors are grouped as personal, sociocultural, and physical contexts, and each can influence what a visitor takes away from a particular exhibit. For example, under the physical context are factors such as advance organizers and orientation to the gallery – things that make a visitor feel comfortable in the museum space. The sociocultural context, which is important to family learning, includes the dynamics within the group a visitor is with, as well as other people, such as docents or museum staff, that the visitor and their group may encounter. Under the personal context is a visitor's motivations for visiting the museum, which can change from visit to visit, as well as the idea that the visitor is always in control of their own learning and cannot be taught a prescribed lesson. The other key factors in the personal context are the visitor's prior knowledge, experiences, and interests, which are the framework upon which visitors will make meaning from museum objects and ideas (Falk and Dierking 2002).

There are some key ways that museums can appeal to each visitor's unique physical, sociocultural, and personal contexts to best convey ideas and messages, allowing that visitor to make connections to their prior knowledge and learn new concepts. An excellent informal learning environment, one that connects visitors within their context to not only objects but ideas, will be comfortable, engaging, reinforcing, and meaningful (Serrell 2006).

For an exhibit space to feel comfortable to a visitor, a museum must take into account factors in the physical context. Advance organizers help a visitor to know what to expect in a gallery, which helps them make choices about what they want to spend time exploring. Clear way-finding and orientation signs (e.g. exits, bathrooms, drinking fountains, directions to other

galleries) also make a visitor feel comfortable, and they are better able to engage with materials when not concerned about finding their way (Rand 1997). In terms of interactive elements, clear signage allows visitors to feel comfortable touching and manipulating interactives. Rules, constraints, and boundaries on how to use interactives help visitors to be more relaxed and creative in their use and more willing to engage (Simon 2010).

To be engaging, exhibit elements should be exciting to visitors – something about the exhibit should entice a visitor to approach it. We know that "learners are engaged by experiences that offer interactivity," (National Academies Press 2009, 140), but that "in order to be educative, experiences must be not only 'hands-on' but also 'minds-on'" (Hein 1998, 2). Interactives can be one part of what makes an exhibit engaging, but it must also appeal to a visitor's interests and be relevant to them and their community. Of course, one advantage that museums have is real objects, which are not inherently engaging, but when used correctly in an exhibit offer a deeper understanding of scale, shape, size, texture, and other features that make an abstract idea concrete (National Academies Press 2009).

A reinforcing exhibit supports visitor goals and allows visitors to feel competent. John Falk identified six "identities" that visitors come into museum settings with as part of their personal contexts. For example, someone who is an "explorer" values learning and likes to see new, exciting discoveries. A "facilitator," on the other hand, is looking to help guide the experience of someone else, often a child being guided by a parent, but sometimes a friend helping another friend have an enjoyable day at a museum (Falk 2008). Over half of museum visitors (55%) show a dominant motivation when they arrive at the museum, and most will

enact those identities throughout their visit (National Academies Press 2009). Exhibits that have elements that appeal to various identities will reinforce what visitors are there to do. To allow visitors to feel competent, exhibits should also appeal to "multiple intelligences" (Gardner 1983). These intelligences are various ways of learning, knowing, and expressing oneself, and most people are particularly strong in some, less strong in others. There are now nine identified intelligences, so exhibit that appeals to linguistic, mathematical, kinesthetic, and intrapersonal intelligences, for example, will be more successful for more visitors than an exhibit that only appeals to one or two. Appealing to multiple intelligences also requires that interactives or experiments have the possibility to be collaborative and also have more than one possible outcome to be "learned."

Finally, exhibit elements that are meaningful will provide visitors with experiences that are personally relevant and change visitors cognitively and affectively (Serrell 2006). To do this, museums must make connections between a visitor's prior knowledge and experiences and the unknown – new facts, ideas, or ways of thinking that they can assimilate or accommodate with that prior knowledge (Piaget 1952). This is best achieved in informal education settings using the pedagogy of constructivism, creating an environment "with which the learner can make connections" and that has "a familiar reference, object, idea, or activity that will allow the learner to engage with the issue" (Hein 1998, 38). A constructivist exhibit (or exhibit element) is ideally suited to informal environments because it is the most compatible with the kind of free-choice learning visitors are already engaging in. A traditional didactic exhibition, perhaps modeled after formal classroom education, would have to be followed by visitors in a certain sequence in order to gain information from simple to complex, like a chapter in a textbook.

There would be specific learning goals and yes-or-no style questions with correct and incorrect answers. That style of exhibit would not be especially compatible with an exhibit that is comfortable, engaging, reinforcing, or meaningful. In a constructivist exhibit, however, the "active participation of the learner is required" (Hein 1998, 34). A visitor is going to pick and choose what they want to engage with, so to make meaning, a constructivist exhibit has multiple starting and ending points with no prescribed lesson that must be learned in order to move on to the next element. To connect to visitors' prior knowledge, there should be many points of view to consider, such as multiple interpretations of objects that allow many visitors to connect at least one perspective to their own lives. Finally, interactives and experiments in a constructivist exhibit must have a range of possible results, as well as ways of interpreting those results. It is more important that results make sense in the learner's context than that the results are completely scientifically correct. Visitors are able to make sense of the exhibit using the context they came into the museum with, which will result in the most successful experience for each individual.

Best practices for family learning in museums

An important function of museums as a place of learning is to be a place where families learn together. We know, for example, that "participation of a parent improves the quality of child engagement within exhibits," as discussions are longer, attention is more focused, and children digest more complex ideas than they could on their own (National Academies Press 2009, 149). And while parents recognize that museums and other informal learning environments are valuable resources for learning and fostering intellectual curiosity, when a family visits a museum together, their focus is on time spent together, not time spent learning.

Members of a family visiting a museum together all have their own individual identities to enact within exhibits, but groups also want to "enact their identities as families" (Dierking 2010). They are drawing on their own shared knowledge and experiences as well as their culture together as a family, and they will continue to recall the experience and pass information amongst themselves, integrating the experience into that family culture (Borun et al 2002). Therefore, it is important to keep in mind general museum education best practices, but also consider how an intergenerational family group will respond to exhibits and how best to serve their needs.

To best support family learning in museums, it is obviously important to support the children learning in the museum with age appropriate content. It is also important to consider the family unit and make adjustments for that configuration. Perhaps most important is to support the adult caregivers who are guiding the experience. While content, especially interactives, needs to be child-friendly, signage, labels, instructions, and other supplementary materials must assist parents or other adults to create a more beneficial experience.

To support children's learning in museums, it is useful to consider general developmental stages and design a variety of activities or interactives that support learning at those stages. For example, preschool students around age four enjoy being read to as well as simple counting exercises. To make an exhibit more enriching for families that may have children of multiple ages, a museum could incorporate a simple counting exercise with a more difficult measuring activity, appealing to children ages seven and eight (Wood 1997). In this way, older siblings can help younger, while adult caregivers help both. One study observed that younger siblings benefit from older children's inquiries to parents that the younger children

could understand, but were not necessarily old enough to formulate (Hall and Schaverien 2000). Connecting content in a museum to the curriculum standards from state or local school districts can also help children have an enriching experience, as they will have some prior knowledge from formal education to draw upon.

We know that the most effective interactives in exhibits are elements that support parent-child interactions and that "when children engaged in exhibits with their parents, their exploration is broader and deeper than when children engage in exhibits alone" (Bertschi et al 2008, 3). Therefore, an important part of family learning is getting a family in a situation where they can actually learn together. The Philadelphia/Camden Informal Science Education Collaborative (PISEC) offers guidelines for "family-friendly" exhibits, including exhibits that are multi-sided and multi-user – more than one body is engaging directly with the interactive. Exhibit elements should also be accessible to both adults and children physically and in terms of readability. Elements should be multi-modal, appealing to various learnings styles, and relevant to various levels of existing knowledge. Finally, interactives should be multi-outcome, meaning that the result is open-ended enough to generate discussion after a family is finished using it. When families can work together and discuss the results, there is a deeper and more lasting effect. (Borun et al 1998)

Finally, supporting the caregivers in family learning environments is key. While the next section will discuss more specifically how to help parents in family groups learning about science in museums, there are some general guidelines for helping adult "leaders" in family groups. First good writing is important, both in labels and interactives. Parents want big

headlines and bullet points to guide them to the main points of a panel or interactive, as well as text that is pithy enough to be read quickly but still sounds good when read aloud, negating the need for a lot of paraphrasing by the adult (Rand 2010). However, one study found that "environmental design and activity type were more effective than labels overall in promoting parent-child collaboration" (Bertschi et al 2008, 7). In this case, arming adult leaders with inquiry skills can make an experience more enriching. Judy Rand lists types of "productive questions" for adults to support conversation that will connect children to exhibit content. These types of questions include attention focusing questions about noticing exhibit elements, as well as comparison questions that help children key into how elements fit together. There are measuring and counting questions that would be very appropriate in science learning, along with "action questions" that ask children to make predictions. Finally there are types of questions about reasoning and problem solving that generate conversation beyond the exhibit elements on display. Adult leaders that are equipped with provocative questions can make the most of exhibits that are well-designed for family learning (McRainey and Russick 2010).

Best practices for families learning about science in museums

This project is especially concerned with helping families connect to science in informal education settings. While children begin engaging in science learning at birth, mastering basic understandings of gravity and laws of motion at an early age, it is important to start building the ability and desire for science literacy at a young age. The National Research Council recognizes six strands of science learning that are integral to communicating science to children, including: sparking interest and excitement, understanding science content, engaging in scientific reasoning, reflecting on science, using the tools and language of science, and

identifying with the scientific enterprise (Fenichel and Schweingruber 2010). Using these guidelines and, again, supporting parents in their role as leaders, museums can be effective places of science learning for families.

When it comes to sparking an interest in science learning, we know that getting the conversation started can having lasting impacts: “the most important outcome of everyday parent-child scientific thinking may be that the children develop an early interest in science, value science as a cultural practice, and form an identity as someone who is competent in science” (Crowly et al 2001, 18). To get parent-child conversations sparked, interpretive materials, more than exhibit elements, may be the key. In a study on inquiry at science museum exhibits, researchers found that “human mediation may be the key to helping museum learners take full advantage of their environment” (Gutwill and Allen 2010, 712). And “visitors showed significantly greater cognitive gains when objects were accompanied by interpretive labels than when they were explained purely as sensory phenomena” (National Academies Press 2009, 138-139). Good interpretation to spark conversation is as important as authentic objects and interactives, if not more so.

The second of the “six strands” is understanding science. Helping families to understand science in informal learning environments can be a demanding task, since we know that families are at the museum to support their own agendas and spend time together as families, more than to explicitly learn new concepts. However, museums can also be an ideal place for family learning as they “offer direct access to a vast array of phenomena in the form of exhibits” and are a place where “visitors engage in authentic, self-directed inquiry” (Gutwill and Allen

2010, 711). Gutwill and Allen point out that museums are also “fundamentally social” places, where intergenerational groups interact, draw upon each other’s knowledge, and build new knowledge together.

As with any kind of family learning in museums, involvement of the adult group leaders (usually parents) is crucial. To begin understanding science concepts, children develop “islands of expertise” about certain topics (Palmquist and Crowley 2007). Islands of expertise are “a topic in which children happen to become interested and in which they develop relatively deep and rich knowledge,” and tend to begin as things that young children encounter frequently such as trains or dinosaurs (Crowley and Jacobs 2002, 333). These “islands” start as interests that are sparked in children, which are then supported and deepened by children’s families through toys and play time, museum visits, watching television programs or reading books about the topic, and especially through conversation. Once again, “family conversations provide a mechanism for children and parents to collect and integrate pieces of knowledge into more sophisticated conceptual understanding” and emphasizing to parents the importance of having conversations and supporting curiosity is key to maintaining children’s interest in those “islands” (Palmquist and Crowley 2007, 784). In museums, parents make conversation with their children based on that child’s expertise and connections to their shared history. In the example of a child interested in and knowledgeable about trains, a parent can take the opportunity in an informal learning environment to connect an exhibit about water vapor to that child’s prior knowledge of steam coming out of a locomotive (Crowley and Jacobs 2002).

Adults help also children understand areas of science in which they have not built up "islands of expertise" when visiting informal learning environments. When looking at exhibit elements and participating in interactives, parents "helped children select and encode relevant evidence" of scientific ideas using explanatoids, "brief, sketchy, and somewhat mundane explanations that parents introduce into everyday collaborative explorations" (Crowley et al 2001, 17). For example, explanatoids can be play-by-play commentary that offers a child a deeper understanding of why they are doing certain steps of an interactive experiment. They can also be questions or prompts for children to fill in with explanations that help to point out aspects of an exhibit that will make a new connection for the child. Parents are providing connections to prior knowledge for children that the children would be unlikely to come up with on their own, scaffolding them from learning that they can do by themselves to learning that can only be achieved with intervention. This is Vygotsky's theory of zones of proximal development, and it is a critical way that intergenerational groups learn together in museums (Vygotsky and Cole 1978).

Despite these natural tendencies for adults to connect experiences to children's prior knowledge, museums can further support and bolster the understanding of science by giving adult leaders more resources to start conversations and provide explanations. There is evidence that "family members of all ages will seek information as well as confirmation of their understanding of an idea from museum mediation resources when they are available" (Palmquist and Crowley 2007, 9). Even adults that consider themselves knowledgeable about science have the desire to know that they are helping children learn correct information, and will seek out not just good resources for that information, but for ways of presenting it. A study

on parent-child interactions in science museum exhibits, for example, found that “parents were often puzzled about how to support learning in exhibits” and want “specific questions to ask” their children, rather than having museum just point out the fact that asking questions is important (Bertschi et al 2008, 3). It has been suggested that “informal spaces could provide suggestions to adults on how to successfully support youth in the exhibits,” by providing resources similar to those available for teachers and chaperones on field trips such as information “included in the exhibit at parent eye level, written in a parent hand-out, or on a Web site” (Zimmerman et al 2010, 502).

One important way that museums can support adults and offer specific questions is by encouraging inquiry skills. Inquiry-based activities help children understand science, but also support the National Academies science learning strands three and four, “engaging in scientific reasoning” and “reflecting on science,” as inquiry questions can range from simple to complex and can continue to stimulate conversation long after a museum visit ends (National Academies Press 2009). Inquiry questions or inquiry-based activities should “involve[s] finding sources of information appropriate to a task, working to understand the information resources and how they relate to the task, and then, in those cases for which some action is expected, applying this understanding in a productive way” (Owens et al 2002, 617), which incorporates understanding, reasoning, and reflecting. Another study agrees, saying that activities must “involve asking a question or making a plan at the beginning of an investigation and interpreting results by making observations, interpretation, or explanations during or after an investigation” (Gutwill and Allen 2010, 716).

There are a number of recommendations for what good, engaging inquiry-based activities will include to help visitors connect to prior knowledge and make gains in understanding. First, activities should identify explicitly that they are going to help build inquiry skills and specify how they are going to do it, allowing adult leaders to have metacognition about the skills they are practicing: “Numerous studies in the learning sciences have shown that people learn new skills better if they are explicitly articulated, demonstrated, and practiced” (Gutwill and Allen 2010, 716). An interactive can say, for example, that it’s a model experiment, and go on to briefly explain the science that the experiment is based on. Or a questioning prompt during an activity can connect to actual questions that scientists would ask to draw conclusions in the same area of study. Inquiry activities should also “minimize cognitive load” (Gutwill and Allen 2010, 716). The Gutwill and Allen study, for example, eventually reduced the learning goals of their activities from six to two, shortened activities to no more than 10 to 15 minutes, and increased colorful icons and highlighted phrases in their text to make the goals as obvious as possible. The same study recommends activities that are collaborative, support learners’ natural curiosity, build their confidence, and support reflection. These recommendations “helped families focus” in the exhibit and also “incorporate knowledge at home” afterwards (Gutwill and Allen 2010, 735).

The type of questions asked in inquiry-based activities can make a difference too. Judy Rand’s general “productive questions” for adults to support conversation in exhibits are a good place to start, with questions that focus attention on particular exhibit elements, as well as science-appropriate questions about measuring and counting (Rand 2010). A study by Owens et al also lists “question stems” that help askers get to the root of “what does this mean, and how

can I use this information?" (Owens et al 2002, 617). Some of these question stems are especially appropriate for promoting science learning in informal settings. For example, a question stem like "What is a new example of ___?" encourages visitors to not only examine the exhibit element on display in front of them, but to relate it to something in their prior knowledge. However, it is also an open-ended question, and the answer could be different even across visitors in the same group. Another good science inquiry "stem" is "What are some possible solutions for the problem of ___?" This again gets visitors thinking about and beyond the exhibit in front of them, and could also be useful in discussing emerging science topics (Owens et al 2002). Creating thought-provoking, open-ended questions for parents to ask in inquiry-based activities can have an important payoff, since "offering care-givers a structured, co-investigative role in exploring phenomena may significantly enhance family learning" (Gutwill and Allen 2010, 738). Participating in inquiry along with children lets parents expand on their tendency to offer explanatoids, but also allows them to feel comfortable with topics that may not be completely comfortable explaining on their own (Tare et al 2011).

Other than supporting understanding, reasoning, and reflection through parent-child conversations and inquiry-based activities, museums can encourage intergenerational groups to use the "tools and language of science" and begin "identifying with the scientific enterprise," strands five and six of science learning (National Academies Press 2009). These steps are especially critical in presenting emerging science, as using science language and thinking as a scientist can help casual science learners to move from understanding science as "finished" to understanding it as a working scientist does, as an "unfinished," process (Chittenden et al 2004). "One of the most consistent ways that nonscientists' perceptions of science seems to differ

from those of scientists is that many children and adults tend to perceive science as a set of established facts rather than as an ongoing process of knowledge construction" (National Academies Press 2009, 108-109). However, beyond helping visitors to see and understand new scientific ideas, "the strength of the museum environment lies not in helping visitors acquire scientific facts but in offering visitors a chance to develop and practice competencies in science – predicting, evaluating evidence, and forming theories" (Bertschi et al 2008, 2). This includes the previous sections on understanding and inquiry, of course, but using real scientific tools and conducting model experiments also allows visitors to begin to identify as not just someone who understands science, but someone who engages in the scientific enterprise.

One well-known model experiment that is especially useful in helping visitors understand the idea of "unfinished" science is the "Footprints Puzzle," where children try to reconstruct a prehistoric scene based on the trace evidence of footprints, thereby identifying with how scientists begin to understand phenomena they cannot directly observe by "inferring, developing explanations, and weighing the explanations against the evidence" (Ault and Dodick 2010, 1105). While this "puzzle" is often used in classrooms to teach students about the process of science, it would be a simple model to use in a museum paleontology gallery, which likely has trace fossils that visitors could observe, ask questions about, and develop explanations for. This is an open-ended model that incorporates real scientific ideas.

Informal science learning environments like museums have historically "been occupied by showing what science has achieved" and by "explaining well-established science and technology principles" (Chittenden et al 2004, 51-52). Using the many tools and resources

available to museum educators to teach families about science in museums, it should be possible to not only showcase past achievements and known facts but scaffold and challenge visitors to understand the working processes of science and the way those processes are being applied to new science and technology every day. Just one museum visit can “influence understanding of scientific contents, arguments, explanations, models, and facts” in a way that lasts well beyond the visit, and it is up to museum educators to exert that influence to maximize science literacy for future generations (National Academies Press 2009, 136).

Chapter 3: Methodology

Based on the literature review and the following evaluation data, I decided on a gallery guide format to best present emerging science to the family audience. I surveyed professional in the museum field, created and revised guides based on their feedback and the literature, and tested these with the people who would contribute to their creation (curators and collection managers) and who would use them (visitors and families). I conducted several rounds of surveys, revising the products after each round.

My first step to gather data was to poll museum professionals currently working in institutions that present emerging science, or have attempted to present emerging science in the past. To obtain participants for this survey, I sent a recruiting email to three museum professional listservs: Museum-L, a general museum discussion list; Museum-Ed, a museum education list; and AAMG-L, the Association of Academic Museums & Galleries. From the recruitment email, potential participants were directed to a survey website (Survey Monkey), where they completed an informed consent agreement before being allowed to continue on to the survey. In total, 17 participants from a variety of institutions completed the entire survey. (See appendix A1.)

The purpose of this initial survey was to gather information in two main categories: "programs and exhibitions" and "logistics." The programs and exhibitions category asked participants to describe the way their museum currently presented emerging science or had presented it in the past, as well as what has worked well and not-so-well about those presentations. This category also asked why their institutions found it valuable to present these

kinds of programs, and what concerns they have heard from their visitors about "controversial" emerging science topics, if any.

The second category, logistics, asked how participants were actually making emerging science programs and exhibitions happen. In order to know how best to approach the protocol for curator collaboration, I asked who at each institution was mainly in charge of organizing or presenting emerging science, and who they collaborated with (e.g., curators, researchers, etc.) To determine what a realistic schedule is for keeping the topics and materials up-to-date, this category also asked how frequently each museum changed the exhibits or presented new programming, and exactly how current they felt the science could be (i.e., research still underway, papers that have recently been published in scientific journals, discoveries that have made their way to news sources for the general public, etc.). Finally, this category asked what each participant felt were the major challenges in presenting emerging science in their institution (staff, budget, public reaction, etc.).

The museum professional surveys also included a demographics section to determine what types of institutions were presenting emerging science (e.g., small university museums, large science centers, etc.). The participants were also asked to provide their position at the museum, such as educator or curator, and the length of time that they have worked at their current institution, and the museum field in general. This information was gathered to help understand the perspectives of the people working on these issues from various angles and over varying lengths of time.

While surveying museum professionals broadly, I also looked at examples of several museums I knew to be presenting emerging science. While I was not able to get the personal perspective from these museums, I felt that it was important to perform a broader survey of what is currently being presented at some of the larger museums in the United States and abroad.

Drawing on the breadth of information from practicing museum professionals, my literature review, and my personal experience in the Museum and Field Studies program, I created the first draft of the gallery guide for testing purposes. (See appendix D.) The first draft was developed to incorporate current science, connections to the content already on display in the museum gallery, and follow-up activities for families to do at home.

For this first draft, I used the somewhat controversial topic of colony collapse disorder in honeybees. This was a topic that could be connected to the exhibit already on display in the museum at that time, and a topic I had worked on the initial exhibit presentation of and was comfortable with. Since I was not collaborating with a curator or collection manager on this version of the gallery guide, I wanted to work with something I understood, and also something that drew on a fairly broad emerging science topic, rather than the research of a particular scientist. The first draft of the guide had the headings of “In today’s news”, “So what?”, “At the museum”, “Activities for families”, and “What can you do?”

With the initial draft of the gallery guide completed, the next step was to survey the guide’s two audiences: the family audiences that would use the guides in the museum and the curators and collection manager that would eventually participate in creating the guides.

To survey a family audience, I recruited participants from the UCMNH's family email list, as well as families visiting the museum's outreach booth at the Boulder Farmer's Market. I recruited specifically parents or guardians that had visited museums in the past year with children aged kindergarten through fifth grade. I recruited families that were already museum visitors in order to have participants who were comfortable in a museum environment, had feedback that would be informed by previous museum use, and would actually be potential users of the gallery guides in the future. The decision to aim the guide at families with children in the elementary-school age range was to fill a particular gap that I saw in my background research. I found that while there were emerging science programs in existence aimed at adults and teenagers, and certainly a vast array of science learning programs aimed at families, there was little geared towards younger children and their parents that specifically addressed emerging science.

The focus group was held at UCMNH, to allow the participants to view the bee exhibit before looking at and offering opinions on the accompanying gallery guide. Three parents of elementary-age children attended the focus group. The group began by looking through the bee section of the gallery, after which participants were given a copy of the gallery guide and a survey. Participants completed the survey before the group discussion to provide a backbone for the discussion, but were also encouraged to fill in questions further or add additional notes throughout the focus group process. (See appendix A3.)

The surveys began with demographic information about the typical group with which participants would visit the museum – makeup of the group, ages, and relationships – as well as

how frequently that group typically visits museums, in order to understand how each family was approaching the museum. One parent visiting with older children, for example, would likely use museum resources differently than a group of two adults visiting with one younger child. The demographic portion also asked about the participant's level of science education and comfort level discussing general science issues. To get further background on how families are already discussing current science, the survey also asked how the participant interacts with science in their daily lives (e.g. did they visit other science museums, participate in science fairs, watch nature programs, etc.). The parents were asked to describe how frequently they talk with their family groups about science in general and emerging science in particular, and how they tend to answer questions their children had about science topics. They were also asked about how they currently use museums as a resource (like asking questions of docents or seeking out additional resources), and their primary motivation for visiting museums (fun, learning, relaxation, etc.). These initial questions helped to establish a baseline of how important emerging science is for each family, how comfortable the parents are discussing these topics, and how well museums are serving their needs.

Each participant was asked to look at the gallery guide and provide feedback on both content and design. Along with basic gut reactions, they were asked specifically to comment on where they would expect to pick the guide up in the museum, how they would expect to use it with their families, and how they thought various family members might react to the guide.

Once all the participants had filled out their surveys, we had a group discussion using the survey as a guide. I chose the focus group format over one-on-one surveys to get a deeper

understanding of what the parents were looking for by asking first for their gut reactions, and then giving them time to explore those reactions and bounce ideas off of one another. The discussion time also gave me a chance to probe deeper into their reactions, and try to gain consensus (or determine if there was not consensus) when someone brought up specific points. I was able to expand on the "gut reaction" questions with more specific examples like, "What would you like to see more or less of?" that were more useful than they might have been on just a written survey.

At the end of the focus group, I invited the participants to complete a follow-up survey at a later time. Since the focus group participants visited without their children for the day's evaluation project, I asked them to return to the museum with their family group at some point in the two weeks following the focus group. I prepared packets for each participant with a prototype gallery guide and a follow-up survey, as well as a thank-you gift for their participation. The goal was to get not only theoretical focus group feedback, but also practical, real-world feedback from the same parents.

The follow-up surveys began by again asking for the demographic information of the visiting group (members, ages, and relationships), and how long the group spent using the guide in the museum. It then asked which parts of the guide the group read or tried, which parts were most useful, and which were most fun. Participants were asked if they felt like using the guide enhanced their visit, made it easier to discuss emerging science issues, or made them more likely to seek out emerging science in the future. Finally, they were asked about their enjoyment of the guide, and whether they thought they would use something similar on a

future visit to the museum. Two of the three participants completed follow-up surveys (See appendix A4).

While collecting focus group data from potential users, I was also collecting feedback from the curators and collection managers at UCMNH. I surveyed this group to collect opinions about the gallery guide in general, as well as how they would want to be approached to collaborate on a guide. I recruited for this survey by sending a recruitment email to the 17 curators and collection managers in anthropology, botany, entomology, paleontology, and zoology at UCMNH. Like the survey for museum professionals, potential participants were directed to a survey website (Survey Monkey), where they agreed to an informed consent agreement before being allowed to continue on to the survey. In total, nine of the museum's curators and collection managers completed the survey (See appendix A2).

The participants were asked for feedback in two categories: "gallery guide" and "protocol for collaboration." Under the "gallery guide" section, participants were asked for gut reactions to content and design, as well as what they thought from a scientific standpoint might be missing in terms of headings or content areas. They were also asked to recommend other ways to connect emerging research content to the museum galleries.

The second section, "protocol for collaboration," asked specific questions about how participants would most like to participate (or not) in creating a similar guide. First, they were asked if they would rather come to the museum's educators with ideas, or have the education staff bring ideas to them (related to exhibits currently on display). They were also asked if they would be willing to share their own research or help interpret research, and how involved they

would want to be with creating the educational activities that complement the more research-based portions of the guide. Finally, participants were asked how frequently they would be willing to collaborate on a guide, and what they saw as major roadblocks to the success of a collaboration like this one.

Based on the feedback from the first parent focus group and the survey of curators and collection managers (presented in chapter 4, Data Analysis), I revised the gallery guide template in preparation for another round of focus group surveys. (See appendix D.)

At this time, I also wrote up a protocol for collaboration based on the survey responses of curators and collection managers to the "logistics" section of their survey. The protocol includes six steps: initial email, initial content development, first project meeting, development and revisions, activity development, and final revisions. (See appendix G.) I asked paleontology collection manager Toni Culver to work with me on testing this protocol, with her giving feedback about the initial steps, and then as we progressed through the protocol in as realistic a way as possible. To test the protocol, Ms. Culver and I created a new gallery guide based on her current research of fossil trackways.

After completing the first step of the protocol, "initial email," Ms. Culver and I combined steps two and three, "initial content development" and "first project meeting" to decide on the subject matter of the guide. At the first project meeting, we decided on broad topics and a schedule for future meetings. The next step, "development and revisions," was a two-week time, during which I created a guide based on my template and filled it in with information that Ms. Culver provided to me. I then emailed that guide to Ms. Culver for corrections and

feedback, and we repeated this revision process twice. This was also when I worked on step five of the protocol, "activity development," creating the in-gallery and at-home family activity components of the guide. Ms. Culver and I decided at the first project meeting that she did not wish to be involved with that step, but was able to provide feedback on the finished project. (Collaborators may have ideas for educational activities or may wish to participate in that stage of development.) Finally, step six was the final accuracy check and completion of the guide. Throughout the process, I took feedback from Ms. Culver on what parts of the protocol for collaboration worked well and what could be more streamlined.

I tested the final, revised guide in one-on-one interview surveys in the paleontology gallery at UCMNH's appropriately themed "Making Tracks" fossil family day. I was not able to recruit enough participants to hold a second focus group, and instead decided to conduct one-on-one interviews with a revised guide at the museum's weekly family days. (See appendix A5.) I recruited individual participants for this survey using the same recruitment materials previously used at the Boulder Farmer's Market. I still surveyed only adults, while their children and other members of their group were engaged with family day activities in the gallery. In total, seven participants completed the interview surveys.

The surveys were nearly identical to those given to participants in the focus group, though slightly condensed. The main difference in this case was that I filled in each survey as I interviewed the participants, in hopes of getting more feedback than if they filled out the surveys on their own and turned them in to me.

The initial demographic information – makeup of visiting group, number of visits to museums, and science education of participant – remained the same, and I also asked participants the same questions about their engagement with general and emerging science in their everyday lives. I gave each participant a copy of the new paleontology-themed gallery guide and asked similar questions about gut reactions to content and design. For this survey, I specifically added the question of what the visitor would like to see more or less of in the guide, since I found that particularly useful in drawing out answers at the focus group. Finally, I again asked participants if they would be attracted to pick up the guide, if they thought they would use it, where they expected to find it, and how they would expect to use it.

The final products of these procedures are a protocol and template for the creation of emerging science gallery guides, the two finished guides that focus on different ways of presenting emerging science – broad current research and specific curator or collection manager research, either of which can be "plugged in" to the template for creating future gallery guides. The final guide template has three main headings on the front "research" page ("In today's news", "How do scientists learn about…", and "Why do scientists study…?") and two main headings on the back "activities" page ("At the museum" and "at home"). The protocol for collaboration to be followed in the creation of future guides should provide the best possible working relationship between a museum educator and a collaborating researcher.

Chapter 4: Data Analysis

All of the surveys and focus groups performed for this research yielded much more qualitative results than quantitative. By using an open-ended approach, I was able to probe deeper and look for common threads amongst answers that may not have been apparent from multiple-choice answers.

Survey of current presentation of emerging science in museums

I collected anonymous survey data from 17 individuals who self-identified as currently presenting or having previously presented emerging science topics in a museum setting. The respondents represented varying sizes of institutions, and while many were natural history museums, respondents also included a children's museum, a zoo, an aquarium, and research institutions. (See figure 1.) While several reported as simply "university museums," where the description "university" overlapped with other descriptions such as "natural history," I represented the museum genre over the university descriptor.

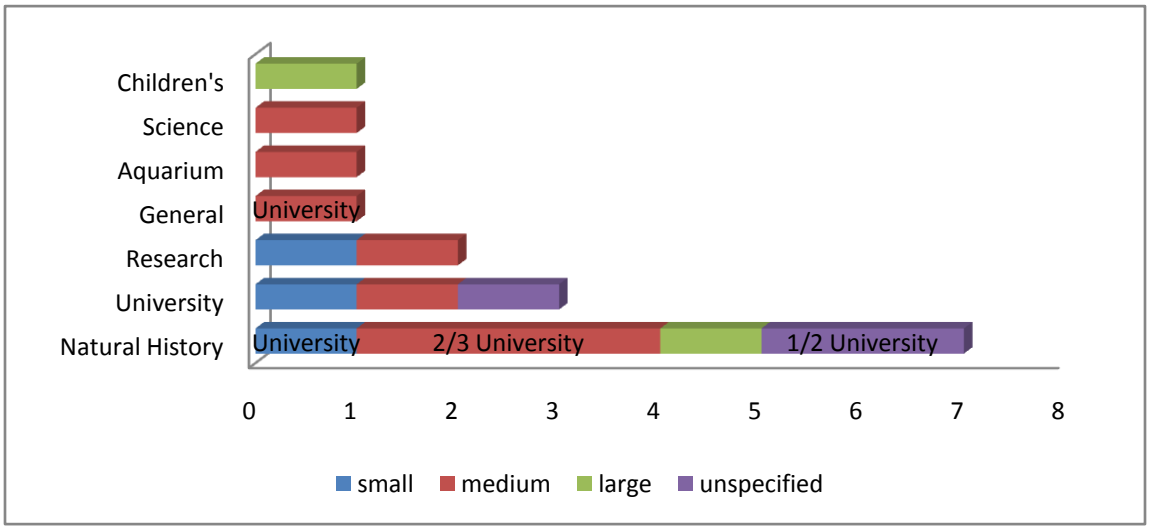

Figure 1. Demographics of participant museums (See appendix B1, question 9.)

The questions on this survey covered what types of programming respondents present and how they keep it current, as well as logistics such as who in the museum is responsible for creating, changing, or updating the programing and what they feel are some of the major challenges.

The first question asked participants "What does your institution currently present to the public in terms of current/emerging science programs or exhibits?" The major categories of responses were in-museum lectures, symposia and cafe scientifique-style salons, programs (e.g. family days, special events), and exhibits (both temporary and long-term). (See figure 2.)

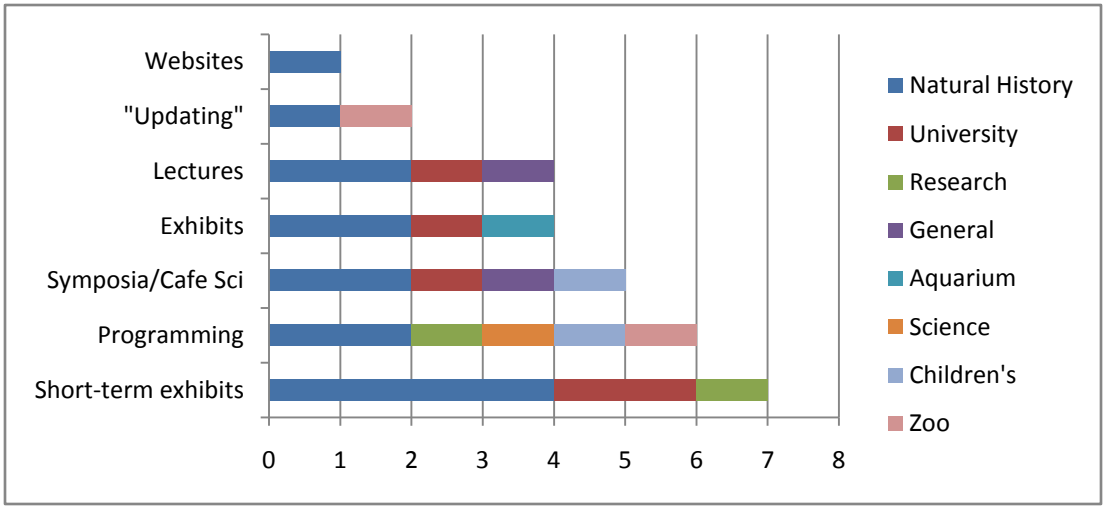

Figure 2. "What does your institution present…" (See appendix B1, question 1.)

The most popular answer, with 40% of respondents, was short-term or temporary exhibits that could be changed quickly to respond to emerging science topics. Two of those museums self-identified as large science institutions, the others as small or medium university museums. The second largest category (35% of respondents) identified educational programming. Some of these overlapped, but in this case over half identified as medium or

large institutions, including a zoo and a children's museum. That these two forms of conveying emerging science were by far the most popular answers makes sense, given their flexibility and relative low cost.

Only one institution, the large zoo, responded that they update label copy when new developments arise, which is not surprising, given the relative difficulty and expense of changing permanent labels. More surprising was that only one institution, a small university natural history museum, explicitly mentioned that it regularly uses their website to convey emerging science information. However, two other museums said in a later question that they update their websites frequently when asked about how often they are able to update their emerging science content, bringing the actual total to three institutions. The education staff at the other institutions may be less involved in the website development or management, or they may not have the time and resources to update a website frequently. It is notable, though, that in my research of other large science institutions, I did find websites to be a common way of communicating emerging science. Websites are useful as both a stand-alone part of a museum's online presence or as an easy-to update element within a museum's exhibit galleries (e.g. The Science Museum of Minnesota's "Science Buzz" kiosks).

The second question on the survey asked respondents "Why does your institution consider it valuable to present current/emerging science to visitors?" (See figure 3.)

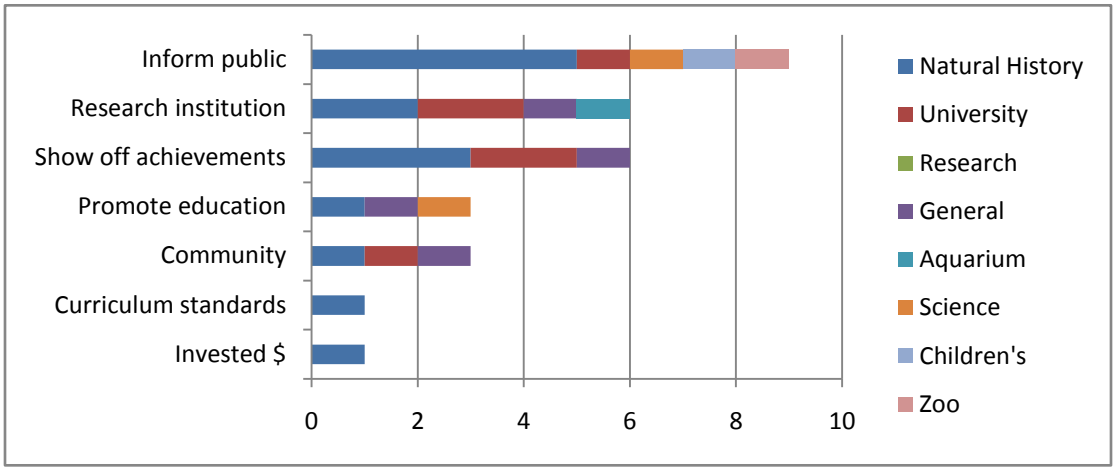

Figure 3. "Why does your institution consider it valuable…" (See appendix B1, question 2.)

The largest response to this question, with nearly 60% of respondents, was an answer along the lines of informing the public or adding educational value for visitors. Education for its own sake is at the root of free-choice learning, so it follows that museums would seek to promote this. The second highest number was a tie between "showing off the achievements" of the scientists at an institution, and being "a research institution" by mission. Taken together and including overlap, this answer is also at nearly 60% of respondents. These answers came almost exclusively from the university natural history museums, although the aquarium also had an extensive research component. It is a good sign that museums are having some success with featuring the achievements of their own researchers, because showing the public that science is a process rather than a finished "answer" is an important part of helping the public to understand emerging science. It is especially interesting to note here that all of the museums that responded with either "presenting research" or "showing off research achievements" also answered that they had curatorial support as a part of the development of their presentations on emerging science. The other answers for this question included benefiting the community

and keeping up with curriculum standards, as well as one institution that felt pressure to account for the money that was invested in its research (e.g. grant money that requires reporting).

The third question, "What kinds of programs and exhibitions have been successful at your institution and what has been less successful?" yielded mostly success stories. The success stories were scattered, with a few consistencies of note. (See figure 4.)

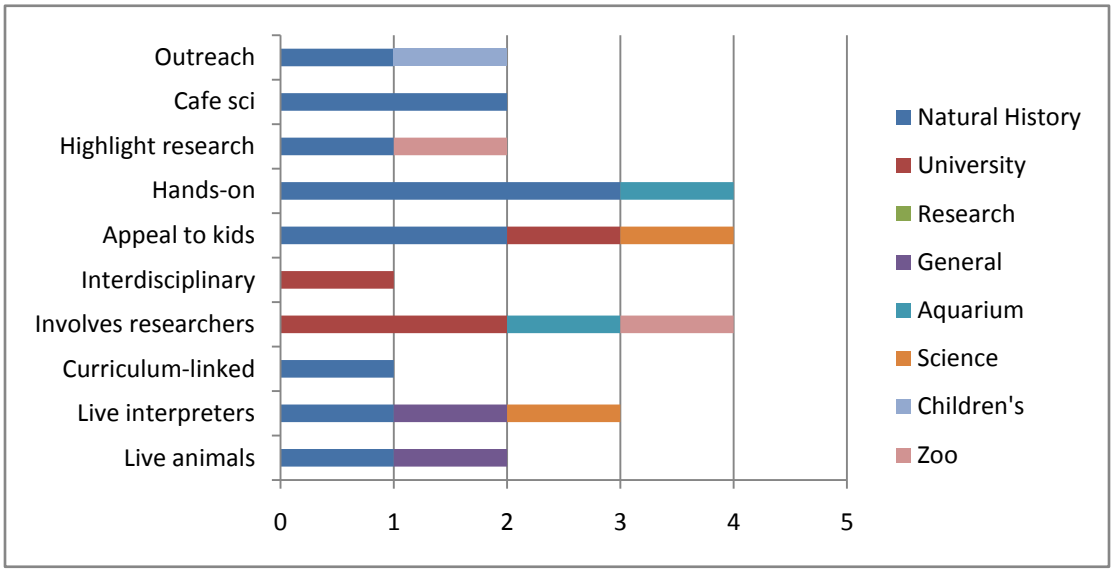

Figure 4. "What kinds of programs…have been successful…" (See appendix B1, question 3.)

About a quarter of respondents said that directly involving the public with researchers was successful – of those, two were university museums, and the others were the zoo and the aquarium. Another quarter of respondents, all science museums that did not overlap with the first group, said that engaging families had been successful, with two specifically mentioning getting kids excited about dinosaurs. Live facilitated programs and live animals were also

popular with museums that identified as medium or large facilities, and special events like family days were mentioned by several medium-sized natural history museums.

Programs that were less successful included “static exhibits,” replicating a wetland inside the museum (when apparently the real wetland was nearby), and the most commonly cited failure, “sit-down lectures.” One medium-sized natural history museum also responded that any exhibit without hands-on activities present was generally less successful. (See figure 5.)

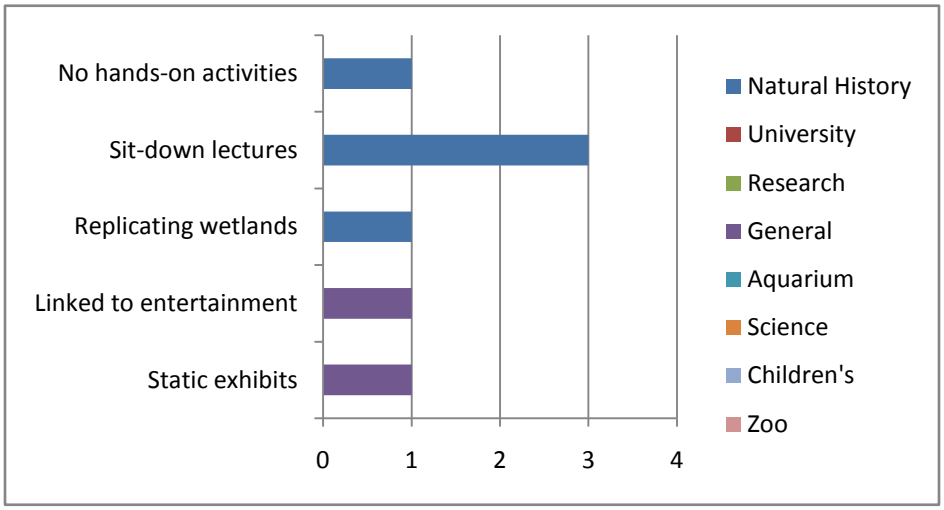

Figure 5. “What has been less than successful?” (See appendix B1, question 3b.)

One interesting difference between the successes and failures is that while people do not want to be “sat-down” to listen to a researcher talk about their work, museums do report having successes with direct visitor-researcher involvement and activities. Also consistent is the idea that engaging families and thinking about topics that tend to get kids excited is better than static exhibits without hands-on activities.

To gauge how visitors were responding specifically to the presentation of sometimes-controversial emerging science topics, respondents were asked about their institution's evaluation of exhibits and visitor concerns. (See figure 6.)

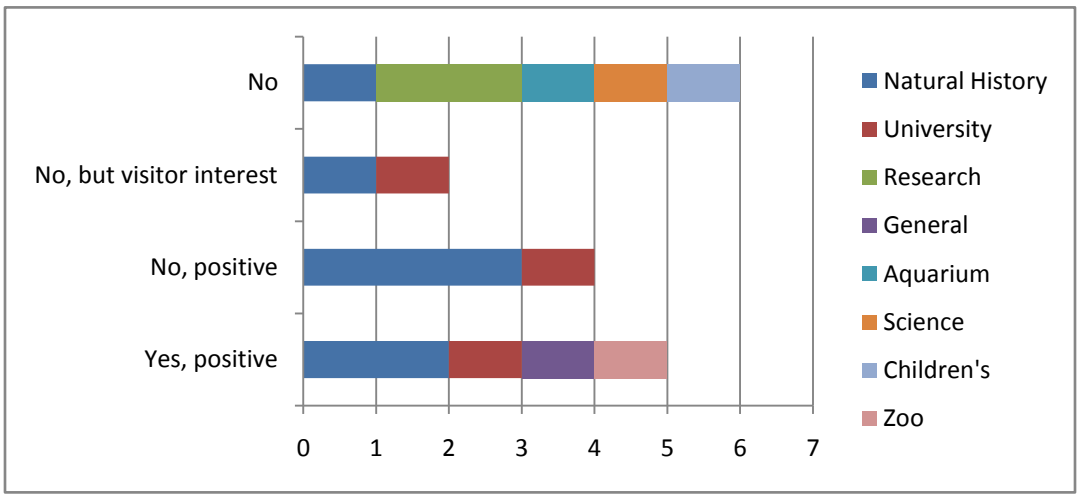

Figure 6."Have you done evaluation/have visitors expressed interest?"
(See Appendix B1, question 4.)

About a third of the institutions had done some kind of evaluation, and all of those had received positive feedback from visitors. Another third had not done specific evaluation, but had perceived visitor interest in emerging science based on comment cards, surveys, and informal conversations.

The second section of the survey, about the logistics of presenting current science, began by asking respondents "Who in your institution is in charge of communicating current/emerging science to the public?" (See figure 7.)

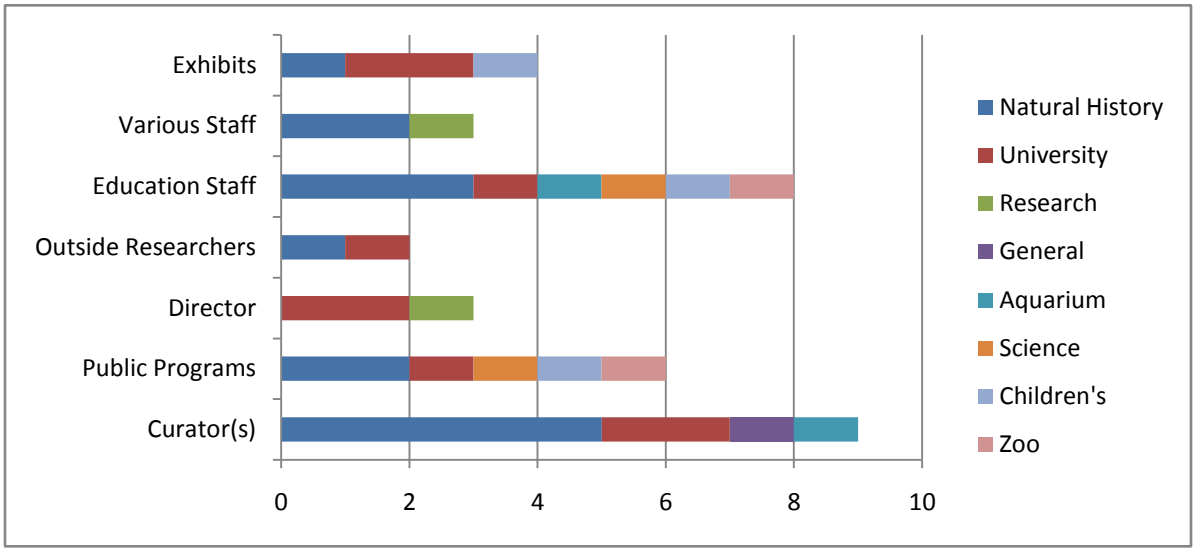

Figure 7. "Who…is in charge of…emerging science…" (See Appendix B1, question 5.)

About half of the institutions responded that curators are involved with the process, and half responded that educators were involved. Of those, half (or a quarter of total respondents) indicated that both a curator and an educator worked on the process (all university museums). Public programs and exhibits staff were involved in fewer cases, although at one institution the communications coordinator was solely responsible for presenting emerging science. In total, however, only four institutions had only one staff person working on this type of presentation; the others listed either curators or the director of the museum as taking the lead. The most common response was to have two or three departments working together, often curators and educators.

A logistical element that I was especially curious about was how frequently museums were able to change the content of their emerging science exhibits or programming, and how current the subject matter could be. (See figure 8.)

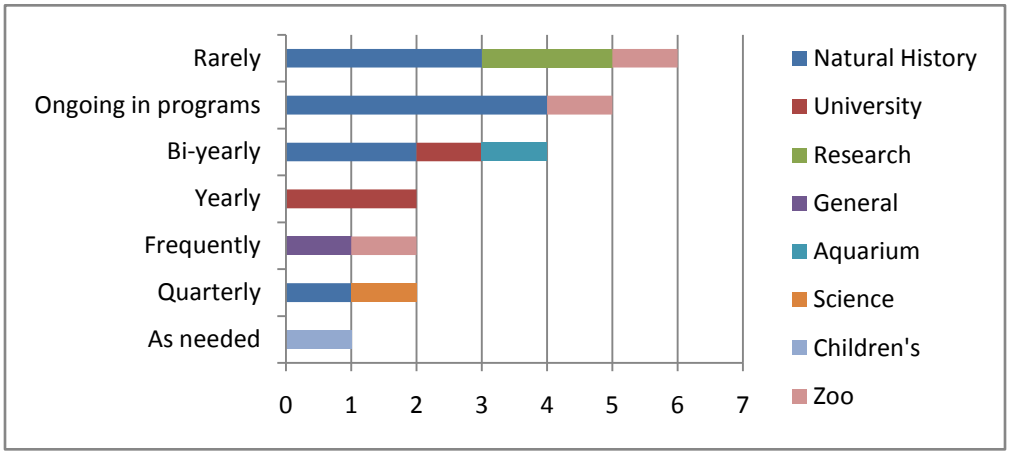

Figure 8. "How frequently do you…change content?" (See Appendix B1, question 6.)

Many institutions responded that they changed exhibits on a yearly or bi-yearly basis. Five out of six of those institutions were medium-sized university natural history museums, only one of whom also indicated that they were making changes "as needed" in their programming. Two other medium-sized science institutions responded that they were changing exhibits somewhat more regularly, up to four times per year. Five institutions noted that they update programs (e.g. tours, lectures, family days) on an ongoing basis, but over half of those also said that they were not able to make changes in their exhibits frequently, if at all. Only two institutions – a university museum and the zoo – mentioned their web presence changing frequently.

Another logistical issue is funding the presentation of emerging science. (See figure 9.)

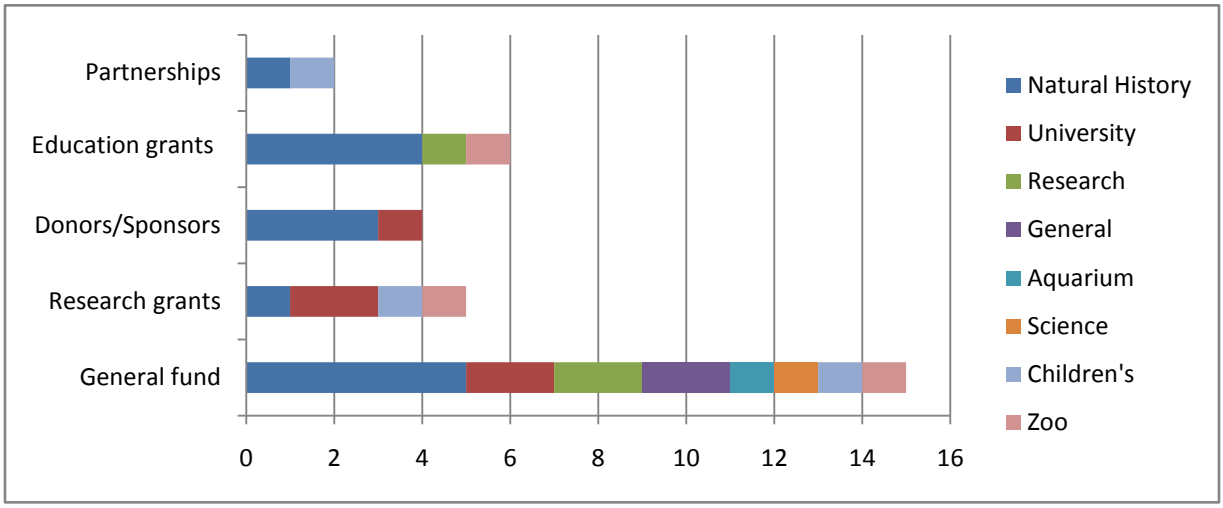

Figure 9. "How does your institution fund current…" (See Appendix B1, question 7.)

Almost all of the institutions surveyed said that some or all of the funding for these exhibits comes from their general operating budget; only two said that they were funded exclusively by grants. However, two-thirds of respondents also mentioned curatorial or educational grants as sources of funding, and a quarter also mentioned donors or sponsorships. In general, though, many museums are limited by their operating budgets, and whatever they can bring in through research or education grants (which is a process that is frequently limited by time).

Finally, a general logistics question that was very revealing about the sources of frustration for institutions presenting emerging science: "What are the challenges faced?" (See figure 10.)

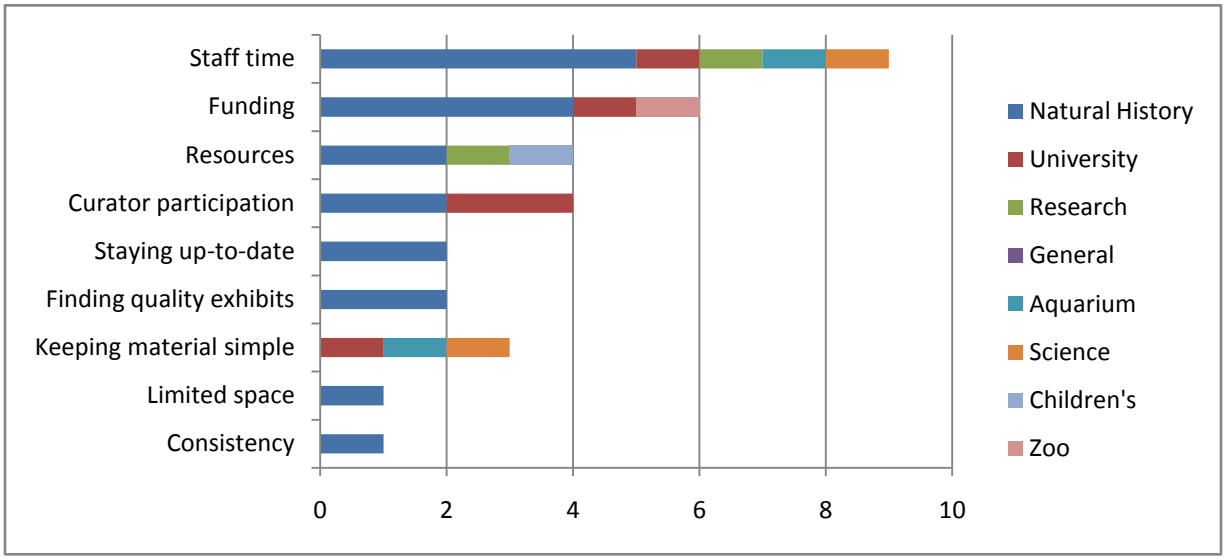

Figure 10. "What are challenges faced…" (See Appendix B1, question 8.)

The largest response with over 50% was time – finding time amongst other duties, balancing curator time, and just generally not enough staff to add emerging science content to day-to-day duties. This is naturally linked to the second highest response of "funding." With a lacking budget, staff resources are stretched thinner. However, funding is also an issue for updating exhibits or label copy, producing materials, or putting on events. Another interesting trend with almost a quarter of respondents was lack of curator participation or support from researchers. As noted above, creating the link between the public and research sections of the museum is vital to the success of programs. Two museums mentioned that just keeping up-to-date was difficult, and two others noted the related problem of keeping volunteers or docents current. One natural history museum also noted that consistency was an issue – for example, if the museum updates one gallery, should it update all of them? How current should the science in the museum be, and must it be that way museum-wide?

The museum professional survey provided important insights that I considered in both the creation of the gallery guide, and the protocol for collaboration with curators and collection managers. It revealed that it was important to not only provide educational opportunities about emerging science, but also promote the research being done at the university, and it was encouraging to learn that none of the museums surveyed had received negative feedback about current science programming. Based on these survey results, I came to several conclusions that guided the construction of the first draft of the gallery guide. Logistically, this survey revealed the importance of curator involvement in creating any materials, and it also helped me to clarify my expectations of staff time and of how frequently a guide like mine could be refreshed in the galleries, which helped me to think about a realistic protocol for collaboration with the curators and collection managers at UCMNH. I chose the guide format as a way for visitors to engage with researchers, curators, or collection managers, without the confines of a lecture. The guide is also a budget-friendly option, since finding resources was a major concern. Based on survey results and my literature review, I wanted the guide to have plenty of engaging questions and hands-on activities that clearly connect to familiar content already in the galleries.

Survey of UCMNH curators and collection managers

Based on my literature review and the responses from the survey of museum professionals, I created a first draft of the gallery guide. The first draft linked an exhibit about bees in the “Modern Life” gallery with the emerging science topic of colony collapse disorder. This draft was used to get initial reactions in both the following survey of UCMNH curators and collection mangers as well as the family focus group discussed in the next section.

The questions in this survey also asked for suggestions on the protocol for collaboration and discussed potential challenges. I collected anonymous survey data from nine individuals who work at UCMNH as either curators or collection managers in anthropology, botany, entomology, paleontology, or zoology.

I first asked for gut reactions to the content of the guide. (See figure 11.)

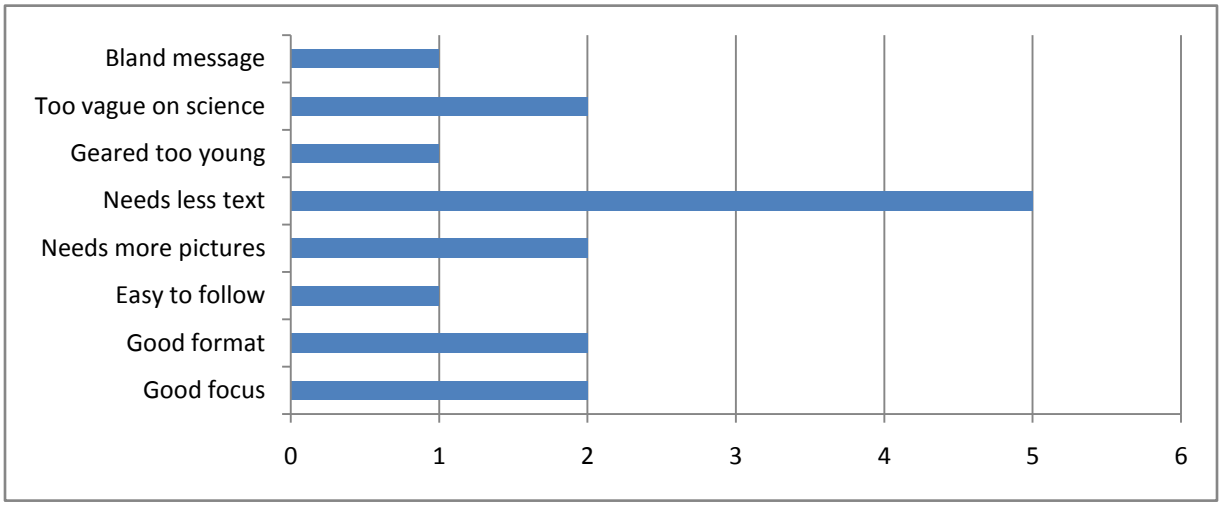

Figure 11. "What are your initial gut reactions?" (See Appendix B2, question 2.)

I received mostly positive reactions to the idea of presenting current science, but some criticism that the actual science presented was too vague and geared towards too young an audience. At the same time, over half of the respondents said that there was too much text for a family to read in a gallery. I also asked for reactions to the overall design, of the guide. I received good feedback on the headings and clear formatting, but also many requests for more color, images, and overall fun design. (See figure 12.)

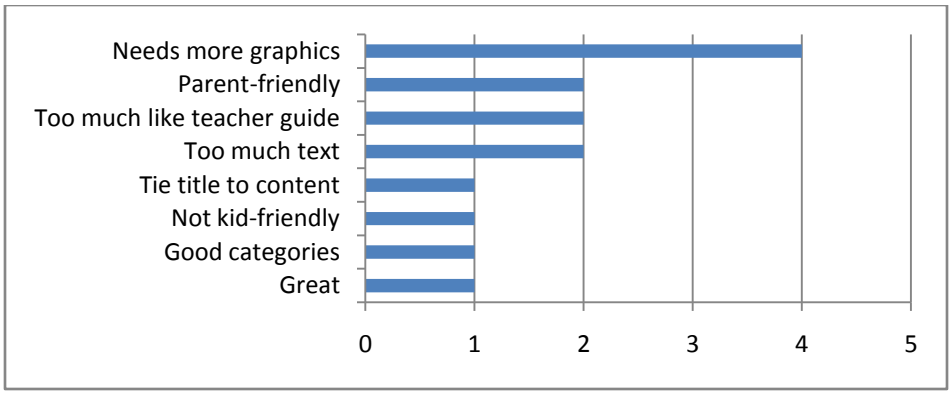

Figure 12. "What are you reactions to overall design?" (See Appendix B2, question 4.)

This section also asked the respondents to think about what kinds of information or headings were missing in the guide, and what other kinds of activities or content should be included. (See Appendix B2, question 3.) About half of the surveys said that there might already be too much content, but there were also several helpful suggestions, including more background, and tying that background to research and gallery objects more clearly. More graphics was a common theme here as well, but one respondent also suggested interesting charts or graphs to help young people visualize the data more clearly. Finally, I asked for other ways to connect research to the museum galleries. The most common response here was to add a website component, either in the gallery or online for use at home. (See Appendix B2, question 5.)

The second section of the survey asked questions about collaborating on a gallery guide to assist me in writing up the protocol for collaboration. When asked if they would be willing to share their research or help interpret other research, 100% of respondents said yes. One collection manager mentioned that time would be a key factor, since responsibility to the

collection comes first, and another said that they might not be comfortable presenting UCMNH research as a non-curator, but would be willing to help interpret or develop other research.

To get an idea of how to start the collaboration process, I asked if the participants would prefer an educator to come to them with ideas or ask them to form the initial content. (See figure 13.)

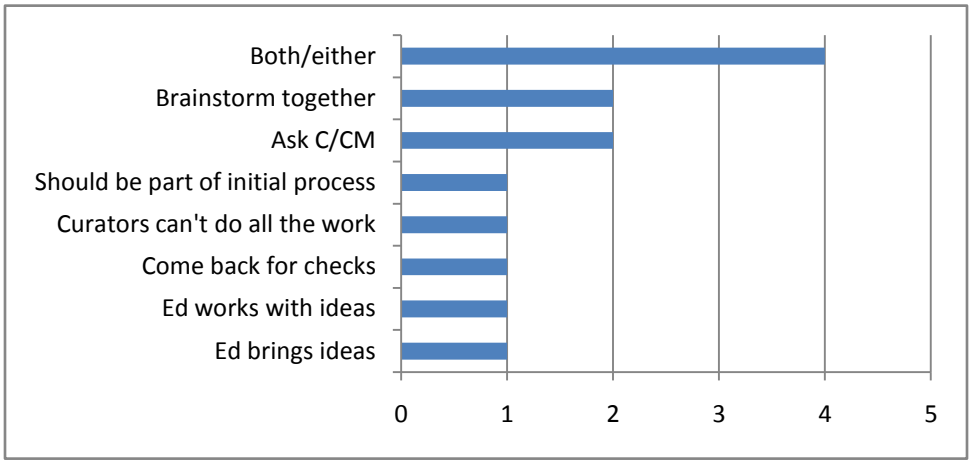

Figure 13. "Would you rather come with ideas, or be asked what to present?" (See Appendix B2, question 6.)

Two respondents indicated that they would prefer to initiate the ideas, and one said that the educator leading the project should have ideas in place when coming to the curator. The other surveys indicated either that they would prefer a truly collaborative effort, or that either party could initiate the idea, but cautioned that curators and collection managers could not do all the work, but also that educators should not proceed without their input.

When asked how involved they would like to be with the creation of the family activities portion of the guide, eight of the nine respondents said that they were willing to be involved,

but many of those also included a caveat that time was a serious factor in the process, and they would be more likely to participate in a well-planned process. (See figure 14.)

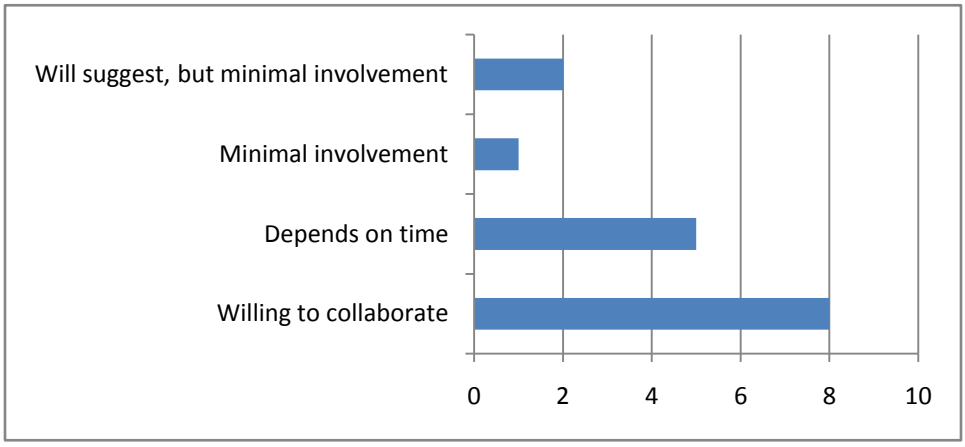

Figure 14. "How involved would you like to be in creation/activities? (See Appendix B2, question 8.)

Several also said that while they would prefer to defer to education staff on activities, they felt it was worthwhile to be a part of the process to make clarifications and suggestions along the way. The answers were similar when asked how frequently the curators and collection managers would be willing to collaborate on a guide – many said that time would be the deciding factor. (See Appendix B2, question 9.) Overall, the most common responses were once or twice a year, depending on other commitments and an appropriate process (not "last-minute").

Finally, I asked the curators and collection managers to suggest a process for collaboration. (See appendix B2, question 10.) Two of the respondents said that they thought a guide like this should be a part of the original planning process for an exhibit, which may have been a clarity problem on my part; perhaps because I created the guide for a relatively new

gallery, it was not clear enough that the guides would be designed to supplement existing exhibit elements with emerging science. Two others suggested very similar processes of an initial meeting, the educator creating a draft, and the curator giving feedback until a final draft was approved by both parties. Again in this question, respecting curators' and collection managers' time and having a streamlined process was emphasized by many of the respondents as the most important factor.

Surveys on parent/guardian reactions to the gallery guide

I collected anonymous survey data from three focus group participants and seven interview survey participants about the gallery guide. The respondents were all parents or guardians who visit museums with children aged kindergarten to fifth grade. These surveys asked general demographic information, background on how respondents already relate to science, and reactions to prototype gallery guides. The focus group responses to the first draft of the guide informed the future drafts (interview survey participants responded to the third draft of the guide), but because the sample size is small overall, data for all ten participants will be presented together. (See Appendix D for the first draft of that guide, which was used for focus group testing and Appendix F for the first draft of the paleontology guide, which was used for the interview surveys.)

The first section of the focus group survey was basic background information about museum visitation. While their frequencies varied, most of the families visited museums monthly to every other month. Two visitors said yearly (classified in the survey as one to three

times per year), and one focus group participant visited more frequently than once per month with a family group. (See figure 15.)

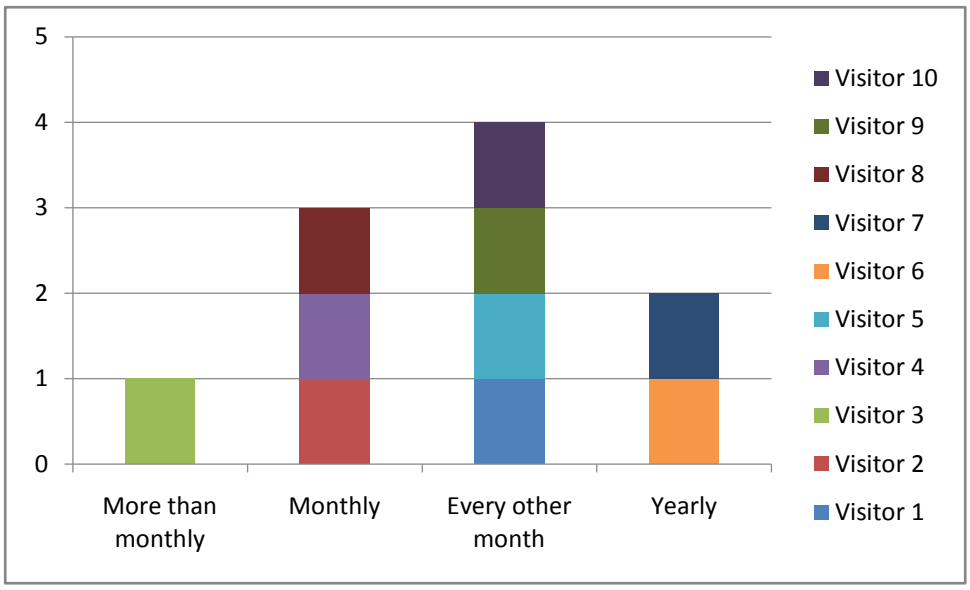

Figure 15. "On average, how frequently do you visit...with an intergenerational group?" (See Appendix B3, question 1.)

This section also asked what the makeup of the group was for a typical museum visit. Visitors were able to state multiple options for their typical makeup. (See figure 16.)

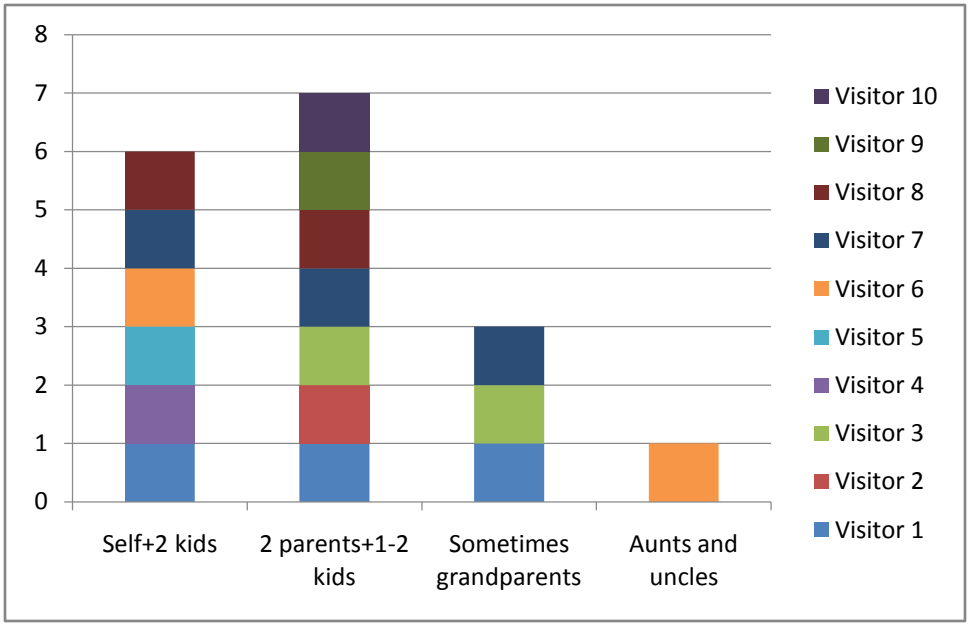

Figure 16. "What is the makeup of the group…" (See Appendix B3, question 2.)

Nearly all of the groups were made up of two children and either one or two parents. In addition to parent-child visitor groups, three of the participants said that they sometimes have grandparents in the group, and one mentioned aunts and uncles as well. Several families also said that they occasionally have other children (friends) in the group as well.

The next two questions were asked to understand the participants' levels of education in, interest in, and comfort with science. (See figures 17 and 18.)

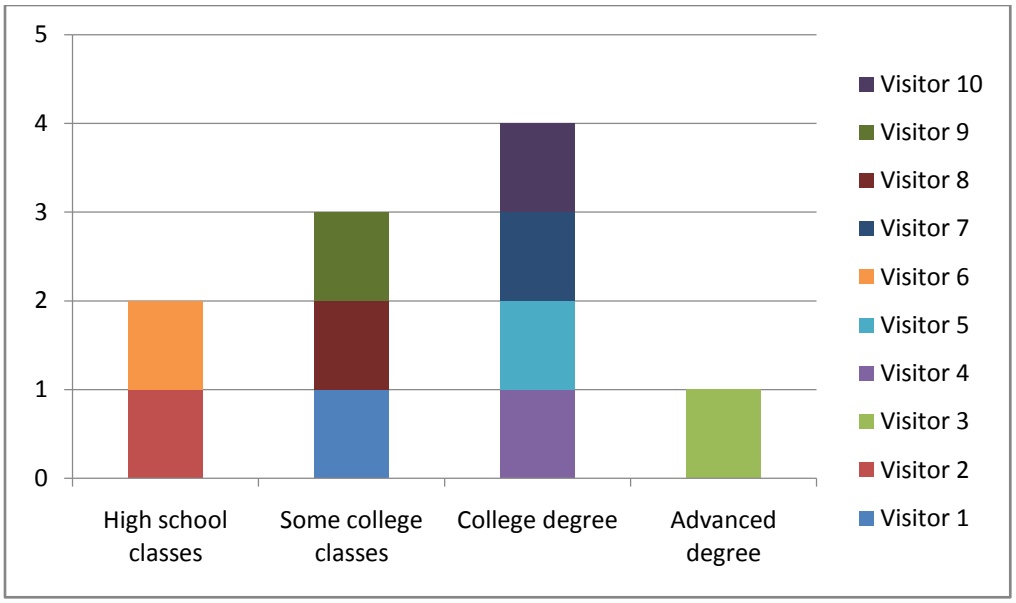

Figure 17. "What is your highest degree of science education?" (See Appendix B3, question 3.)

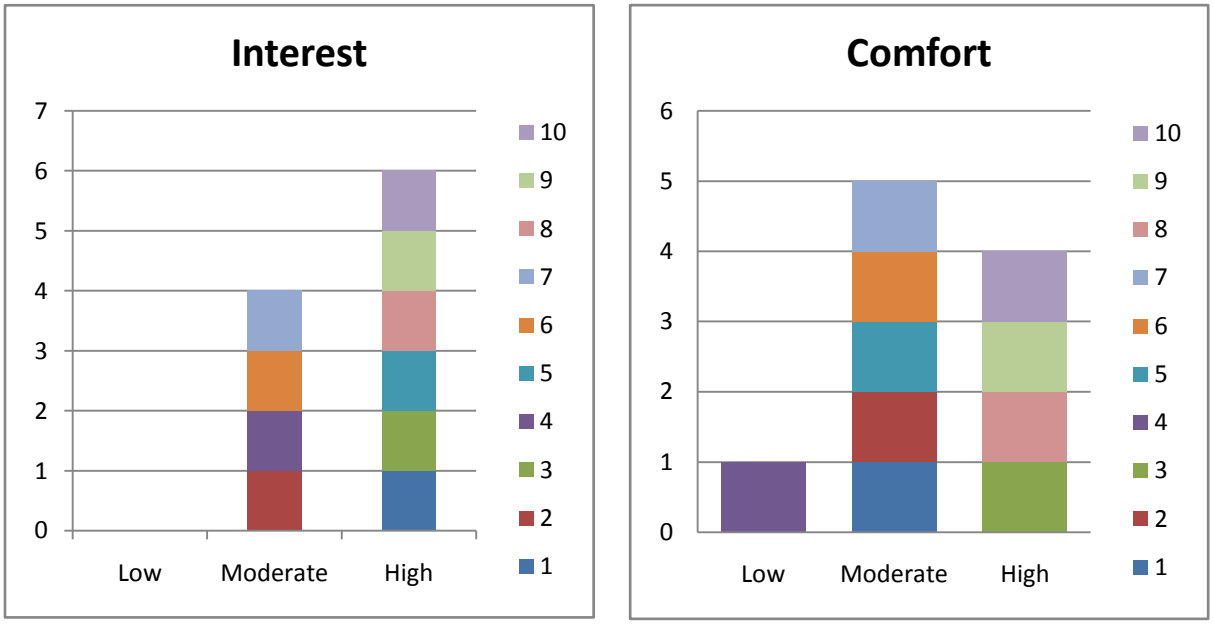

Figure 18. "How would you rate…interest and comfort...discussing science concepts?" (See Appendix B3, question 4.)

As the figures show, the distribution in the participants' science education varies from some high school classes to an advanced science degree. This was somewhat reflected in the

participants' level of interest in and comfort with science topics, but both still varied. The participant with the advanced degree indicated high interest and comfort, but all participants indicated that they were at least moderately interested in science topics. However, surprisingly, when asked about comfort level discussing science topics, one of the participants with a science degree indicated low comfort, and one moderate comfort but high interest. For the most part, however, those who indicated a high interest level also indicated a high comfort level, and the same with the "moderate" level.

The final portion of the demographics information was asking how the visitors and their families currently interact with science and museums. I asked the participants how frequently they talked with their families about science – something learned at school, a television program, or a science-related activity like gardening. As a follow-up, I also asked how frequently they discuss emerging science topics, in particular. (See figure 19.)

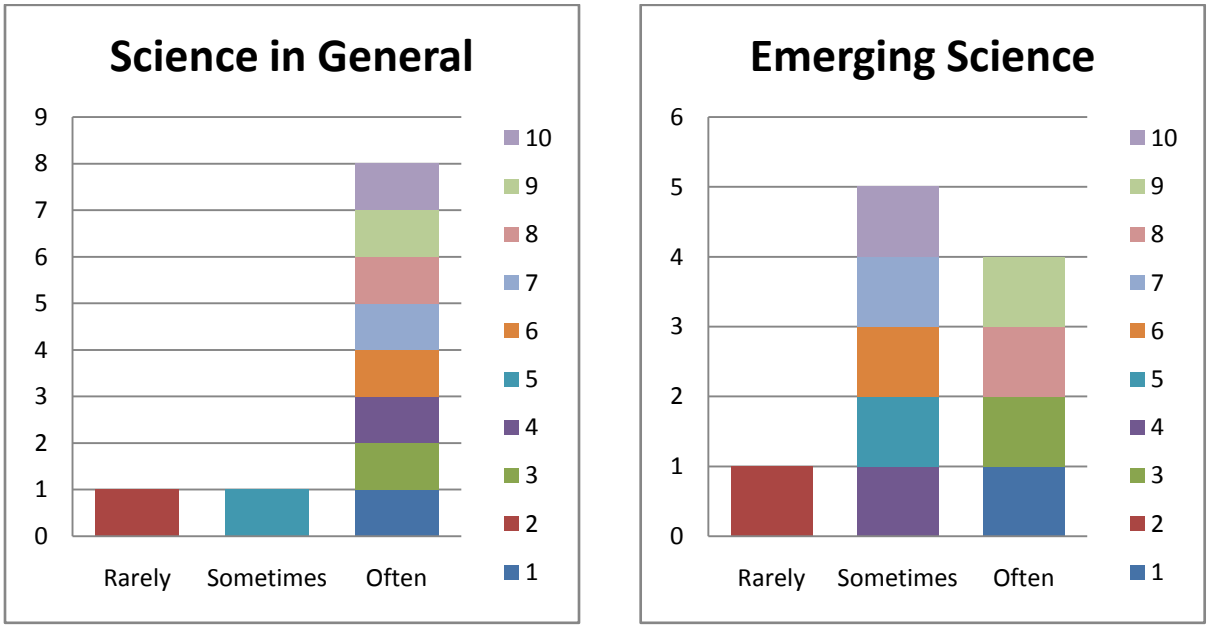

Figure 19. "How frequently do you talk…about science in general/emerging science?" (See Appendix B3, question 5.)

Most respondents here felt that they talked about general science topics "often" with their family groups, with only one participant answering "sometimes" and one answering "rarely." Many more participants answered that they only sometimes discussed emerging science topics. However, half of those who answered that they frequently discuss general science topics also frequently discuss emerging science, and the participant whose family group rarely discusses general science topics, also rarely discusses emerging science.

Along with asking how frequently the participants discuss science, I wanted to know what kinds of resources they use to answer their families' questions about science, as well as their own. For this question, I listed a few possibilities, such as books, museums, internet, or their own science knowledge. (See figure 20.)

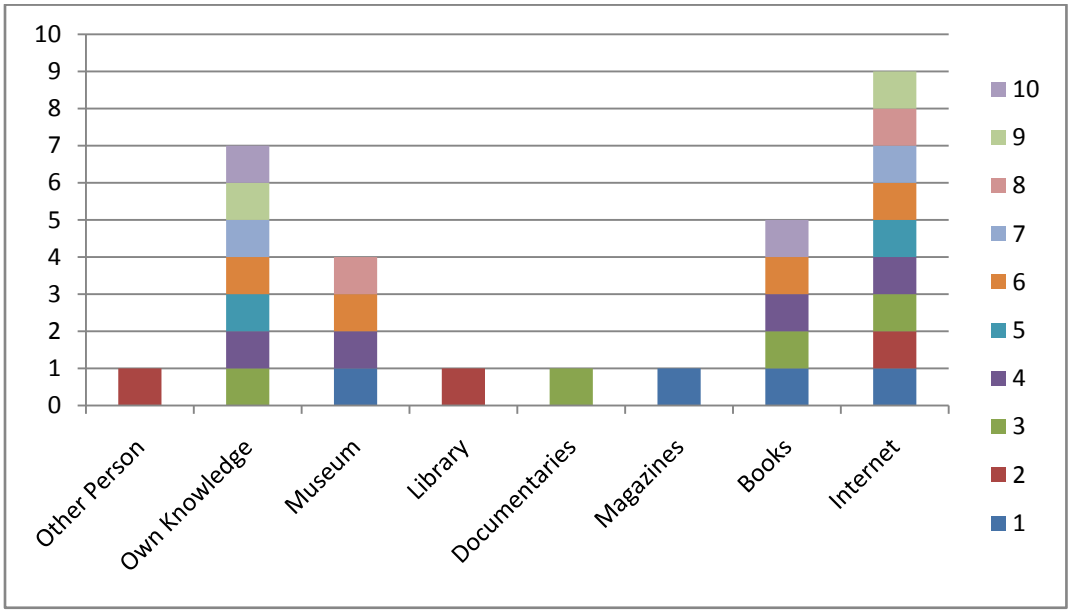

Figure 20. "How do you answer your own/your group's questions about science?" (See Appendix B3, question 6.)

For general science questions, most respondents used either the internet or their own knowledge, with six participants overlapping on both of those options. Books and museums

were less popular answers, but still used by several participants. When I asked the survey participants how they answer emerging science questions in particular, the internet was by far the most popular answer, with eight out of ten saying that would be their main resource. One visitor mentioned the radio was a good source, and another mentioned newspapers, but for the most part, internet was the most useful here. (See Appendix B3, question 7.)

In this section, I asked a few questions about museum use to the focus group that I left off of the interview surveys in order to shorten and streamline those surveys. I was interested in the participants' comfort level using the museum as a resource, and their primary motivations for visiting the museum. All three responded that they were comfortable navigating in a museum and using its resources, and that they would ask questions of museum staff if any arose on their visit. For primary motivation, all three listed "fun" first. One mentioned that "learning comes as a bonus," and another that their family has a "curiosity about the natural world" and enjoys seeing new things. While these responses paint the visitors as mostly looking for an enjoyable experience in the museum, their responses to later questions also show them to be in something of a facilitator mode as well.

After the introductory information, the rest of the survey focused on responses to the gallery guide. All ten participants were asked to look over an iteration of the guide, and the first question was whether it was something they would be attracted to pick up in a gallery. Eight out of ten said that yes, it was something they would pick up, while one visitor said they might pick it up, and one said that they would probably not. I asked the focus group participants to supply reasons why they would or would not pick up the guide (but left that

question off of the interview surveys, as I wanted to spend as much time as possible on the more descriptive "gut reaction" sections). Two of the participants mentioned that they liked having a piece of the exhibit to take home and follow-up with. One said particularly that it was nice to have as a supplement for the exhibit that could then also be used later on. The other participant said that the word "current" would be an attractor to pick up the guide in the gallery, adding a fresh angle on the exhibits currently in place. (See figure 21.)

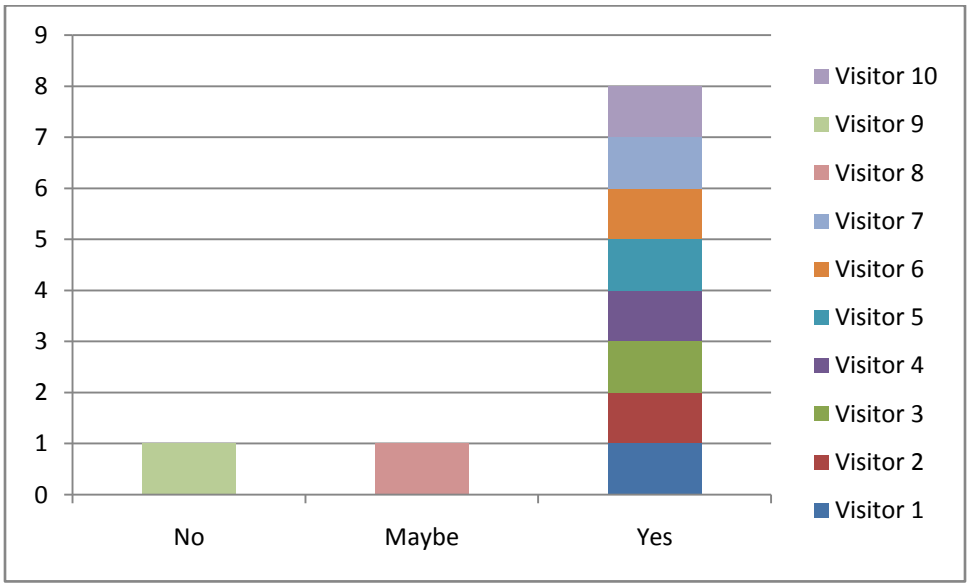

Figure 21. "Is this guide something you would…pick up in a gallery? Why/why not?" (See Appendix B3, question 11.)

Next, I asked the participants for their gut reactions to the content of the guide (e.g. subject matter, amount of information or activities, grade level, etc.). I received some positive feedback on content. Several visitors who noted that the guide was age-appropriate, informative, and had good questions for kids. A couple also mentioned that it had good activities for their group. (See Appendix B3, question 12.) However, many of the gut reactions

were more in line with the next question of what the visitors would like to see more or less of in the guide. (See figure 22.)

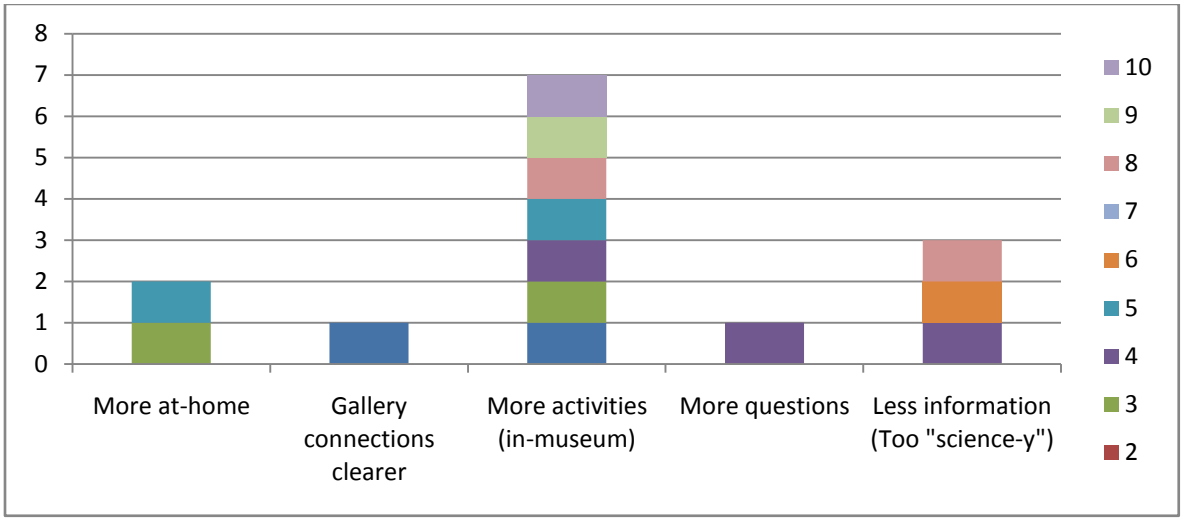

Figure 22. "In terms of content, what would you like to see more or less of?" (See Appendix B3, question 13.)

In general, the visitors wanted more activities, for use both in the museum and at home. In the focus group discussion about this question, the participants brainstormed ideas that they thought would make for more fun and useful activities, both in the galleries and for follow-up at home. Ideas for the in-museum activities included more games, experiments, and space on the guide itself for kids to write or draw. The visitors also had ideas for follow-up activities such as more internet links, more detailed experiments, and a mail-in section to send back to the museum. Although I had added more activities in response to the feedback from the focus group, visitors in the interview surveys still indicated that more activities would be better, both in the museum gallery and in the at-home section. Two participants specifically mentioned that they would like to see more activities that children could manipulate on the page itself, such as circling answers or drawing lines to match things up. Another somewhat common answer was

that the guide had too much content or information, or that it looked "too science-y," especially on the front page. One respondent was uncertain after looking at the front page, but was happy to see the activities on the back. This visitor suggested having signage for the guide display both the front and the back, so that parents could see that it was informative but also contained activities for families.

After discussing the content of the guide, I asked the participants for gut reactions to the design of the guide (e.g. format, size, color, etc.). (See Appendix B3, question 14.) With the focus group draft, visitor 1 said that more pictures and color would make the guide more appealing. Visitor 2 appreciated the simple and clean layout, but visitor 3 brought up the fact that there was not enough room for writing or drawing activities, and the group discussed possibly using the front and back of the page.

The responses from the interview surveys were fairly scattered, with a few positive and a few negative, and most complaints were similar to those about content. Two respondents though the organization was good and liked the headings, while another thought the layout on page two worked especially well. As far as suggestions for improvement, one respondent requested more color, one more bullet points, and two reiterated that the first page had too much information and seemed too "news-y."

Finally, I asked about participants' expectations for where to find the guide and pick it up to use on their visit. (See Appendix B3, question 15.) The responses were fairly evenly split amongst the front desk or museum entrance; at the entrance to the exhibit gallery; and within in the exhibit, near particular exhibit elements. One focus group participant suggested that

perhaps guides could be placed strategically at various places around the museum. (See figure 23.)

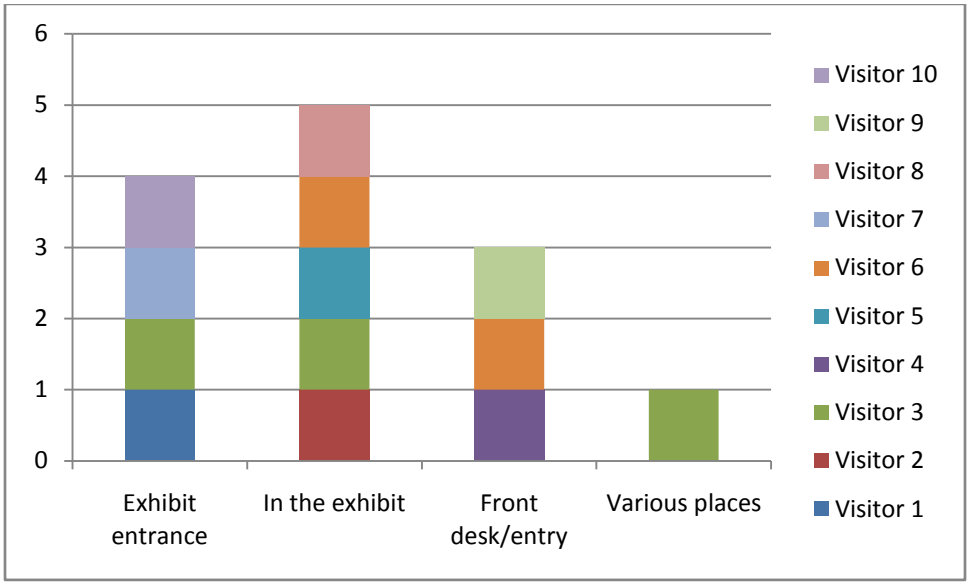

Figure 23. "Where would you expect to pick this guide up/find it in the museum?" (See Appendix B3, question 16.)

Along with expectations of where to find the guide, I asked participants how they expected to use the guide – for example, would they do the activities in the gallery, read aloud to their group, scan the materials and summarize for younger children, just take it home, etc. (See figure 24.)

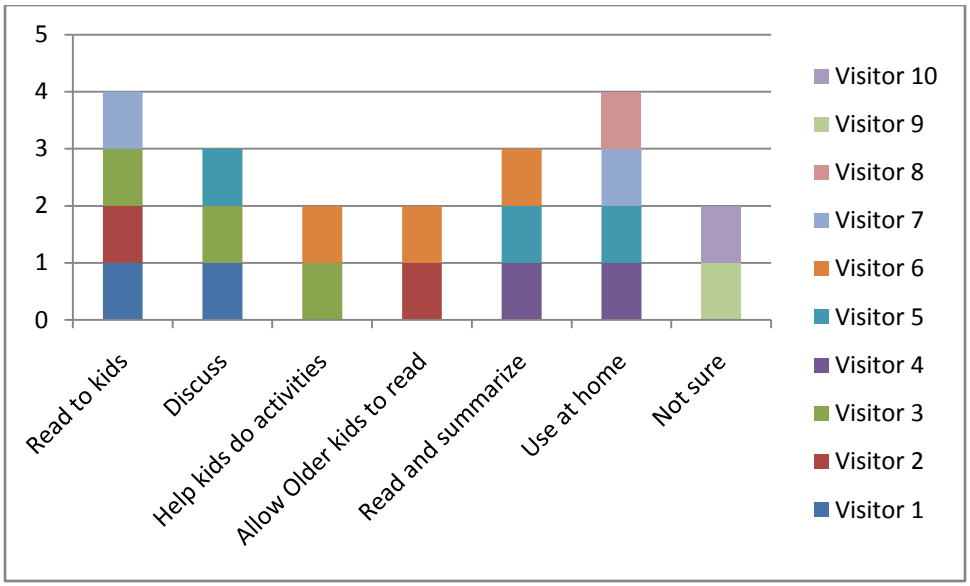

Figure 24. "How do you expect that you would use this guide with your family?" (See Appendix B3, question 17.)

The responses were quite varied across the ten participants. (See figure 34.) While all three focus group participants said that they would read at least some parts of the guide aloud to their family, only one survey participant said the same. However, three survey participants said that they would be likely to read on their own and provide a summary of the information to their group, and one visitor with older children said that it would be fun for those children to have a chance to read it on their own. Four of the survey participants said that they would use the guide later at home to follow up for look for project ideas.

Follow-up survey for parent/guardians using the gallery guide

I asked all ten focus group and interview survey participants to complete a follow-up survey on a future visit, and I received two completed surveys. The follow-up survey asked for

some very basic demographics on the visiting group, information on what parts of the guide each group used, and a few questions about the overall usefulness of the guide.

The follow up groups include a three-person group of one adult with two children, and a five-person group of one adult and two children, plus two of the children's friends. The first group spent about five to ten minutes using the guide, and the second group spent about 20 minutes using the guide.

I asked the groups which parts of the guide they used during their visit. Both used the first four sections at least "some," and both checked that they used the "So what?" section "a lot." One group did not use the fifth section "What can you do?", while the other group used it "a lot." The next questions asked the groups which portions were most useful, and then most fun. Both groups indicated that "In today's news" was useful – one group additionally chose "so what," and the other group additionally chose "activities for families." The groups did not overlap on what they thought were the most fun aspects of the guide: one group chose "activities for families" and "what can you do?" while the other chose "so what?" and "at the museum."

Both groups felt like the guide encouraged discussion and contributed to overall learning, and both would likely use the guide again on a future visit. One commented in particular that the older children in the group (age 10) used the guide to interpret for the younger children (age 6), and enjoyed being leaders. The same group also said that the guide helped to focus the children on particular aspects that they might have otherwise overlooked.

Chapter 5: Discussion

Through my literature review, several rounds of surveys, focus groups, and interviews, and a successful collaboration with a UCMNH collection manager, I arrived at the final products of this research. The gallery guide template was informed in its first draft by mainly my literature review and survey of museum professionals who present emerging science programs, and then later by a survey of UCMNH curators and collection managers, as well as a focus group and interview surveys with adults who visit museums with children. The protocol for collaboration was informed by the museum professional survey and UCMNH survey as well, and also by my test collaboration with collection manager Toni Culver.

Gallery guide – initial development

The decision to create a gallery guide and the first draft of that guide were based on my literature review and initial survey of museum professionals. It was created to be a simple template that would be a starting point to solicit feedback and begin conversations with family users, curators, and collection managers towards a final draft.

The background research came from sources on general museum education, family learning in museums, and informal science learning and I aimed to incorporate as many of the best practices from those areas of my literature review as possible. From the perspective of general museum education and excellence in exhibit elements, I wanted the guide to be comfortable, engaging, reinforcing, and meaningful (Serrell 2006), while also incorporating best practices in family learning and informal science education.

To provide a level of comfort, the guide is laid out in a familiar format – a newspaper headline to indicate "current" science news, followed by subheadings broken up with bullet points. I made the fonts large enough to read comfortably while on the move in the gallery, and tried to leave white space on the page so that the effect was uncluttered and easy on the eyes.

To be engaging, the guide needed to be interesting and enticing to visitors so that they will approach it, needed to connect to the real objects in the gallery, and it needed to feature interactives to engage "minds-on" learning (Hein 1998). I put in pictures and large headings to attract visitors and make it clear that there were family-friendly activities in the guide. I put in several activities and questions that asked visitors to pay attention to specific aspects of the exhibit, connecting them to familiar objects like jars of honey and bee specimens. Finally, the activity section includes interactives meant to engage different levels of learners. For example, a question about where a child might encounter bees can be adjusted to a young child thinking about the colors of the bees, to give somewhat older children a chance to discuss potential fears about bees or connect to a time in the family's history that they were around bees, and to give school-age children a way to connect to something they learned about bees in a formal science class (Wood 1997). There are also activities to engage different learning styles or intelligences, such as making sounds, moving or acting like a bee, and drawing a scene. Engaging multiple levels of knowledge and styles of learning is also in keeping with the PISEC guidelines for family-friendly exhibits (Borun et al 1998).

To make the guide reinforcing, one area of focus was on reinforcing the family dynamic, since spending time together is the number one priority of visiting family groups (Dierking

2010). Again, in keeping with PISEC "family-friendly" recommendations, the guide is at least somewhat multi-user, since more than one visitor can look at it simultaneously, but the activities can also engage multiple family members at the same time. It is also multi-outcome, since there is no set order of use, and the activities are meant to generate more questions and exploration of both the exhibit gallery and the subject matter in the guide. A "reinforcing" experience is also about reinforcing the visitor's and family group's identity in visiting the museum. A parent who wants to have a "facilitator" identity on their visit will be reinforced by having a new resource for activities and discussion questions. They will also have enough background information that they can not only interpret for children, but answer questions without having to search for answers in a traditional label, reinforcing their role as a leader. A family that is in the museum to be "explorers" will have a new way of looking at an exhibit that they may already be familiar with (Falk 2008). Additionally, the guide contains follow-up at-home activities like the "what can you do?" section, highlighting ways families can make a difference and help preserve bee habitat. The at-home activities reinforce the learning that took place in the museum, prolong family conversations, and make visitors feel good about their visit.

To make the guide meaningful, I tried to provide experiences to change visitors cognitively and affectively (Serrell 2006), making connections to prior knowledge and helping visitors to construct new ideas and feelings about the materials. Tying an exhibit about bees to current bee research was not difficult, as colony collapse disorder was (and still is) an emerging science topic. This, in turn, is a very easy topic to connect to visitors' everyday lives, since pollinators affect food, and food affects all visitors! The food-pollinator-colony collapse

connection is a theme that runs throughout all of the sections of the guide, so that no matter how a family chooses to use it (reading portions, engaging in the in-gallery activities, taking the guide home to do the at-home activities), there is a way for them to connect their lives to the subject matter. This is in keeping with the idea of the museum as a constructivist learning environment. The facts about colony collapse disorder and how it affects pollinators are clearly laid out in the "In Today's News" section, but the guide is not a didactic "read from start to finish" learning tool. Instead, there are multiple entry points, inquiry-based discussion questions that are meant to be open-ended and encourage discussion, and different viewpoints for different visitors and family groups to connect with based on their personal learning style, sociocultural context, and visiting identity. Having one main connection point that runs through each guide is also in keeping with best practices for family learning about science – "minimizing cognitive load" (Gutwill and Allen 2010, 716). By keeping the science relatively simple and focusing on one main idea, approached from many ways and at varying levels, the guide will help as many visitors as possible construct new ideas.

Another way to make the guide meaningful and promote the kind of parent-child interactions that deepen the experience for both (Bertschi et al 2008), the guides focus on inquiry-based questions like "why does ____ matter to you?" and "what do you think would happen if ____?" Since parents know best where their children's expertise lies, a guide that offers them various ways of starting conversations through inquiry questions will help them focus their children's attention in more productive ways (Palmquist and Crowley 2007; Owens et al 2002). Knowing that parents are also looking for a way to back up their own knowledge and be a co-investigator in inquiry activities (Bertschi et al 2008; Zimmerman et al 2010), these

types of questions, along with brief summaries of research and background information, give the adult group leaders better tools to offer children support to learn, such as brief "explanatoids" during experiments, as well as other forms of scaffolding during scientific conversations (Crowley et al 2001; Vygotsky and Cole 1978).

A final key to making this particular guide meaningful is the focus on emerging science. Using the tools and language of scientists can help visitors start to identify with scientists and feel a part of the scientific community, which is key to helping them understand science as a work in progress rather than a finished product (National Academies Press 2009; Chittenden et al 2004). This in turn influences their overall science literacy as consumers of emerging science as well as science in general, they key to coming with science that has an impact on their daily lives (van Dijk 2011). The gallery guides encourage users to think critically about emerging science topics by presenting facts, open-ended inquiry questions, and real-life models and experiments for visitors to engage in. In the museum, children (and adults) are encouraged to use scientific tools like magnifying glasses and rulers to help them identify as doing science. With inquiry questions and experiments both in the museum and in the at-home section, visitors practice the science competencies of "predicting, evaluating evidence, and forming theories" (Bertschi et al 2008, 2). The at-home portion of the guide also encourages families to keep thinking about and talking about the exhibits they saw, the activities the participated in, and the new connections they constructed in their own personal context, as well as within the -family group

While the literature review formed the core museum education values of the gallery guide, the survey of museum professionals informed the logistical angle of this project. With it, I hoped to learn about some of the challenges of creating a delivery method for emerging science content that was both family-friendly and workable for the museum professionals putting it together.

Based on the survey results, the current most common ways of presenting emerging science are flexible and easily-changed modes such as short-term exhibits, one-time programs, and web-based information. One of the reasons that I chose the gallery guide is that it seemed like another flexible option that required less overall staff involvement than a program or exhibit, as well as less cost, since these are both common concerns in university museums. It can easily be updated to any topic, like a program or website, but it is less of an investment than even a short-term exhibit.

The surveys provided useful data on successful versus unsuccessful programs, which helped inform the content of the guide. One aspect of successful programs was interactive elements, which is certainly confirmed by the literature. The guide is an interactive on its own, and also gives visitors new ways to interact with some of the more static exhibits in the galleries. Another common "success story" program involved visitors directly interacting with researchers, but this is difficult given the constraints on everyone's time. Opportunities for researcher-visitor programs like lectures or demonstrations tend to be limited for visitors and may not be appropriate for younger age groups. The gallery guide provides visitors a link to researchers by

featuring their research, and because it has been informed by those researchers through the collaboration process.

Along with interacting with researchers, I learned that showing off the research and achievements of an institution is important, and so in the case of the guide that focused on work being done by a museum collection manager, I made the first "headline" section emphasize that fact ("Scientists at CU are working on…"). Again, the guide is flexible enough to accommodate this, while still being able to also focus on broader research with a different headline (such as the bee guide's "Have you heard?").

The surveys indicated a wide range in the frequency with which museums were able to update their emerging science content. Many said that they updated somewhere between 2-4 times a year, but programs were updated more regularly, as well as web-based content. Because the guide falls somewhere between a one-time program and a temporary exhibit, the schedule for updating it should fall somewhere within that time frame, perhaps on a bi-monthly basis.

Finally, the surveys overwhelmingly indicated that time and funding were the issues that held museums back from presenting more or better emerging science content (and along with time constraints, a lack of curator/researcher support). These are common limiting factors in museums, of course, but are especially problematic for something like emerging science that seems like additional content, over and above typical exhibits and programming. My hope is that the guide will address these issues by being cheap to produce and having a reliable template and protocol for collaboration.

Gallery guide – subsequent drafts

From the first draft based off of the literature review and initial museum professional survey, the guide went through a number of revisions based on feedback from the curator and collection manager survey, the visitor focus group, interview surveys, and follow-up surveys. (See appendices D, E, and F.)

The feedback on the first draft of the guide from the curators and collection managers was important in shaping the information included and the overall design. Merging the perspectives of a museum educator and a researcher can be difficult, especially when it comes to label-writing, because informal science education and research language are very different ways of communicating science. However, having the researcher feedback in mind is just as important as making sure the information is being conveyed as clearly as possible to the visitor audience. The most important suggestions from the curators and collection managers were to have as much real background and science content as possible, and make sure that the links between gallery objects and research are clear. I tried to address these concerns by breaking down the headings into the more "newsy" opening heading, and the "how do scientists learn about…" heading, so that there could be both background on the research, as well as some insight into the process. Making the links between objects and research more clear came by expanding the activities section onto a second page and making more explicit reference to objects in the gallery.

The responses from the focus group and interview surveys were also very useful in shaping the guide. The sample size of family visitors was small, and cannot be considered

representative of the visiting population of UCHMN, but some real visitor input to augment theoretical knowledge of how visitors learn and behave in museums was valuable to focus and revise the gallery guide tool.

The visitors I surveyed were comfortable in museums, and with talking about general science topics, but feel less confident when it came to discussing emerging science content. They also did not tend to see museums as a place to get information about emerging science. One aim of this guide is to address that and help people to understand that museums are not only a resource, but that research is currently being conducted in the museum setting.

The adults in the family evaluations also indicated a comfort with "traditional" static exhibits, so by using information that is relevant to the gallery and activities that connect traditional displays to emerging science, the guide may help family groups scaffold new ideas about emerging science from the guide. For example, in the paleontology gallery guide that I created with Toni Culver, we connected the fossil trackway research to trace fossils already in the gallery. If visitors already know how to "use" those objects in the gallery, learning about a research project to figure out which animal made the newly-discovered tracks is a reasonable next step. Also, while visitors are comfortable in museums, they can be overwhelmed or feel like they need to look at every object in order to have the "right" experience. A guide helps to focus the visitor's attention to a specific area, increasing their ability to achieve a state of "flow" and have the best possible museum experience (Csikszentmihalyi and Hermanson 1995).

Another aspect of comfort for visitors was the suggestions of where to place the guide in the gallery so that visitors could find it. In the end, it seemed that the best way to attract

visitors was by placing guides throughout the introductory spaces (lobby, entrance to the hall) and throughout the gallery, along with clear signage and perhaps even intervention by museum staff to point them out.

The reactions to the content and design were also very constructive. Respondents said they would be intrigued enough by the design to pick up a guide, as long as it was obvious to them that the guide was a resource for families, and some were even excited by the heading of "current," to let them know that this was about something new and interesting. The final guide has much more color and graphic excitement than the first draft, while remaining true to what the researcher felt was important to communicate about her work. The second round of testing, the interview surveys with families at the museum's family day, revealed a desire in those visitors for even less text and more design, as they found the "newsy" front intimidating, while being drawn to the more colorful activity side. While adding more graphics, color, differentiating boxes, and spaces for activities, I was constantly removing information, paring back to essential facts about the research and simplifying relevant background information while searching for more activities and questions to connect visitor experience to the research and exhibit.

The follow-up surveys revealed many of my hopes for the guide were realized for the families that used them. The families reported that they used the guides together, sometimes with the parents reading to children, sometimes with children reading to each other, but overall working as a group to explore the gallery. True to constructivist theory, they used different sections of the guide in different ways, and found a variety of sections to be "most useful" and

"most fun." The families also reported that they felt that the guide encouraged discussion and contributed to learning, and that it helped the family groups to focus on particular things in the gallery that they might have missed, although those things were most likely different for all of the groups. Finally, they indicated that they enjoyed using the guide, and would continue to use it at home, as well as look for new guides on future visits.

Protocol for collaboration

An important part of being able to present emerging science in a museum is the collaboration between the researchers and museum educators. As referenced above, both the survey of museum professionals and the survey of UCMNH's curators and collection managers confirmed that time was a major concern in whether or not participation in the creation of a guide was feasible. Based on this feedback, I created and tested the protocol for collaboration.

When asked about their willingness to participate, they were very willing to contribute their research and expertise, although at varying levels of commitment. The curators and collection managers also expressed varying levels of interest in and comfort with planning the educational activities section of the guide. To take these factors into account, the protocol for collaboration expressly states that the educator and curator or collection manager should decide in the initial planning what the level of involvement should be on the researcher's side, and plan a schedule accordingly.

Additionally, at least one collection manager indicated that they would be less confident speaking about research, especially that of the section's curator, but all of the respondents felt that they would be willing to help interpret research within their field. This should be a

consideration during the “Initial content development” phase of the protocol -- the decision to focus on a particular scientist’s research versus a broader emerging science topic, which can then be narrowed down.

The process suggested by most curators and collection managers is basically the finished protocol outlined in detail in appendix G: initial meeting, exchanges either in-person or over email, and a final approval meeting. To make the protocol run as smoothly as possible, saving time and staff resources, I also added the step of “initial email,” with an explanatory email, flow chart outlining the process, and schedule template. (See appendix G.) Giving the collaboration partner (the curator or collection manager) a clear and up-front explanation of the expected time commitment and projected schedule should make it easier for them to decide if they can commit time to the project and how involved they would like to be. I also put the initial content development before the initial meeting. In the initial email, the educator asks the curator or collection manager to specify if they would like to decide on the topic of the guide or if they would like the educator to do that. This should streamline the first project meeting by providing a focused topic that the collaborators can immediately begin to build upon rather than spending in-person time deciding on a topic. Finally, I added “activity development” as a separate step that should not be started until there has been at least one round of email exchanges on the more information-based sections of the guide. This should help the educator to have a good understanding of both the research being presented and what is most important to the researcher before deciding on activities to make those connections in the gallery and at home.

Ongoing questions

As with any project, there are ongoing questions about how the information can be most useful going forward. One of the biggest concerns that came out on the part of the people who would actually produce the gallery guides was time. This is an issue that I tried to address with the protocol for collaboration, but adding another task, however well-organized, to the daily duties of a curator or museum educator is a lot to ask. Any museum that is considering implementing a program to showcase emerging science can reference the reasons that the institutions responding to my surveys think emerging science is important or valuable to present, such as bettering the community or showing off researcher achievements, and consider how those fit into the mission statement at their institution.

Another consideration of time restraints is how often to update the guides within the museum. On one hand, a month is a fairly long process when responding to truly emerging science, such as a newly-reported discovery in the news. On the other hand, a month is quick turnaround to produce a guide that is a collaboration between two busy museum professionals. Shortening the protocol would be frustrating for everyone involved, so I think that the key here is to carefully consider the topics presented, but also to know that people will still be looking for solid information about emerging science topics even a month out, and that the real advantage in the museum is that they will be presented in a way that makes them easy to understand and relate to.

The question of presenting science in the news versus science that a curator or collection manager is working on at the moment also came up during the process. I think that

both of these are valuable ways of looking at emerging science, and will probably depend on who is available for collaboration, what they're working on, and what they think the important issues in the field are at the time.

A suggestion that came up from several surveys was to either incorporate a web component or make the entire guide web-based. The pros here are that web content can be very dynamic – an online guide could have many more links to additional content – and that something like an iPad in a gallery can be more flashy and exciting than a piece of paper. However, I chose not to make the guide an online experience for several reasons. First, developing an online gallery guide still takes just as much, if not more time, because instead of just the researcher and educator collaborating, there would need to be another person involved to put the content online and design it in a web-friendly way. Also, in talking with the focus group participants, they indicated that they would most likely not look for something like this online before visiting a museum. That means that they would either need to use it in the gallery or at home afterwards. A university museum cannot afford to have enough technology to give every visitor a mobile device to use in the gallery, and that creates a major accessibility issue for people who might be interested in using guide, but do not have a mobile device capable of displaying an online version. Also, most visitors would use cell phones, which do not make for as shareable an experience as something that can be easily passed around, drawn on, or used for experiments. As far as using a guide as strictly an at-home follow up experience, it would eliminate most of the important connections between the museum and research, taking away the ability for visitors to connect to their prior knowledge and sociocultural context using the familiar setting of a museum exhibit. With technology changing more quickly all the time, it

is certainly a possibility in the future, but for the time being these guides are the best answer, especially for a museum with limited funds.

Finally, further evaluation would be important to make the guide tool even more useful for visiting families. The small sample size of the focus group and interview survey participants gave useful feedback about their experiences in museums and their reactions to the tool, but that small group may not represent the average museum visitor accurately. A larger evaluation of families using a guide in a real-life setting would further clarify which sections, questions, and types of activities were most useful to a broader swath of family groups. It would also be interesting to survey visiting for existing knowledge, as well as perceptions, about upcoming emerging science topics. While traditional front-end evaluation may be more difficult when the content is changing rapidly, broad ideas about a topic area could help focus a guide's content and provide a better experience for families who use it.

Recommendations

A few final suggestions concern the guide itself, and how it should be used in an actual museum setting. First, when developing the guide activities, keep experiments, models, and questions simple and related more to the gallery than to the research, since the more families interact with the exhibits, the better chance they will have to remember the experience and incorporate it into their existing knowledge base. There should be one to two main ideas connecting research, gallery objects, and the visitors, and those common threads should be woven throughout all of the activities.

Second, to actually disseminate the guide to visitors, it should be available in multiple locations, and displayed so that families can see what is on both sides. It may also be useful to have front-desk staff let visitors know that it is available, and a brief description of what it is.

Finally, creating a repository of "productive questions" and "question stems" that work well for gallery and at-home inquiry activities would be a great add-on to this project. Focus groups or post-visit evaluations for families about the usefulness of the questions for sparking interest, encouraging conversation, and creating connections could lead to a handy resource for assembling guides. Having consistent types of questions could also provide another level of comfort and familiarity for families that are repeat visitors to the museum.

Conclusion

My hope in producing this thesis is that I can positively impact the state of emerging science education in the country today. I know that museums value the presentation of emerging science, but have difficulties with the execution for a variety of reasons. I would like my gallery guide template and protocol for collaboration to be a tool that can help museums strapped for time and money to showcase these ideas.

While some visitor are uncomfortable with learning about or discussing emerging science, perhaps despite understanding its value, there are always museum visitors, especially children, who want to know about the new dinosaurs being uncovered or the new insect behavior that a scientist is studying. By presenting emerging science in a fun and digestible way, my ultimate desire is to help family groups to gain science literacy and make the next generation more informed and ready to interpret the ever-growing stream of current science research.

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Appendices

Appendix A: Survey Instruments

1. **Survey for museum professionals**
2. **Survey for University of Colorado Museum of Natural History Curators and Collection Mangers**
3. **Survey for family focus groups**
4. **Follow-up survey for family focus groups**
5. **Revised survey for individual interview surveys**
6. **Revised follow-up survey for individual interview surveys**

1. Survey for museum professionals

This survey asks 12 questions in 3 parts: current science programs and exhibitions, logistics, and demographic information.

PART 1: Programs and exhibitions

1. What does your institution currently present to the public in terms of current/emerging science programs or exhibits?

2. Why does your institution consider it valuable to present current/emerging science to visitors/families?

3. What kinds of programs and exhibits have been successful at your institution? What has been less than successful?

4. Has your institution done evaluation specifically on your programs or exhibits about current/emerging science, and have visitors/families expressed interests or concerns about this kind of programming?

PART 2: Logistics

5. Who in your institution is in charge of communicating current/emerging science to the public, and with whom do they collaborate for research, presentation, exhibition, and approval (e.g., curators, outside researchers, etc.)?

6. How frequently does your institution change the content of current/emerging science exhibits or programs? How current can the subject matter be?

7. How does your institution fund current/emerging science presentation?

8. In terms of these logistics, what are the challenges faced in presenting current/emerging science (e.g. support from administration, exhibits, curators, finding sources, keeping up-to-date)?

PART 3: Demographic information

9. What is the size and type of institution at which you currently work?

10. What is your position at your institution?

11. How long have you worked at your current institution?

12. How long have you worked in the museum field generally?

2. Survey for University of Colorado Museum of Natural History Curators and Collection Mangers

This survey will ask ten questions in two parts: reactions to the gallery guide and protocol for collaboration.

PART 1: Gallery Guide

1. Please look at the gallery guide, designed to present current science to families in the Modern Life gallery. What are your initial gut reactions?

2. What do you think is missing in terms of content or opportunity to present content (e.g. amount of information, activity ideas presented, follow-up ideas, etc.)?

3. What are your reactions to the overall design (e.g. aesthetics, format, size, learning styles, general usefulness, etc.)?

4. What are other ways we can connect research to the galleries/other resources that you recommend?

5. Other Comments?

PART 2: Protocol for Collaboration

6. If you were collaborating with the education or exhibits section on this guide, would you rather they come to you with ideas in place, or ask you for ideas on what to present?

7. Would you be willing to share your research in this way, or would you be willing to help interpret or develop other research to share in this way?

8. How involved would you like to be with the creation of the guide and coming up with gallery connections or other activities?

9. How frequently would you be willing to collaborate on a gallery guide like this?

10. What suggestions do you have for a process to collaborate on a guide, and what barriers do you anticipate?

3. Survey for family focus groups

Demographic Information

1. On average, how many museums per year do you visit with an intergenerational group?
2. What is the makeup of the group with which you typically visit museums (number of people, ages, and relationship)?
3. What is your highest level of science education (ex: high school science classes, undergraduate science degree, etc.)?
4. How would you rate your level of interest and comfort with discussing science concepts?

Introductory Questions

1. How frequently do you talk with your group about science in general (ex: learning science in school, science-related activities like gardening)? Emerging science in particular?
2. How do you answer your own/your group's questions about science (ex: books, magazines, internet, museums, own knowledge)? Emerging science in particular?
3. Do you consider the museum a place where you are comfortable asking questions or navigating museum resources? If yes, who do you ask questions of or what resources might you use?
4. If you were visiting a science museum with a child, and there was a question you could not answer, would you be comfortable using the museum as a resource to learn along with the child?
5. When/if you visit a science museum, what is your primary motivation (ex: fun, learning, etc.)?

Now please look carefully at the gallery guide.

6. Is this guide something you would be attracted to pick up in a gallery? Why/why not?
7. Please give any gut reactions to the **content** of the guide (ex: subject matter, level, amount of information or activities).
8. Please give any gut reactions to the **design** of the guide (ex: format, size, color, etc.).
9. If this guide was available to you, would you use it while visiting the museum?
10. Where would you expect to pick this guide up/find it in the museum?
11. How do you expect that you would use this guide with your family (ex: read it to kids, do the activities, take it home, read it online to prepare for a visit, etc.)?
12. How do you think your various family/group members would react to this guide and the activities (ex: other adults in your group, different-aged children, etc.)?

4. Follow-up survey for family focus groups

1. What was the makeup of the intergenerational group that used the guide on your visit today (number of people, ages, and relationships)?

2. Approximately how long did you spend using the guide? Was this an appropriate amount of time?

3. What parts of the guide did your group use?

	A lot	Some	Not at all
In today's news			
So What?			
At the museum			
Activities for families			
What can you do?			

4. What parts of the guide did your group find most useful (**X** all that apply)?

	X	COMMENTS?
In today's news		
So What?		
At the museum		
Activities for families		
What can you do?		

5. What parts of the guide did your group find most fun (**X** all that apply)?

	X	COMMENTS?
In today's news		
So What?		
At the museum		
Activities for families		
What can you do?		

6. Do you feel like your group's visit to the museum today was enhanced in any way by using the guide (ex: more fun, more engagement, more learning, etc.)?

7. Do you feel like the guide made it easier to discuss emerging science issues with your group?

8. Do you think this experience will make it easier/more likely for your group to seek out and discuss emerging science?

	Yes	Somewhat	Not Really
1. Did you enjoy using the guide today?			
2. Did your family enjoy using the guide?			
3. Would you use a similar guide on future visits?			

9. Where would you look to pick up a guide like this on future visit?

10. What kind of topics would you like to see covered by a guide like this on future visits?

11. Other thoughts, feedback, or ideas?

5. Revised survey for individual interview surveys

Demographic Information

1. On average, how many museums per year do you visit with an intergenerational group?

   Yearly (1-3) Every other month (4-6) Monthly (7-12) More frequently

2. What is the makeup of the group with which you typically visit museums?
   a. Total number of people in your group? _____
   b. Ages? _____
   c. Family/group relationship? _____

3. What is your highest level of science education?

   High school classes Some college classes College degree Advanced science degree

4. How would you rate your level of interest and comfort with discussing science concepts?

   INTEREST: Low Moderate High

   COMFORT: Low Moderate High

Introductory Questions

1. How frequently do you talk with your group about science in general (ex: learning science in school, science-related activities like gardening)?

   Rarely Sometimes Often

1.a. Emerging Science in particular?

   Rarely Sometimes Often

2. How do you answer your own/your group's questions about science?

   Books Magazines Internet Museums Your own knowledge

   Other?_____

2.a. Emerging Science in particular?

   Books Magazines Internet Museums Your own knowledge

   Other?_____

Now please look carefully at the gallery guide.

3. Is this guide something you would be attracted to pick up in a gallery? YES NO
   Why/why not? _____

4. Please give any gut reactions to the **content** of the guide (ex: subject matter, level, amount of information or activities).

5. In terms of **content**, what would you like to see more or less of?

6. Please give any gut reactions to the **design** of the guide (ex: format, size, color, etc.).

7. If this guide was available to you, would you use it while visiting the museum? YES NO
   Why/why not? _____

8. Where would you expect to pick this guide up/find it in the museum?

9. How do you expect that you would use this guide with your family (ex: read it to kids, do the activities, take it home, read it online to prepare for a visit, etc.)?

10. Other thoughts, comments, or suggestions?

6. Revised follow-up survey for individual interview surveys

1. What was the makeup of the intergenerational group that used the guide on your visit today (number of people, ages, and relationships)?

2. Approximately how long did you spend using the guide? Was this an appropriate amount of time?

3. Which parts of the guide did your group use?

	A lot	Some	Not at all
In today's news			
How do scientists learn about…			
So What?			
At the museum			
Activities for families			
What can you do?			

4. Which parts of the guide did your group find **most useful** (**X** all that apply)?

	X	COMMENTS?
In today's news		
How do scientists learn about…		
So What?		
At the museum		
Activities for families		
What can you do?		

5. Which parts of the guide did your group find most fun (check all that apply)?

	X	COMMENTS?
In today's news		
How do scientists learn about…		
So What?		
At the museum		
Activities for families		
What can you do?		

6. Do you feel like your group's visit to the museum today was enhanced in any way by using the guide (ex: more fun, more engagement, more learning, etc.)?

7. Do you feel like the guide made it/will make it easier to discuss emerging science issues with your group?

8. Do you think this experience will make it easier/more likely for your group to seek out and discuss emerging science?

	Yes	Somewhat	Not Really
9. Did you enjoy using the guide today?			
10. Did your family enjoy using the guide?			
11. Would you use a similar guide on future visits?			

12. Where would you look to pick up a guide like this on future visit?

13. What kind of emerging science topics would you like to see covered by a guide like this on future visits?

14. Other thoughts, feedback, or ideas?

Appendix B: Coded Survey Results

1. **Results of survey for museum professionals**
2. **Results of survey for University of Colorado Museum of Natural History Curators and Collection Mangers**
3. **Results of survey for family focus groups/revised survey for individual interview surveys**
4. **Results of follow-up surveys**

1. Results of survey for museum professionals

1. What does your institution currently present to the public in terms of current/emerging science programs or exhibits?

1	Lectures	Symposia					
2			Programming	Short exhibits			
3	Lecture	Symposia			Exhibits		
4				Short exhibits	Exhibits		
5						"stay up to date"	
6	Lecture	Cafe Sci series	Programming (schools)	Short Exhibits			Web
7					Exhibits		
8				Short Exhibits			
9			Programming	Short Exhibits			
10		Cafe Sci series	Programming (school outreach)				
11				Short Exhibits			
12							
13				Short exhibits			
14					Exhibits		
15			Programming				
16			Programming			Updating label copy	
17	Lectures	Symposia					
	4	5	6	7	4	2	1

2. Why does your institution consider it valuable to present current/emerging science to visitors/families?

1	Research University	Community	Show achievements	Promote education			
2					Invested $ in research	Value for visitors	
3		Community	Achievements				
4						Relevance/value	

5							Curriculum standards
6	Research institution						
7			Achievements			Inform public	
8	Reflect research						
9							
10						Educate families	
11		Community	Achievements	Promoted.		Inform public	
12							
13	Research		Achievements			Benefits public	
14	Research						
15				Promoted.		Inform public	
16						Inform public	
17	University museum		Achievements			"vital" to inform public	
	6	3	6	3	1	9	1

3. What kinds of programs and exhibits have been successful at your institution?

1	Live animals	Live Interpreters								
2			Curriculum – linked							
3				Developed w/researchers	Interdisciplinary					
4						Engage families (dinosaurs)	Hands-on and dynamic			
5	Live animals					Appeal to kids (dinosaurs)	Activities			
6								Highlight research	Cafe sci	
7							Open			Virtual

							house activity day			outreach
8						Appeal to kids				
9										
10										Outreach
11									Cafe sci	
12										
13				Kids involved w/faculty research						
14				"Meet the scientist" posters			Exciting posters			
15		Live facilitator				Adapted for diff levels				
16				Student research partnerships				Highlighting research in the news		
17		Gallery talks								
	2	3	1	4	1	4	4	2	2	2

3b. What has been less than successful?

1	static exhibits	Linked to entertainment industry			
2			Replicating wetlands		
3					
4				Inviting visitors to talk with curators	
5					No activities

6					
7					
8					
9					
10					
11				Lecture series	
12					
13					
14					
15					
16					
17				Sit-down lectures	
	1	1	1	3	1

4. Has your institution done evaluation specifically on your programs or exhibits about current/emerging science, and have visitors/families expressed interest or concerns about this kind of programming?

1	Yes, positive			
2	Yes, positive			
3		No, positive		
4			No, but visitor interest	
5				No
6		No, positive		
7		No, positive		
8			No, but visitor interest	
9				No
10				No
11		No, positive		
12				No
13	Yes, positive			
14				No
15				No
16	Yes, positive			
17	Yes, positive			
	5	4	2	6

5. Who in your institution is in charge of communicating current/emerging science to the public, and with whom do they collaborate for research, presentation, exhibition, and approval?

1	Curator of Nat. History							1
2		Communications/public program coordinator						1
3			Director and asst. director	Students and Researchers				2
4	Curatorial staff			Outside researchers	Programming staff			3
5						"Senior staff"		1
6	Curators	Communications (talks)			Ed staff		Director of exhibits	4
7	Curators				Ed staff			2
8	Curator	Public programs					Exhibits	3
9			Director					1
10		Public programs			Education		Exhibits	3
11	Curators					Various staff		2
12					Programming staff			1
13	Faculty curator		Director		Education		Exhibits	4
14	Scientists				Educators			2
15		Marketing			Education			2
16		PR			Education			2
17	Curators							1
	9	6	3	2	9	2	4	

6. How frequently does your institution change the content of current/emerging science exhibits or programs? How current can it be?

1	Technology = frequent						
2		Incorporate on-going in programming	Much slower in galleries				
3				Yearly			
4					Bi-yearly, not always current		
5		Ongoing in programs	Rarely changes in galleries				
6		Monthly in programs					
7		As-needed in programs			Bi-yearly		
8				Yearly			
9			Rarely				
10						As needed in galleries	
11							2-4 times/year
12			Rarely				
13					Bi-yearly		
14					Once or twice a year		
15							3-4 times/year
16	Web frequent	Programing up to date	Labels change rarely				
17			Not frequently enough				
	2	5	6	2	4	1	2

7. How does your institution fund current/emerging science presentation?

1	General operating				
2	General	Curator grants			
3	Operating	Research grants (informal sci)			
4	Operating		Sponsors		
5	General				
6	General		Donors	Grants	
7				Grants	
8	General				
9	General				
10	General	Specific grants			Partnerships
11	Income		Donors	Grants	
12	General			Grants	
13	General	Research grants	Sponsors		
14	General				
15	General				
16	Operating	Research grants		Ed grants	
17				Grants	Partnerships
	15	5	4	6	2

8. In terms of logistics, what are challenges faced in presenting c/e science (support from admin, exhibits, curators, keeping up-to-date)?

1									
2	Not enough resources								
3		Lack of funding	Lack of staff	Lack of curator participation					
4		Budget	Finding time		Finding quality exhibits	Consistency (change one, change all?)			
5	Finding resourc						Keeping		

	es						up-to-date		
6		Limited fundin g	Finding qualified staff	Research /staff collaboration			Keeping up-to-date		
7		Money	Human resources	Communicating w/research				Limited space	
8									Keeping material relevant /simple
9	Admin support								
10	Resource competition								
11		Expense	Staff time		Finding rentable w/content				
12			Balancing curator time						
13				Curator participation					
14			Fitting in w/other staff tasks				Keeping up to date		
15			Staff time						Volunteer understanding
16		Fundin g							
17			Time						
	4	6	9	4	2	1	3	1	2

9. Size and type of institution?

1	Medium-size	General museum			University				
2			NaturalHistory	Large					
3					University				
4			NaturalHistory						
5	Medium-size		NaturalHistory						
6			NaturalHistory		University	Small			
7	Medium		NaturalHistory		University				
8	Medium				University				
9						Small	Research		
10				Large				Children's	
11	Medium		NaturalHistory		University				
12	Medium						Research		
13					University	Small			
14	Medium								Aquarium
15	Medium		Science						
16				Large					Zoo
17			NaturalHistory		University				
	8	1	8	3	8	3	2	1	2

10. Your position? Years at current museum? Years in museum field?

1	Nat. Hist. Curator/15+/20+			
2		Head of Ed./12/20		
3			Asst. Director/5.5/26	
4				Program Developer/3/14
5	Nat. Hist. & exhibits curator/25			
6		Dir. of Ed./8/20		
7		Sci. Educator/0.5/24		
8	Senior curator/5/15			
9	Curator/8/8			
10			CFO/1.5/30	
11				Programs/30/33
12	Curator of zoo/4/4			
13			Director/11/20+	
14		Sci. Educator/5/5		
15				Public programs/5/6
16		Director of teacher and student programs/2.5/20+		
17				Curator of programs/5/16
	5	5	3	4

2. Results of survey for University of Colorado Museum of Natural History Curators and Collection Mangers

Please look at the gallery guide (below), designed to present current science to families in the Modern Life gallery. What are your initial gut reactions?

1	Good focus on current sci.							
2		Good format		More pictures	Less text			
3		Good format	Easy to Follow					
4					Less text			
5						Geared young		
6	Good focus on current sci.				Less text			
7							Too removed from science	"What can you do?" is bland
8					Less text		Too vague in critical messages	
9				More color/pictures	Less text			
	2	2	1	2	5	1	2	1

3. What do you think is missing in terms of content or opportunity to present content (e.g. amount of information, activity ideas presented, follow-up ideas, etc.)?

1	More background							
2		Less content						
3			Tie it together	Highlight "So what"				
4		Less content						
5					More	Be sure		

					"sense of wonder"	to use real objects		
6							More graphics	
7	More real science							
8	Visual charts or numbers							
9								Better layout and headlines for key messages
	3	2	1	1	1	1	1	1

4. What are your reactions to the overall design (e.g. aesthetics, format, size, learning styles, general usefulness, etc.)?

1	Different categories are good	More graphics						
2		More graphics	User-friendly for parents					
3				Great				
4					Tie title to content			
5						Too much like an instructor outline		
6		More graphics					Too much text	
7						Bland, for teachers, etc.		
8			Parent-friendly					Not kid-friendly
9		More graphics					Too much text	
	1	4	2	1	1	2	2	1

5. Are there other ways we can connect research to the galleries/other resources that you recommend?

1					
2	Web				
3					
4	Web				
5		Public talks	Field trips	Exhibits	
6					
7					
8					Actual scenario where bees are extinct, to show the impact
9	Podcasts, QR codes, AV				
	3	1	1	1	1

5. Other comments? – Nothing of note was introduced by this question.

6. If you were collaborating with the education or exhibits section on this guide, would you rather they come to you with ideas in place, or ask you for ideas on what to present?

1	Ed. Brings preliminary ideas	Brainstorm together						
2		Brainstorm together	Ed. Section works with ideas	Come back for content checks				
3					Either	C/CMs cannot do all the work		
4							C/CMs should initiate ideas	
5					Both			
6					Either			
7					Either			
8							Ask C/CMs for ideas	
9								Should be part of initial

								exhb. process
	1	2	1	1	4	1	2	1

7. Would you be willing to share your research in this way, or would you be willing to help interpret or develop other research to share in this way?

1	Yes		
2	Yes		
3	Yes	First responsibility is to collection	
4	Yes		
5	Yes		
6	Yes		
7	Yes		
8	Yes		Not own research, but willing to interpret other
9	Yes		
	9	1	1

8. How involved would you like to be with the creation of the guide and coming up with in-gallery connections ("at the museum") or other activities ("activities for families")?

1	Willing to help	Depends on time		
2	Yes	Depends on time/good planning		
3			Minimal	
4	Just ask			
5	Yes	Time is an issue		Prefer to let educators do the activities
6	Would like to be involved			
7	Would like to be involved	Account for time/planning		
8	Willing to help			More suggestions/ improvements to content than creating
9	Yes, if it is a collaborative effort	Well-planned		
	8	5	1	2

9. How frequently would you be willing to collaborate on a gallery guide like this?

1	Depends on time				
2	Depends on time				
3		Once or twice per year	More if time is used wisely		
4				Part of the job	
5	Depends on time				
6		Once/year			
7		Once or twice per year			
8					Every other month
9	Depends on time/other commitments				
	4	3	1	1	1

10. What suggestions do you have for a process to collaborate on a guide, and what barriers do you anticipate?

1	Initial meeting, editing back and forth until finished product	Time is an issue				
2		Time	Streamline into exhibit development			
3						
4				Ask curators what to focus on		
5	Initial meeting, editing back and forth until finished product					
6		Limited time				

7		High quality in short time			Collaboration and negotiations	
8						How curators perceive involvement of collection managers
9		Need timelines in place	Should be part of overall process		Teamwork and leadership	
	2	5	2	1	2	1

3. Results of survey for family focus groups/revised survey for individual interview surveys

1. On average, how many museums per year do you visit with an intergenerational group?

1		Every other month (4-6 times/year)		
2			Monthly (7-12)	
3				More than monthly
4			Monthly	
5		Every other		
6	Yearly (1-3)			
7	Yearly			
8			Monthly	
9		Every other		
10		Every other		
	2	4	3	1

2. What is the makeup of the group with which you typically visit museums (number of people, ages, and relationship)?

1	Self + 2 kids	Sometimes husband	Sometimes grandparents	
2		2 parents + 2 kids		
3		2 parents + 1 kid	Sometimes grandparents	
4	Self + 2 kids			
5	Self + 2 kids			
6	Self + 2 kids			Aunts and uncles
7	Self + 2 kids	Sometimes husband	Sometimes grandparents	
8	Self + 2 kids	Sometimes husband		
9		2 parents + 2 kids		
10		2 parents + 2 kids		
	6	7	3	1

3. What is your highest level of science education (ex: high school science classes, undergraduate science degree, etc.)?

1		Some college classes		
2	High school classes			
3				Advanced degree
4			College degree	
5			College degree	
6	High school classes			
7		Some college classes		
8		Some college classes		
9		Some college classes		

10			College degree	
	2	4	3	1

4. How would you rate your level of interest and comfort with discussing science concepts?

	Interest			Comfort		
1	High				Moderate	
2		Moderate			Moderate	
3	High			High		
4		Moderate				Low
5	High				Moderate	
6		Moderate			Moderate	
7		Moderate			Moderate	
8	High			High		
9	High			High		
10	High			High		
	6	4		4	5	1

5. How frequently do you talk with your group about science in general (ex: learning science in school, science-related activities like gardening)? Emerging science in particular?

1	Often/often			
2				Rarely/rarely
3	Often/often			
4		Often/sometimes		
5			Sometimes/sometimes	
6		Often/sometimes		
7		Often/sometimes		
8	Often/often			
9	Often/often			
10		Often/sometimes		

1. How do you answer your own/your group's questions about science (ex: books, magazines, internet, museums, own knowledge)?

1	Internet	Museum	Books	Magazines				
2	Internet				Library	Other person		
3	Internet		Books				Own knowledge	Documentaries
4	Internet	Museum	Books				Own knowledge	
5	Internet						Own knowledge	
6	Internet	Museum	Books				Own knowledge	
7	Internet						Own knowledge	
8	Internet	Museum						

9	Internet						Own knowledge	
10			Books				Own knowledge	
	9	4	5	1	1	1	7	1

2a. Emerging science in particular?

1	Internet							
2	Internet	Library	Other person					
3	Internet			Books	Own knowledge	Documentaries		
4	Internet							
5	Internet						Newspaper	
6	Internet			Books	Own knowledge			
7	Internet							
8	Internet							
9			Other person					Radio
10	Internet							
	9	1	2	2	2	1	1	1

2. Do you consider the museum a place where you are comfortable asking questions or navigating museum resources? If yes, who do you ask questions of or what resources might you use? (Focus group only)

1	Yes	Ask whoever's around	Read labels	Research at home later on web	
2	Yes	Front desk or in exhibit			Look for resource library
3	Yes	Staff not always in exhibit			Look for higher level books or materials

3. If you were visiting a science museum with a child, and there was a question you could not answer, would you be comfortable using the museum as a resource to learn along with the child? (Focus group only)

1	Yes		
2	Yes		
3	Yes	Encourage questions	Follow up at home

4. When/if you visit a science museum, what is your primary motivation (ex: fun, learning, etc.)? (Focus group only)

1	Fun	Learning as a bonus		
2	Fun/entertainment			
3	Fun		Curiosity about natural world	Exposure to new topics
	3	1	1	1

1. Is this guide something you would be attracted to pick up in a gallery? Why/why not?

1	Yes	"Current" is attractive				
2	Yes		nice to take home			
3	Yes		Take-home	Supplements exhibit		
4	Yes					
5	Yes					
6	Yes					
7	Yes					
8					Maybe	
9						No
10	Yes					
	8	1	2	1	1	1

2. Please give any gut reactions to the **<u>content</u>** of the guide (ex: subject matter, level, amount of information or activities).

1	Age-appropriate	Kids like question					
2			Good amt of info	Headings easy to use			
3					More activities		
4						Too much info	Good activities
5					More activities		
6						Too much info on page 1	Good activities
7			Informative				
8					More activities	Too "sciency"	
9					More activities		
10	Age appropriate	Good question for kids					

	2	2	2	1	4	3	2

3. In terms of **<u>content</u>**, what would you like to see more or less of?

1	More activities	Gallery connections clearer		
2				
3			More at-home – mail-back section?	
4	More activities			More questions
5	More things for kids to do – circle, connect		More links for at-home	
6				
7				
8	More to manipulate, games			
9				
10	More activities			
	5	1	2	1

4. Please give any gut reactions to the **<u>design</u>** of the guide (ex: format, size, color, etc.).

1	More pictures	More color						
2			Simple and clean	Good family tips				
3					Room for activities			
4						More bullets		
5							Good headings/ broken up well	
6							Well-organized	
7			Pg 2 layout good					
8		More color						Too “news-y”
9				Emphasize “for families”				
10								Page 1 is daunting
	1	2	2	2	1	1	2	2

5. If this guide was available to you, would you use it while visiting the museum?

   All respondents answered yes – one elaborated that it would make a good "checklist" of things to see in an exhibit.

6. Where would you expect to pick this guide up/find it in the museum?

1	Exhibit entrance			
2		Near the exhibit		
3	Exhibit entrance	In the exhibit		Various places
4			Front desk/entry	
5		Near the exhibit		
6		Near the exhibit	Front desk	
7	Exhibit entrance			
8		Near the exhibit		
9			Entry	
10	Exhibit entrance			
	4	5	3	1

7. How do you expect that you would use this guide with your family (ex: read it to kids, do the activities, take it home, read it online to prepare for a visit, etc.)?

1	Read aloud to kids	Discuss and brainstorm				
2	Read to kids					Kids look for keywords
3	Parents read aloud	Discuss and question	Participate in activities			
4				Read to self and summarize to kids	Would use at home	
5		Discuss		Scan and ask questions to kids	Follow up at home	
6			Help kids do activities	Skim and tell highlights to kids		Older kids might read
7	Read to kids				Maybe use at home	
8					Look for ideas or projects to do later	
9						
10						
	4	3	2	3	4	2

4. Results of follow-up surveys

1. What was the makeup of the group that used the guide on your visit today?

1	1 adult, 2 kids (9,4)
2	1 adult, 4 kids (10,6)
3	1 adult, 1 kid

2. Approximately how long did you spend using the guide? Was this an appropriate amount of time?

1	5-10 minutes, good		
2		20 minutes	
3			2 minutes
	1	1	1

3. Which parts of the guide did your group use?

	A lot	Some	Not at all
In today's news	1	2	3
How do scientists learn about…			3
So What?	1, 2	3	
At the museum	2, 3	1	
Activities for families	1, 3	2	
What can you do?	2		1, 3

4. Which parts of the guide did your group find **most useful** (**X** all that apply)?

	X	COMMENTS?
In today's news		1, 2
How do scientists learn about…		
So What?		2
At the museum		
Activities for families		1, 3 (good for "lads")
What can you do?		

5. Which parts of the guide did your group find most fun (check all that apply)?

	X	COMMENTS?
In today's news		
How do scientists learn about…		
So What?		1
At the museum		1
Activities for families		2, 3
What can you do?		2

6. Do you feel like your group's visit to the museum today was enhanced in any way by using the guide (ex: more fun, more engagement, more learning, etc.)?

1	Yes, more learning			
2		10 yo's read aloud to 6 yo's, liked being "guides"		
3			Yes, more fun	
	1	1	1	

7. Do you feel like the guide made it/will make it easier to discuss emerging science issues with your group?

1	Yes
2	Yes, encouraged discussion
3	Yes, much easier
	3

8. Do you think this experience will make it easier/more likely for your group to seek out and discuss emerging science?

1	Yes	
2	Yes, kids were interested to look up more online	
3		Probably not
	2	1

	Yes	Somewhat	Not Really
5. Did you enjoy using the guide today?	1, 2, 3		
6. Did your family enjoy using the guide?	1, 3	2	
7. Would you use a similar guide on future visits?	1, 2, 3		

9. Where would you look to pick up a guide like this on future visit?

1	By the exhibit		
2		At exhibit entrance	
3			Museum entrance
	1	1	1

10. What kind of emerging science topics would you like to see covered by a guide like this on future visits?

1	Butterflies, reptiles, animals, CO history, world experiences			
2				
3			Evolution	

Appendix C: Generic Gallery Guide

Appendix D: Colony Collapse Gallery Guide – first draft

Appendix E: Colony Collapse Gallery Guide – final draft

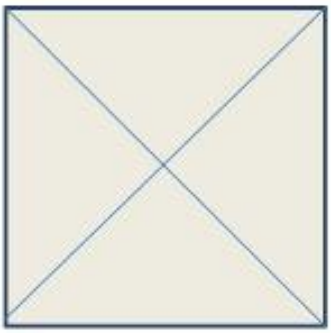
Appendix F: Paleontology Gallery Guide

UCMNH Presents...

CURRENT CONNECTIONS for families

This guide presents **activities** about **current science** for families visiting the ..... Gallery.

In today's news: .....



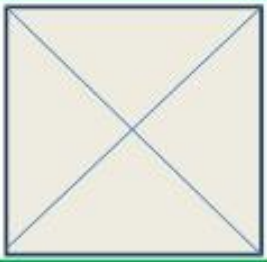
- Bullet points about emerging science/research topic
- Photos/illustrations
- Reference arrows

How do scientists learn about .....

- Bullet points about nature of science, how to learn about science, how to understand in a museum
- Photos/illustrations

So what? Why do scientists study...

- What's so interesting about ...
- Or why does this topic matter in your life...
- Photos/illustrations



Activities for families

At the museum

- Links to objects/labels/activities already in the gallery
- Ideas to connect those objects to the emerging science on page 1
- Photos/illustrations

Try an experiment

- These are potential in-gallery activities
- Aim to incorporate multiple learning styles and age-appropriate levels

Draw the scene
Act it out
Make sounds
Measure, match, circle
Inquiry questions
Etc.

At home

- Links to further reading
- Places to visit
- Local organizations
- Ways to get involved

You be the scientist

Try an experiment

- More activities
- More complex experiments or activities
- Activities that involve everyday objects, craft supplies, observation skills
- Outdoor activities
- Etc.

UCMNH Presents...

CURRENT CONNECTIONS for kids and families

In today's news

Have you heard that honeybees in the United States are in trouble?

Colony collapse disorder (CCD) is killing bees across the country.

It's a mystery that scientists are working hard to solve, before we lose even more honeybees!

What do we know?

- We know that honeybees are dying because of a combination of a fungus and a virus. When both are present in a hive, the bees get sick and die.
- We know that cell phones or pesticides are not causing CCD.

What don't we know?

- We will don't know how the fungus/virus combination is getting to bees, or the best way to stop it.

So what?

Why should you care about honeybees? Honeybees help make about one out of every three bites of food that you eat. They are important to farmers and gardeners who want to grow flowers, fruits, vegetables, and grains.

At the museum

- Check out the bees in the "Modern Life" gallery. There are over 500 species of bees just in Boulder County. Some of them are threatened by Colony Collapse Disorder. If you look up close with the magnifier, you can see pollen on some of their legs.
- Read about how bees make honey in "Honey, We've Got Honey!"
  - Why do we call bees pollinators?
  - How do they help flowers, fruits, vegetables, and grains grow?
  - What do you think would happen if bees disappeared?

Activities for families

- Think about where you usually see bees (not the wasps at your picnics!) and draw the scene. What are the bees doing?
- What sounds do the bees in your scene make? How do they move? Act it out!
- Here are just some of the foods that need honeybees to help them grow: apples, almonds, blueberries, cherries, grapes, peaches, strawberries, broccoli, carrots, pumpkins, soybeans, and sunflowers. What are your favorite foods pollinated by bees?

What can you do?

- If you have a garden, limit use of pesticides, and make sure the ones you use are bee-friendly. Pesticides may not be to blame for CCD, but they do kill healthy bees.
- When you buy foods that rely on pollinators, consider buying locally grown foods when you can. Transporting food and its pollinators may contribute to the spread of CCD.
- Plant bee-friendly pollen and nectar plants, like red clover, foxglove, bee balm, and joe-pye weed.
- Learn more and ask questions at *www.ars.usda.gov/CCD*

UCMNH Presents...

CURRENT CONNECTIONS for families

This guide presents current science news and activities for families visiting the Modern Life Gallery.

In today's news

Have you heard that honeybees in the United States are in trouble?

Colony collapse disorder (CCD) is killing these bees across the country.

It's a mystery that scientists are working hard to solve, before we lose even more honeybees!

What do we know?

- We know that honeybees are dying because of a combination of a fungus and a virus. When both are present in a hive, the bees get sick and die.
- We know that cell phones or pesticides are not causing CCD.

What don't we know?

- We still don't know how the fungus/virus combination is getting to bees, or the best way to stop it.
- We don't know what other factors might impact the bees. For example, some scientists have suggested that transporting bees around the country might be making their immune systems weaker, so they get sick more easily.

So what?

Why should you care about honeybees? Honeybees help make about one out of every three bites of food that you eat. They are important to farmers and gardeners who want to grow flowers, fruits, vegetables, and grains.

One out of every three bites of food in these pictures is **pollinated** by honeybees.

Pollination is when honeybees fly from plant to plant, spreading **pollen**.

The pollen on the flower in this picture is the grainy yellow parts in the middle of the flower.

Pollen spreading from plant to plant is what lets the plants grow and make more plants.

Activities for families

At the museum

- Check out the bees in the "Modern Life" gallery. There are over 500 species of bees just in Boulder County. Some of them, honeybees, are threatened by Colony Collapse Disorder. If you look up close with the magnifier, you can see that some still have pollen on their legs from their important work.
- Read about how bees make honey in "Honey, We've Got Honey!"
  - Why do we call bees **pollinators?**
  - How do they help flowers, fruits, vegetables, and grains grow?
  - What do you think would happen if bees disappeared?
- Here are **just some** of the foods that need honeybees to help them grow: apples, almonds, blueberries, cherries, grapes, peaches, strawberries, broccoli, carrots, pumpkins, soybeans, and sunflowers. What are your favorite foods pollinated by bees?
- Think about where you usually see bees (not the wasps at your picnics!) and draw the scene. What are the bees doing?
- What sounds do the bees in your scene make? How do they move? Act it out!

At home

- If you have a garden, **limit use of pesticides**, and make sure the ones you use are bee-friendly. Pesticides may not be to blame for CCD, but they do kill healthy bees.
- When you buy foods that rely on pollinators, **consider buying locally grown foods** when you can. Transporting food and its pollinators may contribute to the spread of CCD.
- Plant bee-friendly pollen and nectar plants, like red clover, foxglove, bee balm, and joe-pye weed.

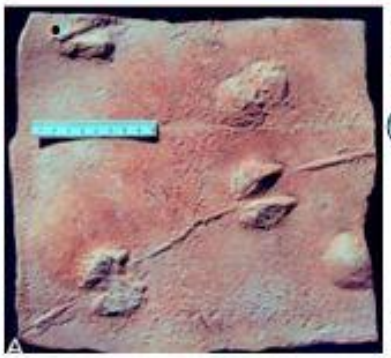
- Learn more and ask questions at www.ars.usda.gov/CCD
- *Check out local bee-keeping groups around Boulder, or find someone you know who keeps a hive and ask if you can take a look!*

UCMNH Presents...

CURRENT CONNECTIONS for families

This guide presents **activities** about **current science** for families visiting the Paleontology Gallery.

In today's news: Scientists at CU are studying fossil tracks and trackways!



Tracks and Trackways are footprints and other markings preserved in soft sand or mud for thousands or even millions of years.

This is a picture of fossil footprints made by a small jumping rodent. It used its hind feet only for jumping, and its tail for balance.

It may have looked like this

Or maybe like this?

What do we know about these tracks?

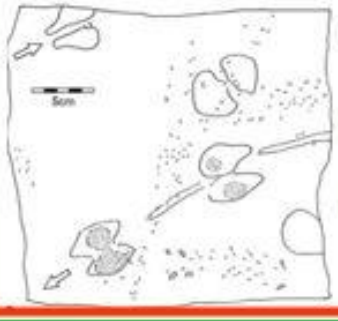
- They were discovered in Colorado
- They are from the Miocene Epoch- about 9 million years old
- They are the first of their kind to be found here in Colorado

What don't we know?

- We don't know exactly which animal these tracks belong to

How do scientists learn about fossil tracks and trackways?

- Many fossils in museums are ***Body Fossils***, like bones or teeth, that belonged to a particular animal.
- Tracks and trackways are ***Trace Fossils***. They show what an animal was doing, like walking or eating.
- If scientists find trace fossils without body fossils around, it is hard to know which animal made the tracks.



- To study a trackway, paleontologists (the scientists who study fossils) make a careful tracing of the fossil so that they can see all of the details.
- They measure the size and shape of the tracks to see if they match any animals whose body fossils have been found in the same area.
- They also look at what is around the tracks. Here, you can also see lots of tiny tracks that belong to insects. Paleontologists can look at animals that eat insects today to find clues to which animal this is and how it lived.

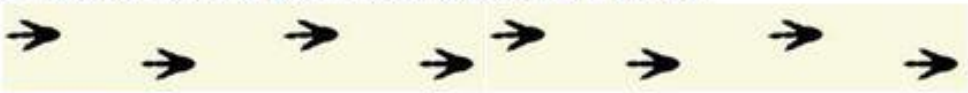
So what? Why do scientists study footprints?

Body fossils tell paleontologists what an animal's skeleton looked like, but ***trace fossils*** can help paleontologists learn about things like: the environment where the animal lived, how it moved its body (and how fast or slow), what it ate, and if it lived alone or in a group.

Activities for families

At the museum

- In the paleontology gallery, find the case of *trace fossils*. Investigate the amphibian trackway.
  - How large was the animal that made those tracks?
  - How many legs did it have?
  - What else do you notice?
- There is another footprint in the gallery, made by a hadrosaur.
  - You be the paleontologist! What can you learn from this track?



Try an experiment

1. Pick two points in the gallery
2. **Walk** normally between the two points, counting each footstep along the way.
3. Now **CAREFULLY run** between the same two points, counting your footsteps again.
   - Compare the numbers - when did you take more steps?
   - Which time were you pressing down harder with your feet?
   - Can you picture what your footprints looked like? Draw them here:

At home

- **Google the recent discovery of a huge dinosaur trackway in Arkansas!**
  - Paleontologists didn't think many large dinosaurs lived in the southern United States, but these tracks prove that they did.
  - They found tracks from *Acrocanthosaurus atokensis*, a large meat-eater. The paleontologists who found the bones of that dinosaur thought it might have had webbed feet, but finding the trackways proves that it actually did not!
- **To learn more and see more trackways, visit Dinosaur Ridge in Morrison, Colorado (www.dinoridge.org)**

You be the scientist

- You can look for tracks while you're out on a hike, in the park, or in your own backyard.
- Use a ruler to measure the tracks - how large is the animal?
- Use your ruler to measure between the tracks. Do you think it was walking or running?
- What's in the area around the tracks? Can you tell what the animal was doing?

Make some tracks

- Use some modeling clay or play-doh as a muddy surface, and place tracks from a toy animal on it to make your own trace fossils.
- Tell the story of what's happening in your trace fossil. Is it a group? Was the animal walking or running? How can you tell? Was it chasing another animal? Draw a picture of the scene or act it out yourself.

Appendix G: Protocol for Collaboration

STEP 1: Initial email – to be sent one week prior to the four-week project development period

Dear (Curator or Collection Manager),

It's time to create a new "Current Connections for Families" museum guide, and this month I would like to focus it on current research in (cognate).

I have attached the most recent "Current Connections" guide on the topic of (cognate) to give you an idea of what it looks like, and the level of detail necessary. For this guide, I collaborated with (curator or collection manger), who could also give you a good idea of the process.

The time commitment for this project is two 30-minute meetings and two-to-three email exchanges over the next four weeks. I have attached a flow chart that outlines the process, along with a calendar that I have filled in with potential dates and deadlines (see below). Of course, these may change after our first project meeting, but it should give you an outline of the expected commitment.

If you are interested and available to participate this month, please let me know within the next week. Additionally, please specify if you would like to decide on the specific topic presented in this month's guide, or if you would like me to bring ideas to the first project meeting.

Thank you for your time, and I look forward to working with you!

STEP 2: Initial content development – during the first week of the four-week period

Initial content development will be done by either the educator who is leading the project or the curator/collection manager, depending on response to the initial email.

Initial content development means deciding on a specific topic within the cognate, including what makes it important and relevant.

STEP 3: First project meeting – during the first week of the four-week period

At the first project meeting, the party responsible for initial development should present the topic and main ideas. The educator should bring a blank gallery guide template, and the two parties should begin to collaborate on bullet points for the topic headings.

The curator/collection manger should decide their desired level of involvement with further development of content and activities.

The two parties should consider the schedule included in the initial email, and set realistic dates for the following steps.

STEP 4: Development and revisions – week two and three of the four week-period

Educator is responsible for putting ideas discussed at first project meeting into the gallery guide template. Educator should attempt to fill in the front page and get one round of revisions back from curator/collection manager before beginning step five.

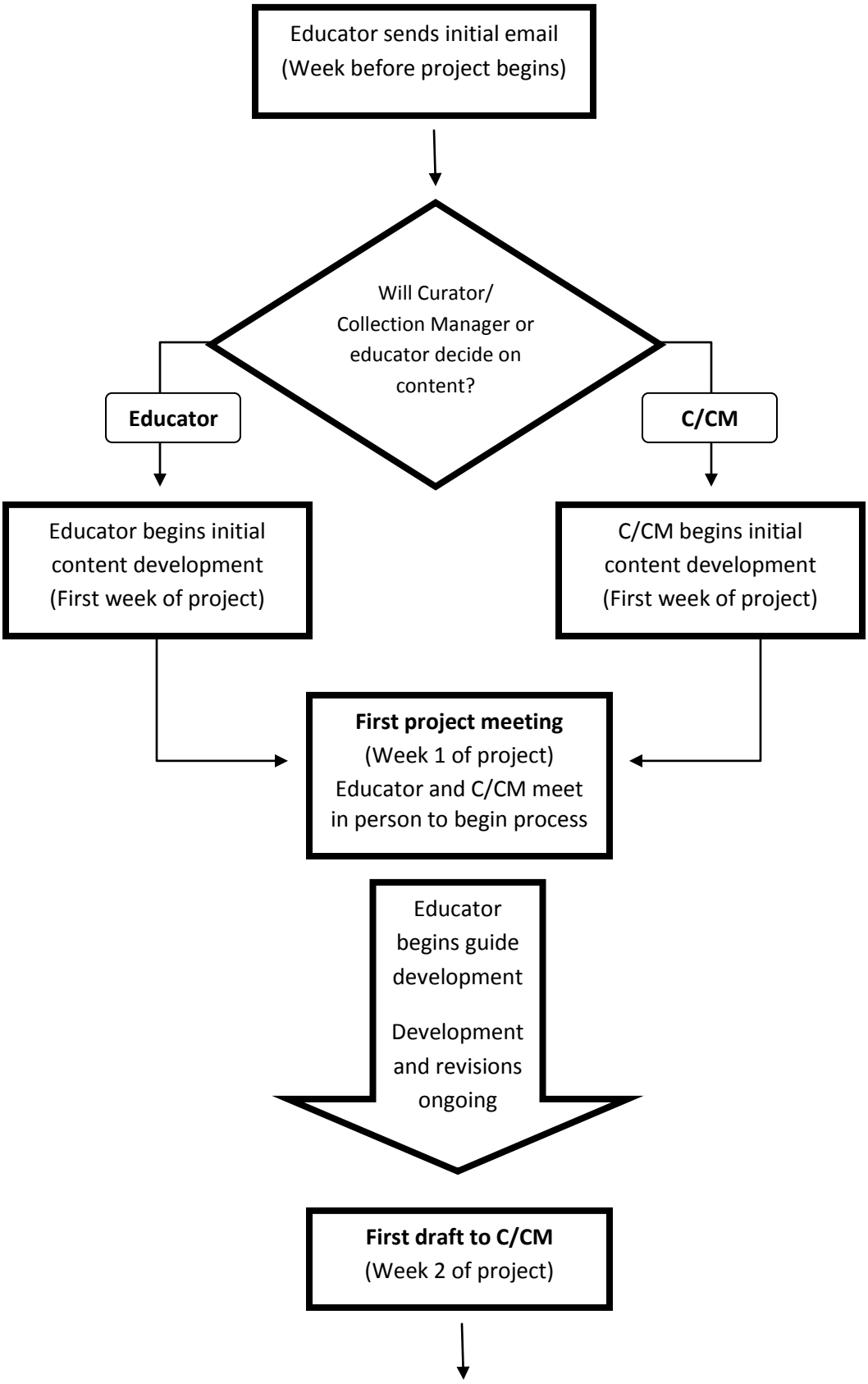
The number of rounds (development by educator and revisions by curator/collection manager) will depend on the comfort level of each party with the materials and the amount of input the curator/collection manager wishes to have in the development of content and activities.

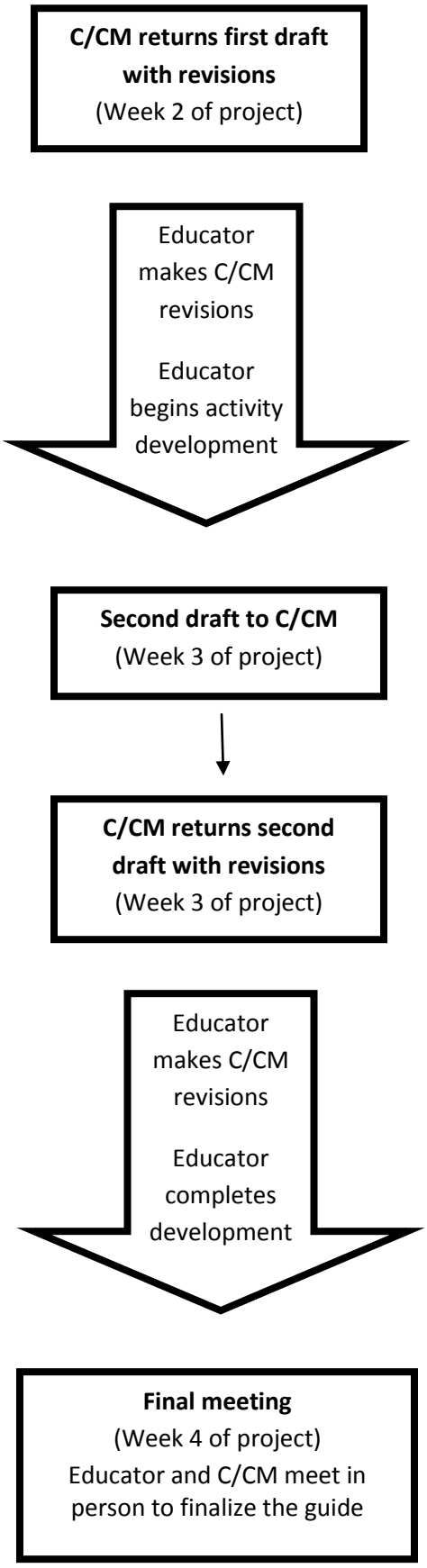
STEP 5: Activity development – week two and three of the four-week period

Develop the "Activities for Families" section of the guide, and continue the development and revision process throughout.

STEP 6: Accuracy checks and final revisions – week four of the four-week period

Both parties should be satisfied with the information and activities provided in the guide. In-person meeting if possible to discuss the finished project and overall satisfaction with the process of collaboration.


Educator sends initial email
(Week before project begins)
Will Curator/
Collection Manager or
educator decide on
content?
Educator
C/CM
Educator begins initial
content development
(First week of project)
C/CM begins initial
content development
(First week of project)
First project meeting
(Week 1 of project)
Educator and C/CM meet
in person to begin process
Educator
begins guide
development
Development
and revisions
ongoing
First draft to C/CM
(Week 2 of project)


C/CM returns first draft with revisions
(Week 2 of project)
Educator makes C/CM revisions
Educator begins activity development
Second draft to C/CM
(Week 3 of project)
C/CM returns second draft with revisions
(Week 3 of project)
Educator makes C/CM revisions
Educator completes development
Final meeting
(Week 4 of project)
Educator and C/CM meet in person to finalize the guide

MONTH						
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1. Send initial email in the week before starting the project.				1	2	
4	5 2. Initial content development	6	7	8 3. First project meeting. (in-person)	9	
11	12 4. Development and revisions (ongoing)	13	14 C/CM: Expect first draft	15	16	
18	19 C/CM: Return first corrected draft	20 5. Activity development (ongoing)	21	22 C/CM: Expect second draft	23	
25	26 C/CM: Return second corrected draft	27	28	29 6. Final meeting (in-person)	30	31