The Social and Contextual Mechanisms of Children's Learning in Museums

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THE SOCIAL AND CONTEXTUAL MECHANISMS OF
CHILDREN’S LEARNING IN MUSEUMS

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ABSTRACT

This study explored the associations between immersive exhibit design, mother-child engagement, conversational interactions, and children’s learning. Participants were 41 mothers and their 6-8-year-old children (Mage=7.15, SD=.79). A within-subjects, mixed methods approach was utilized, including naturalistic observations, interview data, and surveys. Mother-child dyads were video and audio-recorded as they visited four different exhibits: two low immersion exhibits and two high immersion exhibits. Interview data was collected from children immediately following the visit to assess learning. Survey data was collected from mothers to assess education, environmental predispositions, and science-related career. In high immersion exhibits, mothers and children spent more time and asked more open-ended questions than in low immersion exhibits. Children also reported that they learned the most in high immersion exhibits, mentioning high immersion exhibits more often than low immersion exhibits in post-visit interviews. Mothers and children spent more time naming and describing animals and habitats in low immersion exhibits when compared to high immersion exhibits; however, these conversational interactions were not related to children’s learning. Lastly, regardless of exhibit type, children’s explanatory responses and joint talk were related to children’s learning. Implications for museum professionals and future directions for this work are discussed.
CHAPTER ONE
INTRODUCTION

Museums serve as one of the most common platforms for informal learning. Nearly 850 million people visit museums each year (American Alliance of Museums). These institutions provide social learning opportunities that encourage and support science learning (NRC, 2009). This is particularly true for young children and families. A recent IMLS report, Growing Young Minds, recognized that museums “form an extensive, diverse infrastructure of informal learning that is equipped to deliver critical early learning resources to young children and families” (Institute of Museum and Library Services, 2013). Through diverse exhibits and programs, families can engage in meaningful learning experiences in museums.

Specifically, exhibits offer opportunities for families to interact with museum content, serving as an important contextual mechanism that supports learning. Exhibits provide contextual mechanisms for learning through elements of the physical setting (Falk & Dierking, 2013). Moreover, exhibits are designed around specific topics or themes, using objects, communication media, and text information to engage families in entertaining and accessible ways (Bitgood, 2011). By engaging with exhibits, families get the chance to see things they may never get to experience in their daily lives. For example, zoos and aquariums offer opportunities for families to connect with rare animals and ecosystems from around the world. These settings are of particular importance to urban visitors, as they provide the means to connect with content they might not otherwise have access to (Packer & Ballantyne, 2010). It is through these unique
exhibit experiences that families can begin to engage in meaningful learning. In fact, visitors see that zoos and aquariums offer numerous opportunities to learn, and that learning in these settings is fun (Packer & Ballantyne, 2002).

Conversational interactions between children and adults in museums provide social mechanisms for learning. Conversational interactions become one of the most valuable learning tools used in family interactions in museums. Vygotsky and sociocultural theorists (Berk, 2001; Gauvain, 2000; Vygotsky, 1978) emphasize the social context as an important mechanism for learning. Within museums, families use conversational interactions to support learning at exhibits by discussing and explaining content, asking questions, focusing attention, reflecting on past experiences, and creating personal meaning (Haden, 2010).

The current study investigates both the contextual and social mechanisms that support engagement, mother-child conversational interactions, and children’s learning. The study considers the dynamic interaction between the personal, physical, and social contexts in which learning in museums occurs (Falk & Dierking, 2013). The work of Falk and Dierking adds that museum learning not only occurs within a social context, as sociocultural theorists suggest, but also within the context of the physical museum space. Furthermore, this study is based on a view of learning as both a process and a product linked to and supported by mothers’ personal characteristics, exhibit design, and mother-child conversational interactions.
CHAPTER TWO

REVIEW OF THE LITERATURE

Learning in Immersive Exhibits

The museum environment, particularly exhibits, provide varying levels of structure and support through a range of design elements (e.g., signage and media). More specifically, the physical design of exhibits can affect visitors’ interactions and engagement (Bitgood, 2011; Falk & Dierking, 2013; Serrell, 1996, 1998). Immersive exhibits or “simulated immersion” as described by Bitgood (2011) is, “the degree to which an exhibit effectively involves, absorbs, engrosses, or creates for visitors the experience of a particular time and place” (p. 109). These types of exhibits range from dioramas in natural history museums to landscape immersion in zoos and aquariums and include a number of design features such as, authentic looking habitats and/or multisensory elements that make a visitor feel as if they are in a particular place. Studies of visitors suggest that these particular types of exhibits do, in fact, elicit a sense of immersion (Bitgood, 2011; Bitgood, 1990; Perry, Garibay, & Edington, 1995).

However, it is important to note that the range of exhibit features responsible for eliciting a sense of immersion have not been studied in great depth. Thus, the review to follow will focus on the ways in which immersive exhibits, in general, influence visitor engagement and learning, and will call out the role of specific immersive design features on visitor learning and engagement when available. Also, important to note because literature in this area is not limited
to family groups, the discussion of the literature will be framed in terms of how it broadly relates to museum visitors, in general, and when possible, family groups will be highlighted.

**Immersive Exhibit Design**

Bitgood (1990, 2011) suggests that there are a set of design features responsible for providing a sense of immersion. The first is the dimensionality of the physical space, the degree to which the exhibit environment surrounds the visitor. For example, a photograph may create a sense of immersion but does not surround the visitor in the same way as a diorama. The second feature is environmental feedback, including interactivity that allows visitors to elicit a response from the environment. For example, a visitor may press a button in the exhibit that then highlights a particular area within a diorama. A third feature supporting immersion is multisensory experiences such as sounds, smells, or textures. Fourth, object realism reflects authenticity in that it accurately represents a time and place. A fifth feature of immersion is mental imagery, or how well the exhibit encourages visitors to imagine themselves in the particular scene represented. The sixth and final feature supporting immersion is the meaning elicited by the exhibit, defined as the degree to which the subject matter comes to life and elicits understanding. Many of these exhibit features have been found to effect visitor behaviors and may influence learning (Bitgood, 2011; Borun, Chambers, & Cleghorn, 1996; Harvey, Loomis, Bell, & Marino, 1998). The sections to follow describe immersive exhibits in more detail and discuss the research examining relations between immersive exhibit design and visitor behavior.

**Immersion and visitor engagement.** Research suggests that immersive exhibits increase visitors’ level of engagement (e.g., stay-times). It is important to note that collectively, the visitor studies field does not have a common definition for engagement (Wood & Wolf, 2008). However, common measures of visitor engagement exist, including: attention, time spent, exhibit
interactions, and talk (Barriault, 2014; Bitgood, 2011; Sanford, 2010). The literature below will explore these various areas of engagement as they relate to immersive exhibits.

Immersive exhibits may foster visitor attention, and flow. Flow is described as being fully immersed in an experience where an individual’s attention is completely focused and the individual is almost lost in the experience (Csikszentmihalyi, 1988). For example, dioramas with a greater number of immersive design features including environmental feedback and multisensory experiences lead to greater attention and may be responsible for visitors’ experience of flow (Harvey et al., 1998). Similarly, in Peers (1991), visitor attention increased when immersive exhibits were coupled with additional interpretive elements, such as labels and digital media. For example, viewing times at dioramas with interpretive elements and interactives nearly doubled when compared to dioramas that merely had labels alone.

Dioramas are some of the most studied forms of immersion (see Gyllenhall, Garibay, Schaefer, & Des, 2013; Schwarzer & Sutton, 2009 for reviews). However, other forms of immersive experiences have been studied, including landscape immersion, which include naturalistic animal habitats found in zoos and aquariums (Bitgood, 2011). Landscape immersion, first coined by Coe (1985), is the re-creation of animals’ natural habitats so that visitors feel physically and psychological immersed in the habitat (Bitgood, 2011). Zoo and aquarium exhibits that provide a sense of immersion by mimicking the natural habitats of animals are more successful at engaging visitors (Bitgood, Patterson, & Benefield, 1988; Moss, Esson, & Francis, 2010; Shettel-Neuber, 1988), and are an important factor in visitors’ feeling a sense of immersion and connectedness to animals. For example, in Shettel-Neuber, visitors reported feeling a greater sense of closeness to animals in zoo exhibits that depicted an animal’s naturalistic environment.
Furthermore, immersive zoo exhibits that represent animals’ natural habitats are more likely to grab visitors’ attention (i.e., attracting power) and increase stay times (i.e. holding power) better than those zoo exhibits lacking these immersive design features (Bitgood et al., 1988; Moss et al., 2010). For example, in Bitgood et al. (1988) visitors were observed at two different zoo exhibits, one large habitat simulating the animals’ natural habitat and another smaller animal habitat with very few immersive features. The large immersive habitat was associated with increased attracting power and holding power when compared to the smaller habitat. Similarly, Ross, Melber, Gillespie, and Lukas (2012) found that when compared to a more traditional exhibit, zoo visitors were more attentive and spent more time at an exhibit designed to mimic the natural habitat of apes. The ability to capture visitor attention and hold their attention has been associated with learning (see Borun et al., 1996).

Landscape immersion, with the element of live animals, offers a different experience from other immersive experiences in museums (e.g., dioramas). Unlike dioramas with static animal scenes, landscape immersion as seen in zoos and aquariums have active animals that can influence visitor engagement. For example, Kirchgessner and Sewall (2015) found that animal visibility at an immersive zoo exhibit was highly related to how long visitors stayed. Related research shows that holding power was twice as long when animals were active (Bitgood et al., 1988; Luebke, Watters, Packer, Miller, & Powell, 2016). Additionally, larger species of animals also increased visitors viewing times. Furthermore, immersive exhibits depicting natural habitats may elicit more natural animal behaviors thus increasing visitors’ understanding of animals and foster positive environmental attitudes (see Ballantyne, Packer, Hughes, & Dierking, 2007). Similar findings related to holding power have also been found at dioramas (see Harvey et al., 1998). However, variability in engagement at these two types of immersive exhibits can be seen
in the ways in which children talk about animals. Tunnicliffe (1996) found that the content of children’s conversations about animals varied by exhibit type, with more affective talk seen at animal habitats at the zoo and more knowledge-based talk (e.g., questions or references to other knowledge sources like books or classroom lessons) at dioramas in the museum.

Immersive exhibits also encourage particular patterns of interactions (Ash, 2004; Reiss & Tunnicliffe, 2011; Scheersoi, 2009; Tunnicliffe, 2009; Tunnicliffe & Scheersoi, 2010). For example, when viewing dioramas, visitors often move through a behavioral sequence: identify, interest, interpret, and investigate (Reiss & Tunnicliffe, 2011; Tunnicliffe & Scheersoi, 2010). Visitors at dioramas locate (identify) and comment on a salient feature of a diorama (e.g., an animal) - suggesting interest. If visitors’ interest is peaked, they may interpret the scene using anthropomorphic terms as a means of making connections to what they already know (Scheersoi, 2009; Tunnicliffe, 2009). Further investigation occurs through raising questions and creating hypotheses. For example, dioramas present narratives where children can pose hypotheses about what is happening (e.g., “this is a desert. He is master [the giant antelope] is master of all the land” (Reiss & Tunnicliffe, 2011, p. 455).

Thus, visitor engagement at immersive exhibits is also seen in the ways visitors’ talk about their experience. Parents use conversations to introduce biological themes, develop biological principles, and ask questions (Ash, 2003, 2004). In Ash (2004), families visiting dioramas not only talked about biologically-based content (e.g., feeding, breeding, predators, etc.), but also used personification as a scientific reasoning tool, assigning family-role labels to animals displayed in the dioramas (e.g., the bigger animal is mom and the smaller animal is the baby). Engagement with immersive exhibits allows family groups to engage in scientific practices. Ash (2004) found that while families visited dioramas, parents asked questions to
organize and focus the group’s thinking, and helped children observe, interpret, and hypothesize -- all of which are important science process skills. I now turn to discuss visitor learning at immersive exhibits in more depth.

**Immersive exhibits and visitor learning.** Immersive design features have also been associated with visitor learning. Findings from Peart (1984) and Peart and Kool (1988) support the notion that distinctive design features of dioramas in museums (e.g., labels and sound) lead to increased knowledge gains when compared to immersive exhibits without these particular design elements. In a study by Peart (1984), the addition of sound to an exhibit lead to visitor reports of a greater sense of immersion, increased reports of learning, increased affective responses, and higher levels of visitor satisfaction.

More specifically, immersive exhibits offer increased opportunities for visitors to use science process skills. Prior research described patterns of interactions that lead visitors to engage with immersive exhibits, particularly dioramas, in scientific ways as they observe, identify, interpret, and investigate the scenes put before them (Reiss & Tunnicliffe, 2011). Naturalistic studies of visitors interacting with dioramas at a local natural history museum show that visitors spent time observing and identifying animals (Perry et al., 1995). Observing and identifying what is happening in scenes depicted in dioramas can lead to further science inquiry. Tunnicliffe (2009) observed children visiting dioramas as part of a school field trip. Children used observation to identify and label animals, and further interpreted the scenes by creating narratives about what was happening. For example, an 8-year-old girl was observed commenting on a diorama of two giraffes at a watering hole. The girl talked about how the giraffes were standing close to each other, which meant they were being kind to one another. When prompted about why she thought they were being kind, she went on to describe that they were kind to each
other because they had water and there were predators around. The creation of such a narrative shows the child has gone beyond basic observation and labeling, demonstrating her existing knowledge and understanding.

In some instances, visitors at dioramas use higher-level skills (e.g., explanation and interpretation) when they describe relationships, develop hypotheses about what is happening in the scene, and draw conclusions (Korenic, 1995; Tunnicliffe, 2009). However, these higher-level skills may require additional support. In Perry et al. (1995) parents indicated wanting to move their children beyond basic process skills like observing and labeling but did not know how. Support may be critical in moving beyond these basic process skills. Children in Tunnicliffe’s (2009) study of school groups were able to further their inquiry into the dioramas they were observing when a facilitator was present to ask questions.

Summary

The literature reviewed suggests that immersive exhibits are important contextual mechanisms for engagement, conversational interactions, and learning, as immersive design provides the ‘tools’ (i.e., immersive design features like habitat surrounds and interactives) from which visitors construct their experience. When these tools are limited it may be more difficult for visitors to engage in meaningful interactions thus, limiting the learning that can occur. Furthermore, immersive exhibits in and of themselves are important contextual mechanisms that support learning behaviors, but exhibits also serve to support social interactions, providing a content rich context for conversational interactions to occur.

Social Interactions in Museums: Mechanisms for Learning

The idea that social interactions in museums play a critical role in learning derives from sociocultural theory (e.g., Vygotsky, 1978). Briefly, sociocultural theory suggests that learning
cannot be taken out of the social and cultural context in which it occurs (Berk & Winsler, 1995; Bodrova & Leong, 2007; Vygotsky, 1978; Wells, 1999). Sociocultural theory provides the framework for talking about learning as a socially mediated process guided by observation, participation, and support. Moreover, sociocultural theory suggests scaffolding (Wood, Bruner, & Ross, 1976) as providing mechanisms by which parents (Haden, 2010) and the museum environment itself (Allen, 2007; Falk & Dierking, 2013) can provide structure and support for children's learning. Ash (2003) found that parents used questioning to help focus their children’s observations of animals depicted in a diorama, encouraging children to think more scientifically in their explanations of what was happening. For example, when viewing a mountain sheep diorama one child made an observation, stating, “that’s the dad.” The mother further prompted the child’s thinking by responding, “How do you know?” The child went on to describe the mountain sheep as having big horns and identified other animals in the diorama as other “family” members (i.e., the mom and the pups). By asking questions that invite further explanation, parents promote the co-construction of meaning by encouraging children to use science process skills (e.g., observation and interpretation) further supporting scientific learning. Moreover, sociocultural theory emphasizes children as active learners, and the importance of learning while participating in meaningful social activities (Gaskins & Paradise, 2010; Paradise & Rogoff, 2009).

Sociocultural theory has guided both research on parent-child conversational interactions in the developmental literature, and work on family learning interactions in museums. Literature over the past decade suggests that parents scaffold children’s learning - including science learning - through a number of conversational strategies (see Haden, 2010) and that exhibit design can increase potential for social interaction (Borun et al., 1996; Callanan & Jipson, 2001).
Taking a sociocultural approach provides a broad frame for understanding the role of the social process of learning in museums (Astor-Jack, Kiehl Whaley, Dierking, Perry, & Garibay, 2007; Falk & Dierking, 2013; Schuable, Leinhardt, & Martin, 1997).

**Parent-Child Conversations and Children’s Science Learning**

Sociocultural theory asserts that language is the primary tool used to facilitate learning through our shared experiences; these shared experiences exist, in part, because we use language to communicate with each other (Bodrova & Leong, 2007). To further emphasize the importance of this social mechanism for learning and development, literature will be explored concerning the role of parent-child conversations in children’s science learning in museums. It is important to note that little to no research has been published specifically on the effect of zoo and aquarium visits on environmental science learning and the development of environmental literacy, specifically (see Dierking, Burtneyk, Buchner, & Falk, 2002). The body of work to be discussed in the sections that follow has looked at the effect of museums, mainly science centers and children’s museums, on science learning.

**Parent-child conversational styles in museums.** A large body of literature suggests that parent-child conversations support children’s learning in museums (Haden, 2010; Leinhardt, Crowley, & Knutson, 2002; Leinhardt & Knutson, 2004). For example, Borun et al. (1996) found that behaviors associated with learning are conversational in nature and include, asking open-ended questions (e.g., Who, What, Where, Why, How), joint talk (e.g., parent question-child response patterns), explanations, and reading text aloud or silently. Leinhardt and Crowley (1998) characterized these learning conversations that occur in museums as rich with “conversational elaborations” (p. 8). Across different research studies in learning sciences and developmental psychology, conversational elaborations, or elaborative talk, have been defined in
terms of a range of techniques that encourage children's conversational participation in interactions with their parents. These techniques include asking questions, focusing attention, and making associations between the activity and what children already know (e.g., Boland, Haden & Ornstein, 2003; Haden et al., 2014). For example, while visiting the lion house at a zoo a mother and daughter observe a lion sleeping. Mom pointing to the lion asks, “What’s the lion doing there?” The child looks and responds, “It looks like she’s sleeping.” Mom replies, “Yeah, she’s sleeping just like our cat at home, huh? How long do you think lions sleep?” The child answers, “Probably a long time. Our cat sleeps all day and is always awake at night.” Here, the parent used a question to not only focus her child’s attention on the lion but also to engage her child more deeply in a conversation about how long lion’s sleep. By making associations between the lion and the family’s house cat, the parent was able to help her child think about how long lions might spend sleeping by offering a comparison to something the child already knows. This conversational interaction between parent and child illustrates the ways in which parents use elaborative talk to engage children in learning.

Museums are rich with opportunities for these kinds of parent-child conversational interactions. For example, parents with children 4-to-8-years-old engaged in an interactive building exhibit who asked more questions elicited children’s responses more often than parents not using this conversational style (Benjamin, Haden, & Wilkerson, 2010). Joint talk, defined as children’s responses to parents’ questions, is associated with greater understanding and recall of events (Boland et al., 2003; Hedrick, San Souci, Haden, & Ornstein, 2009a), including museum visits (Benjamin et al., 2010; Jant, Haden, Uttal, & Babcock, 2014). Further support for the influence of these conversational styles on joint talk is seen in a study of families with children 6-to-12-years-old visiting an exhibit about evolution (Tare, French, Frazier, Diamond, & Evans,
Parents’ use of elaborative conversational styles such as asking questions and making associations was positively related to children’s responses. Furthermore, parent-child conversational interactions were associated with children’s increased use of STEM related content (Benjamin et al., 2010) and evolutionary content (Tare et al., 2011) in their talk. These findings are consistent across related studies (see Jant et al., 2014), suggesting that parents’ use of elaborative conversational styles promote more joint talk.

It is through these kinds of conversational interactions where parents can promote children’s scientific thinking and understanding (Callanan & Jipson, 2001; Leinhardt & Knutson, 2004). In a study of family groups visiting museum dioramas, families with children four to eight years old used conversational interactions, specifically asking questions, to facilitate their children’s understanding and learning (Ash, 2004). Parents used questions to focus children’s observations of animals and to further engage children in conversational interactions, providing a mechanism by which parents could assess children’s current understanding (Ash, 2004). Parents could then provide appropriate supports for children’s learning through further explanation or connections to prior knowledge (Ash, 2004). Families who were observed asking questions had children who showed greater instances of biological understanding; this was evident in transcriptions of children’s talk. Parents’ questions prompted children to apply personification to describe relationships between animals observed in the dioramas. The use of personification is a starting point for children’s early scientific understanding (Ash, 2003, 2004).

More recently, experimental studies have explored the role of instruction in manipulating the museum exhibit experience for families. Specifically, researchers have found that when providing instruction in elaborative conversational styles prior to visiting an exhibit, parents ask more questions of their children than parents not receiving instruction (Benjamin et al., 2010;
Haden et al., 2014; Jant et al., 2014). For example, after a brief facilitated building activity prior to entering a children’s construction exhibit parents asked twice as many questions of their children while in the exhibit than parents not participating in the pre-activity (Haden et al., 2014). Moreover, related research shows that training in elaborative conversational styles transfers across similar exhibits and into the home (Jant et al., 2014). Parents who were prompted to use an elaborative conversational style engaged in more elaborative talk with their children (2- to 6-years-old) once in a children’s Pueblo exhibit (Jant et al., 2014). This elaborative talk also transferred across similar exhibit experiences. Parents asked more questions and both children and parents made more associations across the two exhibits. Furthermore, pre-exhibit activities extended beyond the visit. During at-home follow-ups, parents continued to use elaborative conversational strategies with their children. This experimental work further confirms the importance of elaborative conversational styles in children’s learning experiences.

The empirical literature on parent-child conversational interactions thus far has provided evidence supporting parents’ use of elaborative conversation as a mechanism for children’s learning in museums (Ash, 2004; Benjamin et al., 2010; Borun et al., 1996; Haden et al., 2014; Jant et al., 2014). This evidence supports the notion that parent-child conversational interactions serve as a valuable mechanism for children’s learning and understanding, more generally, and that conversations are an important social tool by which learning occurs in museums. The following section will focus more specifically on the ways in which parent-child conversational interactions in museums support children’s science learning, and how scientific talk, in particular, can promote scientific thinking and understanding.

Parents’ conversational explanations and their children’s science learning. Broadly, parent-child conversational interactions can reflect children’s current scientific understanding as
well as influence and transform children’s understanding of science (Haden, 2010). More specifically, and as evidenced in the above literature, elaborative conversational styles help focus attention, encourage further conversational interactions through asking questions and offering explanations, and facilitate greater instances of joint talk. It is through these same conversational techniques where parents and children can begin to engage in scientific processes, increasing scientific thinking and understanding. For example, Ash (2004) found that families visiting a diorama engaged in elaborative conversational interactions about biological themes (e.g., characteristics of living things) in order to make sense of what they were seeing.

Furthermore, parents’ explanations about scientific principles, causal connections, and connections to prior experience help children interpret scientific information (Callanan & Jipson, 2001; Crowley et al., 2001). For example, parents help children understand scientific information by offering explanations of scientific principles like gravity (Callanan & Jipson, 2001), motion (Crowley et al., 2001), and characteristics of living things (Ash, 2004). In a study of parents and children (4-to-8-years-old) engaged with an interactive zoetrope exhibit (i.e., an animation device featuring frames of a running horse), Crowley et al. (2001) found that parents used explanations to identify causal connections for what was happening when the zoetrope spins (e.g., Each one of those pictures is a little different pose on the horse, and it makes it look like it is galloping”). In this same study, parents also made connections to children’s prior experience by relating the zoetrope to children’s cartoons (e.g., “This is how cartoons work”). The content of parents’ explanations helps children understand scientific information while also modeling how to think scientifically.

These kinds of explanations further serve to scaffold children’s science learning by showing children how to think scientifically. For example, in a study of parent-child interactions
at an exhibit about change, Callanan and Jipson (2001) found that parents used explanations to focus their children’s thinking on specific content in exhibit videos, purposely discussing what was happening to particular objects as they changed in the time-lapse video. The use of explanations in this way, helps children focus on what is important and relevant to making sense of the event thus helping children develop their scientific thinking and science process skills. When engaging with the zoetrope exhibit with parents, children’s examination of evidence was longer, broader, and more focused on appropriate comparisons than those children engaged without their parents (Crowley et al., 2001). In this study, parents helped children generate and encode relevant evidence by offering explanations, making associations, and focusing attention. Parent’s explanatory talk, including describing scientific evidence, asking questions, and providing explanations influenced children’s use of explanatory conversation and scientific reasoning. Similarly, in Tare et al. (2011) parents’ use of explanatory conversation while visiting an exhibit on evolution encouraged children to ask more questions and describe scientific evidence, participating in more explanatory talk themselves.

Furthermore, parent-child conversational interactions can support children’s scientific understanding and learning. Consistent with the above findings, Fender and Crowley (2007) found that children 6-to-12-years old who heard explanations were more likely to describe the zoetrope as similar to other animation devices and describe its primary function as animation rather than spinning. This finding suggests that parent explanations not only promote children’s scientific thinking but can also help children make conceptual connections furthering their scientific understanding. Other related studies offer support for the notion that parent-child conversational interactions about STEM related content further facilitates scientific understanding. For example, in Haden et al. (2014), parents receiving both instructions on
elaborative talk and building instructions used significantly more STEM talk during an exhibit building activity than those parents not receiving this training. Additionally, young children referenced more types of STEM-related content in follow-up narratives about their experience. These findings suggest that with instruction, specifically instruction on asking questions and STEM specific concepts, parents can promote children’s understanding and learning about science in museums. These findings are consistent with earlier experimental studies, suggesting that children’s STEM-related talk increases when parents receive pre-exhibit instructions on scientific talk and elaborative conversational styles (see Benjamin et al., 2010).

The above literature suggests that parent-child conversational interactions that include parent explanations and asking questions, support children’s scientific thinking and understanding. Specifically, parent-child conversational interactions support children’s science process skills and scientific reasoning by encouraging children to observe and interpret what they see. Additionally, these interactions help children interpret scientific information and show children how to think scientifically by offering explanations and focusing children’s attention on relevant features of their experience. It is clear from the literature that parent-child conversational interactions can provide mechanisms for children’s science learning in museums.

**Parent-Child Conversational Interactions at Immersive Exhibits**

Parents support science learning at immersive exhibits such as dioramas by asking questions and reading labels (Ash, 2003). Specifically, parents support children’s learning at such exhibits by focusing on biological principles including, essence, personification, and analogy. For example, observations of families visiting dioramas found that parents talk about biologically-based content such as feeding, breeding, predators, and the qualities of living things (Ash, 2003). Similarly, Borun et al. (1996) found that families visiting an immersive aquarium
exhibit (i.e., a “living diorama”) engaged learning behaviors associated with science learning including: pointing, asking and answering questions, and commenting and explaining. When compared to other, non-immersive exhibits, families showed more learning behaviors (e.g., asking questions) at immersive exhibits than at an interactive science exhibit. These behaviors suggest that families use conversational interactions at immersive exhibits to engage in inquiry, which in turn may support children’s science learning.

In addition, exhibits can also serve to provide support for parents’ explanations. Tare et al. (2011) found that part of parent-child conversational interactions while visiting an exhibit on evolution consisted of reading exhibit text aloud and rephrasing the text to help children understand. However, few studies examine the ways in which specific exhibit features like labels support parent-child conversations; thus, little is known in the way of what exhibit elements (e.g., types of exhibits or exhibit elements) promote these kinds of conversational interactions, and how museums can create exhibit experiences to fully support parent-child conversational interactions and learning.

Immersive exhibits may encourage particular patterns of behavior that engage visitors in scientific inquiry (Reiss & Tunnicliffe, 2011; Tunnicliffe & Scheersoi, 2010). For example, visitors identify objects in dioramas, further exploring by asking questions and providing hypotheses about what’s happening in the habitat depiction (Ash, 2004; Tunnicliffe, 2009). Although there are few studies focusing explicitly on parent-child conversational interactions at immersive exhibits, and even fewer comparative studies, the research discussed suggests that immersive exhibits elicit parent-child conversational interactions, and these conversational interactions can support children’s scientific understanding by helping children observe, interpret, and hypothesize (Ash, 2003, 2004; Borun et al., 1996). However, future research
investigating parent-child conversational interactions at immersive exhibits is needed. Specifically, more research is needed to systematically understand the role of immersive exhibit design on parent-child conversational interactions and children’s learning. Research in this area will offer empirical data on how immersive exhibits, more broadly, and immersive design features, more specifically, influence parent-child conversational interactions and children’s learning.
CHAPTER THREE

CURRENT STUDY

The current study brings together work on engagement, mother-child conversational interactions, and children’s learning with the study of exhibits that vary on design features associated with immersiveness. A key focus is on how different types of immersive exhibits and maternal characteristics may link to children’s learning. The central question addressed is: How does type of exhibit affect mother-child conversational interactions and children’s learning in museums? Furthermore, the current study explores the association between mother-child conversational interactions, specifically the style and content of these conversations, and children’s learning.

The current study examines the role of both social and contextual mechanisms on children’s learning in a museum. This work uses a mixed-methods approach to investigate the complexities of learning in museums by considering the dynamic interaction between the personal, physical, and social contexts in which learning in museums occurs (Falk & Dierking, 2013). Specifically focusing on the social and contextual mechanisms of learning, mother-child dyads were audio and video recorded as they visited four exhibits, two exhibits were considered high immersion exhibits and two were considered low immersion exhibits. These four exhibits make up a continuum of immersion, which include a variety of immersive design features that lend themselves to feeling a greater sense of immersion (i.e., feeling of time and place). The exhibits explored include, more traditional exhibit galleries and more immersive contextual
place-based exhibits. The traditional exhibit galleries in the current study lack many of the immersive design features discussed by Bitgood (2011). Specifically, low immersion exhibits in the current study lack dimensionality, multisensory experiences, and object realism. While these exhibits include design features like interactivity, they do not include these features to the same degree as contextual place-based exhibits (i.e., high immersion exhibits). High immersion exhibits in the current study include authentic animal habitats that surround visitors (i.e., dimensionality and realism) and multisensory experiences like humidity that create the mental imagery necessary to create immersion and meaningfulness.

Following their visit to the exhibits, children were interviewed, and mothers were asked to complete a survey. Furthermore, and to highlight the personal context of museum learning, the relationship between maternal characteristics, mother-child conversational interactions, engagement, and children’s learning was also examined. To this point, research has not investigated the personal, social, and physical mechanisms influencing mother-child conversational interactions, engagement, and learning in immersive museum exhibits. Research in this area makes a unique contribution to the research literature by considering how personal characteristics (e.g., parental environmental predispositions) and immersive exhibit design influence mother-child conversational interactions, engagement and children’s learning.

**Research Questions and Hypotheses**

**Research Question 1: Type of Exhibit.** How does type of exhibit influence time spent, mother-child conversational interactions, and children’s learning?

**Hypothesis 1.** It was hypothesized that exhibits with added immersive design features (i.e., high immersion exhibits) would prompt more time spent and more mother-child conversational interactions. More specifically, high immersion exhibits would elicit more
elaborative conversational styles (i.e., more open-ended questions and explanatory responses) than low immersion exhibits. Similarly, mothers and children would make more associations and talk more about the exhibit content in high immersion exhibits when compared to low immersion exhibits. In turn, children would report more learning from high immersion exhibits than from low immersion exhibits.

**Research Question 2: Children’s Learning.** How do mother-child conversational interactions influence children’s learning?

**Hypothesis 2:** It was hypothesized that mother-child dyads that demonstrate more of an elaborative conversational style (i.e., more joint talk including more open-ended questions, more elaborative responses, and more associations) and talk more about exhibit content would have children who report more learning.

**Research Question 3: Maternal Characteristics.** How do variations in maternal characteristics influence mother-child conversational interactions and children’s learning?

**Hypothesis 3:** It was hypothesized that mothers who reported having science-related careers, higher levels of education, and higher environmental predispositions would spend more time and demonstrate more mother-child conversational interactions across their entire visit. In turn, their children would demonstrate more learning.

**Hypothesis 4. Mediation Model.** As shown in Figure 1, it is hypothesized that mother-child conversational interactions mediate the relations between the independent variables – maternal characteristics - and the dependent variables - engagement and children’s learning. Baron and Kenny (1986) define a mediating variable as one that “accounts for the relation between the predictor and the criterion... mediators speak to how and why such effects occur” (p. 1176). More specifically, the independent variables of maternal characteristics will influence the
mediator variables associated with mother-child conversational interactions, and in turn will influence the dependent variables of engagement and children’s learning.

![Mediation Model Diagram]

**Method**

The study involved a within-subjects, mixed methods approach, including naturalistic observations, surveys, and interview data. Naturalistic observations included video and audio-recorded observations of mothers and children at each of the four exhibits. Survey data was collected from parents to assess education, environmental predispositions, and career. Interview data was collected from children immediately following the visit to further assess learning.

**Participants**

Participants were 41 mothers and their 6-8-year-old children ($M_{age}=7.55$, $SD=.88$). Forty-six percent ($n=19$) of children were male, and 54% ($n=22$) were female. They were recruited using an online screener (see Appendix A). Recruitment took place on Shedd Aquarium’s website and on-site in the entrance line. The following information was collected on the recruitment screener: parent age and gender, child age and gender, Shedd visit history, and contact information including, name, phone number, e-mail address, and best times to follow up.
The criterion for participation was as follows: (1) one male or one female child between 6 and 8-
years-old, and (2) female parent must accompany the child. Families deciding to visit as a larger
group were asked to split up from the participating dyad during the duration of the study.
Participating groups were offered free admission to Shedd Aquarium and a family pass for a
return visit.

The descriptive data in the section that follows are included to provide an overview of the
study sample. These demographics were asked of mothers in the post-observation survey and
included: race/ethnicity, education, environmental predispositions, and career. The sample
consisted of 75% Caucasian, 10% African American, 10% Hispanic, 2.5% Asian, and 2.5%
reported other. Majority of mothers were highly educated, 8% of mothers reported having a
doctoral or other professional degree, and 19% reported having a Master’s degree, 49% reported
being college graduates, 19% reported being high school graduates, and 5% reported having
some high school. Seven items were asked to assess mothers’ environmental predispositions
(Luebke, 2012). Mothers were also asked to provide their occupation. This was coded into
science-related and not science-related career with 37% of mothers reporting a science-related
career.

Exhibits

Four exhibits were utilized to represent the two types of exhibits, traditional exhibit
galleries and immersive contextual place-based exhibits: (1) Rivers has small diorama-style
animal habitats, limited interpretation in the form of traditional rail signage and small animal
identification labels, (2) Great Lakes is similar to the traditional exhibit gallery of Rivers but has
added interactive elements including an animal touch experience, a digital animal identification
system, digital interactives, and video, (3) Amazon has hands-on props, a digital animal
identification system, digital interactions, and video, where visitors are situated next to animal environments surrounded by set like exhibit design elements; and, (4) Wild Reef has large-scale surround animal habitats, a digital animal identification system, digital interactives, and video, where visitors are situated in such a way that feels as if they are part of the animal environment. Mother-child dyads were observed across all four exhibits.

The four exhibits were chosen based on their immersion scores, which were first evaluated with a separate sample of Shedd Aquarium visitors using Bitgood’s (2011) bipolar immersion scale. Essential to the sense of immersion is the feeling of time and place. Using a 10-point-scale, Shedd visitors were asked at each of the four exhibits to rate the extent to which the exhibit makes you feel that you are in the time and place described. Each of the four exhibits varied in their immersion scores, categorizing them along a continuum of immersion. Wild Reef, categorized as the ‘most’ immersive exhibit, followed by the Amazon Rising, and Great Lakes, with Rivers categorized as having the fewest immersive elements.

Procedure

Observations in exhibits. Mothers and children wore Sennheiser wireless lapel microphones and were instructed to visit each of the four exhibits: Rivers, Amazon Rising, At Home on the Great Lakes, and Wild Reef: Schooling Fish. To ensure visit order was not a factor, exhibit order was counterbalanced using an incomplete counterbalanced measure design. Each dyad was given a map indicating the order they should visit the four exhibits. Dyads were instructed to visit each exhibit as they normally would and to alert the data collector once they were done visiting the last exhibit. Dyads were video and audio recorded as they moved through each of the four exhibits to capture both what they do and what they talk about across the four exhibits. At the end of the video and audio recorded observation, dyads were escorted by the
researcher to a designated meeting space away from the exhibits for the interview and post-survey collection.

A measure of time spent was utilized to assess engagement in its simplest form (Bitgood, 2011; Sanford, 2010). Time spent was calculated as dyads entered and exited each of the four exhibits.

**Parent post observation survey.** After the observation, mothers were asked to complete a post-observation survey that included questions about environmental predispositions, family leisure time, the exhibit experience, and basic demographic information. As shown in Appendix B, the survey included several rating questions that address the mother’s experiences and the perceptions of their child’s visit. For example, the survey contains questions related to educational experience, entertainment experience, connection to animals and nature, environmental science learning, and exhibit specific questions. Additionally, questions were used to obtain basic demographic information including, age, ethnicity, education, and household income. The 8-item environmental predisposition questions are taken from an instrument validated by the Brookfield Zoo (Luebke, 2012). These items are rated on a 7-point-scale and are used to assess prior level of engagement with animals, the environment, and conservation action. Questions related to leisure time are a mix of multiple answer questions and 10-point-scale rating questions and are related to visitation history to cultural attractions and other informal learning settings (e.g., parks), characteristics of leisure time activities that are appealing, and preferred types of attractions. Demographic items are rated on a 10-point-scale and are related to age, ethnicity, education, and household income. Additionally, exhibit experience questions were asked for each of the four exhibits. These included 7-items related to previous knowledge, education experience, entertainment experience, authenticity of experience, and exhibit features.
This survey was administered via SurveyMonkey on an iPad after mother-child dyads were observed in the four exhibits.

**Child Post Observation Interview**

As mothers completed the survey, a post-observation interview was conducted with each child (see Appendix C). The post interview was used to assess children’s memory reports for their exhibit experiences and learning. Children were asked to talk about their experiences in the four different exhibits. More specifically, children were asked to recall what they remembered about each of the four exhibits; and, what they learned across the four exhibits. Specifically, three questions were examined: (1) Did you find any interesting information in these exhibits about taking care of the environment (or nature)? (2) How were these exhibits different from each other? (3) Which exhibit did you learn the most in?

Using photographs of each exhibit, children were first asked to describe each exhibit and discuss what they saw and learned. More specifically, children were asked to select animals seen in each of the exhibits from six animal picture cards. Each exhibit had six animal pictures cards, four pictures that represented animals found in those exhibits and two animals that are not found in those exhibits. Once animals were chosen, children were asked to talk about each animal they selected. Specifically, children were asked to talk about what was interesting about each animal, the name of each animal, what, if anything, they knew about each animal prior to visiting, and what helped them learn about the animals.

To more specifically understand children’s environmental learning throughout their visit, children were asked to talk about what they learned about the environment and nature across the four exhibits. To identify where environmental learning took place, children were also asked to talk about where they were when they learned this and what helped them learn. Lastly, to
understand if children perceived the exhibits as different, they were asked to talk about how the exhibits were different from one another and which exhibit they learned the most in. The child post-observation interview was audio recorded.

**Coding**

Qualitative data from observations and the child interview were coded following guidelines suggested by Haden and Hoffman (2013). Inter-rater reliability was established using Intraclass correlations (Koo & Li, 2016). Two researchers independently coded 20% of the video and audio data. Intraclass correlations (ICC) estimates and their 95% confident intervals were calculated using SPSS statistical package version 22, absolute-agreement, 2-way mixed-effects model. Once reliability was established, no single reliability estimate was below .70. One reliable coder then coded the remaining data with intermittent checks by a second reliable coder.

**Mother-Child Conversational Interactions**

Audio data collected during observations in the exhibits was used to assess mother-child conversational style and content. As the literature reviewed suggests, mother-child conversational interactions, particularly joint talk, is associated with children’s learning and event memory (Haden, 2010). Furthermore, the content of mothers’ explanations helps children understand scientific information while also modeling how to think scientifically (Callanan & Jipson, 2001; Crowley et al., 2001). Data from mother-child dyads was coded separately to establish separate frequencies for both mother and child.

**Conversational style.** Coding for conversational style drew from previous research on parent-child conversational interactions (see Haden, 2010) and included the following:

1. **Open-ended questions:** The number of open-ended questions asked by both the mother and child. Open-ended questions are *Wh*- type questions including, who, what, where,
why, when, and how (e.g., Mother asks, why do you think there is more food in the belly of the fish during high water season?)

2. **Explanatory responses**: The number of responses to open-ended questions by both the mother and child. These included elaborative responses beyond a simple yes or no (e.g., Mother says, now these guys are from the dinosaur age. They’ve lived throughout time. Why do you think? How have they been survivors? Child responds, because it looks like they’re camouflaging, and they never get eaten and probably they can go underwater I think).

3. **Joint Talk**: The proportion of open-ended questions responded to by mothers and/or children. The total number of explanatory responses was divided by the total number of open-ended questions (e.g., Mother says, now these guys are from the dinosaur age. They’ve lived throughout time. Why do you think? How have they been survivors? Child responds, because it looks like they’re camouflaging, and they never get eaten and probably they can go underwater I think).

4. **Associations**: The proportion of time intervals mothers and children spent making associations. For each one minute interval, associations were marked as present or absent. The proportion was calculated as the number of intervals in which the content code was present divided by the total number of intervals. This was done separately for each of the four exhibits so that analyses could compare the proportion of time intervals different content codes occurred in each exhibit. Associations included, questions or statements where mothers and/or children made connections between what they were doing in the exhibit and what they already knew or had previously experienced (e.g., Mother asks, what’s the name of him? Child responds, Paddle fish. I knew it was the paddle fish… we saw the paddle fish bones at the [field] museum).
Intraclass correlations were ICC = .94, .80, and .95 for mothers’ open-ended questions, explanatory responses, and associations, respectively; and, ICC= .82, .88, and .96 for children’s open-ended questions, explanatory responses, and associations, respectively. Joint talk was calculated from open-ended questions and explanatory responses thus no reliability was needed.

**Conversational content.** Mother-child conversational interactions were further coded to assess basic content, including: naming animals and describing animals and habitats. For each one minute interval, each content code was marked as present or absent. Multiple content codes could be present within each one minute interval. For example, naming could be counted once per time interval, but the same time interval might also include describing. The proportions of each content code were calculated as the number of intervals in which the content code was present divided by the total number of intervals.

1. **Naming:** The percent of time intervals mothers and children named animals (e.g., Mother says, these are all lung fishes).

2. **Describing:** The percent of time intervals mothers and children described animals or habitats. The could include describing what the animal looks like, what it eats, what it’s doing in the habitat, features of the habitat itself, etc. (e.g., Mother says, a coral reef is actually an animal. I thought it was a plant; it has all the same stuff like a fish).

  Intraclass correlations were ICC = .73 and .80 for mothers’ naming and describing, respectively; and ICC= .81 and .79 for children’s naming and describing, respectively

**Children’s Learning**

Children’s narrative responses from the child post-observation interview were coded from the audio recording. Photos of each exhibit were available for children to reference during the interview. Specifically, the following questions from the child interview were the focus of
coding: Did you find any interesting information in these exhibits about taking care of the environment (or nature)? Tell me about what you found. How were these exhibits different from each other? What did you see or do in these exhibits that made them different? Which exhibit did you learn the most in? Why do you think you can learned the most there? These items offered an assessment of which exhibits resonated most with children after their visit.

**Exhibit learning.** The number of times children mentioned an exhibit was coded into the following categories:

1. **Name exhibit:** Number of times child named each exhibit.

2. **Describe exhibit:** Number of descriptive statements a child made about each exhibit (e.g., “Amazon because they had these things where you could look up what fish it was, how much it weighed, and stuff.”).

3. **Reference exhibit:** Number of times a child referenced each exhibit. This could include pointing to the exhibit picture or describing an exhibit feature in an effort to name the exhibit he or she was talking about but not saying the exhibit name (e.g., “This exhibit had a huge fish that was really old. I think he was brought to the Shedd in 1933.”).

Intraclass correlations were ICC = .80, .82, and .86 for children’s naming, describing, and referencing, respectively.
CHAPTER FOUR

RESULTS

First, preliminary analyses as well as an overview of the analyses are discussed. This is followed by the full results from the current study. Results are organized by the four hypotheses, including: type of exhibit, exhibit talk and children’s learning, maternal characteristics, and mediation model. Each section includes the hypothesis, statistical analyses, and corresponding results.

Preliminary Analyses and Approach

Hypothesis one was that high immersion exhibits would prompt longer stay times, more mother-child conversational interactions, and in turn, children would report more learning from high immersion exhibits. This hypothesis was tested using a repeated measures analyses of variance (ANOVA) followed by pairwise tests with a Bonferroni adjustment for multiple comparisons (all \( p < .05 \)). Preliminary analyses were conducted to examine this hypothesis across the four separate exhibits. Results of these analyses (see Appendix D) suggested that there were few differences between the two lowest immersion exhibits: Rivers and Great Lakes. Likewise, there were few differences between Amazon and Wild Reef, the two highest immersion exhibits. Therefore, there was empirical, as well as conceptual justification to combine the two low immersion exhibits (Rivers and Great Lakes) and the two high immersion exhibits (Amazon and Wild Reef).
For the main analyses, reported measures from the two low immersion exhibits (Rivers and Great Lakes) were summed and measures from the two high immersion exhibits (Amazon and Wild Reef) were summed together. The advantages of creating a two factor within-subjects variable for immersion included increased statistical power, reduced error in measurement of constructs, and increased generalizability of the measurements as well.

Hypothesis testing began with an examination of differences in time spent, mother-child conversational interactions, and children’s learning by type of exhibit. Hypothesis one about the differences in stay times, mother-child conversational interactions, and children's reports of learning across exhibit types was examined using a Paired-Samples T Test (all ps <.05). To test this hypothesis, total time spent by mother-child dyads and mother-child conversational interactions in high and low immersion exhibits were examined. Lastly, for hypothesis one, the frequency at which children talked about high and low immersion exhibits in their post-observation interview was also examined.

These analyses were followed by an examination of the relations between mother-child conversational interactions and children’s learning. Specifically, hypothesis two was that mother-child dyads that demonstrate elaborative conversations (i.e., more joint talk including more open-ended questions, more explanatory responses, and more associations) and talk more about exhibit content would have children who report more learning. This hypothesis was tested using a series of Pearson Correlations to measure the relations between mother-child conversational style (i.e., open-ended questions, explanatory responses, associations, and joint talk) and content (i.e., naming and describing animals and habitats), and children’s reported learning (all ps <.05).

Then, the results turn to hypothesis three, which examine differences in mother-child conversational interactions and children’s learning by mothers’ characteristics including
education, environmental predispositions, and science-related career. Specifically, hypothesis three was that mothers who reported having science-related careers, higher levels of education, and higher environmental predispositions would spend more time in exhibits and demonstrate more mother-child conversational interactions across their entire visit. In turn, their children would demonstrate more learning.

Lastly, hypothesis four proposed a mediation model. It was hypothesized that mother-child conversational interactions would mediate the relations between maternal characteristics and time spent and children’s learning. These results are discussed below.

**Hypothesis One: Type of Exhibit**

**Time spent.** High immersion exhibits were expected to prompt longer stay times than low immersion exhibits. To test this hypothesis, amount of time mother-child dyads spent in high immersion exhibits and low immersion exhibits was examined. There was a statistically significant difference, dyads stayed longer in high immersion exhibits ($M= 26.31$ minutes, $SD=7.33$) than low immersion exhibits ($M=21.75$ minutes, $SD=8.05$), $t(40)=3.14$, $p<.01$. Consistent with the hypothesis, mother-child dyads spent on average about five more minutes in high immersion exhibits than in low immersion exhibits.

**Mother-child conversational interactions.** The style and content of mother-child conversational interactions was expected to vary by exhibit type, favoring high immersion exhibits compared to low immersion exhibits. Results for conversational style are followed by those for content.

**Mother-child conversational style.** Mother-child conversational style was measured in terms of the frequency of open-ended questions and explanatory responses for both mother and child. Joint talk, characterizing the open-ended question-response patterns of the dyads, was also
considered as an index of conversational style. Joint talk was examined as the proportion of responses to open-ended questions. The proportions were calculated as the number of explanatory responses divided by the total number of open-ended questions. Table 1 provides the means, standard deviations, and statistical outcomes for each conversational style measure.

Table 1. Mother-Child Conversational Interactions by Exhibit Type

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<td>3.27</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Joint Talk</strong></td>
<td>.41</td>
<td>.28</td>
<td>.44</td>
<td>.34</td>
<td>.62</td>
<td>.54</td>
</tr>
</tbody>
</table>

Open-ended questions and explanatory responses. Children asked statistically more open-ended questions in high immersion exhibits ($M=4.85$, $SD=4.39$) than low immersion exhibits ($M=3.41$, $SD=3.78$), $t(40)=2.22$, $p<.05$. However, there was no statistical difference
between the number of open-ended questions mothers asked in high immersion exhibits 
(M=4.56, SD=4.20) compared to low immersion exhibits (M=4.22, SD=4.55), t(40)=.794, p=.43

Explanatory responses were noted when a mother or child responded to an open-ended question, offering more than a yes or no response. Mothers’ and children's explanatory responses did not differ in frequency in high versus low immersion exhibits, ts < .82, ps > .42. There was no statistical difference in mothers’ explanatory responses between high (M=2.20, SD=2.33) and low immersion exhibits (M=1.90, SD=2.18), t(40)=.821, p=.42; or, children’s explanatory responses in high (M=1.56, SD=1.61), and low immersion exhibits (M=1.39, SD=2.07), t(40)=.598, p=.55.

**Joint talk.** Recall above that joint talk was examined as the proportion of open-ended questions receiving a response (children responding to mothers open-ended questions or vice versa) in high immersion exhibits and low immersion exhibits. Specifically, joint talk was examined as the total number of responses divided by the total number of open-ended questions. There was no statistical difference for mother-child joint talk in high immersion exhibits (M=.41, SD=.28) compared to low immersion exhibits (M=.44, SD=.34), t(39)=.62, p=.54.

In sum, consistent with the hypothesis, children asked more open-ended questions in high immersion exhibits than in low immersion exhibits. However, there were no other differences in conversational style found as a function of whether the mother and child were talking while in a high versus low immersion exhibits.

**Content of mother-child talk.** Mother-child conversational interactions were further coded to assess basic content, including: associations, naming and describing animals and habitats. For each one minute interval, each content code was marked as present or absent. Multiple content codes could be present within each one minute interval. For example, naming
could be counted once per time interval, but the same time interval might also include describing. The proportions of each content code were calculated as the number of intervals in which the content code was present divided by the total number of intervals for high immersion exhibits ($M=14.05$, $SD=3.29$) and low immersion exhibits ($M=11.46$, $SD=3.77$).

**Associations.** Associations connected information and experiences in the exhibit to prior knowledge or experiences, and/or Shedd exhibits. Initial descriptive statistics showed that mothers and children spent less than 10% of their time making associations, on average, across high immersion exhibits and low immersion exhibits. However, there was a statistically significant difference in the average amount of time mothers and children spent making associations by type of exhibit. Mothers made associations in proportionally more time intervals while in low immersion exhibits ($M=.09$, $SD=.06$) than in high immersion exhibits ($M=.05$, $SD=.05$); $t(39)=4.70$, $p<.01$. Similarly, children made associations in proportionally more time intervals while in low immersion exhibits ($M=.04$, $SD=.04$) than in high immersion exhibits ($M=.02$, $SD=.02$), $t(39)=3.27$, $p<.01$.

**Naming and describing.** The content of mother-child conversations was further examined to assess whether there were differences between the two types of exhibits in the proportion of time intervals spent naming and describing animals and habitats. Mothers spent proportionally more time naming animals in low immersion exhibits ($M=.60$, $SD=.24$) than in high immersion exhibits ($M=.49$, $SD=.15$); $t(38)=2.80$, $p<.01$. Children's naming of animals did not differ between high ($M=.38$, $SD=.18$) and low ($M=.35$, $SD=.20$) immersion exhibits; $t(39)=.79$, $p=.43$.

Whereas there was no difference in the proportion of time intervals in which mothers described animals and habitats between high ($M=.60$, $SD=.19$) and low ($M=.64$, $SD=.23$) immersion exhibits; $t(39)=1.19$, $p=.24$, there was a trend towards significance in the proportion
of time children spent describing. For children, a greater proportion of time intervals included describing in low immersion exhibits ($M=.47, SD=.23$) than in high immersion exhibits ($M=.41, SD=.21$); $t(39)=2.02, p=.05$.

In sum, the results for content were contrary to the hypothesized differences between exhibit types. Associations, naming and describing animals and habitats by mothers and children occurred in more time intervals in low immersion exhibits compared to high immersion exhibits.

**Children’s exhibit learning.** Lastly, hypothesis one examined children’s reported learning immediately after their visit. It was hypothesized that children would report learning more from high immersion exhibits compared to low immersion exhibits. First, children were asked to name the exhibit where they learned the most. Thirty-two children provided a response to this question. Nearly 69% of children responding ($n = 22$) mentioned high immersion exhibits as exhibits where they learned the most compared to 31% ($n = 10$) of children naming low immersion exhibits as where they learned the most.

Children’s narrative responses from the three questions were also examined. Responses were coded into the following categories: naming exhibit ($M=1.26, SD=1.73$), describing exhibit ($M=6.29, SD=4.61$), and referencing exhibit ($M=3.69, SD=2.39$). The frequencies for each code were relatively low; therefore, the three learning codes were summed to form one dependent learning variable – frequency of responses to interview questions about exhibit learning. Whether children mentioned high or low immersion exhibits in their response was also coded. Across the three questions throughout the interview, children named or referred to high immersion exhibits ($M=5.90, SD=3.97$) more often than low immersion exhibits ($M=4.61, SD=4.22$); $t(41)=2.03, p<.05$. This is consistent with the hypothesis that children would report more learning from high immersion exhibits.
Hypothesis Two: Linking Exhibit Talk and Children’s Learning

It was hypothesized that the style and content of mother-child talk would be related to learning. This hypothesis was tested using a series of Pearson correlations. These results are summarized in Table 2. As shown in Table 2, there was a positive association between children’s explanatory responses and their learning, \( r = .42, p < .01 \), and between joint talk and children’s learning, \( r = .39, p < .05 \).

Table 2. Correlations between Mother-Child Conversational Interactions and Children’s Learning

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>( p )</td>
<td></td>
</tr>
<tr>
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<td>.75</td>
<td></td>
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<tr>
<td>Explanatory response</td>
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<td>.94</td>
<td></td>
</tr>
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<td>Naming</td>
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<td>.02</td>
<td></td>
</tr>
<tr>
<td>Describing</td>
<td>.05</td>
<td>.78</td>
<td></td>
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<tr>
<td>Association</td>
<td>.01</td>
<td>.94</td>
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<table>
<thead>
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<th>Children</th>
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</tr>
</thead>
<tbody>
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<td>.82</td>
<td></td>
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<tr>
<td>Explanatory response</td>
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<td>.01</td>
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<td>Naming</td>
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<td>.20</td>
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</tr>
<tr>
<td>Association</td>
<td>.12</td>
<td>.45</td>
<td></td>
</tr>
</tbody>
</table>

Joint Talk           | .39          | .01     |         |

There was a negative association between mothers’ naming and children’s learning, such that the more intervals of mothers' naming the less information provided by the children in
response to the learning questions, $r = -.36, p < .05$. It is clear from Table 2, that the measures of conversational content were generally not related to the measure of learning.

**Summary.** Overall, children's reported learning suggests that they may have learned more in high immersion exhibits. However, the measures of style and content of mother-child conversations were generally not associated with the measures of children's learning. There is some evidence suggesting that elaborative conversational styles, particularly children’s explanatory responses and joint talk, are related to children’s reported exhibit learning. Specifically, mother-child dyads that exhibited a greater proportion of joint talk and children who offered more explanatory responses mentioned exhibits more often in the post-visit interview.

**Hypothesis Three: Parental Characteristics**

Mothers’ demographic factors were examined to assess differences between the select demographics and engagement, mother-child conversational interactions, and children's learning. It was hypothesized that mothers who reported higher levels of education and higher environmental predispositions would spend more time in exhibits, demonstrate a more elaborative conversational style, and would spend a greater proportion of time talking about exhibit content. In turn, their children would demonstrate more learning in the post-observation interview. To test this hypothesis, mothers were grouped by educational attainment as non-college graduate, college graduate, and graduate school or higher. Mothers’ were grouped into high versus low environmental predispositions based on a mean split, where high predispositions were ratings at or above 4.5 and low predispositions were ratings below 4.5. A third classification of mothers was based on their response to whether or not they had a science-related job.
**Maternal education.** Education was categorized into three groups: non-college graduate (n = 9), college graduate (n = 18), and graduate school or higher (n = 10). Given the three levels, all analyses of maternal education were conducted using a one-way analysis of variance (ANOVA). Main effects were followed by pairwise tests with a Bonferroni adjustment for multiple comparisons. As shown in Table 3, there were very few differences between mothers of different levels of education on the measures of engagement, mother-child interaction, or children's learning. The mean for total time spent differed significantly by mother’s education level, $F(2, 34) = 3.42, p<.05$. Post hoc tests revealed that mothers with graduate school or higher levels of education tended to spend ($p = .06$) more time in the exhibits ($M=56.83$ minutes, $SD=10.52$ minutes) than mothers who reported being non-college graduates ($M=43.95$ minutes, $SD=9.65$ minutes). The mean intervals in which mothers described animals was higher for mothers with graduate school or higher levels of education ($M=.75$, $SD=.16$) compared to mothers who were college graduates ($M=.56$, $SD=.19$), $F(2, 33)=3.76, p<.05$. As shown in Table 3, there were no other differences for the mother-child conversational interactions or learning measures by maternal education.
Table 3. Summary of ANOVAs for Maternal Education and Time Spent, Mother-Child Conversational Interactions, and Children’s Learning

<table>
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<tr>
<th></th>
<th>Non-College Graduate</th>
<th>College Graduate</th>
<th>&gt; Graduate School</th>
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<th></th>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Open-question</td>
<td>5.11 (2.89)</td>
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<td>13.20 (3.50)</td>
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<td>.12</td>
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<tr>
<td>Explanatory response</td>
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<td>7.90 (5.69)</td>
<td>.84</td>
<td>.44</td>
</tr>
<tr>
<td>Naming</td>
<td>.48 (.13)</td>
<td>.50 (.15)</td>
<td>.57 (.14)</td>
<td>1.03</td>
<td>.37</td>
</tr>
<tr>
<td>Describing</td>
<td>.61 (.16)</td>
<td>.56 (.19)</td>
<td>.75 (.16)</td>
<td>3.76</td>
<td>.03</td>
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<td>.09 (.07)</td>
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<tr>
<td>Open-question</td>
<td>11.00 (10.60)</td>
<td>8.83 (6.08)</td>
<td>6.90 (5.69)</td>
<td>.77</td>
<td>.47</td>
</tr>
<tr>
<td>Explanatory response</td>
<td>2.44 (2.74)</td>
<td>2.61 (2.55)</td>
<td>4.80 (4.61)</td>
<td>1.73</td>
<td>.19</td>
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<td>.35 (.12)</td>
<td>.38 (.20)</td>
<td>.40 (.14)</td>
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<td>.52</td>
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<td>.42 (.20)</td>
<td>.41 (.14)</td>
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<td>.52</td>
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<td>Association</td>
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<td>.03 (.02)</td>
<td>.03 (.02)</td>
<td>.32</td>
<td>.73</td>
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<tr>
<td>Joint Talk</td>
<td>.49 (.23)</td>
<td>.45 (.25)</td>
<td>.43 (.16)</td>
<td>.15</td>
<td>.86</td>
</tr>
<tr>
<td>Time Spent (in minutes)</td>
<td>43.96 (9.65)</td>
<td>47.48 (12.50)</td>
<td>56.84 (10.52)</td>
<td>3.42</td>
<td>.04</td>
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<tr>
<td>Children’s Learning</td>
<td>11.11 (7.77)</td>
<td>11.78 (7.08)</td>
<td>9.40 (6.35)</td>
<td>.37</td>
<td>.70</td>
</tr>
</tbody>
</table>

**Environmental predispositions.** How mothers’ environmental predispositions may have affected time spent, mother-child conversational interactions, and children’s learning was further examined. The mean predispositions were normally distributed, with an overall average of 4.56. These mean ratings were further broken down into high and low categories, with the mean cutoff
being 4.5. Fifty-three percent of mothers (n=20) reported low environmental predispositions (M<4.5) and 47% of mothers (n=18) reported high environmental predispositions. (M>4.5).

There was no statistically significant difference in time spent between mothers who had high \( M = 49.25 \) minutes, \( SD = 12.87 \) minutes) versus low environmental predispositions \( M = 48.94 \) minutes, \( SD = 11.41 \) minutes), \( t(36)=.08, p=.94. \) Mothers with high environmental predispositions tended to have fewer intervals of naming \( M=.47, SD=.15 \) than mothers with low environmental predispositions \( M=.57, SD=.13 \), \( t(34)=2.02, p=.05. \) As shown in Table 4, there were no other notable differences in measures of mothers’ talk by environmental predispositions.

Children with mothers who had high environmental predispositions tended to offer more pieces of information in the interview \( M=12.89, SD=6.83 \) than children with mothers reporting low environmental predispositions \( M=9.10, SD=6.54 \), \( t(35)=1.75, p=.09. \) No other differences in the child measures were statistically significant. These results are summarized in Table 4.
Table 4. Summary of Independent Samples T-Test for Mother’s Environmental Predispositions and Time Spent, Mother-Child Conversational Interactions, and Children’s Learning

<table>
<thead>
<tr>
<th></th>
<th>Low Environmental Predispositions</th>
<th>High Environmental Predispositions</th>
<th>t</th>
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</thead>
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</tr>
<tr>
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<td>11.05 (10.47)</td>
<td>6.61 (4.92)</td>
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<td>.10</td>
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<tr>
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<tr>
<td>response</td>
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</tr>
<tr>
<td>Naming</td>
<td>.57 (.13)</td>
<td>.47 (.15)</td>
<td>2.02</td>
<td>.05</td>
</tr>
<tr>
<td>Describing</td>
<td>.65 (.16)</td>
<td>.58 (.20)</td>
<td>1.12</td>
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<td>Association</td>
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<td>.06 (.04)</td>
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<tr>
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<td>8.60 (9.32)</td>
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<td>Explanatory</td>
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<td>.03 (.02)</td>
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<td>.76</td>
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<td><strong>Joint Talk</strong></td>
<td>.41 (.20)</td>
<td>.48 (.25)</td>
<td>1.01</td>
<td>.32</td>
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<tr>
<td><strong>Time Spent (in minutes)</strong></td>
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<td>.94</td>
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<tr>
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<td>9.10 (6.54)</td>
<td>12.89 (6.83)</td>
<td>1.75</td>
<td>.09</td>
</tr>
</tbody>
</table>

**Science-related career.** Children of mothers who reported not having a science-related career asked more open-ended questions (M=10.04, SD=7.94) than children with mothers who reported a science-related career (M=6.14, SD=5.11), t(36)=1.84, p=.07. But there were no other
differences on any measures by mothers’ science related career. These results are summarized in Table 5.

Table 5. Summary of Independent Samples T-Test for Mother’s Science-Related Career and Time Spent, Mother-Child Conversational Interactions, and Children’s Learning

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<tr>
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<td>M (SD)</td>
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<tr>
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<td></td>
</tr>
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<tr>
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<td>Describing</td>
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<td>Association</td>
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<td>.03 (.03)</td>
<td>.45</td>
<td>.65</td>
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<tr>
<td>Joint Talk</td>
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<td>.42 (.28)</td>
<td>.39</td>
<td>.70</td>
</tr>
<tr>
<td><strong>Time Spent</strong></td>
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<td>49.99 (12.89)</td>
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<td>.74</td>
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<tr>
<td><strong>Children’s Learning</strong></td>
<td>10.50 (6.11)</td>
<td>11.57 (8.21)</td>
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<td>.68</td>
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</tbody>
</table>
**Summary.** The analyses of maternal characteristics showed that there were few differences in relation to the hypothesis. Consistent with the hypothesis, mothers with higher levels of education spent more time in the exhibits and spent a greater proportion of time describing animals and habitats than mothers with less education. Furthermore, children of mothers with high environmental predispositions reported more learning than children of mothers with low environmental predispositions. Inconsistent with the hypothesis, mothers with low environmental predispositions spent more time naming animals than mothers with high environmental predispositions. Lastly, and contrary to the hypothesis, children of mothers who reported not having a science-related career asked more open-ended questions than children of mothers reporting a science-related career.

**Child Demographics**

Exploratory analyses were conducted to assess whether or not there were differences in time spent, mother-child conversational interactions, and children’s learning by children’s gender and age. An Independent Samples T-Test was conducted to assess differences by gender; 46% (n=19) of children were male and 54% (n=22) were female. There were no significant differences in any of the measures by gender. These results are summarized in Table 6.
Correlational analyses were conducted to assess associations between children’s ages and time spent, mother-child conversational interactions, and children’s learning. Children were 6-years-old (n=10), 7-years-old (n=15), and 8-years-old (n=15); (M=7.55, SD=.88). There were few links between children’s ages and the measures of time spent, mother-child conversational
interactions, and children’s learning. Age was negatively associated with mother’s naming animals, $r = -0.48, p < 0.01$, and mother’s describing animals and habitats, $r = -0.39, p < 0.05$, such that the younger the child the more intervals of time mothers spent naming and describing animals and habitats. There was a positive association between age and children’s learning, $r = 0.43, p < 0.05$.

These results are summarized in Table 7.

Table 7. Correlations between Child Age and Time Spent, Mother-Child Conversational Interactions, and Children’s Learning

<table>
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<tr>
<th>Child Age</th>
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</thead>
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<tr>
<td></td>
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<td>$r$</td>
</tr>
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<td>.08</td>
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<td>.06</td>
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<td>.12</td>
<td>.46</td>
</tr>
<tr>
<td>Time Spent</td>
<td>-.12</td>
<td>.46</td>
</tr>
<tr>
<td>Children’s Learning</td>
<td>.43</td>
<td>.01</td>
</tr>
</tbody>
</table>
Hypothesis Four: Mediation Model

To test for mediation, a series of correlational analyses were conducted. It was hypothesized that one or more of the variables associated with mother-child conversational interactions (i.e., open-ended questions, explanatory responses, joint talk, associations, naming animals, and/or describing animals and habitats) would mediate the relations between one or more of the variables associated with maternal characteristics (i.e., education, environmental predispositions, and science-related career) and one or more of the outcomes variables of time spent and children’s learning (see Figure 1). According to Baron and Kenny (1986), for mediation to exist, four conditions must be met: (1) mothers’ characteristics (i.e., education, environmental predispositions, and/or science career) must be significantly associated with at least one of the outcome variables (i.e., time spent and/or children’s learning), (2) at least one of mothers’ characteristics must be significantly associated to one or more of the mediating variables (i.e., open-ended questions, explanatory responses, joint talk, associations, naming animals, and/or describing animals and habitats), (3) one or more of the mediating variables must be significantly associated with one or more of the outcome variables of time spent and/or children’s learning, and (4) the impact of the main effect of mothers’ characteristics on time spent and/or children’s learning has to be less after controlling for the mediator – that is, for mother-child conversational interactions.

For the purpose of these analyses, maternal characteristics, including education, environmental predispositions, and science-related career were considered continuous variables. To consider a mediating effect, maternal characteristics must be significantly associated to the outcome variables of time spent and/or children’s learning. However, the independent variables
associated with maternal characteristics were generally not associated to any of the outcome variables of time spent and children’s learning. These results are summarized in Table 8.

Table 8. Correlations between Maternal Characteristics, Children’s Learning, and Time Spent

<table>
<thead>
<tr>
<th>Maternal Characteristics</th>
<th>Children’s Learning</th>
<th></th>
<th>Time Spent</th>
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</thead>
<tbody>
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<td></td>
<td>r</td>
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<td>r</td>
<td>p</td>
</tr>
<tr>
<td>Education</td>
<td>- .09</td>
<td>.34</td>
<td>.32</td>
<td>.06</td>
</tr>
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<td>Environmental Predispositions</td>
<td>.29</td>
<td>.08</td>
<td>-.09</td>
<td>.61</td>
</tr>
<tr>
<td>Science-related career</td>
<td>.08</td>
<td>.65</td>
<td>.06</td>
<td>.73</td>
</tr>
</tbody>
</table>

There was, however, one scenario where the conditions trended towards significance. Maternal education was positively associated with the mediator variable of mother’s open-ended questions, $r = .42, p < .05$, and mother’s open-ended questions were positively associated with the outcome variable of time spent, $r = .42, p < .05$. However, while it trended towards significance, maternal education was not significantly associated with time spent, $r = .32, p = .06$. Therefore, there is no significant effect to mediate; thus, the conditions for mediation were not met.
CHAPTER FIVE
DISCUSSION

The current study investigated differences in mother-child conversational interactions across different types of immersive exhibits at Shedd Aquarium in Chicago. The focus on conversational interactions is guided by sociocultural theory (Vygotsky, 1978), which suggests that supportive language scaffolds learning, serving as a social mechanism that can better support children’s learning (Ash, 2004; Haden, 2010). Furthermore, previous research has pointed to the use of observable behaviors like, conversational interactions, as indicators of learning (Bitgood, 2011; Borun et al., 1997; Falk & Dierking, 2013). The findings from this study offer important insights into how different types of immersive exhibits can influence conversational interactions; and in turn, how children’s learning may be impacted by experiences in different types of immersive exhibits. The discussion to follow is organized by the main findings of type of exhibit, children’s learning, and demographics. This is followed by a discussion of future directions and implications for museum professionals.

Overview of Results

This study utilized a within-subjects mixed methods approach, including naturalistic observations, surveys, and interview data to examine whether or not mother-child conversational interactions differed in high and low immersion exhibits, and whether or not conversational interactions and the type of immersive exhibit influenced children’s exhibit learning. Mother-child dyads were video and audio recorded as they visited four different immersive exhibits.
Upon completion of their visit, mothers were asked to complete a survey and children were asked to participate in an interview about what they learned during their visit.

Observations of mother-child dyads across the four exhibits led to important findings about how engagement and conversational interactions vary across different types of immersive exhibits. First, mother-child engagement and conversational interactions varied by type of exhibit. As predicted, high immersion exhibits elicited longer stay times and more open-ended questions from children. However, contrary to the hypothesis, more conversational interactions around exhibit content were observed in low immersion exhibits compared to high immersion exhibits. Although associations to previous knowledge and or museum content was rare, associations were observed in proportionally more time intervals in low versus high immersion exhibits. Furthermore, mothers had proportionally more time intervals of naming animals, while children had proportionally more time intervals of describing animals and habitats in low immersion exhibits.

Second, the type of exhibit was associated with what children reported shortly after visiting the exhibits. In post-observation interviews, children reported learning the most in high immersion exhibits, mentioning high immersion exhibits more often than low immersion exhibits when responding to interview questions. Furthermore, there were some linkages between mother-child conversational interactions in the exhibits and children's reported learning. Mother-child joint talk and children’s explanatory responses were related to the amount of exhibit specific information children mentioned in the post-observation interview.

Lastly, there were few differences between maternal and child demographics and time spent, mother-child conversational interactions, and children’s learning. Generally, mothers with higher education spent more time in exhibits and a greater proportion of time describing animals
and habitats. Mothers with higher environmental predispositions spent fewer proportions of time naming animals and had children who mentioned exhibits more often in the post-interview. Furthermore, mothers without science-related careers had children who asked more open-ended questions. To conclude, mothers offered more explanatory responses to younger children than older children, and mother-child dyads with younger children spent more time in the exhibits than dyads with older children.

**Type of Exhibit**

The first research hypothesis focused on how time spent, mother-child conversational interactions, and children’s learning varied by type of exhibit. It was expected that high immersion exhibits would elicit higher stay times and more conversational interactions when compared to low immersion exhibits. This hypothesis was based on the idea that exhibit design, in general, influences visitor attention, engagement, and learning (Bitgood, 2011; Serrell, 1996). The current study builds on previous work which shows that immersive exhibits offer more opportunities to engage with exhibit content (Bitgood, 2011), including animals and habitats; and, more specifically, that design features associated with immersive exhibit design better facilitate conversational interactions than less immersive exhibits (Ash, 2004; Reiss & Tunnicliffe, 2011; Scheersoi, 2009; Tunnicliffe, 2009; Tunnicliffe & Scheersoi, 2010). Exploring the role of immersive exhibit design on visitor behavior fills a significant gap in the research literature. To date, few studies have compared differences in engagement, conversational interactions, and children’s learning between high and low immersion exhibits in the context of an aquarium.

As predicted, mother-child dyads spent more time in high immersion exhibits when compared to low immersion exhibits. In other words, high immersion exhibits have greater
holding power as defined by the amount of time visitors spend in the exhibit (Bitgood, 2011). This finding is in keeping with prior research which suggests that exhibits with added immersive design features like habitat surrounds and multisensory experiences have greater holding power (Bitgood et al., 1988; Moss et al., 2010). The exhibits examined in the current study contained a variety of immersive design features as outlined by Bitgood (2011). These include multisensory experiences like soundscapes, and environmental conditions like humidity and lighting that simulate the places described, as well as animal habitats that surround visitors. Prior work suggests that the ability to capture and sustain visitor attention (i.e., holding power) is an important requirement for learning (Serrell, 2016). The current findings suggest that high immersion exhibits are better able to capture and sustain visitor attention than low immersion exhibits. Previous research confirms that there is a positive relationship between how long visitors attend to exhibits and learning (Borun et al., 1996).

The current study also examined the type of conversational interactions that occurred across different kinds of immersive exhibits. It was anticipated that high immersion exhibits would elicit more mother-child conversational interactions. More specifically, it was expected that high immersion exhibits would encourage mother-child dyads to engage more in an elaborative conversational style, which includes more open-ended questions and explanatory responses, as well as a greater proportion of time spent discussing exhibit content, specifically making associations, naming and describing animals and habitats. Examining mother-child conversational interactions, generally, is important as previous work has reported that conversational interactions promote higher levels of exhibit engagement (Barriault, 2014) and support children’s learning (Borun et al., 1996; Haden, 2010).
The findings from this study show that overall, open-ended questions occur more often in high immersion exhibits compared to low immersion exhibits. This finding is significant given the important function of open-ended questions in promoting children’s understanding and learning (Callanan & Jipson, 2001; Crowley et al., 2001; Falk & Dierking, 1992). More specifically, children asked significantly more open-ended questions in high immersion exhibits when compared to low immersion exhibits. However, there was no difference in the number of questions mothers asked across the different types of exhibits. There was also no difference in the number of explanatory responses for mothers and children by exhibit type. It is unclear why children asked more open-ended questions in high immersion exhibits and mothers did not. It may be that high immersion exhibits offer a greater number of exhibit elements for children to engage with; and, therefore more opportunities for children to ask questions. However, this then could also be true for mothers.

Furthermore, it may be that other learning behaviors were present but not coded for in the current study. For example, it may be that mothers were asking closed-ended questions rather than open-ended questions. For example, what’s the name of this animal? This question, like yes or no questions, is limited in its response. Closed-ended questions, unlike open-ended questions, are not associated with learning, and limit the elaborative conversational style necessary to promote it (Benjamin et al., 2010). Given this understanding, these questions were not coded for in the current study. However, perhaps questions, both open and closed-ended, that do not elicit a verbal response lead to other types of learning behaviors like searching for animals, label reading, observing animals with high interest (e.g., pressing your face against the habitat), and affective engagement (Barriault, 2014). These behaviors are also associated with learning and
may be important to investigate further, especially when you consider the context-specific learning that occurs in informal learning settings with live animals (Barriault, 2014).

On the other hand, and contrary to what was predicted, mothers and children talked more about exhibit content in low immersion exhibits when compared to high immersion exhibits. Specifically, mothers spent a larger proportion of time naming animals and making associations to prior knowledge in low immersion exhibits than in high immersion exhibits. It’s important to note that although significantly different, the proportion of time spent making associations was relatively small. This finding is consistent with other studies that have found associations occur infrequently (Benjamin et al., 2010; Marcus, Haden, & Uttal, 2018). Nevertheless, associations help families connect what they are currently doing to what they already know (Benjamin et al.; Jant et al., 2014).

It is unclear why mothers made more associations in low immersion exhibits when compared to high immersion exhibits. One explanation may be that the content of these exhibits was more familiar to mothers. The two low immersion exhibits in the current study represented the great lakes and rivers, which are two recognizable geographic locations, broadly and locally. Familiarity can influence the ways in which parents interact with their children in museums (Swartz & Crowley, 2004), and by providing familiar objects and content museums can better support conversations (Silverman, 2010). Diversely, high immersion exhibits were centered around the Amazon region and the Philippines, which were likely less familiar to families, making associative conversations more difficult given these geographic areas and the related content were less familiar.

Additionally, more associations in low immersion exhibits may be related to the limited design features within these exhibits. Unlike high immersion exhibits, low immersion exhibits
offer fewer design elements from which families can engage. Associations would provide an opportunity for mothers to connect exhibit content to things their children already knew in an effort to support engagement and learning in exhibits that offered fewer exhibit elements and less engaging content. At least one of the low immersion exhibits in the current study had little to no signage and only included small labels with animal names and photos. Label reading was not coded for in the current study, but it is likely that mothers were reading the labels in low immersion exhibits, as there were little to no other exhibit elements from which they could engage. Since labels contained just the animal names, it is consistent with the finding that mothers would spend a higher proportion of time naming animals in low immersion exhibits than in high immersion exhibits, where animal names require additional searching using the digital identification system on a tablet. Furthermore, the simplicity of these labels in conjunction with little to no other exhibit elements, mother-child dyads were not able to engage beyond identifying and describing. However, this is speculative and requires further investigation.

Furthermore, children spent a larger proportion of time describing animals and habitats in low immersion exhibits when compared to high immersion exhibits. With fewer exhibit elements in low immersion exhibits, children had to rely on what they could observe to engage with the exhibit content. As mothers named animals and made connections to prior knowledge, children offered simple descriptive statements about animals, often describing animal characteristics (e.g., colors) and/or animal behavior (e.g., swimming). For example, Mom points to the small label next to the habitat, “Elephant nose.” The child responds and says, “Elephant nose. Yep, it looks like he has an elephant’s mouth.” These findings are consistent with typical patterns of behavior (i.e., naming and describing objects and animals) observed in museums
(Barriault & Pearson, 2010), at immersive exhibits specifically, including dioramas (Tunnicliffe & Scheersoi, 2010) and live animal exhibits (Allen, 2002; Barriault, 2014).

Lastly, and as predicted, children reported learning the most in high immersion exhibits, as well as mentioning high immersion exhibits more than low immersion exhibits in their post-observation interviews. To date, there have been no studies that address differences in children’s reported learning from high and low immersion. Therefore, the current study offers new insights into a previously unexamined area of museum research, which suggests that children learn more from high immersion exhibits than low immersion exhibits. One reason children may have reported more learning in high immersion exhibits is that the high immersion exhibits in the current study offer more design features than low immersion exhibits. Prior research suggests that these added design features (e.g., authentic habitat surrounds, environmental elements like soundscapes and humidity, and hands-on interactives) better support learning by offering more and varied entry points into the exhibit content (Bitgood, 2011; Tunnicliffe & Scheersoi, 2010). Therefore, exhibits that offer more immersive design features for families to engage with may be key to eliciting learning. More specifically, the variety of design features found in high immersion exhibits offers a more awe-inspiring experience for children with floor to ceiling habitats, more hands-on opportunities, and larger animals, all of which are important to children’s recall of their experience (Anderson, Piscitelli, Weier, Everett, & Tayler, 2002; Piscitelli & Anderson, 2002).

When considering exhibit design in zoos and aquariums specifically, children may have reported more learning from high immersion exhibits, as these exhibits offer greater animal visibility with habitat surrounds that make animals visible from multiple angles and perspectives. This in turn, allows more opportunities to see unique animal interactions and behaviors.
Research in this area supports the idea that opportunities to see animal behaviors up-close is associated with positive affective responses, which are predictive of meaning-making (Luebke et al., 2016). With that, the current findings suggest that high immersion exhibits may be more memorable for children; thus, they are more easily recalled immediately after their visit.

To summarize, hypothesis one stated that time spent, mother-child conversational interactions, and children’s learning would differ by type of exhibit. Specifically, high immersion exhibits would elicit more time spent, more conversational interactions, and in turn, children would report more learning. The current findings offer mixed support for this hypothesis. High immersion exhibits had greater holding power, with mother-child dyads spending more time in these exhibits when compared to low immersion exhibits. In addition, the results also suggest that different kinds of immersive exhibits support differences in conversational interactions with children asking more questions in high immersion exhibits, and mothers and children talking more about exhibit content in low immersion exhibits. While immersiveness does not appear to support elaborative conversational styles, it may better support children’s learning immediately after their visit. It is important to acknowledge that little research has been conducted on immersive exhibits and the extent to which different types of immersive exhibits influence engagement and learning (Dancstep, Gutwill, & Sindorf, 2015). With that, the current study is novel and provides important insights into differences in engagement, mother-child conversational interactions, and children’s learning across different types of immersive exhibits. I now turn to discuss the relation between mother-child conversational interactions and children’s learning.
**Children’s Learning**

The second hypothesis explored whether or not mother-child conversational interactions were associated with children’s learning. It was expected that mother-child dyads who talked more in exhibits would have children who reported more learning immediately after their visit. This hypothesis was based on the notion that conversational interactions, particularly those that are elaborative in nature, better support children’s learning (Haden, 2010 for review).

The current study showed that there was a positive association between children’s explanatory responses and their own learning, and between joint talk and children’s learning. Thus, mother-child dyads who engaged in more joint talk and children who offered more responses to their mother’s questions talked more about the exhibits immediately following their visit. Previous work shows that elaborative conversational styles that include open-ended questions are particularly important to children’s understanding and learning (Boland et al., 2003; Haden, Ornstein, Eckerman, & Didow, 2001). However, the joint verbal exchange that comes with responses to open-ended questions may be of particular importance when considering the role of conversational interactions on children’s learning. The current results are consistent with the research literature which suggests that joint talk (i.e., open-ended questions followed by a response) enhances children’s understanding of their experience (Benjamin et al., 2010; Boland et al., 2003; Haden et al., 2001).

Interestingly, and contrary to what was predicted, there was a negative association between mothers naming of animals and children’s learning; thus, mothers who spent more time naming animals had children who mentioned learning in exhibits less often in the post-observation interview. Conversations that include descriptive talk and labeling allow mother-child dyads to engage with the exhibit, but this kind of talk is not enough to support children’s
learning immediately after the visit. This finding supports prior work that suggests a conversational hierarchy, where verbally identifying and/or describing what the visitor experiences happens first (Leinhardt & Knutson, 2004), creating a starting point to develop more detailed narratives that lead to further interest, interpretation, and investigation (Tunnicliffe et al., 2010). However, this lower level talk may limit children’s participation and engagement (Callanan, Castaneda, Luc, & Martin, 2017), and is less likely to support learning (Leinhardt & Knutson, 2004). This further confirms that elaborative conversational styles that include joint talk better facilitate children’s learning (see Haden, 2010 for review).

The current findings support the existing body of work, which shows that elaborative conversational styles, particularly joint talk, are a significant predictor of children’s understanding and learning (Haden et al., 2001). The current study adds to the robust body of research on elaborative conversational interactions, which shows that joint interaction between mother and child is key to learning (Benjamin et al., 2010; Haden et al., 2001; Hedrick, Haden, & Ornstein, 2009b; Jant et al., 2014).

**Mother-Child Demographics**

The third hypothesis explored the links between maternal characteristics including education, environmental predispositions, and science-related career on engagement, mother-child conversational interaction, and children’s learning. It was expected that mothers who reported having science-related careers, higher levels of education, and higher environmental predispositions would spend more time in exhibits and demonstrate more mother-child conversational interactions across their entire visit. In turn, their children would demonstrate more learning. The current findings suggest few differences by maternal characteristics.
Consistent with the hypothesis, mothers with graduate school education or higher spent more time in exhibits than mothers without college degrees. These mothers also spent a greater proportion of time describing animals and habitats when compared to college graduate mothers. These findings are consistent with prior research that mothers’ education is linked to differences in a host of factors (Tenenbaum & Callanan, 2008) including talk (Hart & Risley, 1995).

Furthermore, results related to mothers’ environmental predispositions were mixed. Inconsistent with the hypothesis, mothers with high environmental predispositions spent less time naming animals; however, consistent with the hypothesis, these same mothers had children who reported more information about the exhibits immediately following their visit. While the findings were mixed, they align with the notion that museum visitors carry with them a set of personal interest, beliefs, and needs that guide the ways in which they engage with the museum experience (Falk & Dierking, 2013). This personal context (Falk & Dierking, 2013) contains a visitor’s predispositions as examined in the current study. The current findings build on prior work that suggests predispositions, generally, are significant predictors of cognitive, affective, and behavioral outcomes (Ballantyne, Packer, & Falk, 2011, Myers, Saunders, & Birjulin, 2004; Powell & Bullock, 2014), and that environmental predispositions, specifically, are related to meaning-making (Luebke et al., 2016; Luebke & Matiasek, 2013).

Lastly, exploratory analyses examined children’s demographics, specifically age and gender. The results found no gender differences, and few differences by age. Mother-child dyads with younger children (i.e., 7-year-olds) spent more time in exhibits than older children (i.e., 8-year-olds), and mothers offered more explanatory responses to younger children (i.e., 6-year-olds) than older children (8-year-olds). These findings conflict with previous work that show mothers used more explanatory talk with older children (Tenenbaum, Snow, Roach, & Kurland,
2005), and other work suggesting that mothers’ explanations do not differ by children’s age (Jipson & Callanan, 2003; Tenenbaum & Leaper, 2003; Tenenbaum & Callanan, 2008).

Overall, few differences were found in engagement, mother-child conversational interaction, and children’s learning by maternal characteristics, children’s age, and children’s gender.

**Conclusions and Future Directions**

Overall, the results of this study reveal that mother-child conversational interactions and engagement do vary across different types of immersive exhibits. Furthermore, findings also suggest that more elaborative conversations, specifically joint talk, are linked to children’s learning. Additionally, the current study found that children report learning more from high immersion exhibits when compared to low immersion exhibits, suggesting that in addition to joint talk, immersive exhibit design may better support children’s learning. Empirical work in developmental psychology, learning sciences, and informal learning provide support for the notion that parent-child conversational interactions are an important social mechanism for children’s learning (Haden, 2010; Leinhardt et al., 2002; NRC, 2009; Sobel & Jipson, 2015). Moreover, the current study offers new insights into how contextual mechanisms, like museum exhibits and exhibit design, may influence mother-child conversational interactions, and in turn, how both the physical and social context of the museum experience contribute to children’s learning. To date, research in this area has not systematically investigated mother-child conversational interactions across different types of immersive exhibits. The current findings contribute to this gap in knowledge by offering a systematic analysis of the same families across multiple exhibits, comparing their conversational interactions across high and low immersion exhibits, and investigating the role of both the physical and social context on children’s learning.
Findings from the current study support the notion that both contextual mechanisms like exhibit design, and social mechanisms like mother-child conversational interactions are related to children’s learning.

**Limitations and Future Directions**

While the current study offers important new insights about the role of immersive exhibit design on mother-child conversational interactions and children’s learning, it only begins to explore this important topic. The current results suggest that immersive exhibits are important contextual mechanisms for engagement, conversational interactions, and children’s learning, and that different types of immersive exhibits are related to variability in these areas. Furthermore, conversational interactions are important social mechanisms that serve as both a process and an outcome of learning in museums. However, future research should continue to explore the dynamic interactions between the contextual and social mechanisms of learning in museums. Specifically, future work should explore immersive design features (Bitgood, 2011) that best support elaborative conversations and children’s learning; as well as, the ways in which mother-child conversational interactions in zoos and aquariums support the development of environmental literacy, specifically.

**Exhibit Design Features**

One limitation of the current study is that it did not examine the relations between specific immersive design features (e.g., habitat surrounds) and the trends observed in conversational interactions across the different types of exhibits. Future research should investigate what about immersive exhibit design is most predictive of learning, specifically what design features may be most impactful to promoting elaborative conversations and learning after a visit. Future work in this area is important for zoos and aquariums, specifically, as the use of
immersive exhibit design increases (Dancstep et al., 2015), and the need to create more authentic habitats for animals becomes increasingly necessary for both animal welfare and positive public perception (Grajal, Luebke, & Kelly, 2018). Previous research on zoo exhibit design suggests that designing animal habitats in zoos with immersion in mind is not only beneficial for animals, but also for public perception of animal welfare and in creating positive cognitive and emotional responses in visitors (Ballantyne et al., 2007; Grajal et al., 2018). However, much of this work is limited to zoos; and, aquariums, while similar, should be considered separately, as they serve different audiences and offer a different visitor experience.

Another important exhibit feature to consider is the influence of live animals. Research has found that live animals, particularly the types of animals and animal behaviors visitors are able to observe, influence engagement and learning (Bitgood et al., 1988; Luebke et al., 2016). While the current study suggests there is a link between immersive exhibits and children’s learning, it is limited in that it did not explore particular design features or animals that were associated with children’s learning. Therefore, when considering what contributes to visitor learning, it may be important to examine not only exhibit design features but also the types of animals displayed and behaviors observed. It may also be important to consider other forms of learning that occur in informal settings with live animals. Previous research, while limited, suggests that immersive design features, many of which were included in the exhibits examined in the current study (e.g., observing animals in naturalistic habitats, opportunities to see animals up close, and opportunities to observe animal behavior), have the potential to generate other learning outcomes, including: positive attitudes towards animals, enhanced appreciation of animals, and increased awareness of conservation related issues (Ballantyne et al., 2007). The
influence of live animals, specifically, and alternative indicators of learning should be examined further.

As suggested above, future research should consider other learning behaviors that better capture the unique learning that occurs in zoos and aquariums as visitors engage with live animals. Barriault (2014) suggests that behaviors such as, searching for animals, label reading, observing animals with high interest (e.g., pressing your face against the habitat), and affective engagement are significant indicators of learning in zoos and aquariums. These learning behaviors were not examined in the current study. Therefore, when considering the role of live animal exhibits on learning, it is important to consider other forms of learning, particularly the affective response elicited by visitors when engaging with animal habitats as an indicator of learning. Ballantyne et al. (2007) suggest that the ability to connect with visitors emotionally is an important component to engaging visitors in conservation action -- another important learning outcome of zoos and aquariums. While some research suggests that exhibit design in zoos and aquariums (Luebke et al., 2016) does elicit affective responses better than other kinds of immersive exhibits such as dioramas (Tunnicliffe, 1996), this area warrants further research.

**Conversations that Support Environmental Literacy**

Additionally, the current study examined conversational interactions at a high level, and did not explore, in depth, the content of those conversations. For example, what specifically did mothers and children talk about during joint verbal exchanges? Furthermore, it is important to consider not only science related talk but also affective talk, as compassion and empathy are central to the mission statements of many zoos and aquariums (Patrick, Matthew, Ayers, & Tunnicliffe, 2007). For example, Tunnicliffe (1996) found that school children made more affective related comments while visiting zoo exhibits when compared to children visiting
dioramas at a natural history museum. Future work should examine the content of mother-child conversations more deeply to assess the type of talk elicited across different types of exhibits, and the extent to which different types of talk support scientific thinking, environmental awareness, and conservation learning in aquariums, specifically.

In fact, immersive live animal exhibits, like those found in zoos and aquariums, may be better suited to support scientific thinking and conservation learning, but also the development of environmental literacy. For example, experiences with animals in zoos and aquariums are not only enjoyable and educational (see Dierking et al., 2002 for review), but also engage visitors emotionally (see Ballantyne et al., 2007 for review). These aspects of exhibit experiences are important to conservation learning (Ballantyne et al., 2007) and the development of environmental literacy (Roth, 1992). In informal learning institutions, such as aquariums, zoos, and the like, much of what there is to learn pertains to understanding nature and the natural environment. Through informal learning experiences, such as those found in zoos and aquariums, children can begin to develop environmental literacy, including environmental awareness, concern, understanding, and action (Hollweg et al, 2011; Roth, 1992). Future research is needed to understand how immersive exhibits in zoos and aquariums support the development of environmental literacy.

Much of what we know about environmental literacy comes from work done in formal, or other non-museum settings (e.g., school trips to local nature preserves); although, just a small percentage of the public’s understanding of environmental issues actually comes through formal learning opportunities (Falk, 2001). Furthermore, developing environmental literacy is inherent to the missions of many zoos and aquariums (Patrick et al., 2007). A key focus in these institutions is to “facilitate and support the development of pro-conservation attitudes,
knowledge and behavior among their visitors” (Ballantyne & Packer, 2005, p. 282). In fact, research suggests that encounters with nature and animals in zoos and aquariums contribute to a basic understanding and awareness of environmental issues (Adelman et al., 2000), as well as influencing visitors to rethink their own behaviors and attitudes towards the environment (Packer, 2004). Further exploration is necessary to understand whether or not mothers and children talk about these issues during their visit, and if so, how do these conversational interactions about science, conservation, and the environment vary across different types of exhibits.

**Summary**

The current study explored an important, yet under researched, area of informal learning. Findings add to the growing body of work that conversational interactions are an important social mechanism for children’s learning. However, the current findings only begin to investigate the important role of the physical context of museum exhibits on supporting engagement, conversational interaction, and children’s learning. Exhibits are central to the physical context of museums thus warrant further examination. Findings from the current study provide new evidence that different types of exhibits can influence the ways in which mothers and children interact; thus, influencing children’s learning. However, many questions remain. Future research should explore not only the design features related to immersive exhibits that are predictive of learning, but also how immersive exhibits support other forms of learning and the development of environmental literacy. Furthermore, future work must consider the role of live animals, and examine how types of animals and animal behavior in aquariums contribute to engagement, conversational interactions, and learning.
Implications for Museums

The current study offers important insights that museum professionals at Shedd Aquarium and other zoos and aquariums may find useful when considering ways to design exhibit experiences for learning. First, the findings highlight that mother-child engagement and conversational interactions do vary across different types of exhibits. More specifically, the current work provides evidence that immersive exhibits may better support children’s elaborative talk, and in turn better facilitate children’s learning immediately after their visit. For this reason, the exhibit becomes an important contextual mechanism for engagement, conversational interactions, and learning, as it provides the ‘tools’ (i.e., immersive design features like habitat surrounds and interactives) from which visitors can construct their experience. When these tools are limited it may be more difficult for visitors to engage in meaningful interactions thus, limiting the learning that can occur. This finding is of particular importance to exhibit and experience designers, as immersive exhibits become increasingly popular in modern museums. For the past two decades, immersive exhibits have been on the rise in a variety of museums; and, although immersive exhibit design varies across institutions, immersive exhibits, generally, are perceived by museum professionals as more engaging and better able to attract a broader range of visitors (Gilbert, 2000). Until now, there has been limited comparative research to support the benefits of these larger scale and often more expensive exhibits. With limited budgets, understanding what features of immersive exhibit design are most impactful becomes another important area of this work to explore further. The current study provides practitioners, including exhibit designers and educators, with applied research that helps inform best practices in exhibit design and exhibit interpretation.
APPENDIX A

ONLINE RECRUITMENT SCREENER
Website Copy

We are conducting a research study with mothers and their children ages 6-to-8-years old at Shedd Aquarium. Your family is welcome to visit the aquarium for free, but we ask that just mother and one child participate in the study. You will be able to join your group after participation is complete. Participants will receive a free family pass for a return visit. Here are some of the specifics:

As part of the study, mother-child pairs will be asked to visit four of Shedd Aquarium’s exhibits. After visiting the exhibits, mothers will be asked to complete a post-visit survey and children will be asked to participate in an audio-recorded interview about their experience. This should take no longer than 2 hours. Your visit will be video and audio recorded. If you are interested in participating in this study, please complete this brief survey.

Survey

Thanks for your interest in participating in this study. We would like to ask you a few questions to determine your eligibility.

1. Parent age
2. Parent gender
3. Parent race/ethnicity
   - American Indian or Alaskan Native
   - Arab or Middle Eastern
   - Asian or South Asian (Indo-Pak, etc.)
   - Black or African American
   - Hispanic or Latin o/a
   - Multiracial
   - Native Hawaiian or other Pacific Islander
   - White (Non-Hispanic)
   - Other: _____________________

4. Child age
5. Child gender
6. Child race/ethnicity
   - American Indian or Alaskan Native
   - Arab or Middle Eastern
   - Asian or South Asian (Indo-Pak, etc.)
   - Black or African American
   - Hispanic or Latin o/a
Multiracial
Native Hawaiian or other Pacific Islander
White (Non-Hispanic)
Other: _____________________

5. When was the last time you and your child visited Shedd?
   o This will be the first time.
   o 12 months or less since last visit
   o 1-2 years ago
   o 3-5 years ago
   o 6-10 years ago
   o More than years ago

6. Zip code

7. We will contact you shortly. Please provide your contact information below.
   First name
   E-mail address
   Phone number
   Best time for us to call (day of week and time)
APPENDIX B

PARENT POST-SURVEY
1. Please rate how well each statement describes you. (Pre-dispositional Section)
The scale of 1-7 represents 1 as Not at all, 4 as somewhat, and 7 as Very much.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am interested in animals.</td>
<td></td>
<td></td>
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<tr>
<td>I feel a sense of connection with nature.</td>
<td></td>
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<tr>
<td>I understand wildlife conservation issues.</td>
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<tr>
<td>I pay attention to news about environmental issues.</td>
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<tr>
<td>I volunteer time to support conservation efforts/organizations.</td>
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<tr>
<td>I give money to support conservation efforts/organizations.</td>
<td></td>
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<tr>
<td>I buy earth-friendly products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I engage in conservation efforts at home (e.g., recycling, reducing energy use)</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

2. About how often do you visit the following places?

<table>
<thead>
<tr>
<th></th>
<th>Once a month or more</th>
<th>A few times a year</th>
<th>About once a year</th>
<th>Less than once a year</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art Museums</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Children’s Museums</td>
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<td></td>
<td></td>
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<tr>
<td>Natural History Museums</td>
<td></td>
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<td></td>
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<tr>
<td>Parks (City, State, National, Forest Preserves)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Playgrounds</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Science Museums and Planetariums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zoos and Aquariums</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. When take children to an attraction (like those listed in #2) how important is it that it be educational for them? (Circle one)

Not at all important  1    2    3    4    5    6    7    8    9    10 Very important

4. When you take children to an attraction (like those listed in #2) how important is it that it be fun for them? (Circle one)

Not at all important  1    2    3    4    5    6    7    8    9    10 Very important

5. Parks offer many different kinds of activities, when you take your child to a park, what is he/she most likely to do? (Circle one)

Play on swings, slide, and other playground equipment
Explore plants and/or wildlife
Explore sand and/or water

6. Parks offer many different kinds of activities, when you take your child to a park, what is he/she least likely to do? (Circle one)

Play on swings, slide, and other playground equipment
Explore plants and/or wildlife
Explore sand and/or water

7. Using the exhibit pictures provided, please answer the following questions as they relate to each exhibit you visited today.

Amazon

<table>
<thead>
<tr>
<th>Before visiting today, how much did you know about the animals and ecosystems of the Amazon region?</th>
<th>(I knew nothing at all)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>(I knew a great deal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>My family and I learned new things</td>
<td>(strongly disagree)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(strongly agree)</td>
</tr>
</tbody>
</table>
My family and I enjoyed the exhibit | (strongly disagree) | 1 2 3 4 5 6 7 8 9 10 | (strongly agree)
The exhibit made me feel that I was in the time and place described | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
The labels helped me feel involved in the exhibit | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
The exhibit makes the subject come to life | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
Your overall rating of the exhibit | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)

Wild Reef

Before visiting today, how much did you know about the animals and ecosystems of the Philippines? | (I knew nothing at all) | 1 2 3 4 5 6 7 8 9 10 | (I knew a great deal)
My family and I learned new things | (strongly disagree) | 1 2 3 4 5 6 7 8 9 10 | (strongly agree)
My family and I enjoyed the exhibit | (strongly disagree) | 1 2 3 4 5 6 7 8 9 10 | (strongly agree)
The exhibit made me feel that I was in the time and place described | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
The labels helped me feel involved in the exhibit | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
The exhibit makes the subject come to life | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
Your overall rating of the exhibit | (extremely low) | 1 2 3 4 5 6 7 8 9 10 | (extremely high)
### Great Lakes

<table>
<thead>
<tr>
<th>Question</th>
<th>Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before visiting today, how much did you know about the animals and ecosystems of the Great Lakes region?</td>
<td>(I knew nothing at all)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(I knew a great deal)</td>
</tr>
<tr>
<td>My family and I learned new things</td>
<td>(strongly disagree)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(strongly agree)</td>
</tr>
<tr>
<td>My family and I enjoyed the exhibit</td>
<td>(strongly disagree)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(strongly agree)</td>
</tr>
<tr>
<td>The exhibit made me feel that I was in the time and place described</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>The labels helped me feel involved in the exhibit</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>The exhibit makes the subject come to life</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>Your overall rating of the exhibit</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
</tbody>
</table>

### Rivers

<table>
<thead>
<tr>
<th>Question</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much did you know about the animals and ecosystems of rivers around the world before you arrived today?</td>
<td>(I knew nothing at all)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(I knew a great deal)</td>
</tr>
<tr>
<td>My family and I learned new things</td>
<td>(strongly disagree)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(strongly agree)</td>
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<td>-----------------------------------</td>
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<td>------------------</td>
</tr>
<tr>
<td>My family and I enjoyed the exhibit</td>
<td>(strongly disagree)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(strongly agree)</td>
</tr>
<tr>
<td>The exhibit made me feel that I was in the time and place described</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>The labels helped me feel involved in the exhibit</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>The exhibit makes the subject come to life</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
<tr>
<td>Your overall rating of the exhibit</td>
<td>(extremely low)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>(extremely high)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Your Age:</th>
<th>Ethnic/Racial Heritage:</th>
<th>You</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>_ 21-24</td>
<td>American Indian or Alaskan Native</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_ 25-29</td>
<td>Arab or Middle Eastern</td>
<td></td>
<td></td>
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<tr>
<td>_ 30’s</td>
<td>Asian or South Asian (Indo-Pak, etc.)</td>
<td></td>
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<tr>
<td>_ 40’s</td>
<td>Black or African American</td>
<td></td>
<td></td>
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<tr>
<td>_ 50’s</td>
<td>Hispanic or Latin o/a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>_ 60’s</td>
<td>Multiracial</td>
<td></td>
<td></td>
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<tr>
<td>_ 70’s +</td>
<td>Native Hawaiian or other Pacific Islander</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>White (Non-Hispanic)</td>
<td></td>
<td></td>
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<td></td>
<td>Other (Please list)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education: (Check highest level completed)</th>
<th>You</th>
<th>Child’s Other Parent/ Guardian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some high school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school graduate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some college/vocational or technical school graduate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>College graduate</td>
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<tr>
<td>Master’s degree</td>
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<tr>
<td>Doctoral/professional degree (PhD, MD, JD)</td>
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<td></td>
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<tr>
<td>Parent Occupation:</td>
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<td>----------------------------------</td>
<td></td>
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<tr>
<td>You</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s Other Parent/Guardian</td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Family/household income:</th>
</tr>
</thead>
<tbody>
<tr>
<td>_ Less than $25,000</td>
</tr>
<tr>
<td>_ $25,000 - 49,999</td>
</tr>
<tr>
<td>_ $50,000 - 74,999</td>
</tr>
<tr>
<td>_ $75,000 - 99,999</td>
</tr>
<tr>
<td>_ $100,000 - 149,999</td>
</tr>
<tr>
<td>_ $150,000 - 199,999</td>
</tr>
<tr>
<td>_ $200,000 or over</td>
</tr>
</tbody>
</table>
APPENDIX C

CHILD POST-OBSERVATION INTERVIEW
I hope you had fun at Shedd today. Now we’re going to talk about what you did in each exhibit you visited. [Lay all the exhibit picture cards on the table] Which exhibit do you want to talk about first? [Take other exhibit picture cards away.]

1. Tell me all about this exhibit and what you saw and learned.

[Probe: What else do you remember?]

[Probe: What else did you learn in the exhibit?]

[Probe: Was there anything else? Tell me more about that.]

[Probe: What were you doing when that happened/when you learned that? Was there something in the exhibit that helped you learn about this? Did you know about this before you visited?]

[Probe: Is there anything else you’d like to tell me about this exhibit?]

2. I’m going to show you some animal pictures now. Some of these were in the exhibit, and some you may not have seen. Point to the ones you saw in the exhibit.

As the child points to animals they remember, move those pictures to another row. [Write down the animals the child chooses] Once the child has selected the animals he/she remembers take away animal pictures not chosen. Ask the child the following about all of the animal pictures he/she chose: what can you tell me about these animals? Let the child chose which animals he/she wants to talk about.

[Probe: Did you learn anything new about these animals? Tell me more about that.]

[Probe: What were you doing when that happened/when you learned that? Was there something in the exhibit that helped you learn about this? Did you know about this before you visited?]

[Probe: Is there anything else you’d like to tell me about these animals?]

Now let’s talk about the other exhibits. Which one do you want to talk about next?

Continue asking above questions for each exhibit. Allowing child to choose the next exhibit he/she wants to talk about.

3. Putting all the exhibit pictures out. Did you find any interesting information in these exhibits about taking care of the environment (or nature)? Tell me about what you found.
4. Keeping all the exhibit pictures out. **How were these exhibits different from each other?**

    **[Probe: What did you see or do in these exhibits that made them different?]**

    **[Probe: Which exhibit did you learn the most in? Why do you think you learned the most there?]**
APPENDIX D

PRELIMINARY ANALYSIS
It was initially proposed that there would be differences across the four exhibits; and therefore, a four factor repeated measures analyses of variance (ANOVA) followed by pairwise tests with a Bonferroni adjustment for multiple comparisons was conducted (all ps < .05). Mother-child conversational interactions were examined across each of the four exhibits. The results of these preliminary analyses showed few differences between Amazon and Wild Reef, the two high immersion exhibits, and Great Lakes and Rivers, the two low immersion exhibits. These results are summarized below.

**Mother-Child Conversational Style**

**Mother-child open-ended questions and explanatory responses.** The number of open-ended questions asked by mothers did not differ by exhibit, $F(1, 38) = .516, p = .64$. However, the mean number of questions asked by children differed significantly by exhibit, $F(1, 38) = 3.91, p < .05$. Post hoc adjustments revealed that children asked more open-ended question in Amazon than in Rivers, $p < .01$. The mean number of explanatory responses by mothers, $F(1, 38) = 1.48, p = .23$, and children $F(1, 38) = 2.43, p = .07$ did not differ significantly by exhibit.

**Content of Mother-Child Conversational Interactions**

**Mother-child naming and describing.** The proportion of time spent naming animals differed significantly by exhibit for mothers, $F(1, 38) = 18.45, p < .01$, and for children $F(1, 38) = 4.45, p < .05$. Post hoc adjustments revealed that mothers spent a greater proportion of time naming animals in Rivers than all other exhibits, $p < .01$, and children spent a greater proportion of time naming animals in Rivers than in Great Lakes, $p < .05$.

The proportion of time spent describing animals and habitats differed significantly by exhibit for mothers, $F(1, 38) = 6.47, p < .01$, and for children $F(1, 38) = 5.56, p < .01$. Post hoc
adjustments showed that mothers and children spent a greater proportion of time describing in Rivers than in Amazon and in Great Lakes, $ps < .05$.

**Mother-child associations.** The proportion of time spent making associations differed significantly by exhibit for mothers, $F(1, 38) = 7.08, p < .01$, and for children $F(1, 38) = 19.98, p < .01$. Post hoc adjustments showed that mothers spent a greater proportion of time making associations in Great Lakes than in Amazon, $ps < .05$; and, children spent a greater proportion of time making associations in Great Lakes than in any other exhibit, $p < .01$.

Therefore, there was empirical, as well as conceptual justification to combine the two low immersion exhibits (Rivers and Great Lakes) and the two high immersion exhibits (Amazon and Wild Reef). The advantages of creating a two factor within-subjects variable for immersion included increased statistical power, reduced error in measurement of constructs, and increased generalizability of the measurements as well.
REFERENCES


VITA

Lindsay Maldonado was born and raised in Chicago. Before starting at Loyola University Chicago, she received her Master’s in Child Development from Erikson Institute and her Bachelor’s in Psychology from Northeastern Illinois University. For over a decade, Lindsay has conducted research and evaluation in museums and other informal learning environments. She has engaged in research that examines the interaction between the personal, social, and physical contexts of learning in museums, uncovering the ways in which visitor characteristics, social interactions, and exhibition and program design influence the processes and outcomes of learning. Her current research focuses on how family learning in museums is supported by both group interactions and the physical design of the space.

Currently, Lindsay is the Director of Research and Evaluation at Shedd Aquarium in Chicago. She leads the development, implementation, and management of institutional research and evaluation. Lindsay is an active member of the Visitor Studies Association, an organization that focuses on understanding and improving visitor experiences in informal learning environments through research and evaluation.