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CHATTING ABOUT SCIENCE: A QUALITATIVE STUDY ON INCREASING THE NUMBER AND DEPTH OF SCIENCE-BASED CONVERSATIONS AMONG AQUARIUM VISITOR GROUPS

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Educational Theory, Policy, and Practice

by

Erika K. Poarch
B.S., University of North Carolina at Chapel Hill, 2006
May 2014
Five years ago, I spoke to Dr. James Wandersee on the telephone for the first time; I remember hanging up the phone at the end of our conversation and saying to a friend, “This man is brilliant and actually cares about what I think!” I knew that I had just spoken to someone special, but I had no idea how much a single phone call could change my life. Jim, you believed in me from day one and even when I doubted my abilities, you never seemed to. I always knew I could count on you for help, advice, ideas, and encouragement. From our weekly meetings to the course we taught together, I learned so much from you—not just about science education, but also about the type of educator and mentor I aspire to become. I can only hope that someday I am able to positively impact someone else’s life as you have mine.

And so, this dissertation is dedicated to you, Dr. James Wandersee.

My mentor. My friend.

My inspiration.
Acknowledgements

Writing a dissertation can be a lonely, isolating experience at times, full of doubts and insecurities. At other times, it is exhilarating, full of surprising discoveries, moments of joy, and small but hard-fought victories. It would take an entire book to list everyone who helped me navigate these ups and downs; you know who you are, and I thank you. There are a few people, though, who I feel deserve an individual acknowledgement for going above and beyond to assist me in this endeavor.

First, I would like to thank my committee members, past and present. Without the encouragement, support, and guidance of my mentor and former advisor, Dr. James Wandersee, this dissertation would never have been begun, much less finished. Jim, I appreciate your help more than you could ever know. I would also like to thank Dr. Pamela Blanchard for so gracefully stepping into the role of my advisor once Dr. Wandersee retired. Pam, we’ve learned quite a bit together during this process and I’m incredibly thankful that I had the opportunity to work with you. I know my dissertation is stronger due to your contributions. Dr. Earl Cheek, Dr. Kim MacGregor, and Dr. Robert Gambrell, thank you for giving me so much of your time; I could not have asked for a more helpful or knowledgeable committee.

I would not have made it through this journey without the support of so many of my family members. Before my father passed away, he instilled in me a deep love of the ocean, an appreciation for learning, and a desire to succeed. Daddy, I hope you’d be proud of what I’ve accomplished here. And to my mother: There are no words to tell you how thankful I am for everything you’ve done for me—throughout my entire life and especially during this process. Without the brainstorming sessions, the late-night tear-filled phone calls, the countless editing
emails, and your unwavering belief in my abilities, I never could have finished this dissertation. Thank you for everything, Mum; this accomplishment is yours as much as it is mine.

A “thank you” also goes to my partner, Grady L. Cutrer III, for keeping me grounded and helping me through the day-to-day struggles. Grady, thank you for being so understanding when dissertation writing trumped date night and also for knowing when I needed a little extra encouragement. You came into my life at the beginning of a very stressful time and I’m so grateful that you’ve stuck by my side throughout it all.

I would also like to recognize my friends who offered commiseration, support, or simply a glass of wine when things got tough—you all are great. There’s not a doubt in my mind that the writing of this dissertation would have dragged on for years if not for the ladies in my writing groups: Katherine Renkin, Laura Delrose, Lilia Pitre, Destiny Cooper, and Vanessa Deggins. Thanks for holding me accountable and for sharing in the small victories with me!

And finally, thank you to the staff and visitors at the North Carolina Aquarium at Fort Fisher. Without the support of Education Curator Jennifer Metzler-Fiorino and her team, this research would have been over before it started. And to the visitors: Thank you for sharing your time with me… this work is for you!
Table of Contents

Acknowledgements ........................................................................................................... iii

Abstract ......................................................................................................................... ix

Chapter 1. Introduction .................................................................................................... 1
  1.1 Background ................................................................................................................ 1
  1.2 Statement of the Problem and Significance of Study ................................................. 4
    1.2.1 Phase 1 ............................................................................................................ 4
    1.2.2 Phase 2 ............................................................................................................ 5
  1.3 Study Objectives ....................................................................................................... 6
  1.4 Research Settings ..................................................................................................... 8
  1.5 Reflexivity Statement ............................................................................................. 11
  1.6 Definition of Terms ............................................................................................... 13
  1.7 Frequently Used Acronyms ................................................................................... 14
  1.8 References ............................................................................................................. 15

Chapter 2. Literature Review and Theoretical Background ............................................. 18
  2.1 Informal Education and Learning: A Definition of Terms ........................................ 18
  2.2 Conservation and Ocean Literacy ........................................................................... 23
  2.3 D. B. Gowin’s Theory on Educating .................................................................... 27
    2.3.1 On Educating .................................................................................................. 28
    2.3.2 On Learning ................................................................................................... 29
    2.3.3 On Teaching .................................................................................................. 30
    2.3.4 On Educative Materials ................................................................................... 30
  2.4 J. D. Novak’s Human Constructivism and Gowin’s Theory .................................. 31
  2.5 Michael and Modell’s Active Learning and Gowin’s Theory ................................ 34
  2.6 Gowin’s Theory and Informal Education ................................................................. 38
    2.6.1 On Educating .................................................................................................. 38
    2.6.2 On Learning ................................................................................................... 40
    2.6.3 On Teaching ................................................................................................... 43
    2.6.4 On Educative Materials ................................................................................... 43
  2.7 Factors That Affect Learning in Informal Environments ......................................... 49
    2.7.1 The Personal Context ...................................................................................... 49
    2.7.2 The Social Context ......................................................................................... 51
    2.7.3 The Physical Context ....................................................................................... 54
  2.8 Summary .................................................................................................................. 55
  2.9 References ............................................................................................................. 57

Chapter 3. Methods .......................................................................................................... 62
  3.1 Purpose of Study ..................................................................................................... 62
  3.2 Research Questions ................................................................................................. 67
  3.3 Research Methods ................................................................................................... 68
  3.4 Site Selection .......................................................................................................... 70
  3.5 Phase 1 .................................................................................................................... 72
Chapter 5. Increasing Family Conversations in Aquaria Through Use of VIP Discussion Guides

5.1 Literature Review ............................................ 149
5.2 Methods .................................................. 155
   5.2.1 Creation of Educational Materials ................. 156
   5.2.2 Setting and Participants .......................... 158
   5.2.3 Data Collection: Pre-Visit Interviews .......... 158
   5.2.4 Data Collection: In-Visit Observations .......... 160
   5.2.5 Data Collection: Post-Visit Interviews and Document Collection .... 162
   5.2.6 Data Analysis: Transcription .................... 163
   5.2.7 Data Analysis: Coding and Interpretation ....... 164

Chapter 4. An Examination of the Visit Motivations, Interests, and Self-Reported Learning of Aquarium Visitors

4.1 Literature Review ............................................ 99
4.2 Methods .................................................. 103
4.3 Results .................................................. 108
   4.3.1 Motivations ........................................ 109
   4.3.2 Interests ........................................... 113
   4.3.3 Visitor Learning ................................. 116
4.4 Discussion .............................................. 119
   4.4.1 Family Groups with Elementary School-Aged Children .... 122
      4.4.1.1 Motivations ................................ 122
      4.4.1.2 Interests .................................... 125
      4.4.1.3 Visitor Learning ......................... 129
   4.4.2 Social Groups of College-Aged Young Adults ....... 135
      4.4.2.1 Motivations ................................ 135
      4.4.2.2 Interests .................................... 136
      4.4.2.3 Visitor Learning ......................... 138
4.5 Conclusion .............................................. 142
4.6 References .............................................. 144
Chapter 7. General Conclusions ........................................................................236

7.1 Purpose of Study and Research Questions ..................................................236

7.2 Methods ........................................................................................................237

7.2.1 Methods: Study Sites ..................................................................................237

7.2.2 Methods: Samples ......................................................................................238

7.2.3 Methods: Data Collection ..........................................................................239

7.2.4 Methods: Creation of VIP Discussion Guides ............................................239
# Table of Contents

7.2.5 Methods: Data Analysis ..................................................240
7.3 Findings ..............................................................................241
  7.3.1 Findings: Study 1.B .........................................................241
  7.3.2 Findings: Study 2.B, Study 2.C ........................................244
7.4 Conclusions ........................................................................247
7.5 Limitations ...........................................................................249
7.6 Implications .........................................................................252
7.7 Recommendations for Future Research ...............................254
7.8 References ...........................................................................256

Appendix A. Ocean Literacy Principles (OLP) ...........................258
Appendix B. STRANDS OF INFORMAL SCIENCE LEARNING (SISL) ..........263
Appendix C. Interview Protocol, Study 1.B ................................264
Appendix D. Institutional Review Board Documents ................265
Appendix E. VIP Discussion Guide for Family Groups ...............268
Appendix F. VIP Discussion Guide for Social Groups of College-Aged Young Adults .......270
Appendix G. VIP Discussion Guide Alignment for Family Groups ........................................272
Appendix H. VIP Discussion Guide Alignment for Social Groups of College-Aged Young Adults ...........................................................................273
Appendix I. Consent Forms ........................................................274
Appendix J. Child Assent Form ....................................................276
Appendix K. Pre-Visit Interview Protocol, Studies 2.B, 2.C ............277
Appendix N. Data-Logging Sheets, Studies 2.B, 2.C .......................283
Vita .........................................................................................285
Abstract

Informal science education centers, including aquariums, are often tasked with educating the general public on conservation issues, natural environments, and general science topics. The public tends to see these centers as entertaining leisure destinations in which they have the opportunity to learn something about the presented information. It is widely accepted that learning in informal environments is shaped by the learner’s motivations, interests, background knowledge, and social interactions. However, these impacting factors are rarely studied in depth, particularly across different types of visitors. This qualitative case study project integrates original research on visitor interests, motivations, and self-reported learning into the design of an educational material that provides visitors with guidance but still aligns with the free-choice nature of the aquarium.

To determine visitor motivations, interests, and self-reported learning, the researcher interviewed 122 visitors to an aquarium; these visitors encompassed a variety of group types. Information from this phase was used to create two novel, unique sets of educational materials—the Visitors’ Interpersonal (VIP) Discussion Guides—that contained open-ended questions designed to spark science-based conversations among family groups with elementary school-aged children (n=6) and social groups of college-aged young adults (n=7). Interviews, observations, and document analyses allowed the researcher to assess the impact of VIP Discussion Guides use on the group’s visit experience and science-based conversations.

Use of the VIP Discussion Guides increased the number and depth of science-based conversations among family groups with elementary school-aged children as well as among social groups of college-aged young adults. Visitors reported greater engagement in conversations and increased learning due to use of the VIP Discussion Guides. Additionally, all
participating visitors stated that they enjoyed using the VIP Discussion Guides and would be interested in using a similar guide in the future.

The results from qualitative studies typically do not generalize to different situations, but the methods, VIP Discussion Guides, and conclusions from this research could provide a blueprint for other institutions seeking to design educational materials to increase science-based conversations among their own visitors.
Chapter 1. Introduction

1.1 Background

Human activities have altered the natural world in significant ways. E.O. Wilson, a prominent biologist, stated that overpopulation and over consumption of natural resources have caused considerable impacts on biodiversity (Wilson, 2002). Today, species are becoming extinct at a rate that is 100 to 1000 times greater than historical extinction rates (Primack, 2008). Primack (2008) asserted, “more than 99% of modern species extinctions can be linked to human activity” (p. 127). Scientists have identified a number of factors that contribute to loss of biodiversity, including habitat destruction, invasive species, pollution, overexploitation of species for human use, and global climate change (Hansen, 2009; Primack, 2008; Wilson, 2002). Although almost all habitats on Earth have been impacted by these factors, marine environments may be particularly vulnerable.

The Association of Zoos and Aquariums (AZA) declared that member institutions should promote conservation of aquatic habitats and organisms through engaging educational opportunities (Association of Zoos and Aquariums [AZA], 2009a). Rabb and Saunders (2005) contended that increasing conservation behavior among visitors is “a distinct opportunity and obligation for our institutions” (p. 6). Researchers associated with The Ocean Project found that “the public as a whole does not need to be convinced that ocean conservation is important. Rather, they need to be prompted with reasons to act now” (Mott, Wong, & Meyer, 2011, p. 34). This prompting, they asserted, could—and perhaps should—come from educational programs at zoos and aquariums (Mott et al., 2011, emphasis added).

Other researchers claim that aquaria have an obligation to teach visitors about more general aspects of science. Falk and Dierking (2010) highlighted the importance of informal
science education; less than 5% of an average American’s life is spent in school and only a small portion of that time is dedicated to science instruction. Refuting the claim that “out-of-school educational experiences only support superficial science learning,” these researchers contended instead, “free-choice learning experiences represent the single greatest contributors to adult science knowledge; childhood free-choice learning experiences also significantly contributed to adult science knowledge” (Falk & Dierking, 2010, p. 486, 489).

Similarly, Fenichel and Schweingruber (2010) asserted that informal science education centers should “introduce learners to scientific skills and concepts, the culture of science, and the role science plays in decision making” (p. xii). In their book based on the National Research Council (NRC) report *Learning Science in Informal Environments: People, Places, and Pursuits*, Fenichel and Schweingruber (2010) stated that science literacy is more than remembering a simple collection of scientific facts; one must also understand “at a basic level, the nature and processes of science” (p. 1). Instead of focusing exclusively on conservation education, these researchers all advocated a more general approach, outlined as Strands of Informal Science Learning (SISL), which include introducing visitors to the culture and importance of science in addition to crucial facts and concepts.

This discussion regarding what aquaria should teach visitors appears to be somewhat contrary to the premise behind informal education. Informal education is often used as a catch-all phrase for any learning that occurs outside the classroom, including at aquaria (Norland, 2005). These learning experiences are typically free from “curricular constraints” and are guided by the learner’s needs and interests (Allen, 2004, p. S18). Unlike school settings in which learners are instructed to learn about topics others have chosen, learners in informal settings are free to choose what information to attend to and what information to ignore (Allen, 2004). It is
not surprising that visitors choose to attend to information and exhibits that they find interesting, engaging, or otherwise appealing. Falk (2009) found that visitors were most interested in topics about which they already had a basic understanding; these topics commanded the majority of their attention and were most often recalled post-visit. Thus, an informal learning experience is shaped by a number of internal and external factors, notably a visitor’s interests and prior knowledge.

However, aquarium curators, exhibit designers, and educators are charged with selecting the concepts, facts, and organisms that are highlighted in their institution, which does, in a way, dictate the “curriculum” of the space. As mentioned above, organizations and individuals assert that aquaria should promote a variety of messages and encourage the development of a number of relevant skills (e.g. Fenichel & Schweingruber, 2010; Mott et al., 2011; Rabb & Saunders, 2005). Regardless of the specific message or skills an institution decides to endorse, efforts should be made to address visitors’ diverse interests and background knowledge in a way that encourages the visitors to make meaningful connections to the information presented. These connections are of paramount importance as they help the visitor construct his or her own meanings regarding the experience and the presented information—an activity that constructivists say underlies all learning (Schunk, 2008). Since this meaning-making is highly personal and dependent on an individual’s background knowledge, the learner is primarily responsible for any learning that occurs (Michael & Modell, 2003). An educator’s job is to simply help the learner to learn through selection and utilization of appropriate educational materials (Gowin, 1981; Michael & Modell, 2003).
1.2 Statement of the Problem and Significance of Study

1.2.1 Phase 1. Informal science education researchers recognize that visitors’ interests, motivations, and prior knowledge affect learning at informal science education centers (Falk, 2009; Packer, 2006; Packer & Ballantyne, 2004). Visitors are more likely to attend to information they perceive as interesting and applicable to their level of prior knowledge (Tunnicliffe & Scheersoi, 2009). As individuals often visit informal institutions in social or family groups, the interests, motivations, and prior knowledge of all group members may influence the information to which visitors attend. However, few studies to date examine visitor interests, and even fewer examine visitor interests in relation to prior knowledge or group composition.

The first phase of this study (Chapter 4) began to fill this void; it examined visitor motivations, learning, and interests in relation to group composition. Groups were divided based on ages/grades of the group members: family groups with pre-school-aged children, family groups with elementary school-aged children, family groups with secondary school-aged children, social groups of college-aged young adults, social groups of adults not in school, and adult groups with unspecified families. In addition to providing an overall picture of each group type’s motivations, learning, and interests, this phase emphasized results from two group types: family groups with elementary school-aged children and social groups of college-aged young adults. A limited amount of research has been conducted on aquarium visits of family groups with young children (e.g. Tunnicliffe, 2008), but many of these studies did not focus on the children’s interests. Even fewer studies address aquarium visits of young adults (approximate ages 18-25); to this researcher’s knowledge, this was the first study that addressed the motivations and interests of young adult visitors.
1.2.2 Phase 2. Gowin (1981), Michael and Modell (2003), and other constructivists argued that educating is a social event in which two or more individuals construct meanings that align with their own personal experiences of one or more phenomenon. These social events are often mediated by conversations or discussions; utilization of higher-order questions can lead to increased understanding (Gowin, 1981; Walters, 2006). However, science-based discussions are unlikely to occur without prompting from educators and educative materials (Martin, 2004). Thus, educators interested in increasing the educational value of informal science education centers might elect to utilize higher-order questions on educational materials.

The second phase of this study (Chapter 5, Chapter 6) examined how two different groups (family groups with elementary school-aged children and social groups of college-aged young adults) utilized a specific type of educational material designed for this study: the Visitors’ Interpersonal (VIP) Discussion Guides. These VIP Discussion Guides were informed by visitor interests found in Phase 1 (Study 1.B, Chapter 4), Ocean Literacy Principles (OLN, 2011a, Table 2.1, Appendix A), Strands of Informal Science Learning (SISL) (Fenichel & Schweingruber, 2010, Appendix B), the aquarium’s stated mission and education goals (J. Metzler-Fiorino, personal communication, October 11, 2012; North Carolina Aquarium Society, 2012), and current research on “best practices” in formal and informal education. The VIP Discussion Guides were designed to address the interests and prior knowledge of two specific subgroups of visitors: family groups with elementary school-aged children and social groups of college-aged young adults.

Interviews and observations in Phase 2 helped the researcher understand how members of the two target groups interact with each other, the provided educational materials, informal educators, and exhibits. Particular attention was paid to how visitors utilize the VIP Discussion
Guide during their visit, and whether this type of educational material can increase science-based discussions among visitors, as science-based discussions have the potential to enhance learning (Pedretti, 2004).

Researchers have asserted that utilization of properly designed educational materials may reduce museum fatigue, increase visitor interest and engagement, and encourage repeat visitation—all of which may increase an aquarium’s potential learning yield (Martin, 2004; Pedretti, 2004). However, there is a lack of empirical evidence as to what constitutes “properly designed educational materials.” As such, information gathered during this phase could offer informal educators a template for designing useful educational materials, one that can be modified depending on the motivations and interests of the institution’s visitors. Ideally, by offering a variety of age- and knowledge-appropriate VIP Discussion Guides that address different categories of visitor interests and science concepts, educators could inexpensively repurpose existing exhibits in such a way that increases the learning potential of their institutions. This could potentially encourage visitors to view an aquarium as a space that could be visited repeatedly, as use of different VIP Discussion Guides would allow individuals to learn about organisms and concepts they find interesting.

1.3 Study Objectives

This two-phase, five-part study sought to fill gaps that exist in the current research literature regarding visitor interests and visitor use of educational materials. The initial phase of this study consisted of two parts (Study 1.A and Study 1.B) that utilized semi-structured interviews to examine visitors’ motivations in choosing to visit an aquarium; the information visitors remember regarding facts, concepts, and organisms; and specific facts, concepts, and
organisms visitors would be interested in learning more about in the future. Study 1.A piloted the interview protocol and procedures to be used in Study 1.B.

The researcher used information gained in the first phase, in addition to current research, to create appropriate educational materials (VIP Discussion Guides) that shaped the second phase of this study. During the second phase (Study 2.A, 2.B, and 2.C), groups of visitors were observed and interviewed following an intervention (use of VIP Discussion Guides during a visit). Another set of visitor groups were observed and interviewed without the intervention to serve as a comparison. Interview responses and comparisons of observations were analyzed to determine the extent to which the VIP Discussion Guides affected the visitors, their visit, and their learning. Study 2.A served as a pilot for Studies 2.B and 2.C; the VIP Discussion Guides, interview and observation locations, and interview and observation protocols were tested during Study 2.A and were modified as necessary to ensure smooth and adequate data collection during Studies 2.B and 2.C.

Research Questions, Phase 1:

1) Why do individuals choose to visit an aquarium?

2) What do visitors report learning during a visit to an aquarium?

3) What are visitors interested in learning about on a future visit to an aquarium?

Research Questions, Phase 2:

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?

2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?
3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?

4) What factors influence visitors’ responses to using educational materials (VIP Discussion Guides)?

1.4 Research Settings

Study 1.A was conducted at the Audubon Aquarium of the Americas in New Orleans, Louisiana. Located on the bank of the Mississippi River in downtown New Orleans, the Aquarium of the Americas is a popular tourist destination. This two-story building features animals from the Amazon Rainforest, creatures endemic to the Mississippi River, and inhabitants of the Gulf of Mexico (Audubon Nature Institute, 2012). Visitors can touch stingrays and feed parakeets—two potentially memorable hands-on experiences. Visitation is highest during the weekends and lowest on weekday afternoons (Audubon Nature Institute, 2012). Study 1.A’s main purpose was to test the interview protocol and procedures for Study 1.B. As such, the location of Study 1.A was chosen primarily due to proximity to Louisiana State University as well as the existence of a professional friendship between the researcher and the Education Curator at this aquarium.

Studies 1.B, 2.A, 2.B and 2.C were conducted at the North Carolina Aquarium at Fort Fisher (NCA-FF), one of three AZA-accredited aquariums located on the coast of North Carolina. According to the North Carolina Aquariums’ website, “The Aquariums were established in 1976 to promote an awareness, understanding, appreciation and conservation of the diverse natural and cultural resources of North Carolina’s ocean, estuaries, rivers, streams and other aquatic environments” (North Carolina Aquarium Society, 2012). NCA-FF was renovated in 2002; this renovation tripled the aquarium’s size and the building now covers
93,000 sq. ft. (North Carolina Aquarium at Fort Fisher, 2011). Visitors to NCA-FF can see over 300 species of terrestrial and aquatic organisms, most of which are native to North Carolina (North Carolina Aquarium at Fort Fisher, 2011; J. Metzler-Fiorino, personal communication, January 4, 2011).

All three North Carolina Aquariums have higher non-school group attendance during summer months than winter months, and higher attendance on weekends than weekdays (J. Metzler-Fiorino, personal communication, January 4, 2011). NCA-FF attracts a variety of visitors; annual ticket sales for the fiscal years (June to June) of 2010 to 2011 and 2011 to 2012 are displayed in Table 1.1. Total attendance for the fiscal years (June to June) for 2010 to 2011 and 2011 to 2012 was 415,413 and 427,285, respectively (J. Zazzali, personal communication, October 14, 2012).

Table 1.1. Annual Ticket Sales at NCA-FF by Visitor Type

<table>
<thead>
<tr>
<th>Ticket Sales</th>
<th>2010 to 2011 (June to June)</th>
<th>2011 to 2012 (June to June)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total attendance</td>
<td>415,413</td>
<td>427,285</td>
</tr>
<tr>
<td>Adult attendance</td>
<td>214,963</td>
<td>222,996</td>
</tr>
<tr>
<td>Youth attendance (not with a school group)</td>
<td>86,193</td>
<td>92,102</td>
</tr>
<tr>
<td>School-group attendance (free)</td>
<td>24,383</td>
<td>22,782</td>
</tr>
<tr>
<td>Member attendance (free after initial membership purchase)</td>
<td>59,677</td>
<td>60,119</td>
</tr>
</tbody>
</table>

Note: “Adult attendance” includes seniors (62+), adults (13-61), chaperones, and military members. “Youth attendance” includes all individuals younger than 13. “School-group attendance” includes children enrolled in elementary, middle, or high school in North Carolina; these groups attend the aquarium for free with advance registration. “Member attendance” includes individuals holding an Aquarium membership, a membership with the North Carolina Zoo, and a membership from other AZA-accredited institutions; these individuals attend the aquarium for free after initial purchase of membership. The categories included in this figure do not include all visitors to NCA-FF during these time periods. Examples of other categories of visitors not included in the analysis are: rental participants, special activity participants, and disabled individuals (J. Zazzali, personal communication, October 14, 2012; North Carolina Aquarium Society, 2012).
All of the North Carolina Aquariums have relatively low admission fees: youth (3-12), $6; seniors (62+), $7; adults (13-61), $8. Aquarium members, children under 2, and children as part of a school group are admitted for free (North Carolina Aquarium Society, 2012). NCA-FF is located approximately 15 miles from Wilmington, North Carolina, which is a popular vacation site and the location of two institutions of higher education: the University of North Carolina at Wilmington (enrollment: approximately 13,000 students; University of North Carolina, Wilmington, n.d.) and Cape Fear Community College (enrollment: approximately 28,000 students; Cape Fear Community College, 2012). Further, Raleigh, North Carolina’s state capitol, is a 2.5 hour drive from this aquarium, meaning it is easily accessible for many individuals in North Carolina—including students attending many of the state’s institutions of higher education.

NCA-FF has three distinct exhibition halls (J. Metzler-Fiorino, personal communication, October 11, 2012). The first exhibit hall visitors experience is the Cape Fear Conservatory, covering 20,000 sq. ft. and highlighting local terrestrial and freshwater species found in the nearby Cape Fear River (North Carolina Aquarium at Fort Fisher, 2011). The second exhibit hall contains fish, turtles, and invertebrates found primarily in brackish or estuarine waters; this hall also contains a touch tank where visitors can handle urchins, horseshoe crabs, sea stars, anemones and whelks under educator or volunteer supervision. The final exhibit hall allows visitors to examine marine species found off North Carolina’s coast; this hall also contains a relatively new interactive Megalodon shark exhibit and a bamboo shark touch tank. Although other aquariums have elected to showcase interesting or unusual organisms from around the world, the three North Carolina Aquariums focus primarily on species found in North Carolina’s coastal waters (J. Metzler- Fiorino, personal communication, October 11, 2012).
1.5 Reflexivity Statement

Much of my childhood was spent outdoors: hiking in the Blue Ridge Mountains, skipping rocks across a slow-moving stream, canoeing in a nearby lake, digging for mole crabs on Florida beaches, sailing in Hawaii. As an undergraduate, I channeled my love of the outdoors and obtained a degree in Environmental Science with a minor in Marine Science. During my final semester as an undergraduate, I completed an education internship at the North Carolina Aquarium at Pine Knoll Shores and began to realize the potential for lasting, meaningful learning at informal science education centers. In addition, I recognized that these spaces offered educators a chance to enlighten the public on issues impacting the ocean and the importance of conservation—two topics about which I had always been passionate.

Teaching at both the aquarium and a nearby nature center, I began to understand the importance of tailoring program material to match visitors’ questions and interests. Abstract concepts were easier to understand when visitors were provided with concrete examples they could see and touch—even more so if an educator was available to answer questions. I realized that each person’s background changed the way they approached their aquarium experience, as well as the memories and understandings they took away from the visit. Only when I began graduate school did I realize that others held this same view and called it “constructivism.”

More specifically, I found that my beliefs aligned with Novak’s theory of Human Constructivism (Novak, 2010; Mintzes & Wandersee, 2005). In addition, I found that Gowin’s (1981) explanations of the concepts educating, learning, teaching and educative materials resonated with my own experiences in informal education. Gowin’s theory, supported by Novak’s Human Constructivism, has influenced how I learn, teach, and conduct research. As such, both researchers’ perspectives are described in Chapter 2 of this dissertation.
Current research in informal science education demonstrates that learning is influenced by a host of factors, including visitor’s needs, interests, prior knowledge, self-identity and personal motivations (Falk, 2009; Packer & Ballantyne, 2002; Tofield, Coll, Vyle, & Bolstad, 2003). Each of these factors is highly personal and sometimes even difficult to define. This difficulty can be exacerbated with closed-ended questionnaires that force visitors to artificially make choices or distinctions they may not have made on their own. On the other hand, qualitative methods, such as interviews, allow participants to explain their thoughts, beliefs, and feelings in their own words and give researchers the opportunity to ask for clarification if needed (Patton, 1990). Although interviewing may underestimate an individual’s true understanding, this method has the potential to alert the researcher to more subtle nuances that may better explain the phenomenon in question (Creswell, 2007). Given that knowledge construction is dictated by factors that are highly personal, a research methodology that gives individuals an opportunity to express their own understandings seems most appropriate. For these reasons, this study utilizes a qualitative, interview-based approach.

During my time as a doctoral student at Louisiana State University, I have had a multitude of opportunities that I feel qualify me to complete this research. I have completed courses in qualitative methodology, quantitative methodology, science education, conservation and oceanography; I have attended and presented at local and national education conferences; I have networked with scientists, educators, and aquarium professionals; and I have read, discussed, and published articles on learning in informal environments. This research project served as a culmination of my studies and was enhanced by each of the opportunities described above.
1.6 Definition of Terms

Biodiversity: “the complete range of species and biological communities, as well as the genetic variation within species and all ecosystem processes” (Primack, 2008, p. 19)

Conservation: “a value-driven discipline based on the premise that the preservation of species diversity, ecological systems, and evolutionary processes in nature is important to the maintenance of life on our planet” (Miller et al., 2003, p. 87)

Educative materials: term coined by Gowin (1981) to describe materials used by educator and/or student to construct meanings.

Human constructivism: a worldview described by educational researcher J. D. Novak. The three main tenets of this worldview are: (a) “human beings are meaning makers,” (b) “the goal of education is the construction of shared meanings,” and (c) “shared meanings may be facilitated by the active intervention of well-prepared teachers” (Mintzes & Wandersee, 2005, pp. 48-50).

Informal education: learning experiences that occur outside of school walls; they are voluntary, non-assessed, and socially mediated; they support the life-long, free-choice learning of visitors of a variety of ages; and they are guided by the learner’s individual motivations, needs and interests.

Museum fatigue: “A collection of phenomena that represent predictable decreases in visitor interest and selectivity either during entire visits, within smaller areas (such as cognitive processing, physical fatigue and individual characteristics), factors in the environment (such as exhibit architecture and the museum setting), and interaction between them.” (Davey, 2005, p. 20).
Ocean Literacy: a full understanding of the importance of the ocean, the ways in which the ocean impacts humans, and the ways in which humans impact the oceans.

Participatory design: the planning and construction of educational elements that promote visitor participation, as described by Simon (2010).


1.7 Frequently Used Acronyms

AAoA: Audubon Aquarium of the Americas in New Orleans, Louisiana

AAZPA: American Association of Zoological Parks and Aquariums

AZA: Association of Zoos and Aquariums

COSEE: National Center for Ocean Sciences Education Excellence

HIPPO: Habitat destruction, Invasive species, Pollution, Population, Overharvesting; five factors that can negatively impact biodiversity (Wilson, 2002, p. 50)

IRB: Institutional Review Board

NARST: National Association of Research in Science Teaching

NCA-FF: North Carolina Aquarium at Fort Fisher

NCA-PKS: North Carolina Aquarium at Pine Knoll Shores

NCA-RI: North Carolina Aquarium at Roanoke Island

NGS: National Geographic Society

NGSS: Next Generation Science Standards

NMEA: National Marine Educators’ Association
NRC: National Research Council

NSES: National Science Education Standards

OLN: Ocean Literacy Network

OLP: Ocean Literacy Principles

SISL: Strands of Informal Science Learning

1.8 References


Chapter 2. Literature Review and Theoretical Background

2.1 Informal Education and Learning: A Definition of Terms

When many individuals think of the word “education,” they picture a brick-and-mortar school building, a classroom filled with pupils, perhaps stacks of textbooks, pencils, and examinations. This view is not held only by those outside of the educational realm. Many teachers, researchers, and policy-makers have over-emphasized the importance of classroom-based science instruction; the National Science Education Standards (NSES), written in 1996, applied only to formal, classroom-based science and suggested that informal environments should be used in a limited way to enhance classroom learning via field trips (National Research Council [NRC], 1996, p. 45). Falk (2008) claimed that “this single-minded attention on schooling” was based “on the then prevalent notion that there was little benefit to considering the nonschool setting since most, if not all, science learning was assumed to occur in schools” (p. 245). While there is little doubt that classroom-based science instruction can enhance scientific understanding, it is highly unlikely that this is the only venue in which individuals seek to make sense of the natural world around them. In fact, most Americans will spend less than 5 percent of their life in classrooms, and only a small portion of this class time will be dedicated to science instruction (Falk & Dierking, 2010). In our society, “education” has become synonymous with “schooling;” and yet, education can—and often does—occur outside of school walls (Falk & Dierking, 2010; Falk, Koran & Dierking, 1986).

Some researchers have termed this out-of-school learning as informal or nonformal education. Norland (2005) discussed the difficulty in applying a definition to informal or nonformal education: “Nonformal education resembles something other than traditional, formal education, but what? Nonformal education is not formal education, but what is it? Is it the
opposite? Is it the absence of formal?” (p. 6). She went on to further describe informal education as that “which occurs outside the classroom (after-school programs, community-based organizations, museums, libraries, at home and so on),” focusing on characteristics that are common across many informal education venues: intermittent attendance and leadership, short-term educational events, wide variety in educator abilities and backgrounds, and flexible curriculums often unconstrained by standards (Norland, 2005, p. 7).

The Informal Science Education Ad Hoc committee, commissioned by the Board of the National Association of Research in Science Teaching, expressed dissatisfaction with the term “informal science education,” suggesting that “out-of-school,” “free-choice” or “lifelong science learning” may be more appropriate (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003, p. 109). Regardless of the term used, this committee recognizes that any definition of this type of learning should reflect: “learning that is self-motivated, voluntary, and guided by the learner’s needs and interests, learning that is engaged throughout his or her life” (Dierking et al., 2003, p. 109). However, given that “informal science education” is the term I have heard used most consistently by aquarium educators, this research will use the term “informal education” to describe the learning experiences that occur at aquaria and other science education centers. These learning experiences occur outside of school walls; they are voluntary, non-assessed, and socially mediated; they support the life-long, free-choice learning of visitors of a variety of ages; and they are guided by the learner’s individual motivations, needs and interests.

The flexibility of informal education requires voluntary learner involvement; no learning occurs if the learner is unwilling to engage with the experience. As such, Falk (2009) stated that informal education is guided by the learner’s needs and interests; visitors are most likely to attend to material that they already understand at a basic level. Allen (2004) suggested that free-
choice or informal environments are particularly suited to this type of learning, because “hands-on exhibits are novel, stimulating, evidence-rich, multisensory, and fun” (p. S17) and these characteristics may encourage visitor engagement. Further, a visitor’s learning choices are supported “without any teachers forcing learners to do something unappealing, without curricular constraints, without testing or accountability” (Allen, 2004, p. S17-S18). The very nature of this type of learning (free from grades, testing, or potential failure) allows visitors to engage in educational activities in an intellectually safe environment, where pressure to succeed is low and learning is fun.

Due to the dissimilarities between informal education and formal schooling, there has been some debate as to whether visits to aquaria and other informal education centers should be considered meaningful educational events or simply entertainment events. During the 1980’s and 1990’s, some researchers saw education and entertainment as mutually exclusive goals, asserting that visitors primarily saw informal education spaces as places of entertainment and staff saw these spaces as educational opportunities (Falk, Moussouri, & Coulson, 1998; Packer & Ballantyne, 2004). Falk and colleagues (1998) rejected the prevailing view that education and entertainment existed as a continuum, insisting instead that each construct should be viewed on its own continuum. Their research suggested that visitors viewed education and entertainment as compatible; both motivations were seen as relevant and important (Falk et al., 1998). Spock (2006) said, “the muddling and unhelpful effects of the entertainment-versus-education… debates are a distracting irritant,” suggesting that museum visits—including aquarium visits—are a mixture of both education and entertainment (p. 169).

Similarly, Packer and Ballantyne (2004, 2010) rejected the notion that education and entertainment are mutually exclusive goals or motivations for an informal education center visit.
Instead, these researchers asserted, “the educational and entertainment aspects of the visit are not only compatible, but synergistic” (Packer & Ballantyne, 2010, p. 27). In an earlier study, Packer and Ballantyne (2002) found that visitors to an aquarium placed greater emphasis on entertainment than education, though these visitors were also likely to say that the aquarium was a place where learning is fun. Research has suggested that museums (including aquaria) are “less efficient at teaching facts or concepts than are books or the Internet” (Packer, 2006, p. 330).

This led Packer (2006) to propose the idea of “learning for fun,” meaning that “visitors engage in a learning experience because they value and enjoy the process of learning itself, rather than for any instrumental reasons, such as the attainment of specific learning outcomes” (p. 329).

Additionally, Packer & Ballantyne (2004) contended that visitors to informal education centers seek “an experience in which education is entertainment, discovery is exciting, and learning is an adventure” (p. 68, emphasis in original).

Unlike the learning that occurs in many formal classroom situations, particularly at the university level, learning in informal science centers is not undertaken in an attempt to become an expert in the field of study. Rather, visitors to an aquarium, for example, may be content to learn a few new facts about sharks or alligators. Falk (2009) said that in informal education contexts,

> Learning tends to take the form of confirmation of existing understandings, attitudes and skills in order to allow the individual to be able to say, “Okay, I now know that I know/believe that.” The goal is not “mastery” in the traditional sense, but rather to provide the individual with a feeling of personal competence. (p. 61)

Falk (2009) asserted that this type of learning helps to build a visitor’s identity; his research led him to identify five categories of visitor identities.

> It is important to note that in addition to having different identity-related motivations, visitors to an informal science education center will also have different interests, prior
experiences, and prior knowledge. Since each of these factors influences the information and exhibits an individual attends to, it is likely that any learning that occurs will be unique to the individual and thus potentially difficult to measure using traditional tools. Falk and Dierking (1997) claimed, “learning is the process of applying prior knowledge and experience to new experience,” meaning that the new knowledge gained during a visit may not be immediately clear or available for recall (p. 216). Informal education centers can provide visitors with experiences that make abstract concepts more concrete; the knowledge gained from these experiences can result in learning if it is incorporated into existing cognitive structures and used in future events to help the individual make new meanings.

In line with Falk and Dierking’s research, Storksdieck, Ellenbogen, and Heimlich (2005) argued that “learning outcomes” may be difficult to define and measure in informal settings. Instead of defining learning outcomes as simply a set of facts the visitor can recite after an educative event, these researchers encouraged educators to examine alternative outcomes as evidence of learning (Storksdieck et al., 2005). Meaningful learning occurring in informal science education centers may not look like traditional learning, but research has shown that learning can—and does—occur at these locations (Falk et al., 1998; Falk & Storksdieck, 2010; Sherwood, Rallis, & Stone, 1989).

As mentioned above, informal education can occur at any setting outside of a traditional school. Science centers (zoos, aquaria, nature centers, botanical gardens, science museums, etc.) represent a specific sub-set of informal education centers in which visitors can learn important scientific concepts in a leisure setting. Each type of science center presents visitors and educators with site-specific challenges and opportunities. This research is concerned primarily
with informal learning in public aquaria, but will also examine research regarding informal
learning at zoos due to similarities between these two venues.

### 2.2 Conservation and Ocean Literacy

According to the AZA, aquariums should promote conservation of underwater habitats,
and the animals that live in these habitats, through engaging educational experiences (AZA,
2009a). In fact, Rabb and Saunders (2005) claimed, “having a positive effect on the
conservation outlook and behaviour [sic] of visitors and other audiences is a distinct opportunity
and obligation for our institutions” (p. 6). Miller and colleagues (2004) defined conservation as
“a value-driven discipline based on the premise that the preservation of species diversity,
ecological systems, and evolutionary processes in nature is important to the maintenance of life
on our planet” (p. 87).

Recently, the worldwide population exceeded 7 billion people—a number that is
continuing to grow (United States Census Bureau, 2012). E.O. Wilson, a prominent biologist
and conservationist, estimated that the population should level off between 8 and 10 billion by
the century’s end (Wilson, 2002). Any increase in the population will necessarily be connected
to an increase in consumption of natural resources, an occurrence that many scientists feel our
planet cannot support (Primack, 2008; Wilson, 2002). Wilson (2002) listed the damages that
humans have caused up to this point: fresh water stores and arable lands have been overused and
are currently at levels he describes as “risky;” carbon dioxide levels are the highest they have
been in 200 years, and natural nitrogen and carbon cycles are unbalanced. Hansen, a climate
scientist, explained that humans alter the natural carbon cycle in two major ways: by the burning
of fossil fuels and deforestation (2009, p. 118). These two actions are tied directly to what
Hansen (2009) considered “the greatest threat civilization faces”: human-made climate change
Wilson (2002), on the other hand, asserted, “We are inside a bottleneck of overpopulation and wasteful consumption” (p. xxiii). Both scientists agree: an increasing population increases energy and other resource demands, which has directly—and negatively—impacted the environment and the organisms that live in it (Hansen, 2009; Wilson, 2002).

The exact nature of these impacts varies by geographical location, but all areas on our planet—terrestrial and marine—have been influenced in some way. As many as half of all species of plants and animals may be extinct by the end of the century, and some species will likely become extinct before scientists even identify them (Wilson, 2002). Species from all kingdoms are becoming extinct at a rate that is 100 to 1000 times greater than the natural background rates—the relatively constant extinction rates observed over most of the geological history (Primack, 2008). Further, Primack (2008) asserted, “more than 99% of modern species extinctions can be linked to human activity” (p. 127). Due to the complexity of ecosystems and species interactions, it is difficult to estimate the full impact of species extinction, but it is likely that species loss will significantly alter natural systems.

Although there is rarely a single reason for a species to go extinct, biologists have identified a number of potential causes of extinction. Wilson (2002) identified five factors that often work together to reduce biodiversity. Wilson’s five factors, given the acronym HIPPO, include the threats described by Primack (2008) above. These five factors are: habitat destruction, invasive species, pollution, population, and overharvesting (Wilson, 2002). These factors may vary in influence based on local physical and biological dynamics. However, Wilson (2002) said, “the prime mover of the incursive forces around the world is the second P in HIPPO—too many people consuming too much of the land and sea space and the resources they contain” (p. 50). As Wilson (2002) pointed out, the sheer number of people on the planet
(population) is an issue affecting biodiversity, but the amount and type of resources consumed is just as detrimental.

Although these are global issues, much of the destruction that occurs is “out of sight, out of mind” for most of the American population. As such, conservation-based education is becoming increasingly important. Informal science education facilities have a responsibility to bring this information to the public’s attention and determine how to best inspire conservation behavior. In fact, Ogden and Heimlich (2009) described aquariums and zoos as “purposeful collection[s] of animals used to further the cause of conservation through systematic education and research” (p. 357). Miller et al. (2004) stated, “to affect conservation, education needs to reinforce values and beliefs that have a positive effect on nature and change values and beliefs that have a negative effect on nature” (p. 90).

Gowin (1981) would argue that it is not enough to simply change an individual’s values and beliefs, as these are thoughts and feelings that do not necessarily translate into actions. If informal educators have any hope of affecting conservation, they must inspire changes in individuals’ thinking, feeling, and acting. Thus, the cognitive and affective domains are both worth addressing in informal education. One cannot expect individuals to act on conservation-based suggestions after being inundated and overwhelmed by dry facts; these presented facts must have both an intellectual and emotional component to be meaningful (Gowin, 1981). Ideally, by demonstrating conservation actions while also providing emotionally- and intellectually-appealing information, “our institutions can become transformative models, inspiring and motivating urban people around the globe to have a more harmonious and sustainable relationship with the natural world” (Rabb & Saunders, 2005, p. 1).
Recognizing that it would be nearly impossible to inspire visitors to embrace conservation of all natural habitats and all organisms during a single visit, many informal science centers focus their attention on the habitats and organisms showcased at their institution. As such, aquaria typically focus on marine and freshwater environments and inhabitants, though adjacent terrestrial areas may be highlighted as well. Marine environments are of particular concern as the ocean “defines and dominates everything about our planet. It covers most of our planet, is home to most of the life on Earth, regulates our weather and climate, provides most of our oxygen, and feeds much of the human population” (Ocean Literacy Network [OLN], 2011b). However, many children—and adults—do not fully grasp the importance of the ocean or the ways in which human actions impact aquatic ecosystems (OLN, 2011b).

Researchers involved with The Ocean Project found that “the public as a whole does not need to be convinced that ocean conservation is important” (Mott, Wong, & Meyer, 2011, p. 34). In particular, individuals who choose to visit an aquarium are already interested in the ocean and its inhabitants, at least in part. These visitors have a self-identity of being “green-friendly” (Mott et al., 2011, p. 35). By selecting to visit an aquarium as a leisure activity, these “green” visitors are seeking ways to project and reinforce this self-identity (Falk, 2009; Mott et al., 2011). However, it is unlikely that many of these “green” visitors are fully aware of the importance of the ocean and the effect of their personal actions upon the ocean.

Acknowledging this, scientists and informal marine educators formed the Ocean Literacy Network (OLN) in an effort to enhance the public’s understanding of ocean science. Specifically, the OLN has identified seven important principles related to the ocean, its inhabitants, and human impacts upon it. A truly ocean literate individual should understand these principles, be able to communicate them effectively, and use them to make informed, responsible decisions.
about the ocean and its resources (OLN, 2011a). Table 2.1 lists the seven Ocean Literacy Principles (OLP); these principles are further described in Appendix A.

Table 2.1. Ocean Literacy Network’s Seven Ocean Literacy Principles (OLP)

<table>
<thead>
<tr>
<th>OLP #1</th>
<th>The Earth has one big ocean with many features</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLP #2</td>
<td>The ocean and life in the ocean shape the features of Earth</td>
</tr>
<tr>
<td>OLP #3</td>
<td>The ocean is a major influence on weather and climate</td>
</tr>
<tr>
<td>OLP #4</td>
<td>The ocean makes Earth habitable</td>
</tr>
<tr>
<td>OLP #5</td>
<td>The ocean supports a great diversity of life and ecosystems</td>
</tr>
<tr>
<td>OLP #6</td>
<td>The ocean and humans are inextricably interconnected</td>
</tr>
<tr>
<td>OLP #7</td>
<td>The ocean is largely unexplored</td>
</tr>
</tbody>
</table>

Informal marine science education centers should be prepared to continue to educate the public about ocean science and the OLP. These educational efforts should be grounded by a solid theoretical foundation. According to Novak (2010), “a comprehensive theory of education is needed to give vision and guidance for new practices and research leading to the steady improvement of education.” Gowin’s theory on educating, described below, could inform new practices in informal education as these educators strive to teach the public about ocean science and the OLP.

2.3 D. B. Gowin’s Theory on Educating

During his time as a professor of education at Cornell University, D. B. Gowin insisted that educators and education researchers required a new theory on educating—one that drew from the fields of psychology and sociology, but did not rely exclusively on them.

Dissatisfaction with classical and behaviorist views of education led Gowin to describe a new change theory, one focused on “changes in the meaning of experience of persons” (Gowin, 1981, p. 39). The ideas of individually constructed meanings and meaningfulness are central to this
theory; Gowin (1981) asserts, “the key event is a teacher teaching meaningful materials to a student who grasps the meaning of the materials under humane conditions of social control” (p. 28, emphasis in original).

Educative events are purposeful interventions designed to change the learner’s meanings; as such, each event is influenced by the interaction of four “commonplaces:” teacher, curriculum, learner, and governance or social environment (Gowin, 1981, p. 25). Ideally, these four commonplaces work together in a manner that increases the student’s “effective intelligence and emotional responsiveness;” both cognitive and affective gains are considered important in this theory (Gowin, 1981, p. 47). In fact, Gowin (1981) asserted that understanding the meaning of a concept (cognitive gain) and recognizing the significance of the same concept (affective gain) leads to “a powerful moment in educating” that he calls “felt significance” (p. 43, emphasis in original). This felt significance has the potential to change a student’s behaviors, thereby integrating thinking, feeling, and acting—a primary goal in Gowin’s theory.

In his theory on educating, Gowin (1981) defined a number of concepts crucial to understanding meaningful educational episodes. Four of these concepts are particularly relevant to informal education and will be discussed in this review: educating, learning, teaching, and educative materials. In addition, this review contains support for Gowin’s theory from formal and informal education researchers; although these supporting researchers may not utilize or refer to Gowin’s theory explicitly, each is compatible with the main ideas expressed by Gowin. Further, this review will clearly demonstrate how Gowin’s theory, originally intended to explain aspects of formal education, is applicable to informal education.

2.3.1 On Educating. As mentioned earlier, “educating” and “schooling” are often used interchangeably, though the two concepts are not actually synonymous. Gowin (1981) was very
clear on this point: “at the present time, schooling is not educating…. Educating reduces boredom, enhances living, changes the meaning of human experience” (p. 16). He further defined educating as such:

Educating, as an eventful process, changes the meaning of human experience by intervention in the lives of people with meaningful materials, to develop thinking, feeling, and acting as habitual dispositions in order to make sense of human experience by using appropriate criteria of excellence. (Gowin, 1981, p. 35-36)

Gowin was careful not to define education in terms of test scores, passing grades, or time spent in lessons. Instead, he focused on meanings, thoughts, feelings, and actions, noting that any or all should be changed during a successful educational experience. In fact, Gowin (1981) asserted that the integration of thinking, feeling, and acting allows individuals to construct or change the meanings they attribute to the world around them.

2.3.2 On Learning. Gowin, like many educational theorists, separated educating and learning: The first concept relates to the social process of constructing shared meanings as enacted by two or more people and the second concept describes the learner’s role in constructing said meanings. Specifically, Gowin (1981) defined learning as “the active reorganization of an existing pattern of meaning” (p. 124). All individuals enter an educative event with an existing pattern of meaning, also called prior knowledge. This existing pattern of meaning is dictated by earlier experiences and the individual’s understanding of those experiences. Once the learner chooses to learn, he must actively build connections between prior knowledge and new knowledge, both of which must be meaningful for lasting learning to occur (Gowin, 1981). As more connections are made between the new and old information, personal meanings are likely to change. Gowin’s emphasis on meaning-making is in line with a constructivist epistemology, which asserts that learners actively create their own understandings in a manner that aligns with their own personal experiences in specific situations (Schunk, 2008).
Thus, learning is always situated within a physical and social context; interactions with other individuals will influence how the learner makes sense of his experiences and the meanings he makes from these experiences (Schunk, 2008).

**2.3.3 On Teaching.** As discussed above, learning is “the active reorganization of an existing pattern of meaning” and primarily the responsibility of the learner (Gowin, 1981, p. 124). Teaching, on the other hand, is “the achievement of shared meaning in the context of educating” (Gowin, 1981, p. 62). An educator’s job, then, is to assist the students as they construct their own meanings related to the phenomenon in question. To do this, Gowin (1981) asserted, the teacher has a responsibility to help the learner recognize what he already knows, what he needs to know, and which materials will help him gain this necessary knowledge. These materials are of paramount importance; the “retrieval and reconstruction of primary materials into educative materials is the main teacher-curriculum task” (Gowin, 1981, p. 74). By translating primary materials into age- and knowledge-appropriate educative materials, the teacher decides which meanings she wishes the student to grasp. During the educative episode, she should check to ensure the student is constructing meanings that are in agreement with the teacher’s intended message.

**2.3.4 On Educative Materials.** During the course of an educational event, teachers may use a variety of tools to help the learner construct meanings. Gowin (1981) asserted that teachers should design these materials in a manner such that they serve as an intermediary between difficult primary sources (such as scientific papers) and the students. Further, these materials should be vetted by teachers and other experts based on criteria of meaningfulness and excellence to ensure that students can potentially use them to construct meanings. According to Gowin (1981), educational materials must be considered “excellent” as judged by two standards:
those employed by the content area and those employed by education. Standards of excellence may vary between content areas; excellence in science may be concerned with factual knowledge whereas excellence in art may be concerned with beauty (Gowin, 1981). Standards of excellence in education relate to how well the material may be used to construct or negotiate meanings: how useful it is in educating.

2.4 J. D. Novak’s Human Constructivism and Gowin’s Theory

Joseph D. Novak, a colleague of Gowin’s at Cornell University, was also concerned with how individuals constructed their own meanings in efforts to understand the world around them, particularly in science education. Drawing from the same historical studies and epistemological ideals, Gowin’s theory and Novak’s theory of Human Constructivism share many key ideas, particularly related to the concepts of educating, learning and teaching (Gowin, 1981; Mintzes & Wandersee, 2005). Mintzes and Wandersee (2005) describe the three main tenets of Human Constructivism: human beings are meaning makers, the goal of education is the construction of shared meanings, and shared meanings may be facilitated by the active intervention of well-prepared teachers (p. 47-51).

Similar to Gowin’s emphasis on meaning-making, the first tenet of Novak’s Human Constructivism asserts that true meaning-making is a uniquely human activity; the ability of humans to communicate verbally allows us to share ideas and create meanings (Ausubel, 2010; Gowin, 1981; Mintzes & Wandersee, 2005). Although there can be consensus among individuals concerning certain meanings, Human Constructivism insists that no two individuals will construct exactly the same meanings when presented with identical information (Mintzes & Wandersee, 2005). Meaning construction is highly idiosyncratic and influenced by an
individual’s existing cognitive structure, which is determined by his or her previous experiences and understandings (Ausubel, 2010).

The second tenet of Human Constructivism (the goal of education is the construction of shared meanings) is reminiscent of Gowin’s definition of teaching as “the achievement of shared meaning in the context of educating” (Gowin, 1981, p. 62; Mintzes & Wandersee, 2005). From this view, a teacher’s role is not to merely deliver content; rather, he or she is to assist the student in constructing their own meaning regarding the concepts in question (Mintzes & Wandersee, 2005). To this end, the teacher and student must both approach the educational episode willing and prepared to change in some way.

Constructivism, in general, rejects the idea of “absolute truth,” insisting that reality is constructed by individuals and no one individual’s view or reality is true for everyone else (Schunk, 2008, p. 236). In its most extreme applications, this idea may pose a problem for science teachers as they are typically charged with teaching students about canonical scientific knowledge. Novak’s Human Constructivism addresses this concern. In this worldview, negotiation of meanings refers to a “coming to terms” and building robust explanations of scientific events, not simply a “compromise” between all individuals (Mintzes & Wandersee, 2005, p. 50). In fact, Mintzes and Wandersee (2005) cautioned, “science is decidedly not about compromise nor even about reaching unanimity of opinion” (p. 50). Therefore, it is imperative that teachers help students construct meanings that are aligned with current scientific understanding, while also recognizing their own limits of understandings and misconceptions.

The teacher’s role in meaning-making is further elucidated in the third tenet of Novak’s Human Constructivism: shared meanings may be facilitated by the active intervention of well-prepared teachers (Mintzes & Wandersee, 2005, p. 50). Here, Novak emphasized the need for
educators to be knowledgeable about not only their content area, but also about effective and applicable teaching strategies. Suggested teaching strategies include “graphic organizers, metacognitive tools, confrontation techniques and targeted analogies…. as well as the use of small groups, historical vignettes, and conversations about science” (Mintzes & Wandersee, 2005, p. 51). Educators are encouraged to examine the techniques they choose to make certain they are appropriate and useful in their own classrooms. The emphasis on “active intervention” is reminiscent of Ausubel’s (2010) emphasis on meaningful and active, rather than rote, learning to enhance retention of important information.

Both Gowin (1981) and Novak (2010) viewed educating as a purposeful intervention designed to help the learner construct meanings or to instigate “a change in the meaning of experience” (Novak & Gowin, 1984, p. xi, emphasis in original). These theorists agreed that individual meaning-making results from the integration of thinking, feeling, and acting and can be facilitated by the interactions between teachers and learners (Gowin, 1981; Novak, 2010; Novak & Gowin, 1984). Learning is the responsibility of the learner, who must choose to learn new material in a meaningful manner (Novak & Gowin, 1984). Novak (2010) clarified,

Meaningful learning is a process in which new information is related to an existing relevant aspect of an individual’s knowledge structure…. The learner must actively seek a way to integrate the new information with existing relevant information in her or his cognitive structure. (p. 59-60).

Gowin (1981) and Novak (2010) both emphasized the importance of a learner’s prior knowledge and the teacher’s responsibility to recognize the extent of the learner’s prior knowledge. In fact, Novak and Gowin (1984) quoted Ausubel: “The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly” (as cited in Novak & Gowin, 1984, p. 40). Thus, teaching relates to the educator’s role in helping a student utilize his or her prior knowledge and current experience to construct new meanings that
are compatible with the educator’s intended meanings (Gowin, 1981; Mintzes & Wandersee, 2005).

2.5 Michael and Modell’s Active Learning and Gowin’s Theory

Michael and Modell (2003) encouraged teachers and students to take a hands-on, minds-on approach to education, particularly science education. In active learning experiences, they contended, students and educators alike are actively involved in the experience; thinking, speaking, working, and interacting together in order to clarify meanings (Michael & Modell, 2003). Like Gowin and Novak, Michael and Modell (2003) also embraced a constructivist philosophy on learning, claiming:

Knowledge cannot be transmitted from one individual to another individual in any mode. Knowledge is built by the learner using internal cognitive processes acting on stimuli from the environment. The result is a mental representation, or model, of the “real world” that can be used to solve problems. (p. 5, emphasis in original).

It is for this reason that the learner is ultimately responsible for learning, not the teacher. In fact, the teacher’s primary responsibility is simply “helping the learner to learn” (Michael & Modell, 2003, p. 9). Similar to Novak (2010), these researchers discouraged rote learning in favor of meaningful learning, which they defined as “learning with understanding” (Michael & Modell, 2003, p. 14). To enhance learning with understanding, students should strive to link new material to old material, thereby incorporating the new material into their existing cognitive structure. Stronger, more meaningful connections between old and new knowledge increases the likelihood that new information will be retained, presumably allowing for easier retrieval in the future (Ausubel, 2010; Michael & Modell, 2003).

Michael and Modell (2003) emphasized the importance of actively constructing multiple representations of new knowledge for meaningful learning. By “multiple representations,” these authors simply mean different ways of examining, sorting, categorizing, explaining or
connecting the new knowledge in light of the old knowledge already possessed by the learner (Michael & Modell, 2003). Increasing the number and type of meaningful links increase the likelihood that the information will be remembered. Although quick to remind the reader that learning is primarily the responsibility of the learner, Michael & Modell (2003) suggested that educators can help learners build these multiple representations in two ways: (a) present the information using a variety of senses (vision, hearing, touch) or (b) provide different examples of the phenomenon in question.

Gowin’s and Novak’s positions on teaching, while philosophically important, do not necessarily provide teachers with a pragmatic “blueprint” as to how this shared meaning-making might occur. Michael and Modell (2003) clearly described how educators should approach an educative event, asserting that teaching should be dictated by the students’ input state, the desired output state, and the learning experience itself.

Formal and informal educators alike know that learners do not come to the educational experience as a “blank slate.” Every individual has a set of prior knowledge, experiences, and interests that is unique and greatly influences any future learning. Michael and Modell’s (2003) concept of “input state” describes where learners actually are at the beginning of the lesson. This includes the students’ existing cognitive structure, emotional maturity, pre-existing misconceptions, and expectations related to the learning experience (Michael & Modell, 2003). It would be impossible to ascertain all of this information for every single student present during a lesson, but the authors encouraged educators to attempt to acquire a general understanding of these factors, particularly by engaging learners in active discussions prior to, and during, any lessons. Identifying the students’ input state is a crucial first step in teaching (Michael & Modell, 2003).
In addition to understanding the students’ input stage, an educator must be able to clearly define the desired output state. This output state includes any skills, knowledge, or attitudes the student should gain by the end of the lesson, or what the student should “be able to do upon completing the learning experience” (Michael & Modell, 2003, p. 28). Ideally, learners and educators should both be included in defining the output state (Stevens & Levi, 2005). At the very least, educators should inform learners of the expected output state prior to the lesson. Elucidating the end goals is also a crucial step in teaching; Michael and Modell (2003) claimed this “provides direction for designing appropriate learning experience[s]” (p. 42).

Educators have little control over students’ input state, given that the input state relates to all that came before the lesson. However, in an attempt to help students reach the output state, educators have greater control over the learning experience: “the set of activities, classroom experiences, and intellectual challenges that the instructor has designed to help students reach the desired output state” (Michael & Modell, 2003, p. 29). Similar to the other researchers described in this review, Michael and Modell (2003) placed a heavy emphasis on teaching that provides meaningful learning experiences, whereby learners build and test their own mental models. Since each learner’s mental model is unique, students cannot build and test these models by listening passively as the educator describes the phenomenon in question. Truly meaningful learning, Michael and Modell (2003) asserted, occurs only when students are actively engaged in the lesson. Thus, teaching should include opportunities for active engagement.

For many educators, “active engagement” may suggest physical movement—hands-on or discovery learning. Although Michael and Modell (2003) did not discourage physical activity during lessons, they were more concerned with mental activity. Further, they insist that active learning can occur in any setting, even if students are sitting completely still in a lecture hall. In
teaching, the educator’s job is to assist students in understanding what mental activities are appropriate, encourage students to engage in these appropriate activities, and provide opportunities for students to be mentally active. Being mentally active can include students checking their prior understanding against newly presented information, building connections between new and old information, and asking for clarification on points they do not understand. Each of these active learning techniques can only be performed by the student. For this reason, Michael and Modell (2003) said, “we must keep in mind that the responsibility for learning lies with the learner” (p. 53).

At the same time, educators can assist students in their learning by creating an active learning environment full of active learning experiences. Michael and Modell (2003) asserted that any learning environment can become more active if both the teacher and student are willing to commit to a new way of learning. Unlike Gowin, who focused on educative materials, Michael and Modell (2003) focused on educative techniques. The primary educative technique Michael and Modell (2003) suggested using is teacher-student dialogue that probes for true understanding. This dialogue should not ask for true-false or right-wrong answers; instead, this dialogue should seek to illuminate students’ mental models through in-depth explanations. Students could be tasked with making predictions, connecting two previously unrelated topics, or explaining an observed phenomenon in their own words. By engaging students in active dialogues, teachers can quickly and easily assess the concepts students understand, the misconceptions students continue to hold, and the progress students are making towards the desired output state. Additionally, teachers are able to adapt the learning experiences in such a way to more fully support the students’ learning for understanding, or meaningful learning (Michael & Modell, 2003).
2.6 Gowin’s Theory and Informal Education

While all of the above constructs, ideas, and theories were intended to address formal science education (that which occurs in schools and laboratories), these can be directly applied to informal science education (that which occurs outside of the classroom). The following section of this literature review examines four main concepts Gowin (1981) described (educating, learning, teaching, and educative materials) in light of the unique opportunities and challenges present in informal science education centers.

2.6.1 On Educating. All of the educational theorists described above agreed that a primary goal of education is to make or change meanings. Novak and Gowin (1984) stated, “an education that intervenes in the lives of children creates a world they could never see without the education” (p. 11). Informal science education centers are uniquely positioned to help members of the public achieve this goal; an aquarium, for instance, allows visitors to enter and experience a world that is typically unseen. By examining creatures that are usually hidden, thinking about the patterns they see, and participating in conversations with educators or other visitors, individuals can construct meanings about underwater habitats and ocean inhabitants. Ideally, this exposure may encourage feelings such as wonder, amazement, or empathy, thoughts about the importance of a healthy ocean, and future actions related to conservation. The interplay of these feelings, thoughts, and actions may help a visitor construct or change the meanings he attributes to concepts such as “ocean,” “shark,” “science,” or “conservation.”

The educational opportunities offered at informal science education centers are dictated by exhibit and program design; Davidsson (2009) argued that each exhibit is “a result of conscious and unconscious choices of what aspects of science to include or exclude” (p. 199). She found that staff members charged with exhibit design at Nordic science and technology
centers were less concerned with scientific content and more concerned with issues of “practical and organisational [sic] character” (Davidsson, 2009, p. 204). Although the results of Davidsson’s (2009) study may or may not generalize to American institutions due to cultural and institutional differences, she rightly pointed out that staff members and educators at these informal science education centers can be seen as guardians of knowledge—the knowledge educators and exhibit designers consider important is more likely to be highlighted in exhibits and programs (Davidsson, 2009).

A visitor’s familiarity with the knowledge presented at informal science education centers is likely to be determined by her prior knowledge and experiences. Anderson, Lucas, Ginns, and Dierking (2000) researched the experience of 11- and 12-year-old students at an interactive science museum. These researchers asserted, “visits to informal learning centers often result in the students experiencing many phenomena and ideas that are new to them” (Anderson et al., 2000, p. 659). On the other hand, Falk and Needham (2011) found that adults visiting a science center were less likely to feel the presented information was entirely “new;” adult visitors reported learning about things they “sort of already knew” (p. 10). Ash (2003) claimed this differentiated knowledge of family groups—and, presumably, social groups—can lead to scientific dialogue among group members. This dialogue is an important facet of educating in informal centers as it allows visitors to construct their own meanings with the input of others from their social group. In addition, Pedretti (2004) argued that dialogue can encourage deep thinking about and lasting interest in science and science concepts.

However, informal educators must present opportunities for this dialogue to occur, particularly by providing content that invokes dialogue (Pedretti, 2004). Martin (2004) stated, “we know that scientific discourse is not likely to arise spontaneously” during informal science
education experiences (p. S73). Instead, educators at informal science education centers should attempt to purposefully scaffold this discourse or dialogue between visitors. Mortensen and Smart (2007) found that use of free-choice worksheets focused on observation of objects increased curriculum-related or science-related conversations during school field trips. Similarly, Pedretti (2004) found, “extensive scaffolding (i.e. through science center educational guides…) significantly enhances visitor experiences and the making of meaning” (p. S43). Thus, the educational mission of an informal science education center, such as an aquarium, could be furthered through the use of appropriate educational materials that encourage scientific dialogue between visitors and enhance meaning-making.

2.6.2 On Learning. According to Gowin (1981), learning refers to the learner’s role in constructing new meanings; the learner (or in informal education, the visitor) must choose to make meaningful connections between new and old information. The educators cannot make this choice, as their job is simply to help the learner to learn (Michael & Modell, 2003). If the learner decides to engage with the presented material in a meaningful way, she will not simply walk through exhibits passively, glancing at displays and skimming over signs. Instead, she may choose to speak with an educator about her past experiences with the ocean, connect a presented idea to something she learned in school, or read a sign that interests her and summarize it for a companion. In each of these instances, the visitor could incorporate the new material into her existing cognitive structure, making connections between that which she already knows or is interested in and the new information presented by the aquarium’s education team. Since these connections are based on knowledge and interests that are somewhat unique to this visitor, the meanings she makes are likely to be highly idiosyncratic and personalized. In addition, her
meanings will be unlike the meanings made by any other visitor, even those in her social group who are viewing the same exhibits at the same time!

Learning, including learning that occurs in informal education centers, is highly idiosyncratic and potentially difficult to measure. Rennie and Johnston (2004) reminded educators that learning is personal, is contextualized, and takes time. Storksdieck and colleagues (2005) stated that the evidence for learning at informal science education centers has been “weak” (p. 353) because profound changes in attitude and understanding take time. Lukas and Ross (2005) found that a quick visit through a zoo exhibit contributed to a small increase in knowledge about apes, but not a change in attitudes. Further, they claimed, “a casual zoo visit may not fully impart the educational messages zoos intend to provide” (Lukas & Ross, 2005, p. 41).

Other researchers have published evidence that learning does actually occur in informal science education centers. Sherwood et al. (1989) found that students who handled live horseshoe crabs and sea stars displayed short- and long-term cognitive and affective gains. Falk and colleagues (1998) found that visitors’ motivations influenced their learning; individuals with high education motivations showed significant conceptual learning and individuals with high entertainment motivations showed significant vocabulary development and an increase in overall understanding of the topics on display. Years later, Falk and Dierking (2010) summarized their own work and that of other researchers interested in visitor learning:

The majority of visitors significantly increase their conceptual understanding of science on a variety of levels—basic information, breadth, and depth of understanding—immediately following a visit, and for most of these individuals this understanding persists and grows for two or more years after the experience. (p. 488)

Storksdieck and colleagues (2005) encouraged researchers to broaden the definition of learning used in informal education research. These researchers encouraged the examination of
alternative learning outcomes, such as incidental learning outcomes, broader outcomes, and re-affirmation outcomes in addition to conceptual understanding (Storksdieck et al., 2005).

After reviewing over 40 studies conducted on visitors’ understanding of conservation topics at the Monterey Bay Aquarium, Yalowitz (2004) outlined five main themes:

- “Visitors notice and remember conservation information,
- Visitor variable affect the salience of conservation information,
- Visitors learn new ocean conservation information at the aquarium,
- Visitors want more conservation information,
- Affecting behavior change in visitors is challenging, complicated, and difficult to measure” (pp. 285-286)

This suggests that, at least at the Monterey Bay Aquarium, visitors are aware of, receptive to, and learning about the conservation message promoted by educators in aquaria (Yalowitz, 2004).

Given the conflicting evidence presented above, one can reasonably assert that learning in informal science education centers is a highly complex undertaking that is difficult to measure and demonstrate. At an informal science education center, learning is influenced by the interaction of a variety of factors—such as visitor interest, motivation and prior knowledge—and results from the intersection of three contexts—the personal, social, and physical context (Falk & Dierking 1992/2011; Falk & Storksdieck, 2005). These factors will be discussed in a later section. Even with these difficulties and complexities, Falk and Dierking (2010) claimed that “free-choice learning experiences represent the single greatest contributors to adult science knowledge; childhood free-choice learning experiences also significantly contributed to science knowledge” (p. 489).
2.6.3 On Teaching. Teaching refers to the educator’s role of helping the learner construct meanings (Gowin, 1981). Gowin (1981) asserted that choosing which educative materials to use is one of the educator’s main curriculum-related tasks. This is true in informal education; informal educators are tasked with deciding which programs to offer, which concepts to discuss, and which facts to highlight. Given that any learning that occurs in informal education centers is voluntary, free-choice, and guided by the visitors’ needs and interests, educators should be aware of visitors’ needs and interests (Tofield, Coll, Vyle, & Bolstad, 2003). Further, educators should use this knowledge to design programs that appeal to visitors’ interests and address concepts in a manner that is scientifically accurate.

According to Michael and Modell (2003), the educator should strive to ascertain the learner’s input state or prior knowledge, identify the output state or the goals of the educative event, and design a learning experience that assists the learner in moving from the input state to the output state. In informal education, this may be particularly difficult as visitors are typically at the venue for a short period of time, each visitor enters the learning experience with a vastly different input state, and each visitor may have a different desired output state—one that may or may not align with the stated goals of the informal education center. Educators can address these difficulties through conversations with individual visitors or by offering numerous programs that appeal to a variety of different needs, interests, and background knowledge levels.

2.6.4 On Educative Materials. As described above, learning is the responsibility of the learner and an educator can only help the learner to learn by choosing proper educative materials (Gowin, 1981; Michael & Modell, 2003). As such, educators working in an informal environment cannot force visitors to interact with or make meanings from the material presented. Allen (2004) calls this a “constructivist dilemma”:
We expect these institutions to provide a hugely diverse visiting public with entertainment, the freedom to choose their own path, follow their personal interests, do their own inquiry, and create their own meanings. Yet at the same time, we want our museums to be respected educational institutions where people can spend an hour and come away having learned some canonical science. (p. S18)

To this end, informal education researchers have determined a number of factors related to educative material design that may encourage visitors to engage in meaningful learning. In informal settings, educational materials—such as exhibits, signage, and presentations—should (a) be scientifically accurate; (b) clearly elucidate difficult scientific concepts; (c) be potentially meaningful, related to the visitor’s prior understanding; (d) encourage thoughtful examination of presented material, rather than rote memorization; and (e) allow for active learning, in which visitors are physically and mentally active during the learning experience.

After over a decade of researching visitors’ interactions with hands-on exhibits, Allen (2004) described four main aspects of exhibit design that engage visitors and support visitor learning. Allen (2004) asserted that exhibits, a specific type of educative material, should be designed in a manner such that they are:

- **Immediately apprehendable:** visitors introduced to an exhibit for the first time “will understand its purpose, scope and properties almost immediately and without conscious effort” (Allen, 2004, p. S20). Although visitor understanding is determined in large part by an individual’s prior knowledge, educators can assist visitors by adopting an easy-to-understand, user-centered design. This reduces the amount of effort used by a visitor in answering questions such as “what is this?” and allows them to focus on questions such as “what does this mean for my life?” In reducing the amount of cognitive energy necessary to initially identify the purpose of the exhibit, designers allow visitors to increase the amount of cognitive energy used in making meaning from the exhibit.
• **Physically interactive:** many informal science education centers contain exhibits that respond to visitor actions and are physically interactive. This hands-on experience “is the part of science learning that involves giving the learner access to the key phenomena of the natural world” (Allen, 2004, p. S24). However, some science education researchers caution that educative materials should be hands-on and minds-on (Michael & Modell, 2003). It is not enough for the learner to be encouraged to touch something; he must also be encouraged to **think** about what he has touched. In an aquarium, many of the exhibits cannot be physically interactive as human/fish interactions may be harmful to the human or the fish. At the same time, some exhibits, such as touch tanks or shell carts, allow visitors to touch and manipulate living animals and artifacts. Such exhibits may be particularly memorable for visitors and can be used to further the institution’s educational mission (Sherwood et al., 1989).

• **Conceptually coherent:** educators and exhibit designers recognize underlying themes and connections among and between exhibits, but research has shown “that most visitors did not fully recognize the intended themes” at the Exploratorium (Allen, 2004, p. S26). This lack of recognition is an issue at many informal science education centers; educators and exhibit designers should attempt to make these themes and connections more easily apparent to visitors. By clearly elucidating important concepts described or displayed in exhibits, educators can help visitors integrate new information into their existing cognitive structures.

• **Applicable to diverse audiences:** visitors to informal science education centers vary in background knowledge, interests, skill sets, and abilities. Allen (2004) charged that informal science education centers should “be more inclusive of diverse people in all
aspects of their operations and offerings” (p. S27). As such, exhibits should be multisensory and multimodal: using different senses, appealing to different learning styles, and applicable to different knowledge levels. Additionally, exhibits should address the concerns and interests of different groups of individuals.

Although Allen’s work was conducted at the Exploratorium, a well-known science center in San Francisco, California that promotes hands-on inquiry, each of these design aspects could be useful in a variety of informal science education centers, including aquaria. Exhibits in new aquaria could be designed as meaningful educational materials according to Allen’s criteria outlined above. It may not be feasible to re-design exhibits in an existing aquarium as aquarium tanks, once established, may be difficult to change to any appreciable extent. However, the manner in which these exhibit tanks are used by educators and volunteers could easily be changed to address Allen’s design criteria. Interpretive programs and tours could be designed in such a way that the existing exhibits could be used as effective educative materials.

Similarly, Simon (2010) encouraged informal educators to adopt a participatory approach to creating educative materials, including exhibits, signage, and programs. These materials should allow or even encourage visitors to interact with educative materials, interact with each other, contribute ideas or objects to the exhibits, control the messages displayed by educative materials, and use the center to express their own identity. In a participatory informal education center, “the institution serves as a ‘platform’ that connects different users who act as content creators, distributors, consumers, critics, and collaborators” (Simon, 2010, p. 2).

Simon’s (2010) emphasis on participation and interaction encourages visitors to make meaningful connections between their own lives and the information on display, often by explicitly discussing these connections with others. As mentioned previously, increasing the
number and type of connections an individual makes between new information and old information increases the likelihood that the new information will be integrated meaningfully into an individual’s cognitive structure; thus, it will be more easily retrieved in the future (Gowin, 1981). In short, an increased number of personal connections to the new material could lead to meaningful learning of this material. Additionally, Simon (2010) argued that participatory educative materials allow visitors to gain specific skills, giving them the ability to “collaborate and interact with people from diverse backgrounds; generate creative ideas both alone and with others; access, evaluate, and interpret different information sources… be self-directed learners” (p. 193-194).

However, not all participatory educative materials are particularly useful; these materials must also pass the tests of excellence Gowin (1981) discussed. Simon (2010) emphasized the need for any participatory educative materials to be audience-centered; instead of focusing on the information the center wishes to provide, educators should begin the design process by “mapping out audiences of interest and brainstorming the experiences, information, and strategies that will resonate most with them” (p. 35). In other words, the presented experiences, information, and strategies should be meaningful for visitors and appeal to a wide diversity of audiences. If an informal education center asks visitors to create educative materials, the center must carefully scaffold the process by providing explicit expectations and instructions for creation. Visitors are more likely to participate in creating educative materials if they believe the work will be of true value to the institution and other visitors (Simon, 2010). Regardless of whether the visitors are asked to interact with or create educative materials, these experiences should be fulfilling for visitors. Falk (2009) asserted that visitors strive to achieve personal identity-related goals during a museum visit; participatory educative materials should assist visitors in this regard.
Although Simon (2010) acknowledged that many types of educative materials can be re-framed in a way that encourages participation, she focuses on three types specifically: exhibits, comment boards, and tours. In order to make each of these more participatory, Simon (2010) encouraged the use of dialogue, in a manner that is similar to Michael and Modell’s (2003) approach to active and meaningful discussions. Simon (2010, p. 139) identified three primary reasons to ask visitors questions:

- To encourage visitors to engage deeply and personally with a specific object
- To motivate interpersonal dialogue among visitors and around a particular object or idea
- To provide feedback or useful information to staff about the object or exhibition

These questions can either be personal or speculative. Personal questions ask an individual to relate the material to a prior experience, “What is your favorite part of a trip to the beach? Why?” Speculative questions use objects and evidence to provide creative, imaginative responses to speculative questions that have no “right” answer. Aquarium visitors could be asked the speculative question, “What would your world be like if you were a shark? What would you miss most about the ocean if it were to disappear tomorrow?” In both types of questions, educators are inviting visitors to share their own thoughts, feelings, and memories—not only with the educator, but also with each other. If educators choose to use educative materials that utilize questions, they should find a way to acknowledge visitors’ answers in a manner that is both meaningful and fulfilling. In addition, Simon (2010) reminded educators to “respond to participants’ questions and thoughts instead of pushing your own agenda” (p. 158). As discussed above, participatory educative materials should always be audience-centered.
2.7 Factors That Affect Learning in Informal Environments

Falk and Dierking (1992/2011) asserted that three contexts interact during an individual’s museum visit: the personal context, the social context, and the physical context. The personal context is influenced by the visitor’s prior experiences; this context includes the visitor’s interests, prior knowledge, personal motivations, and self-identity (Falk & Dierking 1992/2011). The social context is influenced by the visitor’s interactions with others, including individuals from their own social group, strangers, and museum personnel (Falk & Dierking, 1992/2011). The physical context relates to the setting of the institution; an aquarium’s physical context often includes low lighting, fish tanks, and benches or seating at larger exhibits (Falk & Dierking, 1992/2011). The elements included in Falk and Dierking’s (1992/2011) physical context may contribute to a phenomenon described as museum fatigue. These three interconnected contexts, and their potential implications, are discussed below.

2.7.1 The Personal Context. A visitor’s interests, prior knowledge, and personal motivations—Falk and Dierking’s (1992/2011) personal context—greatly influence the ways in which she experiences an informal science education center, the exhibits she focuses on, and the information she will remember after her visit. Packer and Ballantyne (2002) sought to determine which motivational factors inspired an individual to attend a museum, an aquarium, and an art gallery. These researchers asserted, “motivational factors include both the personal characteristics that visitors bring with them to the visit, such as personal goals and capability beliefs, and the situational characteristics that they find in the setting itself, such as opportunities for learning, and aspects that arouse interest” (Packer & Ballantyne, 2002, p. 185). In all three informal education centers, Packer and Ballantyne (2002) found five categories of visitor motivations, framed by visitors’ expectations of what they might gain from the experience:
• *Learning and discovery*: visitors expected to learn new things, expand their knowledge, become better informed, and experience something new or unusual

• *Passive enjoyment*: visitors expected to enjoy themselves and to feel happy or satisfied

• *Restoration*: visitors expected to be able to relax physically and mentally, to feel less stress, to recover from their daily life

• *Social interaction*: visitors expected to spend time with family and friends, to interact with others

• *Self-fulfillment*: visitors expected to challenge their abilities or understanding, to make things more meaningful, and to develop self-knowledge and self-worth

As one would expect, stated motivations varied between individuals and between sites. Aquarium visitors ranked *passive enjoyment* as the most important motivation, with *learning and discovery* as the second most important motivation (Packer & Ballantyne, 2002). This suggests that visitors see an aquarium more as an entertaining and enjoyable leisure setting than as an educational setting. However, this does not mean that visitors did not expect to learn at the aquarium; they viewed the aquarium as a place that offered many learning opportunities and a place where learning is fun (Packer & Ballantyne, 2002). In sum, these researchers found that although aquarium visitors felt *passive enjoyment* was the most important motivational factor, all visitors to the three informal education centers were open to “discover new things, expand their knowledge and be better informed” (Packer & Ballantyne, 2002, p. 195).

After decades of research on learning at informal education centers, Falk (2009) found that visitor identity—another facet of the personal context—was the most important factor influencing an individual’s choice to visit an informal education center, as well as how the individual would utilize the center during the visit. Individuals seek ways in which to express
and reinforce their self identities, particularly in the leisure experiences in which they choose to engage. Falk (2009) defined identity as

… a reflection and reaction to both the social and physical world we consciously perceive in the moment, but identity is also influenced by the vast unconscious set of family, cultural, and personal history influences each of us carries within us. (p. 72)

Thus, our identities are built upon our prior experiences, background knowledge, relationships with others, and understanding of the world. Identity is “the combination of both internal and external social forces—both cultural and individual agencies contribute to identity” (Falk, 2009, p. 72).

Overall, Falk, Heimlich, and Bronnenkant (2008) found that visitors entered the learning experience with specific expectations as to what opportunities the informal educational center afforded; these expectations were typically tied to the visitors’ identity-related motivations. Visitors approached the experience in a manner that addressed their expectations and identity-related motivations—if these expectations and motivations were met, the experience was seen as satisfactory (Falk et al., 2008). These researchers suggested that museum educators and professionals should design intervention strategies, such as tours and programs, that appeal to a variety of identity types in order to enhance cognitive and affective outcomes.

2.7.2 The Social Context. Falk and Dierking’s (1992/2011) social context encompasses all potential social interactions that may occur at a museum or an aquarium: interactions between members of an intact social group, interactions with other visitors, and interactions with educators, volunteers, or staff members. These social interactions are important; as Gowin (1981) said, “educating is a social event of sharing meanings” (p. 10). At an aquarium, the construction of these shared meanings is mediated by the visitor’s interactions with exhibits and companions (Packer & Ballantyne, 2005). Packer and Ballantyne (2005) described the five
potential benefits of social interaction in learning as originally explained by education researcher Paris: “the shared goal of learning together enhances motivation; people stimulate each other’s imaginations; and there are social supports for learning… learning through observation and modeling, and providing benchmarks for monitoring accomplishment” (p. 187). The importance of social interactions has been discussed extensively in theoretical literature on learning in informal environments (e.g. Falk, 2009; Falk & Dierking, 1992/2011). However, little research has been conducted on the effects of social interaction among visitor groups—particularly non-family groups (Falk & Dierking, 1992/2011).

Research on family group interactions suggests that conversations are of paramount importance as individuals attempt to construct meanings at informal science education centers (Falk & Dierking, 1992/2011). Walters (2006) found that the interaction between an adult and a child led to more “constructivist or inquiry-like behavior” (p. 27) than the interaction between two children without an adult present. Although the researcher does not provide a concrete definition of “constructivist or inquiry-like behavior,” he alluded to higher-order questioning in the article, suggesting that the presence of an adult can lead to questions that may enhance learning (Walters, 2006). Tunnicliffe and Scheersoi (2009) provided more specific examples of visitor conversations; these researchers found that visitors “look for an animal, name it, describe salient features and behaviours [sic], make affective comments… and interpret in anthropomorphical terms” (p. 19) as well as discuss “human/animal interactions” (p. 20). These conversations are common among family groups (Tunnicliffe, 2008); as described above, parents often assume the role of facilitator for their child’s learning (Falk, 2009).

However, Briseño-Garzón, Anderson, and Anderson (2007) asserted that adults visiting the aquarium as part of a family group are not only facilitators for younger visitors—these adults
are independent learners as well. Adult visitors in family groups were unlikely to see the trip as an opportunity for adult learning, but these individuals did, in fact, show cognitive and affective gains after the visit (Briseño-Garzón et al., 2007). Briseño-Garzón and colleagues (2007) suggested designing activities and programs that allow diverse interactions among family members and encourage all members of the family group to engage in age- or knowledge-appropriate learning.

As mentioned above, little research has been conducted on social interactions of non-family groups, although these groups constitute a considerable portion of aquarium and museum attendance (Falk & Dierking, 1992/2011). Theoretical arguments have been made that social interactions affect, and perhaps even enhance, learning in informal science education centers (Falk, 2009; Falk & Dierking, 1992/2011). Packer and Ballantyne (2005) examined the experiences and learning of solitary adults and paired adults visiting a museum in Australia. Although there were differences between the groups—the pairs spent more time speaking to other visitors, spent less time reading text, and spent more time looking at displays—both solitary and paired visitors reported learning at the museum (Packer & Ballantyne, 2005). Packer and Ballantyne summarize their results and state “these findings indicate that neither solitary visitors nor those with companions have any advantage in terms of the learning they experience during their visit” (p. 186). Given the emphasis on social interactions in the literature, this conclusion is somewhat surprising; one might expect greater learning to result from social interactions. However, the authors were quick to note that these findings do not contradict the benefits of social interaction. Rather, the authors suggested that there may be parallel benefits associated with solitary learning (Packer & Ballantyne, 2005). More research is needed on the interactions between adults in social groups.
2.7.3 The Physical Context. The physical context, as described by Falk and Dierking (1992/2011), includes elements of the setting: the architecture of the building, resting spaces, and objects contained within the building. Certain aspects of the physical context, such as lack of carpeting or comfortable seating areas, may increase the possibility of a phenomenon some museum researchers describe as “museum fatigue” (Falk & Dierking, 1992/2011). Some museum researchers and practitioners claim that museum fatigue can affect visitors and influence the ways in which they experience the aquarium. However, there has been considerable disagreement as to what, exactly, constitutes museum fatigue.

In the 1920s and 1930s, early museum researchers described museum fatigue as “decreased attention (either stopping at exhibit displays or viewing time) across successive exhibit viewing” (Bitgood, 2009). More recently, researchers have expanded the concept of museum fatigue to include not only decreased attention, but also decreased interest and increase in “cruising behavior” after a certain amount of time (Davey, 2005). Serrell (1997) found that visitors spent less than 20 minutes in exhibitions, suggesting that visitors’ interest and attention was limited. Falk, Koran, Dierking, and Dreblow (1985) found that visitor interest started at a high level, stayed at this high level for approximately 30 minutes and then decreased to a low level. During this low interest period, visitors were more likely to move quickly through exhibits and were more selective as to which exhibits they stopped to view intensely (Falk et al., 1985). Davey (2005) stated that this behavior is “indicative of diminished interest towards exhibits” (p. 18). Although these studies look at the entire museum visit, “museum fatigue” has also been used to describe similar behaviors within a single exhibition gallery (Bitgood, 2009; Davey, 2005).
“Fatigue” implies physical or mental exhaustion, yet Bitgood (2009) was quick to point out that sheer exhaustion does not explain visitor behavior within a single exhibition hall. Thus, he asserted, museum fatigue may be a combination of processes: “physical and mental exhaustion, satiation, competition, choice, and poor design” (Bitgood, 2009, p. 199). Davey (2005) claimed “there is interplay between visitor attributes (cognitive processing) and environmental factors (exhibit design)” that contributes to museum fatigue (p. 19-20). Incorporating the original definition and more recent research, Davey (2005) offered a new definition of museum fatigue:

A collection of phenomena that represent predictable decreases in visitor interest and selectivity either during entire visits, within smaller areas (such as exhibit galleries), or across a few successive exhibits. These changes are likely to be attributed to a combination of such visitor factors (such as cognitive processing, physical fatigue and individual characteristics), factors in the environment (such as exhibit architecture and the museum setting), and interaction between them. (p. 20).

Bitgood (2009) asserted that the behaviors described as museum fatigue are actually avoidance behaviors to stave off exhaustion; visitors are more selective as to what elements they choose to attend to in an effort to reduce the amount of mental or physical energy they must exert during the visit. Rounds (2004) suggested that museums (including aquaria) offer “too much to see in a single visit,” which forces the visitor to make choices regarding how he allocates his attention among different exhibit elements (p. 395). Selective viewing may reduce museum fatigue and is, Rounds (2004) asserted, a successful visit strategy for the curiosity-driven visitor. In addition to selective viewing, Bitgood (2009) suggested that museum fatigue may be lessened by the “use of effectively designed pamphlets and self-guides” that shape the visitor experience (p. 196).

2.8 Summary

Aquariums have evolved from small, private collections of hardy fish to larger, public institutions that blend entertainment and education in a leisure setting. The learning that occurs at aquaria and other non-school science education centers is known as informal learning; this
learning is voluntary, non-assessed, and socially mediated. Educators, researchers, and scientists have presented arguments for of a variety of topics and concepts to be incorporated as part of the “curriculum” of aquaria. These topics include conservation, the Ocean Literacy Principles, the *Strands of Informal Science Learning*, and others. However, research suggests that the highlighted topics and concepts should also encompass visitor interests in order to increase visitor engagement and potential learning.

Learning in informal science education centers is often difficult to describe and measure, particularly because it may not “look” like traditional, school-based learning. In addition, this learning is idiosyncratic and influenced by a variety of contexts (the personal, social, and physical contexts). As in all educational settings, the learner must choose to learn, and this choice is dictated by the learner’s motivations, interests, prior knowledge, and self-identity. Given that each visitor and each visit is unique, the learning that occurs at informal science education centers is incredibly complex.

However, researchers can begin to understand this learning by examining it through one or more theoretical lenses. This review—and by extension, this research—is informed by the theoretical work of Gowin, Novak, Michael and Modell, Falk, and Simon, among others. Gowin’s work, particularly concerning the concepts of educating, learning, teaching, and educative materials, is of paramount importance. It provides a structure upon which an argument is built that contends that learning in informal environments could be enhanced by the use of properly designed educational materials that encourage thoughtful, meaningful, and memorable discussion amongst visitors.
2.9 References


Chapter 3. Methods

3.1 Purpose of Study

This two-phase, five-part qualitative study sought to determine the impact of specifically-designed educational materials on aquarium visitors’ experiences and related learning. These educational materials, known as Visitors’ Interpersonal (VIP) Discussion Guides, combined visitor interests, important science concepts, and research on learning in informal environments in a series of questions related to exhibits in the North Carolina Aquarium at Fort Fisher (NCA-FF). Formal and informal education researchers have found that discussions, either between educators and students or within social groups, encourage meaningful, memorable learning (Gowin, 1981; Michael & Modell, 2003; Pedretti, 2004; Simon, 2010). Thus, educational materials that promote discussions about science concepts have the potential to enhance aquarium visitors’ experiences and related learning. The questions included in the VIP Discussion Guide have considerable potential to spark science-related conversations among social and family groups, but still allow visitors to choose which concepts to attend to—an essential feature of informal education experiences (Norland, 2005).

Research on learning at informal science education centers, including aquaria, suggests that an individual’s visit is guided by his or her interests, motivations and prior knowledge (Falk, 2009; Falk & Dierking, 2011/1992; Packer & Ballantyne, 2002). Michael and Modell (2003) stated that the learner must choose to learn and this choice is often influenced by the learner’s interests. Ausubel claimed, “the most important factor is what the student already knows. Ascertain this and teach him accordingly” (as cited in Novak & Gowin, 1984, p. 40). To date, little research has been conducted that explicitly examines aquarium visitor’s interests and motivations. The first phase of this study did just that; visitors were interviewed in an effort to
determine why they chose to visit the aquarium, what they learned, and what they would be interested in learning about on a future visit. Further, these visitors’ responses were analyzed by group composition. Group composition was described as families with children in grades a) K-5, b) 6-8, and c) 9-12, social groups of college-aged young adults, and social groups of non-college adults. Particular emphasis was placed on family groups with elementary school-aged children (K-5) and social groups of college-aged young adults.

Phase 1 consisted of two parts: Study 1.A and Study 1.B. Study 1.A was conducted at the Audubon Aquarium of the Americas (AAoA) in New Orleans, Louisiana, and served as a pilot in which the researcher tested the interview protocol and procedures for Phase 1. Information from Study 1.A informed necessary modifications to the interview protocol and procedures, which were then used during Study 1.B at NCA-FF. The interview responses from Study 1.B informed the creation of educational materials used in Phase 2 of this study.

Given that educating the public is a primary goal or mission of the majority of American aquaria, it is reasonable to assume that educators working at these institutions would be interested in designing and using educational materials that enhance a visitor’s experience and learning (AZA, 2009a). Gowin (1981) asserted that selecting, designing, and modifying age- and knowledge-appropriate educational materials is an educator’s primary task. Phase 2 of this study determined the extent to which provided educational materials (VIP Discussion Guides) affected visitors’ aquarium experience and related learning. These VIP Discussion Guides integrated visitor responses from Phase 1, Ocean Literacy Principles (OLN, 2011a; Table 2.1; Appendix A), Strands of Informal Science Learning (SISL) (Bell, Lewenstein, Shouse, & Feder, 2009; Fenichel & Schweingruber, 2010; Appendix B), the aquarium’s stated mission and education goals (J. Metzler-Fiorino, personal communication, October 11, 2012; North Carolina
Aquarium Society, 2012), and current research on “best practices” in formal and informal education.

During Phase 2, participants were interviewed after using the provided educational materials to assess the impact of these materials. Unlike Phase 1, which addressed the interests of all types of visitors to the target aquarium, Phase 2 focused on the experience of two groups: family groups with elementary school-aged children (Study 2.B) and social groups of college-aged young adults (Study 2.C). These two groups make up a significant percentage of the target aquarium’s visitor population and are commonly seen in aquaria across the country. Although prior research has examined the experiences of family groups visiting informal science education centers, little to no research exists regarding the experiences of young adults visiting science education centers as social groups.

Phase 2 consisted of three parts: Studies 2.A, 2.B, and 2.C. Study 2.A was conducted at NCA-FF and provided an opportunity for the researcher to assess the interview protocols, observation protocol, VIP Discussion Guides and research procedures. This pilot study revealed that a small number of modifications were necessary; these necessary modifications were addressed prior to initiation of Studies 2.B and 2.C, also at NCA-FF. Figure 3.1 demonstrates how each part (Studies 1.A, 1.B, 2.A, 2.B, and 2.C) informed and affected later parts of this research. Figure 3.2 provides a visual representation of all steps included in this research.
Figure 3.1. Outcomes from each part of this research (Studies 1.A, 1.B, 2.A, 2.B, and 2.C) inform and affect later parts of the research as demonstrated above.
Figure 3.2. Research Flowchart. Elements highlighted in yellow relate to Phase 1; elements highlighted in blue relate to Phase 2; elements highlighted in green relate to both Phases 1 and 2.
### 3.2 Research Questions

The primary question guiding this research was, “How does the use of educational materials, designed to address visitors’ interests, motivations, and background knowledge, affect the experience and learning of aquarium visitors?” As discussed above, this research was conducted in two phases; the first phase determined visitors’ interests and motivations and the second phase determined the effect of using the provided educational materials. As such, the following sub-questions guided the different phases of this study:

**Phase 1:**

1) Why do individuals choose to visit an aquarium?

2) What are visitors interested in learning about on a visit to an aquarium?

3) What do visitors report learning during a visit to an aquarium?

**Phase 2:**

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?

2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?

3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?

4) What factors affect visitor responses to using educational materials (VIP Discussion Guides)?
3.3 Research Methods

According to Creswell (2009), qualitative research “is a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem” (p. 4). Denzin and Lincoln (2005) asserted that qualitative researchers are “attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them” (as cited in Creswell, 2007, p. 36). Regardless of whether the researcher is interested in a specific problem or a more general phenomenon, qualitative research focuses on the meanings people make and the ways in which individuals interpret their own experiences.

Falk and Dierking (1992/2011) demonstrated that the experience of museum visitors (including aquarium visitors) is shaped by a variety of social, personal, and contextual factors—no two visits are exactly alike. Learning, too, is highly idiosyncratic; individuals construct meanings by integrating new experiences and understandings into their existing cognitive structure (Mintzes & Wandersee, 2005; Novak & Gowin, 1984). A researcher interested in the experience of aquarium visitors, such as the meanings they construct or the ways they interact with educational materials, would likely seek out a research method that addresses the participants’ unique experiences and interpretations. Given my interest in the individual’s perspective related to their visit and their use of educational materials, I elected to use a qualitative approach for both phases of this study.

Although qualitative research may utilize a variety of data collection techniques, one of the most common is the qualitative interview (Creswell, 2007). Interviewing, according to Patton (1990), seeks to “find out what is in and on someone else’s mind” (p. 278). Interviews allow an individual to elaborate on his thoughts, feelings and actions, using his own words to explain how he understands his own unique experience. Patton (1990) described three
approaches to qualitative interviewing, while also noting these approaches could be combined: the informal conversational interview, the general interview guide approach, and the standardized open-ended interview. Both phases of this study utilized a combined interview guide and standardized open-ended approach. The interview guide approach allows the researcher to enter the interview with a “list of questions or issues that are to be explored,” but without adherence to specific wording determined prior to the interview (Patton, 1990, p. 283). In the standardized open-ended interview, questions are written out in advance, asked in the same order, and asked using the exact same words for each interview. A combination of the two approaches (interview guide and standardized open-ended) allows for more flexibility as the researcher can probe for better understanding but also ensure that similar data will be collected from each individual or group.

Many qualitative researchers stress the need for triangulation—the use of multiple approaches, perspectives or data sources to study the same phenomenon—to “increase the accuracy and credibility of findings” (Patton, 2002, p. 93; Tashakkori & Teddlie, 1998). One method of triangulation that Patton (2002) suggested is combining interviews, observations, and document analysis, as these three methods may reveal “different real-world nuances” (p. 248). Phase 2 of this study utilized interviews primarily, but the researcher also conducted observations of participants during their visit, noting the amount of time groups spend at selected exhibits, the ways in which visitors interact with each other, and the ways visitors interact with provided educational materials. Further, the researcher asked participants to mark the questions they talked about on the VIP Discussion Guide; the marked VIP Discussion Guides served as a third source of data. Serrell (1997) stated, “museum practitioners can become informed about ways to improve their educational exhibitions by carefully watching how visitors spend time and
pay attention in existing exhibitions” (p. 108). One could suggest that watching how visitors use provided educational materials, in addition to exhibitions, could also provide researchers with valuable information, particularly regarding potential ways to improve educational materials. The data gathered during observations of the participants’ visit were used to support or refute participants’ claims during the interviews and strengthened conclusions made during the research.

3.4 Site Selection

Qualitative research typically occurs in the natural setting in which participants experience the phenomenon in question (Creswell, 2007). As a researcher interested in learning at aquaria, my natural setting was an aquarium. Researchers have examined the learning experience of visitors at a number of aquariums with high visitation rates, such as the Monterey Bay Aquarium in California (Yalowitz, 2004) and the National Aquarium in Baltimore (Falk, 2009), but the visitor experience at these larger venues may not be completely analogous to visitor experiences at smaller venues. To increase the potential usefulness of this research, I decided to conduct this study at smaller, less well-known venues.

Study 1.A, as described earlier, was part of a course project at Louisiana State University. Thus, the selection of this site was primarily due to convenience (the AAoA is approximately an hour and a half from Louisiana State University) as well as a prior, professional acquaintance with the AAoA’s Education Curator, Ms. Tricia LeBlanc. As described later, the data collected during Study 1.A was not included in analysis, which meant the location of Study 1.A was not as important as the information gathered from the process of Study 1.A.

Studies 1.B, 2.A, 2.B, and 2.C were conducted at a different location, NCA-FF, for the reasons outlined here. The state of North Carolina has three public aquariums: The North
Carolina Aquarium on Roanoke Island (NCA-RI), The North Carolina Aquarium at Pine Knoll Shores (NCA-PKS), and The North Carolina Aquarium at Fort Fisher (NCA-FF). Educators at these three locations communicate regularly; themes, programs and special events are similar at these aquariums (J. Metzler-Fiorino, personal communication, January 4, 2011). Due to previous work I did with NCA-PKS, I was familiar with the exhibits, organisms, and programs highlighted at the three North Carolina Aquariums. Although these aquariums are medium sized, they offer visitors a chance to see local freshwater and saltwater species in a well-organized, clean, and enjoyable setting. My experiences with NCA-PKS and the staff at that location could potentially bias the proposed research; it would be difficult for me to bracket at this location. Creswell (2007) described “bracketing” as an action in which “investigators set aside their experiences, as much as possible, to take a fresh perspective toward the phenomenon under examination” (p. 59-60). Bracketing at the NCA-FF posed less of a challenge because I have never worked at this location and have toured the facility only a few times as a visitor.

Further, the NCA-FF is located on the coast, approximately 15 miles from Wilmington, North Carolina, a popular vacation destination (North Carolina Aquarium at Fort Fisher, 2011). Two establishments of higher education are located in Wilmington: University of North Carolina at Wilmington (enrollment: approximately 13,000 students; University of North Carolina, Wilmington, n.d.) and Cape Fear Community College (enrollment: approximately 28,000 students; Cape Fear Community College, 2012). Raleigh, North Carolina’s state capital, is a 2.5 hour drive from this aquarium. Therefore, the aquarium serves a range of local and out-of-state visitors of a variety of ages. In 2010, the NCA-FF had 445,849 visitors, including 30,513 school children admitted for free (North Carolina Aquarium at Fort Fisher, 2011). Visitation is higher
during the summer months than winter months, and higher on weekends than weekdays during winter months (J. Metzler-Fiorino, personal communication, January 4, 2011).

As mentioned previously, the NCA-FF is a medium-sized aquarium; the building is approximately 93,000 sq. ft. (North Carolina Aquarium at Fort Fisher, 2011). Fees are comparatively low at this aquarium: each visitor pays between six and eight dollars, depending on age (North Carolina Aquarium at Fort Fisher, 2011). This fee allows visitors to see over 300 species, including a rare albino alligator, loggerhead sea turtles, green moray eels, sharks, seahorses, and stingrays (North Carolina Aquarium at Fort Fisher, 2011).

Once a site has been selected, the researcher must identify and contact a gate-keeper (Creswell, 2007; Patton, 2002). The gate-keeper for Study 1.A was Tricia LeBlanc, Education Curator at AAoA and the gate-keeper for Studies 1.B, 2.A, 2.B, and 2.C was Jennifer Metzler-Fiorino, Education Curator at NCA-FF. Prior to allowing me to conduct research at their respective institutions, Ms. LeBlanc and Ms. Metzler-Fiorino requested a detailed research plan and, in the case of Ms. Metzler-Fiorino, a letter of support from an advising professor. Both Ms. LeBlanc and Ms. Metzler-Fiorino were supportive of this research project.

3.5 Phase 1

As described earlier, the primary purpose of Phase 1 was to identify visitors’ interests and motivations through informal interviews. Phase 1 was piloted at the Audubon Aquarium of the Americas in New Orleans, Louisiana as part of a Qualitative Methods course at Louisiana State University in the fall of 2011 (Study 1.A; Figures 3.1 & 3.2). The influences of information gained during Study 1.A are discussed throughout this section as appropriate.
3.5.1 Participants, Phase 1. Although Falk (2009) asserted that no two visitor experiences are exactly alike, it is reasonable to believe that many visitors will have similar interests and motivations, particularly those who visit in family or social groups. Phase 1 examined the interests and motivations of a typical visitor or a typical group of visitors to NCA-FF. As such, this phase elicited interviews from a range of visitors. Individual adults, social groups of adults, and family groups with school-aged children were interviewed. Family groups with very young children (approximate age 0-4 years) were not approached for this research.

Six visitor groups were interviewed during Study 1.A; this allowed the researcher to determine if any modifications to the interview protocol and procedures were necessary. During Study 1.B, 122 individuals in 63 groups were interviewed; this sample provided the researcher with a wealth of information regarding the interests and motivations of a wide variety of visitors. After a group or single individual completed their interview, the next intact group or single individual passing by the interview location was asked to participate. Sixty-five groups or single adults were approached for this research; two groups declined to participate and 63 groups agreed, giving a response rate of approximately 97%.

The sampling strategy used for this phase most closely resembles typical case sampling as described by Creswell (2007) and Patton (2002). Creswell (2007) stated that the purpose of typical case sampling is that it “highlights what is normal or average” (p. 127). In describing sites that are chosen using typical case sampling, Patton (2002) said, “the site is specifically selected because it is not in any major way atypical, extreme, deviant, or intensely unusual” (p. 236). The same could be said for choosing individuals or groups using typical case sampling: these individuals or groups are not drastically different from the majority of other individuals or groups that utilize the same facility. A typical case at both the AAoA (Study 1.A) and NCA-FF...
(Study 1.B) includes individuals or groups of individuals who elect to visit the aquarium primarily as a leisure activity, who spend between 30 minutes and 3 hours in the aquarium, and who pay attention to at least some of the exhibits. By examining the responses of a number of “typical case” visitors, the researcher was able to gain a solid understanding of the experience of many visitors to the AAoA and NCA-FF.

Participants were interviewed with others from the group in which they visited the aquarium: solo visitors were interviewed alone and family groups and social groups were interviewed together as a unit. Research suggests that group dynamics are likely to shape less-structured interviews; participants can elaborate on other participants’ answers and individuals, particularly children, may feel more comfortable answering questions if surrounded by other individuals with whom they are familiar (Patton, 1990). Given that group dynamics inevitably influence the visitor experience (Falk, 2009; Packer & Ballantyne, 2005), research concerned with the visitor experience could be more authentic if these dynamics and interactions are part of the research process. Children under the age of 18 were only interviewed with a parent or guardian present.

3.5.2 Data Collection, Phase 1. As described above, the data collection technique utilized during this phase was qualitative interviews that followed a combination interview guide/standardized open-ended approach as described by Patton (1990). This combination approach allowed the researcher to probe for deeper understanding, ask for clarification, and follow interesting or informative tangents, but also ensured the same type of information was gathered from all participants (Patton, 1990). Given that the interview site was an informal education center that most groups viewed as a leisure setting, it seemed most appropriate to follow Novak’s (2010) advice on interviewing: “Interviews should be conducted in a friendly,
cordial manner. They should not be ‘interrogations’ where questions are fired at the interviewee in rapid succession” (p. 116). Visitors often view informal science education centers as relaxation venues; the interview process should also feel relaxed as to not detract from the visitor experience (Packer, 2006).

During study 1.B at NCA-FF, potential participants were solicited for interviewing near the end of the exhibits, but prior to the gift shop entry. This location was chosen because it ensured that visitors have had a chance to see most, if not all, of the available exhibits and it provided a semi-private but not secluded space to conduct interviews. In addition, the researcher discovered during Study 1.A that visitors were less likely to agree to participate in the study after exiting the gift shop. This suggested that visitors saw the gift shop as the “end” of the aquarium experience and were unwilling to prolong it after this point by participating in the study. Visitors were more likely to participate in Studies 1.A and 1.B if approached prior to gift shop entry.

The aquarium agreed to provide the researcher with a small table and seating. In addition to wearing business casual attire, the researcher also wore a lanyard with her LSU student identification card visible. This established the researcher’s authority and credibility, but also was not too intimidating for the informal venue. As visitors walked by the chosen location, the researcher introduced herself as a graduate student interested in visitors’ experiences and asked visitors if they would agree to answer a few short questions about their visit to the aquarium. During Study 1.A, the researcher found that family group interviews using a very similar interview protocol lasted between 2 and 6 minutes and visitors were more likely to agree to participate if informed that the questions should take approximately 5 minutes to answer. Thus, when requesting visitor participation in Study 1.B, the researcher informed potential participants of the expected time commitment.
When visitors agreed to participate, each adult was given a copy of the project description and consent form to sign. Children under the age of 18 were asked for their assent in addition to their parents’ consent prior to the interview. Participants were informed that the interview would be audio recorded with their permission, no names or identifying information would be associated with their answers, and that there were no “wrong” answers to any of the questions. The interview protocol (Appendix C) used during Study 1.B was tested during Study 1.A and modified slightly to obtain more specific information regarding what visitors learned during their visit. Visitors were encouraged to expand upon others’ answers during the interview; efforts were made to gather information from all participants. The final questions solicited demographic information as appropriate: visitor’s grade/age, number of prior visits, and hometown.

3.5.3 Data Analysis, Phase 1. The data from Study 1.A were not included in data analysis as the study occurred at a different location and used a slightly different protocol. After completion of the interviews in Study 1.B, each audio file was transcribed verbatim by the researcher and trained assistants using QuickTime audio program and Microsoft Word. In an effort to protect confidentiality, identifying information was not included on the transcripts; each participant was identified by group number, gender, and grade/age. Transcription assistants did not have access to participants’ provided personal information beyond these basic characteristics. The researcher checked all typed transcripts against primary audio files to assure accuracy of the transcriptions.

Holsti (1969) described coding as “the process whereby raw data are systematically transformed and aggregated into units which permit precise description of relevant content characteristics” (as cited in Guba & Lincoln, 1981, p. 243). To begin the coding process, Guba
(1981) suggested the researcher read through all of the data and look for recurring patterns—a process called convergence. This resulted in a list of potential patterns, which were then subjected to the second phase, known as “verification.” Verification tested “the utility, scope, and inclusiveness of [the] category system” (Guba, 1978, p. 54). Coding for divergence, the third phase, included a “fleshing… out” of the data to build robust descriptors of categories and determine placement of interview responses within the categories (Guba, 1978, p. 57). At this stage, a large number of categories had been identified in order to encapsulate all of the participants’ responses. The final phase, prioritization, resulted in identification of a smaller number of themes to be discussed within the manuscript (Guba, 1978).

In Study 1.B, the first interview was coded by question; the categories or codes were manually entered into SPSS and recorded in a codebook. Each subsequent interview was analyzed in the same manner; if a visitor’s responses did not align with current categories, a new category was created. Since a coding scheme or category system is a dynamic entity (Guba and Lincoln, 1981), categories were modified until the system was complete and all data were accounted for. After initial coding of all interview transcripts, the researcher recoded all interviews using the completed system and checked for discrepancies. Any discrepancies were noted and corrected. After all interviews were re-coded, the researcher looked for overall themes that described or explained visitors’ responses. Participant responses regarding visit motivations were coded using an expanded version of Packer’s (2004) visitor motivations. Chapter 4 describes this expansion process.

The researcher utilized SPSS 17.0, a statistical software package, to quantize and manage the data. Tashakkori and Teddlie (1998) described quantizing as “converting qualitative information into numerical codes that can be statistically analyzed” (p.136). Although this was a
qualitative study, quantizing the data in Phase 1 allowed the researcher to utilize descriptive statistics, such as frequency counts, to determine which replies were most common and, ultimately, emphasize observed outcomes (Kisiel, 2010). Basic descriptive statistics were run on the quantitized data to determine the proportion of visitors who gave each response. Use of the SPSS software allowed the researcher to determine how responses varied by group type. The information gained during Study 1.B influenced the creation of educational materials in Phase 2.

3.6 Phase 2

As mentioned previously, the primary purpose of the second phase of this study was to examine the effects of using provided educational materials on aquarium visitors’ experiences. The researcher designed two unique VIP Discussion Guides (educational materials) that incorporated visitor responses from Study 1.B, Ocean Literacy Principles (OLN, 2011a; Table 2.1; Appendix A), Strands of Informal Science Learning (SISL) (Bell, et al., 2009; Fenichel & Schweingruber, 2010; Appendix B), the aquarium’s stated educational mission and goals (J. Metzler-Fiorino, personal communication, October 11, 2012; North Carolina Aquarium Society, 2012), and teaching methods supported by current research in formal and informal education. The researcher assessed the impact of these materials through pre-visit interviews, observations, and post-visit interviews with groups of visitors who utilize the materials (VIP groups) and groups of visitors who do not utilize the materials (comparison groups). This phase was piloted at the NCA-FF in mid-November, 2012 (Study 2.A). The influences of information gained during Study 2.A influenced Studies 2.B and 2.C (also conducted at NCA-FF) and are discussed throughout this section as appropriate.

3.6.1 Participants, Phase 2. This phase (Studies 2.A, 2.B, and 2.C) employed purposive sampling as described by Tashakkori and Teddlie (1998) in which the researcher selected
“individuals/groups based on specific questions/purposes of the research in lieu of random sampling and on the basis of information available about these individuals/groups” (p. 76). In addition, these groups were *homogenous samples* as described by Patton (2002). Patton (2002) noted that this sampling strategy allows the researcher to “describe some particular subgroup in depth” (p. 235). The selected homogenous subgroups typically have similar backgrounds and experiences, which allows the researcher to gain insight regarding potential or typical responses of members of the subgroup.

The information gained in Study 1.B determined the subgroups of interest: Study 2.B examined family groups with elementary school-aged children (approximate ages 6-11) and Study 2.C examined social groups of college-aged young adults (approximate ages 18-25). Given the proximity of the NCA-FF to a number of universities and colleges, these two subgroups represent a significant portion of visitors to this aquarium. In addition, these two subgroups are understudied in the existing literature. For this research, a family group with elementary school-aged children was defined as a group that includes one or two adults and two to three children who appeared to be in elementary school (approximate age 6-11). A social group of college-aged young adults included two or three individuals (approximate age 18-25) who may or may not be related; these individuals did not necessarily have to be enrolled in college during the study period, but were required to be within the ages listed above.

Qualitative studies, particularly those interested in gathering a larger amount of information from participants, generally have smaller samples than quantitative studies. After consulting with senior researchers, the sample size for Study 2.A was set at one to two groups from each subgroup; this allowed the researcher to determine if the interview protocols, observation protocol, VIP Discussion Guides or research procedures required modification prior
to Studies 2.B and 2.C. Also after consultation with senior researchers, the sample size for study
2.B was set at nine groups of family groups with elementary school-aged children. Six family
groups utilized the VIP Discussion Guide (VIP groups) and 3 family groups did not (comparison
groups). The sample size for Study 2.C was set at 10 social groups of college-aged young adults;
7 groups used another VIP Discussion Guide (VIP groups) and 3 did not (comparison groups).
These samples allowed the researcher to draw reasonable conclusions about the effects of the
VIP Discussion Guides, but also kept the generated data to a manageable amount.

During Studies 2.A, 2.B, and 2.C, participants were interviewed with others from their
social group. As described in Phase 1, group dynamics are likely to shape the visit, the interview
and interview responses. During Study 2.B, children under the age of 18 were only interviewed
with a parent or guardian present. To protect the safety of participants, an application for
approval was submitted to Louisiana State University’s Institutional Review Board (IRB). The
application packet for this study included (a) a project description; (b) all consent forms; (c) pre-
visit interview protocols; (d) observation protocols; (e) post-visit interview protocols; (f) a signed
security of data agreement; and (g) a certificate of completion of the National Institute of
Health’s online training course, “Protecting Human Research Participants.” The approved
application and forms f and g are found in Appendix D.

3.6.2 Creation of Educational Materials, Phase 2. According to Gowin (1981), the
creation of age- and knowledge-appropriate educational material is the educator’s main
curriculum-related task. The educational materials designed for this study were two age-
appropriate VIP Discussion Guides; one guide was applicable to family groups with elementary
school-aged children, the other was applicable to social groups of college-aged young adults.
These VIP Discussion Guides were similar to many self-guided tours in use today, but were
innovative in that they encouraged reflection and conversation amongst visitor groups rather than simply presenting dry facts. Self-guided tour handouts are fairly common in informal science education centers, as they are a low-cost but potentially engaging way to highlight important themes and concepts displayed at the center (Norris, 2009). These types of materials provide visitors with guidance and important information, but also allow visitors to choose which information to attend to—an important facet of informal education (Norland, 2005).

The design and content of these educational materials is of paramount importance; poorly designed materials are unlikely to have a positive impact on visitors’ experiences. Review and synthesis of the literature led the researcher to identify five defining characteristic of concepts and exhibits that increase visitor attention. These five defining characteristics, and the primary researchers who studied them are represented in Table 3.1.

Table 3.1. Defining Characteristics of Concepts and Exhibits Attended to by Visitors.

<table>
<thead>
<tr>
<th>Defining Characteristic</th>
<th>Explanation of Defining Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Visitors find the elements interesting (Falk, 2009)</td>
</tr>
<tr>
<td>b</td>
<td>Elements support visitors’ visit motivations (Falk, 2009; Packer &amp; Ballantyne, 2002)</td>
</tr>
<tr>
<td>c</td>
<td>Elements relate to concepts visitors already understand at a basic level (Falk, 2009)</td>
</tr>
<tr>
<td>d</td>
<td>Elements help visitors build or express their self-identity (Falk, 2009; Spock, 2006)</td>
</tr>
<tr>
<td>e</td>
<td>Elements are participatory (Simon, 2010)</td>
</tr>
</tbody>
</table>

Note: These defining characteristics were distilled from the literature by the researcher. Each defining characteristic was discussed in depth by one or more primary researchers, as described in Chapter 2. The names of these researchers and publication dates are included in parentheses.

Visitor responses from Study 1.B regarding topics and concepts that visitors would like to learn about on a future visit allowed the researcher to design materials that address these topics
and concepts, which increased the possibility that visitors will find the materials interesting (defining characteristic a, Table 3.1). Given that the responses from Study 1.B were analyzed by group type, the researcher was able to utilize responses from each subgroup (family groups with elementary school-aged children and social groups of college-aged young adults) to design questions for the VIP Discussion Guides that addressed the specific interests of these subgroups. Additionally, the information gained during Study 1.B allowed the researcher to determine the exhibits and concepts that currently piqued visitors’ interest; some of these exhibits and concepts were addressed explicitly in the VIP Discussion Guides. The researcher also included topics and concepts deemed important by the NCA-FF as described in the institution’s educational mission and by the gatekeeper for this site, Ms. Jennifer Metzler-Fiorino, Education Curator. In addition, the Ocean Literacy Principles (OLP; Table 2.1; Appendix A) and Strands of Informal Science Learning (SISL; Appendix B) were included as appropriate.

Information gained from Study 1.B on visitor motivations (why visitors chose to attend the aquarium) was incorporated into the design such that use of the materials will enhance the experience expected by the visitor, not detract from it (defining characteristic b, Table 3.1).

By selecting two specific subgroups of visitors (family groups with young children and social groups of college-aged young adults), the researcher was able to reasonably estimate the scientific knowledge base (defining characteristic c, Table 3.1) of the visitors through the use of the National Science Education Standards [NSES] (National Research Council [NRC], 1996). Although it is unlikely that all visitors possessed levels of scientific literacy as described in NSES, the standards describe what students should know by the end of each grade band. Thus, it was reasonable to assume that individuals who have completed a certain amount of schooling have, at the very least, been introduced to some of the topics covered by the NSES.
Falk (2009) asserted that visitors to informal education centers use the visit to build upon or enhance their self-identity. Falk (2009) identified five self-identities common among informal education visitors: explorer, facilitator, experience seeker, professional/hobbyist, and recharger. Researchers with The Ocean Project found that visitors to aquaria had a “green” self-identity, suggesting they are interested in the natural world and conservation (Mott, Wong, & Meyer, 2011). Spock (2006) suggested that museum visitors were enacting a curiosity-driven self-identity; visiting an aquarium allows an individual to show that she is curious about the ocean and its inhabitants. Bell et al. (2009) and Fenichel and Schwiengruber (2010) agree that one strength of informal science education centers is the opportunity for visitors to self-identify as knowledgeable science learners. Different elements of the VIP Discussion Guides addressed a variety of these self-identities (defining characteristic d, Table 3.1).

In her book The Participatory Museum, Simon (2010) encouraged informal education centers to offer visitors an active, participatory experience instead of expecting visitors to act as passive recipients of displayed content; active participation increases visitor engagement (defining characteristic e, Table 3.1). Simon (2010) defined participatory institutions as

… place[s] where visitors can create, share and connect with each other around content. Create means that visitors contribute their own ideas, objects, and creative expression to the institution and to each other. Share means that people discuss, take home, remix, and redistribute both what they see and what they make during their visit. Connect means that visitors socialize with other people—staff and visitors—who share their particular interests. Around content means that visitors’ conversations and creation focus on the evidence, objects, and ideas most important to the institution in question. (p. ii-iii.)

Although Simon (2010) advocated a participatory design for most, if not all, elements in an institution, recreation of existing exhibits is prohibitively expensive. Instead, one might encourage the use of participatory educational materials: materials that encourage visitors to “create, share, and connect with each other around content” (p. ii).
Simon (2010) stated, “asking visitors questions is the most common technique used to encourage discussion around objects” (p. 139). She listed three reasons to ask visitors questions:

(a) To encourage visitors to engage deeply and personally with a specific object

(b) To motivate interpersonal dialogue among visitors around a particular object or idea

(c) To provide feedback or useful information to staff about the object or exhibition

(Simon, 2010, p. 139)

Michael and Modell (2003) also encouraged utilizing dialogue in educational settings, claiming that discussions help individuals connect new material to existing cognitive structures. Thus, these discussions could encourage meaningful learning, particularly if individuals within a group share prior experiences they can use to frame these discussions.

By including questions that address a variety of concepts and encouraging visitors to select those questions that interest them, the VIP Discussion Guides gave visitors an opportunity to “pull specific content of interest instead of consuming content that is pushed out indiscriminately by the institution” (Simon, 2010, p. 37). This allowed visitors to discuss content that appealed to them while also providing accurate scientific content around which these conversations were built.

Based on Simon’s (2010) recommendations, the VIP Discussion Guides contained questions that (a) encouraged visitors to engage deeply with an exhibit or concept and (b) sparked interpersonal dialogue between individuals within family and social groups. As described above, these questions addressed both visitor interests and important scientific concepts. Appendices E and F contain the VIP Discussion Guides for family groups with elementary school-aged children and social groups of college-aged young adults, respectively. Appendices G and H show how each question is aligned with selected Ocean Literacy Principles.
(OLP), *Strands of Informal Science Learning* (SISL), and identified visitor interests (see Appendix G for VIP Discussion Guide Alignment for family groups; see Appendix H for VIP Discussion Guide Alignment for social groups).

### 3.6.3 Data Collection, Phase 2

Studies 2.A, 2.B, and 2.C utilized three data collection techniques: qualitative interviews with an *interview guide/standardized open-ended* approach, unobtrusive direct observations of participants, and document analysis of visitors’ marked VIP Discussion Guides. As described in Section 3.5.3, the combination approach to interviewing allowed the researcher to obtain similar, in-depth information from all participants. Patton (2002) reminded the researcher that interview responses, while valuable, are colored by the participant’s perspective and may not reveal a full, accurate account of the phenomenon under question. Patton (2002) and Tashakkori and Teddlie (1998) suggested combining interviews with a secondary data collection technique, such as observations. Observations, according to Patton (2002), can “provide a check on what is reported in interviews” (p. 306). The observations recorded for each participating group were used to confirm or refute the participants’ claims during interviews. A third data collection technique, document analysis, further strengthened the researcher’s conclusions.

Study 2.A served as a pilot for Studies 2.B and 2.C. During Study 2.A, the researcher interviewed and observed one to two groups from each subgroup. This allowed the researcher to determine optimal ways to solicit visitor participation, the most advantageous viewing spaces for observations, specific wording that garnered desired information during pre- and post-visit interviews, and visitor responses to the design and content of VIP Discussion Guides. Gathering this information in Study 2.A enhanced the quality of data gathered during Studies 2.B and 2.C. The interview protocols, observation protocols, and VIP Discussion Guide were modified
slightly; some interview questions were removed or reworded, a list of learning-related behaviors was added to the observation protocol, and one question set was replaced with another on the VIP Discussion Guides.

As described in Section 3.6.1, during Study 2.B, the researcher elicited interviews and conducted observations of nine family groups with elementary school-aged children—six VIP groups and three comparison groups. Study 2.C included interviews and observations of 10 social groups of college-aged young adults—seven VIP groups and three comparison groups. After completion of both interviews, groups were offered one 10-dollar gift card to the aquarium gift shop.

3.6.3.1 Pre-Visit Interviews. During Studies 2.A, 2.B, and 2.C, pre-visit interviews took place shortly after the visitors entered the aquarium but prior to the first exhibit. Groups who appeared to fit the criteria for inclusion (described in Section 3.6.1) were approached by the researcher. The researcher introduced herself as a graduate student conducting research on visitors’ aquarium experiences. The group was informed of the study procedures and benefits, and asked to participate. When individuals agreed to participate, they were asked to read and sign the appropriate consent form (Appendix I). Individuals under 18 were asked to read and sign the assent form (Appendix J), or if the individual was unable to read, a parent/guardian was asked to read the assent form to the child. Parents/guardians were also required to sign a consent form stating that the researcher was allowed to interview adults and children within their family group. Participants were informed that the interviews were to be audio recorded with their permission, and that they would be observed during their visit, but no identifying information would be connected to the audio recordings or observations. In addition, the researcher
attempted to reassure visitors that there were no “wrong” answers to the interview questions and no “expected” behaviors for the observations.

Before the pre-visit interview, groups were designated as a VIP group (would use the VIP Discussion Guide on their visit) or a comparison group (would not use the VIP Discussion Guide on their visit). For every three groups, two were designated as VIP groups and one was designated as a comparison group. The pre-visit interview consisted of six questions similar to questions asked during Studies 1.A and 1.B (Appendix K) and took an average of 2.6 mins (Study 2.B) and 1.45 mins (Study 2.C) to complete. These questions solicited demographic information (age/grade, hometown, number of prior visits) as well as visitor motivations and interests. Visitors were encouraged to expand upon others’ answers during this interview and efforts were be made to gather information from all participants.

After completion of the pre-visit interview, participants in VIP groups were given the appropriate VIP Discussion Guide, a clipboard, a writing utensil, and verbal instructions for usage (see Appendices E and F for VIP Discussion Guides). Participants were informed that the VIP Discussion Guide contained questions intended to spark conversations at a number of exhibits throughout the aquarium. The participants were informed that they were not obliged to answer all of the questions on the VIP Discussion Guide, only those that they found interesting or intriguing. The researcher asked participants to circle or otherwise mark questions they discussed. At this time, participants in VIP groups were also informed of the post-visit interview location, which was clearly marked on the VIP Discussion Guide.

Comparison groups were not given a VIP Discussion Guide. Instead, at the end of the pre-visit interview these groups were given a generic map of the aquarium; that map was similar
to the map on the VIP Discussion Guide but without the accompanying questions. The location of the post-visit interview location was also clearly marked on this map.

3.6.3.2 During-Visit Observations. Groups were observed at two exhibits from a single vantage point within one exhibit hall. These two exhibits (the salt marsh exhibit and the touch tank) were selected by the researcher with input from Ms. Metzler-Fiorino on the basis of the following qualifications:

1) must have corresponding questions on the VIP Discussion Guide,
2) must be easily observable from a discreet place, and
3) must be far enough apart to provide the researcher time to relocate between interviews and observations.

Guba and Lincoln (1981) claimed, “observational techniques… make it possible to record behavior and events as they occur” (p. 192). These researchers described a number of observation strategies, including strategies that were used in this study: running notes and notes on thematic units (Guba & Lincoln, 1981, p. 203-204). Running notes are commonly known as field notes, whereby the researcher records actors, actions, and discussions of interest (Guba & Lincoln, 1981). Notes on thematic units relate to particular behaviors of interest to the researcher; notes on thematic units may be made during observations or these units may be separated from running notes after the observation (Guba & Lincoln, 1981).

Patton (2002) stated that field notes “should record such basic information as where the observation took place, who was present, what the physical setting was like, what social interactions occurred, and what activities took place” as well as “what people say” (p. 303). The researcher should also include her “own feelings, reactions to the experience, and reflections about the personal meaning and significance of what has been observed” and her “insights,
interpretations, beginning analyses, and working hypotheses about what is happening in the setting and what it means” (Patton, 2002, p. 303-304). Creswell (2007) encouraged the researcher to utilize an observation protocol; the observation protocol for this research is found in Appendix L.

During the observation period, the researcher utilized the observation protocol (Appendix L) to record time spent at the exhibit, engagement in learning-related behaviors (LRB), and notable discussions. The researcher started a stopwatch at the conclusion of the pre-visit interview. The amount of time elapsed between the pre-visit interview and the first group member’s stop at one of the target exhibits was recorded. This research used Serrell’s (1997) definition of a stop: “both feet planted on the floor, visitor’s head or eyes pointing in the direction of the element for two to three seconds or more” (p. 112). The time between the first group member’s stop and the last group member’s exit from the exhibit was recorded as “total group time.” Each exhibit had a “total group time,” although all members of the group may not have been present for the entire duration of that time.

The second visitor engagement measure focused on the identification of visitors’ learning-related behaviors (LRB). The researcher constructed a checklist of LRB a priori, based on observations during the pilot study and research conducted by Borun, Chambers, Dritsas, and Johnson (1997) and Bitgood (2010). Examples of LRB include “touch object briefly,” “seek or share information,” and “talk to companion.” These identified LRB have the potential to increase learning among group members (Bitgood, 2010; Borun et al., 1997). LRB were checked once on the protocol if displayed by one or more group members. The researcher also verbally noted observed behaviors in audio-recorded field notes each time the LRB occurred.
The third visitor engagement measure included portions of visitor conversations. Due to the acoustics in the exhibit hall and ambient noise, it was impossible to hear all conversations between group members. However, some conversation segments could be overheard. Typically, these segments were comprised of loud, excited utterances as a visitor experienced something novel or surprising. Allen (2004) said that visitors who experienced novel or unexpected outcomes were more likely to remember the learning experience itself; thus, these loud, excited conversation snippets were worth noting. When a conversation segment was overheard, the researcher spoke into an audio recorder and identified the speaker, repeated the visitor’s words verbatim, and described accompanying physical actions.

3.6.3.3 Post-Visit Interviews and Document Collection. In Studies 2.A, 2.B, and 2.C, after participants completed their visit, the group was asked to complete a post-visit interview. This interview occurred near the aquarium exit, in a semi-secluded space near a stairwell, which was clearly marked on the participants’ VIP Discussion Guides (VIP groups) or maps (comparison groups). The post-visit interview also used a combination interview guide/standard open-ended approach, and consisted of 10 questions with follow-up probes used as necessary (Appendix M). This interview focused on the participants’ aquarium experience, use of the VIP Discussion Guide, and reported learning. In Study 2.B, this interview lasted an average of 6 mins; in Study 2.C, the post-visit interview lasted an average of 5.7 mins. As with the pre-visit interviews, these interviews were audio recorded and efforts were made to solicit information from all participants. The researcher collected the VIP Discussion Guides and confirmed that participants circled or otherwise marked each of the questions they discussed as a group. Upon completion of the post-visit interview, groups were offered one 10-dollar gift card to the aquarium gift shop. After completion of interviews and observations of each group, the
researcher utilized an audio recorder to dictate and expand upon written field notes. These audio recordings also included reflective notes and initial impressions about the data.

In an effort to determine how the VIP Discussion Guides impacted visitor actions and interactions, the researcher also interviewed and observed comparison groups that did not undergo the educational intervention (use of VIP Discussion Guides). Comparison groups were selected such that the group closely matched one or more VIP groups. By matching comparison and VIP groups, the researcher was able to note potential effects of educational materials on visitors’ behaviors and conversations during the aquarium visit.

3.6.4 Data Analysis, Phase 2. Similar to Study 1.A, described in section 3.5.3, data collection during Study 2.A was not included in overall analysis. This was due to slight differences between protocols, VIP Discussion Guides, and procedures as well as temporal differences, which might have confounded any findings. As described in Section 3.5.3, all interview audio files from Studies 2.B and 2.C were transcribed verbatim by the researcher and trained assistants using QuickTime audio program and Microsoft Word. Observation notes from Studies 2.B and 2.C were transcribed by Dragon Dictate for Mac 3, a speech recognition program designed for Macintosh computers. The researcher checked all typed transcripts of interviews and observation notes against primary audio files to assure accuracy of the transcriptions. Identifying information was not included on any transcripts; each participant was identified by group number, gender, and grade/age. Transcription assistants did not have access to additional personal information provided by participants.

In the first step of data analysis in Studies 2.B and 2.C, information from interviews, observations, and collected documents was recorded on data-logging sheets (Appendix N). Each participating group’s data-logging sheet contained spaces for observed LRB, marked questions,
recalled questions, time spent at each exhibit, recalled topics of conversations, and details from recalled conversations. These data-logging sheets allowed the research to gain an overall understanding of each group’s experience, which could easily be compared to other groups within the study.

In addition, an inductive content analysis of the data-logging sheets, interview transcripts, and field note transcripts was conducted (Patton, 2002). Interviews from Studies 2.B and 2.C were coded utilizing categories from the literature and from Phase 1, when appropriate. Answers that addressed new concepts were coded using the four phases of coding as described in Section 3.5.3 (convergence, validation, divergence, prioritization). A full description of data analysis procedures for Studies 2.B and 2.C are in Sections 5.2.7 and 6.2.5, respectively.

3.7 Reliability/Data Quality

In qualitative research, the researcher is the instrument used to study the phenomenon of interest. This has the potential to alter data collection and, thus, data quality. Guba and Lincoln (1981) reminded the researcher:

It is difficult, although not impossible, for the observer to guard against the intrusion of his own biases, attitudes, prejudices, or assumptions. One way to neutralize such biases and assumptions is to include them, insofar as they become known to the observer, in the final report. (p. 208)

Patton (2002) also recognized the importance of researcher effects; he stated that the researcher should “report any personal and professional information that may have affected data collection, analysis, and interpretation” (p. 566). In an effort to identify her own biases, attitudes, prejudices and assumptions—as well as any changes in these throughout the research process—the researcher kept a reflexive journal, as described by Tashakkori and Teddlie (1998).

During the interview process, the researcher must be careful to limit the extent to which she influences the responses of participants through subtle cues and expressions of agreement or
disagreement (Guba & Lincoln, 1981; Tashakkori & Teddlie, 1998). At the same time, Patton (1990) encouraged researchers to demonstrate that they value the participants’ views by offering encouragement or even praise. The researcher must also give the participants adequate wait time between questions; just enough silence may prompt participants to elaborate upon their answers, while too much silence might make participants feel uncomfortable and unwilling to proceed (Novak, 2010). Awareness of these potential issues, adequate training, audio recording of data, and honest reflection ensured the reliability of data collection during interviews.

The quality of data obtained during observations may be impacted by the presence of the researcher; participants may alter their behavior if they realize they are being observed. This phenomenon is called “participant reactivity.” Guba and Lincoln (1981) suggested that participant reactivity may not affect this data collection method as much as presumed. However, Patton (2002) said, “problems of reactivity are well documented” (p. 567) in qualitative research. He suggested that “researchers should strive to neither overestimate nor underestimate their effects but to take seriously their responsibility to describe and study what those effects are” (Patton, 2002, p. 568). Thus, the researcher attempted to note any potential influence of her presence on participants. However, there seemed to be little impact on participants, perhaps due to the semi-hidden observation location. One group remarked that they did not see the researcher at all during their visit.

Both interviews and observations rely on field notes, at least in part, for data collection. It is imperative that these field notes are detailed and accurate. Creswell (2007) claimed, “Reliability can be enhanced if the researcher obtains detailed fieldnotes [sic] by employing a good-quality tape for recording and by transcribing the tape” (p. 209). Patton (2002) suggested utilizing both audio recorded and handwritten field notes; both forms of field notes were used
during interviews and observations. In addition, the researcher dictated and elaborated upon all handwritten field notes immediately following the final interview with each group, as described in Section 3.6.3. Guba and Lincoln (1981) stated, “The absence of a time lag between observation (or any other data collection) and recording is a major guarantee of validity” (p. 192) or reliability of data. Patton (2002) emphasized the importance of “data clarification, elaboration, and evaluation” (p. 384) as soon as possible after data collection to ensure the quality of data. Very little time elapsed between data collection, data recording, and initial data analysis. Without exception, data analysis relied on verbatim transcripts of interviews, observations, and field notes, as well as primary documents marked by participants.

Accurate transcription of interviews and field notes is of paramount importance; this raw data allows the researcher to draw conclusions from the participants’ own words (Patton, 2002). As mentioned previously, audio files were transcribed by the researcher and trained assistants. The researcher checked all transcriptions against primary audio files to ensure accuracy. Verbatim excerpts of transcripts were used in this report to support the researcher’s conclusions.

Finally, Creswell (2009) encouraged researchers to be aware of any changes that may occur over the course of coding data, particularly related to the meaning of codes or categories. Creswell (2009) suggested constantly comparing the data with the codes and making detailed notes about the meanings of codes in the codebook. As described above, the researcher coded all data from Studies 1.B, 2.B, and 2.C at least two times; any discrepancies between codings was noted and resolved.

3.8 Validity/Conclusion Quality

In this study, “reliability” refers to the accuracy of data collected by the researcher and “validity” refers to the accuracy of conclusions drawn from the data by the researcher. Creswell
(2009) claimed that validity is “based on determining whether the findings are accurate from the standpoint of the researcher, the participant, or the readers of an account” (p. 191). He suggested utilizing at least two of the eight most common validation strategies: triangulation, member checking, right and thick descriptions, clarification of bias, presentation of negative or discrepant information, prolonged time in the field, peer debriefing, and use of an external auditor (Creswell, 2007; Creswell, 2009).

As described above, this research included a triangulation of data sources (interviews, observations, and document analysis). Examining multiple sources of revealed additional information, increased understanding, and supported conclusions drawn from the data.

Creswell (2007) advocated thick, rich descriptions because these allow the reader to determine the transferability of the research (p. 209). Additionally, thick descriptions lend credibility to the narrative; readers are encouraged to utilize the data and descriptions provided to determine if they agree with the conclusions drawn by the researcher (Creswell, 2009). Thus, the researcher utilized thick, rich descriptions in this report.

Through the use of a reflexive journal (Tashakkori & Teddlie, 1998, p. 93), the researcher attempted to identify any biases that could potentially affect this research. However, there were not any identified biases in this research.

Although the definition of “prolonged time in the field” varies among research projects, this study did require an extensive time commitment in which the researcher was immersed in the research setting. Spending additional time at the research site allowed the researcher to gain a greater understanding and appreciation of the culture of the institution and the experiences of the visitors.
3.9 References


Chapter 4. An Examination of the Visit Motivations, Interests, and Self-Reported Learning of Aquarium Visitors

4.1 Literature Review

Individuals are presented with science learning opportunities daily; activities such as walking in the woods, speaking with a colleague, or watching documentaries have the potential to substantially alter an individual’s understanding of scientific concepts. In fact, Falk and Dierking (2010) contended that Americans construct the majority of their science understanding through out-of-school experiences, claiming that “free-choice learning experiences represent the single greatest contributors to adult science knowledge” (p 489). Free-choice or informal learning experiences have also been shown to have an impact on children’s science knowledge (Borun, Chambers, Dritsas, & Johnson, 1997; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; Falk & Dierking, 2010; Sherwood, Rallis, & Stone, 1989; Tofield, Coll, Vyle, & Bolstad, 2003) and the influence of these experiences is often felt or remembered years later (Falk & Dierking, 1997). Dierking and colleagues (2003) described free-choice or informal learning as “learning that is self-motivated, voluntary, and guided by the learner’s needs and interests, learning that is engaged in throughout his or her life” (p. 109). Further, these learning experiences are typically free from curriculum standards (Norland, 2005), testing (Allen, 2004), and expectations of subject mastery (Falk, 2009).

Informal science education venues, such as zoos, aquaria, nature centers, and botanical gardens, represent one type of vehicle for these informal learning experiences. These attractions allow visitors to learn important science concepts as they interact with objects, exhibits, educators, and other visitors. The public views these spaces primarily as entertaining leisure venues, while also recognizing the existence of educational opportunities (Packer, 2006; Packer
Packer and Ballantyne (2002) found that aquarium visitors, in particular, placed greater emphasis on entertainment rather than education. However, these visitors were also likely to say that the aquarium was a place where learning was fun, suggesting that entertainment and education were not seen as mutually exclusive outcomes of an aquarium visit.

Visitors typically enter an informal science education center with a set of expectations regarding the visit experience and potential outcomes. These expectations often shape the individual’s visit motivation, or why he or she decided to visit the venue. Falk (2009) asserted that an individual’s visit motivations were greatly influenced by her self-identity and described five categorical identities: Explorers, Facilitators, Experience Seekers, Professionals/Hobbyists, and Rechargers. Similarly, Rounds (2004) suggested that many individuals were motivated to visit museums (including aquaria) by their curiosity-driven identities.

However, not all researchers equate visit motivation with visitor identity. Packer (2004) and Packer and Ballantyne (2002) identified five categories of visitor motivations that are framed by visitors’ expectations of what they might gain from the experience: Learning and Discovery, Passive Enjoyment, Restoration, Social Interaction, and Personal Self-Fulfillment. Packer and Ballantyne (2002) found that adult aquarium visitors were most likely to list Passive Enjoyment as their primary visit motivation, stating that they expected to enjoy the visit or to feel happy or satisfied. In that study, the second most important motivation for aquarium visitors was Learning and Discovery, meaning that visitors expected to learn new things, expand their knowledge, become better informed, or experience something new or unusual (Packer & Ballantyne, 2002). This suggests that these aquarium visitors viewed the aquarium primarily as an entertaining leisure venue, but also recognized the opportunities for learning that existed at the aquarium. This led Packer and Ballantyne (2004) to assert that entertainment and education
were not mutually exclusive visit motivations; rather, entertainment and education were compatible and synergistic. Although Packer’s (2004) quantitative research on visit motivations was certainly informative, it involved only adults and may not translate to other types of visitors, such as family groups with younger children.

Once individuals have elected to visit an informal science education center, they are more likely to attend to exhibits and concepts that interest them than to ones that do not align with their interests (Dohn, 2011; Falk, 2009; Falk & Dierking, 2011/1992; Falk, Moussouri, & Coulson, 1998; Simon, 2010). This idea should not be surprising to anyone who has attempted to learn about a topic that they found uninteresting. This emphasis on interest may be particularly relevant in informal science education centers, as visitors have chosen to spend their free time in these places, which are both a leisure destination and an educational space (Packer, 2006; Packer & Ballantyne, 2002). So, if we accept the premise that visitors to informal science education centers attend to and learn about what interests them, then what are these visitors actually interested in learning about?

Few research studies have been conducted regarding specific interests of visitors, particularly visitors of a variety of ages. The research that has been conducted is often presented with only the most general of results. For example, Tunnicliffe and Scheersoi (2009) stated that visitors “are especially attracted by young animals, big and dangerous animals and action in an enclosure” (p. 19). While this is likely true, this information does not help educators who intend to design educational materials based on visitor interests. Similarly, educators may have a general understanding of visitor interests based on their own experience and anecdotes from other educators, but the empirical evidence is simply lacking. This study begins to fill this gap,
identifying interests of a variety of visitor groups in hopes that this information will be able to assist educators in designing interesting and engaging educational materials or programs.

Learning can—and often does—occur at informal science education centers (Allen, 2002; Allen, 2004; Ash, 2002; Bell, Lewenstein, Shouse, & Feder, 2009; Falk & Adelman, 2003; Falk & Dierking, 1992/2011; Falk & Needham, 2011; Fenichel & Schweingruber 2010; Sherwood et al., 1989; Tofield et al., 2003). However, learning is personal, contextualized, and accumulated over time, potentially making it difficult to measure accurately after a single educational experience, such as a visit to an aquarium (Falk & Dierking, 1997; Pedretti, 2006). Further, many traditional assessment methods used to measure learning in school—such as pre- and post-tests, multiple-choice exams, or written essays—are considered ineffective and intrusive in an informal setting (Falk & Storksdieck, 2005; Storksdieck, Ellenbogen, & Heimlich, 2005). Bell and colleagues (2009) stated, “pretesting requires that learners be put on the spot in a manner that is inconsistent with the leisure-oriented and learner-centered nature of most informal environments” (p. 67). Instead, these researchers suggested utilizing techniques such as interviews, observations, journaling, and questionnaires to gather data, but still recognized that individual learning may be difficult to measure after a single educational intervention (Bell, et al., 2009).

Researchers have maintained that learning in informal science education centers may not look like the learning that occurs in school settings (Falk, 2008; Storksdieck et al., 2005). Storksdieck and colleagues (2005) argued that in addition to looking for traditional factual acquisition, researchers should also examine incidental learning outcomes, broader outcomes, and re-affirmation outcomes (p 354). Further, these researchers stated, “Assessment should not necessarily ask: how much did the average visitor/participant learn about X? An equally (or
more) appropriate question leading to more valid and useful results would be: ‘Who learned what?’” (Storksdieck et al., 2005, p. 355). Examining the learner’s own perception of his or her learning gains has gained quite a bit of support in recent years; the National Research Council recognized the potential for individuals to self-identify as science learners and considered this to be a crucial part of their *Strands of Informal Science Learning* (Bell, et al., 2009; Fenichel & Schweingruber, 2010).

According to Falk and Dierking (1992/2011), learning in informal environments is influenced by three contexts: the personal context, the social context, and the physical context. The research presented in this paper focuses on the personal context, which includes an individual’s visit motivations, learning interests, and background knowledge (Falk & Dierking, 1992/2011). There is little doubt that a visitor’s interactions with others (the social context) and the institution’s setting (the physical context) also impact learning in informal environments; however, a comprehensive examination of the social and physical contexts is beyond the scope of this research. Particular emphasis was placed upon family groups with elementary school-aged children and social groups of college-aged young adults; these two group types represented the majority of interviewed groups.

### 4.2 Methods

This study was part of a larger, multi-year research project focused on visitors’ aquarium experiences and related learning. This phase of the research project sought to determine participants’ visit motivations and learning interests. Three primary research questions guided this qualitative case study:
1. Why do individuals choose to visit an aquarium?

2. What are visitors interested in learning about on a future visit to an aquarium?

3. What do visitors report learning during a visit to an aquarium?

Visitors were asked to participate in short, semi-structured interviews at the conclusion of their aquarium experience.

Data for this study were collected at an aquarium that admits over 400,000 visitors annually (J. Zazzali, personal communication, October 14, 2012). Visitation at this aquarium is higher during summer months than winter months, and—in the winter—is higher on weekends than weekdays. Data were collected over a three-day period (Thursday, Friday, and Saturday) in January, 2011. This period coincided with winter break for many local schools and universities.

This aquarium is located on the East Coast of the United States, approximately 15 miles from a city that is both a popular tourist destination and home to two institutions of higher education. Thus, the aquarium serves a mixture of family groups and social groups of a variety of ages and education levels. In an effort to determine the visit motivations and interests of the aquarium’s varied audience, data was gathered from family groups with school-aged children, social groups of college students, social groups of adults not attending college, and individual adults. Family groups with children who appeared to be younger than three years old were not approached for this study. Attempts were made to solicit responses from all members within participating groups. Sixty-five groups or single adults were approached for this research; two groups declined to participate, giving a response rate of approximately 97% (Table 4.1). A total of 122 individuals in 63 groups provided responses to some or all of the interview questions. However, individuals within a group were not required to answer all interview questions; as such, individuals occasionally deferred questions to others within their group instead of
providing their own responses. Visitors were also allowed to provide more than one answer to a single question.

Table 4.1. Description of Group Types

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Description of Group Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school</td>
<td>Included one or two adults with one or more children currently enrolled in pre-kindergarten. (n=3)</td>
</tr>
<tr>
<td>Family Group with Elementary</td>
<td>Included one or two adults with one or more children currently enrolled in elementary school. (n=22)</td>
</tr>
<tr>
<td>Family Group with Secondary</td>
<td>Included one or two adults with one or more children currently enrolled in secondary school (i.e. middle or high school). (n=7)</td>
</tr>
<tr>
<td>Social Group of College-aged Adults</td>
<td>Included one or more young adults, approximate ages 18-25. These individuals were typically, but not necessarily, enrolled in a college or university. (n=20)</td>
</tr>
<tr>
<td>Social Group of Adults</td>
<td>Included one or more adults, older than approximately 25 years, who were visiting without children. (n=8)</td>
</tr>
<tr>
<td>Adult Group-Family Unspecified</td>
<td>Included one or more adults, older than approximately 25 years, whose answers suggested they were visiting with children of unspecified ages who were not present for the interview. (n=3)</td>
</tr>
</tbody>
</table>

Note. n denotes number of groups in each described category.

After completion of their visit, groups or individuals who fit the study criteria were invited to participate in a short interview as they passed the interview location. The selected interview location was near the end of the exhibits, but prior to entry into the gift shop. This location was deemed most appropriate by the researcher as it ensured that visitors had a chance to explore most, if not all, of the exhibits and group members who may have wandered apart during the visit were typically reunited by the time they reached this location. In addition, earlier research conducted by the author found that visitors often viewed the gift shop as the “end” of the aquarium experience.

Prior to the start of each interview, potential participants were informed of the purpose of the study, alerted of the expected time commitment (approximately 4-6 minutes), and asked to
read and sign the appropriate consent forms. At this time, the researcher requested permission to record the interviews, noting that identifying information would not be connected to respondents’ answers. As mentioned earlier, 122 individuals (Table 4.1) elected to participate in the interviews, answering open-ended questions about why they chose to visit the aquarium, what they learned during their visit, and what they might be interested in learning about on a future visit. Most interviews lasted between 4 and 6 minutes; the shortest interview lasted approximately 2 minutes and 30 seconds, the longest interview lasted approximately 7 minutes. All interviews were transcribed by the researcher and trained assistants; all transcripts were double-checked against original audio files to ensure accuracy of transcriptions.

The researcher coded interview responses related to visit motivation using two coding schemes. The first coding scheme was naturalistic (Guba, 1978; Guba & Lincoln, 1981) and open (Creswell, 2009), in that all codes emerged during the course of data analysis and were unique to this research. The second coding scheme began with codes described in previously published research on visit motivations (Packer, 2004; Packer & Ballantyne, 2002). Packer’s (2004) visit motivation categories were originally used with closed-ended questions; visitors were asked to select visit motivations that resonated with them. The current study utilized open-ended questions, which meant that visitor responses did not always align with Packer’s (2004) defined categories. As such, Packer’s (2004) categories were expanded slightly to fit visitor responses; visitor responses were included within a category only if they were closely related to existing category exemplars. Table 4.2 shows Packer’s (2004) original categories, with added response categories created by this researcher in italics. Use of both coding schemes allowed the researcher to describe visit motivations that may be unique to visitors at the studied aquarium while also situating this study within the wider framework of visit motivation research.
Table 4.2. Packer’s (2004) Visit Motivation Categories with Expansions

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive Enjoyment</td>
<td>To enjoy myself&lt;br&gt;To feel happy and satisfied&lt;br&gt;To be pleasantly occupied&lt;br&gt;To be entertained&lt;br&gt;For something to do&lt;br&gt;For fun&lt;br&gt;To spend quality time with family/friends&lt;br&gt;To do things with my companions&lt;br&gt;To interact with others&lt;br&gt;To develop close friendships&lt;br&gt;To meet new people&lt;br&gt;To bring the family together more&lt;br&gt;</td>
</tr>
<tr>
<td>Social Contact</td>
<td>To experience something new or unusual&lt;br&gt;To do something exciting&lt;br&gt;To be better informed&lt;br&gt;To discover new things&lt;br&gt;To explore the unknown&lt;br&gt;To think about my personal values&lt;br&gt;To make things more meaningful for me&lt;br&gt;To feel confident about my own abilities&lt;br&gt;</td>
</tr>
<tr>
<td>Learning &amp; Discovery</td>
<td>To expand my knowledge&lt;br&gt;To explore new ideas&lt;br&gt;To satisfy my curiosity&lt;br&gt;To use my imagination&lt;br&gt;To see the animals&lt;br&gt;Because I like aquariums&lt;br&gt;To think about my personal values&lt;br&gt;To make things more meaningful for me&lt;br&gt;To feel confident about my own abilities&lt;br&gt;</td>
</tr>
<tr>
<td>Personal Self-Fulfillment</td>
<td>To discover more about myself&lt;br&gt;To feel good about myself&lt;br&gt;To get a feeling of achievement&lt;br&gt;To develop my spirituality&lt;br&gt;</td>
</tr>
<tr>
<td>Restoration</td>
<td>To recover from the stress and tension of everyday life&lt;br&gt;To relax mentally&lt;br&gt;To get away from the responsibilities of everyday life&lt;br&gt;To find peace and tranquility&lt;br&gt;To have a change from my daily routine&lt;br&gt;</td>
</tr>
</tbody>
</table>

*Note.* Italicized motivations were added to Packer’s (2004) categories to better fit the data for this study.
Identification of visitor interest and self-reported learning was accomplished through the use of a four-phase coding system based on Guba’s (1978) work in naturalistic inquiry. These four phases included coding for convergence, verification of patterns, coding for divergence, and prioritization. Coding for convergence resulted after an initial reading of all interview transcripts (Guba, 1978; Patton, 2002); recurring themes were noted and assigned a numerical value for quantizing, as described below. The second phase, verification, included another examination of the transcripts and determination of the degree to which the identified themes fit the data (Guba, 1978). Coding for divergence, the third phase, included a “fleshing… out” of the data to build robust descriptors of categories and determine placement of interview responses within the categories (Guba, 1978, p. 57). At this stage, a large number of categories had been identified in order to encapsulate all of the participants’ responses. The final phase, prioritization, resulted in identification of a smaller number of themes to be discussed within the manuscript (Guba, 1978).

The researcher quantized and managed the data using SPSS 17.0, a statistical software package. Tashakkori and Teddlie (1998) described quantizing as “converting qualitative information into numerical codes that can be statistically analyzed” (p. 136). Quantizing the data allowed the researcher to determine which replies were most common. Additionally, this technique permitted the researcher to examine the extent to which replies varied between the categories of groups as defined in Table 4.1.

4.3 Results

As described above, groups were asked open-ended questions related to visit motivations, learning interests, and learned material. Groups were allowed to provide multiple answers to a single question. Visitors provided a wide range of responses to these open-ended questions; the
most common responses are discussed below. Descriptions of group types, and number of
groups in each group type, can be found in Table 4.1.

In the Tables presented in the following sections, the stated percentages refer to the
percentage of groups within each group type who provided the target response. If an individual
within a group provided the target response, the entire group was noted to have given the
response. During analysis, each group type was examined individually; the number of groups
within a group type who provided the target response was divided by the total number of groups
within that group type. Groups were allowed to provide more than one answer to each question,
which may result in totals greater than 100%.

4.3.1 Motivations. To begin each interview, participants were asked about their visit
motivations—why they chose to visit the aquarium that day. As shown in Table 4.3,
approximately half of all groups identified an Educational motivation, with visitors reporting
they wanted to “explore and learn about the world around us” (male, adult, group 10); “see the
fish and how they moved around” (female, 2nd grade, group 15); and “we’ve heard… how
educational it was, how good the exhibits looked, how really cool all the sea life was and we
wanted to check it out” (male, college, group 34). A greater percentage of family groups with
pre-school or elementary school children (67% and 59%, respectively) identified an Educational
motivation than any other group type (Table 4.3). Social groups of adults not in college were
least likely to give this response, with only 25% describing an Educational motivation (Table
4.3).

Most frequently, visitor groups identified Leisure motivations when asked why they
chose to visit the aquarium; 71% of all groups gave leisure-related reasons for visiting the
aquarium (Table 4.3). These Leisure motivations included responses such as “[we were
Table 4.3. Visit Motivations Provided by Percentage of Groups per Group Type

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Education</th>
<th>Leisure</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school (n=3)</td>
<td>67</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>Family Group with Elementary (n=22)</td>
<td>59</td>
<td>68</td>
<td>27</td>
</tr>
<tr>
<td>Family Group with Secondary (n=7)</td>
<td>43</td>
<td>71</td>
<td>14</td>
</tr>
<tr>
<td>Social Group of College-aged Adults</td>
<td>45</td>
<td>85</td>
<td>30</td>
</tr>
<tr>
<td>(n=20)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Group of Adults (n=8)</td>
<td>25</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>Adult Group - Family Unspecified (n=3)</td>
<td>67</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>All Groups, combined average (n=63)</td>
<td>49</td>
<td>71</td>
<td>29</td>
</tr>
</tbody>
</table>

Note. The numbers above refer to the percentage of groups in each group type who provided an answer coded as Education, Leisure, and Other. The number of groups in each group type is described by “n.”

Visitors also provided responses that were neither educational nor leisure-based (listed as Other in Table 4.3). Slightly less than a third of all groups (29%) gave responses such as “we had some free tickets and we’ve never been” (female, college, group 11); “because, um, it’s part of the Earth” (female, 3rd grade, group 14); and “we got a pass for the year so we plan on coming back” (male, adult, group 54). Table 4.3 shows that this type of response was most
common among social groups of adults (63%) and least common among family groups with pre-
school children (0%) and adult groups with family unspecified (0%).

Next, visitor responses were sorted into the five visit motivation categories described by
Packer (2004): Learning and Discovery, Passive Enjoyment, Restoration, Social Contact, and
Personal Self-Fulfillment. Using Packer’s (2004) classification scheme, Learning and Discovery
was the most commonly identified motivation (71% of all groups, Table 4.4). Passive
Enjoyment was a motivation for 51% of all groups and Social Contact was important to 27% of
all groups (Table 4.4). Only one group identified a Restoration motivation (2%) and no groups
identified a Personal Self-Fulfillment motivation (0%, Table 4.3). Packer’s (2004) categories did
not encompass all visitor responses; 10% of all groups identified a motivation that did not align
with Packer’s (2004) categories (Table 4.4).

Table 4.4. Packer’s Visit Motivations Provided by Percentage of Groups per Group Type

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Learning &amp; Discovery</th>
<th>Passive Enjoyment</th>
<th>Restoration</th>
<th>Social Contact</th>
<th>Personal Self-Fulfillment</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school (n=3)</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Family Group with Elementary (n=22)</td>
<td>59</td>
<td>55</td>
<td>0</td>
<td>14</td>
<td>0</td>
<td>23</td>
</tr>
<tr>
<td>Family Group with Secondary (n=7)</td>
<td>86</td>
<td>43</td>
<td>0</td>
<td>43</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Social Group of College-aged Adults (n=20)</td>
<td>70</td>
<td>65</td>
<td>0</td>
<td>35</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Social Group of Adults (n=8)</td>
<td>88</td>
<td>38</td>
<td>13</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adult Group, Family Unspecified (n=3)</td>
<td>67</td>
<td>33</td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Groups, combined (n=63)</td>
<td>71</td>
<td>51</td>
<td>2</td>
<td>29</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. The numbers above refer to the percentage of groups in each group type who provided an
answer that fit into each of Packer’s (2004) motivation categories.
Learning and Discovery was the most common type of motivation described by all groups (Table 4.4). This category included responses such as “it’s our field trip” (male, 4th grade, group 1); “to experience the magic of the ocean” (male, college, group 31); and “we came a couple of years ago, um, just to kind of introduce her [his pre-school daughter] to our habitat. I’m an avid fisherman myself, just wanted to introduce her to some of the wildlife” (male, adult, group 41). All family groups with pre-school children (100%) cited a Learning and Discovery motivation. Family groups with elementary school children had the lowest percentage of Learning and Discovery responses, although 59% of these groups identified Learning and Discovery as a motivation (Table 4.4).

Responses such as “to have fun” (male, 5th grade, group 42); “we both thought it would be a fun thing to do and it would be quiet this time of year” (male, adult, group 7); and “I like the ocean and I love seeing the animals” (female, college, group 17) were coded as a Passive Enjoyment motivation. Passive Enjoyment responses were highest in social groups of college-aged young adults (65%) and family groups with elementary school children (55%, Table 4.4). However, both social groups of college-aged young adults and family groups with elementary school children were more likely to offer Learning and Discovery responses (70% and 59%, respectively, Table 4.4). No family groups with pre-school children identified Passive Enjoyment as a visit motivation (0%, Table 4.4).

Restoration was an uncommon visit motivation, with only 2% of all groups providing this response (Table 4.4). A single individual from a social group of adults provided this motivation, saying that he liked “just the feeling of aquariums—relaxing” (male, adult, group 28). No other group types identified restoration as an important motivation.
Social Contact, on the other hand, was an important motivation for 27% of all groups (Table 4.4). This response was most common among adult groups with unspecified families; 67% of this group type gave Social Contact motivations. Examples of a Social Contact motivation include “I went with my girlfriend” (male, college, group 11); “I just decided to bring him because he hasn’t seen it before” (female, adult, group 25); and “we wanted to spend time with the family” (male, 6th grade, group 56). This response was least common among family groups with elementary school children (14%, Table 4.4).

Visitors also provided responses that did not align with Packer’s (2004) categories (10% of all groups, Table 4.4). As shown in Table 4.4, almost a quarter (23%) of all family groups with elementary school children provided Other responses, such as “we haven’t been here in a while” (male, 2nd grade, group 1); “my sister had to go to a birthday party” (male, 2nd grade, group 54); and “mom wanted to go on a hike lately and there were some trails [at the aquarium]” (female, 4th grade, group 26). Social groups of college-aged young adults also provided Other responses (5%, Table 4.4); all other groups did not.

4.3.2 Interests. When visitors were asked which animals, in particular, they were interested in seeing during their visit, 23 unique answers were provided. As shown in Table 4.5, the five most common responses among all groups were sharks (51%), jellyfish (32%), turtles (22%), alligators (17%), and generic fish or “everything” (17%). Other, less common responses included stingrays, seahorses, snakes, frogs, and others. Within most group types, a greater percentage of groups expressed a desire to see sharks than any other animal (Table 4.5). Only adult groups with unspecified families mentioned other animals as frequently as they mentioned sharks; one-third of adult groups with unspecified families stated that were interested in seeing
sharks, alligators, or generic fish/everything (Table 4.5). As mentioned previously, groups were allowed to provide more than one answer to each interview question.

Table 4.5. Viewing Interests Given by Percentage of Groups Within each Group Type

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Sharks</th>
<th>Turtles</th>
<th>Alligators</th>
<th>Jellyfish</th>
<th>Generic Fish/Everything</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school (n=3)</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Family Group with Elementary (n=22)</td>
<td>50</td>
<td>27</td>
<td>23</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Family Group with Secondary (n=7)</td>
<td>57</td>
<td>29</td>
<td>0</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td>Social Group of College-aged Adults (n=20)</td>
<td>45</td>
<td>20</td>
<td>25</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Social Group of Adults (n=8)</td>
<td>50</td>
<td>25</td>
<td>0</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>Adult Group, Family Unspecified (n=3)</td>
<td>33</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>All Groups, combined (n=63)</td>
<td>51</td>
<td>22</td>
<td>17</td>
<td>32</td>
<td>17</td>
</tr>
</tbody>
</table>

*Note.* The numbers above refer to the percentage of groups in each group type who claimed to be interested in seeing each organism.

Visitors provided 33 different responses when asked what they would be interested in learning about on a future visit. Almost a third of all groups (30%) said they would be interested in learning about sharks during their next trip to the aquarium (Table 4.6). Other common answers among all groups included mammals (21%), jellyfish (13%), turtles (11%), alligators (8%), ecosystems (8%), and local species (8%, Table 4.6). Individuals also expressed interest in learning about snakes, frogs, anemones, seahorses, sea stars, animal husbandry, and other topics, although these responses were not as common as the responses shown in Table 4.6; less than 8% of all groups expressed an interest in each of these less common topics.
Table 4.6. Future Learning Interests Given by Percentage of Groups Within each Group Type

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Sharks</th>
<th>Turtles</th>
<th>Alligators</th>
<th>Jellyfish</th>
<th>Mammals</th>
<th>Ecosystems</th>
<th>Local Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school (n=3)</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>67</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Family Group with Elementary (n=22)</td>
<td>45</td>
<td>9</td>
<td>18</td>
<td>18</td>
<td>14</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Family Group with Secondary (n=7)</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Social Group of College-aged Adults (n=20)</td>
<td>25</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Social Group of Adults (n=8)</td>
<td>25</td>
<td>13</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Adult Group, Family Unspecified (n=3)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Groups, combined (n=63)</td>
<td>30</td>
<td>11</td>
<td>8</td>
<td>13</td>
<td>21</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. The numbers above refer to the percentage of groups in each group type who claimed to be interested in learning about each organism on a future visit.

Family groups with pre-school children were most interested in learning about aquatic mammals (67%, Table 4.6). Sharks were the most common learning interest of family groups with elementary school children (45%, Table 4.6). Family groups with secondary school children had a wider range of interests; these groups were equally interested in sharks, mammals, ecosystems, and local species (14%, Table 4.6). Social groups of college-aged young adults also reported a variety of learning interests, although sharks were mentioned slightly more often than other topics (25%, Table 4.6). Sharks, jellyfish, and mammals were described as future learning interests by an equal percentage of social groups of adults (25%, Table 4.6). Adult groups with unspecified families were less interested in the common responses; only mammals were identified as an interest of this group (33%, Table 4.6). One male from this group said he “would be interested in a little bit more on the scientific arena of it” (male, adult, group 59).
4.3.3 Visitor Learning. The researcher encouraged groups to recall information and material they learned during their visit to the aquarium. Visitors provided open-ended responses and were encouraged to provide additional details when applicable. Unable to find existing themes within the literature that could adequately describe and differentiate between visitors’ responses, the researcher elected to define new visitor learning categories. These five categories of visitor learning—Factual, Observational, Conceptual, Species Awareness, and Emotional/Affective—are explained below.

When asked what they learned during their visit, individuals from all groups were most likely to provide a “factoid” or Factual answer (60%, Table 4.7). Observational answers were also given by slightly less than half of all groups (48%, Table 4.7). Just under a third of all groups (32%) gave a Conceptual answer (Table 4.7). Groups also reported they learned about the existence of one or more new species; these answers were categorized as Species Awareness (22%, Table 4.7). The least common responses were Emotional/Affective, provided primarily by younger groups (10%, Table 4.7). Examples responses from each of these categories are provided in the following sections.

Responses such as “I learned the difference between skates and stingrays… one has a barb that can sting and one doesn’t” (female, 5th grade, group 3); “we saw that [Hurricane] Floyd killed the most people” (female, college, group 27); and “sea turtles live to be 90 years old” (female, 7th grade, group 50) were coded as Factual answers. As shown in Table 4.7, these were common responses among all groups, but especially family groups with secondary school students (86%) and family groups with elementary school students (73%, Table 4.7). These responses were least common among social groups of adults (25%) and family groups with preschool children (33%, Table 4.7).
Table 4.7. Visitor Learning Responses Given by Percentage of Groups Within each Group Type

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Factual</th>
<th>Emotional/Affective</th>
<th>Observational</th>
<th>Conceptual</th>
<th>Species Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Group with Pre-school (n=3)</td>
<td>33</td>
<td>33</td>
<td>33</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Family Group with Elementary (n=22)</td>
<td>73</td>
<td>14</td>
<td>64</td>
<td>36</td>
<td>9</td>
</tr>
<tr>
<td>Family Group with Secondary (n=7)</td>
<td>86</td>
<td>14</td>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Social Group of College-aged Adults (n=20)</td>
<td>55</td>
<td>5</td>
<td>45</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Social Group of Adults (n=8)</td>
<td>25</td>
<td>0</td>
<td>50</td>
<td>25</td>
<td>38</td>
</tr>
<tr>
<td>Adult Group, Family Unspecified (n=3)</td>
<td>67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All Groups, combined (n=63)</td>
<td>60</td>
<td>10</td>
<td>48</td>
<td>32</td>
<td>22</td>
</tr>
</tbody>
</table>

Note. The numbers above refer to the percentage of groups in each group type who provided answers that fit into Factual, Emotional/Affective, Observational, Conceptual, and Species Awareness categories.

Observational responses included answers such as “I did learn that albino alligators look like they are upside-down when they are right-side up” (male, college, group 34); “If you touch an anemone in the middle it kind of closes” (female, 5th grade, group 39); and “the top of its [the dusky shark’s] teeth was different than the bottom of its teeth…. The top is triangles and the bottom was spikes” (male, 1st grade, group 43). This response was most common among family groups with elementary school children (64%) and least common among adult groups with unspecified families (0%, Table 4.7).

Responses were coded as Conceptual if the individual described a scientific concept such as predation, extinction, habitat destruction, or conservation. Conceptual responses were more elaborate than Factual responses, though the required level of elaboration varied based on the
individual’s age or grade level. Predation and defense were popular concepts, as shown in the following excerpt:

Male 1 (adult): The red drum have spots on their tails and it’s so larger fish will mistake which side of its head is, so they don’t know where the eyes are.
Interviewer: Okay… do you know if other fish have the same kind of thing?
Male 1 (adult): There are several, yeah, that have spots like that…. (group 42)

A second grade boy explained a similar concept: “Whatever that fish is in there with the streamers, when they’re young, when a predator tries to attack them, they’ll grab it, they’ll get the streamers instead” (group 20). College students provided a Conceptual response describing the effects of habitat destruction:

Female (college, group 8): They [the albino alligators] haven’t been discovered since Hurricane Katrina.
Male (college, group 8): Oh yeah. Their nesting habitat in Louisiana was destroyed.

Conceptual responses were most common among college-aged young adult groups (40%, Table 4.7), although more than a third of family groups with elementary-school students (36%, Table 4.7) also gave this kind of response. No family groups with preschool children or adult groups with unspecified families provided a Conceptual response (0%, Table 4.7).

Individuals also reported an increased awareness of new species, providing responses such as “I learned there was a fish called a Gag Fish” (male, 2nd grade, group 20); “I guess I didn’t realize how many different species of fish there were” (male, adult, group 7); and “we learned about the Megalodon… never knew that it existed” (female, college, group 27). Species Awareness responses were most common among social groups of adults (38%) and social groups of college-aged young adults (35%, Table 4.7). These responses were not given by family groups with pre-school children or adult groups with unspecified families (0%, Table 4.7).

The least common type of response was Emotional/Affective. When asked what they learned, individuals providing an Emotional/Affective response said, “I love all of the animals”
(female, kindergarten, group 38); “I learned that it’s important to be with your friends” (male, 1st grade, group 60); and “Fish aren’t that bad” (female, 4th, group 44). These responses were most common among family groups with pre-school children (33%, Table 4.7). Social groups of adults and adults with unspecified families did not provide Emotional/Affective responses (0%, Table 4.7).

4.4 Discussion

People choose to visit an aquarium for a variety of reasons. Typically, each visitor has a specific set of visit motivations, expectations, or goals to be fulfilled during the visit. Other members of one’s social or family group may influence these individual visit motivations. The majority of the visitor groups in this study saw the aquarium visit as a pleasant leisure experience, a chance to have fun, and an opportunity to spend time with family and friends.

Aquarium visitors typically have a set of expectations related to the visit experience. Though visitors may not be able to expressly define these expectations, they are often tied to the individual’s visit motivations. Thus, a visitor who says he came to the aquarium to “check out some exotic water creatures” (male, adult, group 58) expects to be introduced to something novel and likely exciting. Similarly, a visitor who says he came to the aquarium to “learn and draw the creatures that we see” (male, adult, group 45) will expect to obtain information related to aquatic life—often purposefully seeking out individuals or exhibits that provide facts related to an interesting concept or organism. Visitors who came to the aquarium to “spend time with family” (male, 6th grade, group 56) desire social interactions situated in a space that might provide fodder for the ensuing conversations.

In short, visitors expect the aquarium to offer an experience that addresses and fulfills their specific, personal reasons for visiting. The extent to which the visitor’s expectations and
motivations are met has been linked to the degree of satisfaction visitors attribute to the experience (Falk, 2009). Visitor satisfaction may also encourage visitor engagement and subsequent learning (Falk et al., 1998; Packer, 2006).

In an effort to increase visitor engagement and learning, aquarium professionals should address the three main motivation categories described by participants in this study (Learning and Discovery, Passive Enjoyment, and Social Contact). Learning and Discovery is likely a visit motivation familiar to aquarium educators; programs that encourage visitors’ sense of wonder are popular in aquaria around the country. Development of educational programs and materials that specifically encourage meaningful learning and personal discovery should be encouraged. This may be particularly important for older visitors, such as college-aged young adults, who may be under the impression that the aquarium is a space for children to learn, as discussed later in this chapter.

Passive Enjoyment is another learning motivation aquarium educators may be aware of and may already encourage in their institutions. Visitors who expressed a Passive Enjoyment motivation were looking for something fun to do for the day but did not emphasize learning specifically. These visitors may be less likely to attend a specific educator-led program than visitors who identified a Learning and Discovery motivation. Aquarium professionals may wish to focus on the physical context in order to best serve these visitors, such as making sure important areas (such as restrooms, elevators, or specific exhibits) are clearly marked or by providing adequate seating near exhibits of interest.

Visitors who identified a Social Contact motivation might be best served if aquarium professionals designed programs and activities that specifically encouraged group interactions. Fenichel and Schweingruber (2010) argued that “by designing environments that encourage
conversation and support mediation among learners, informal science educators can help their visitors gain deeper knowledge from even one experience and enjoy themselves more in the process” (p. 60). Simon (2010) described a number of ways in which museum staff could promote visitor participation and conversation, including asking questions of visitors. Given that Social Contact was seen as an important visit motivation for a large number of visitors, it is likely that these visitors would welcome activities designed to increase interactions between group members.

When addressing each of these motivations, educators should capitalize on identified visitor interests. As discussed previously, learners are more likely to attend to information and exhibits they find interesting and intriguing. Individuals in this study identified sharks, aquatic mammals, jellyfish, turtles, alligators, ecosystems, and local species as learning interests—either that they were interested in seeing these animals or learning about these topics on a future visit. This may not surprise front-line educators who field questions about these topics, but these educators may be surprised by the proportions of visitors from each group type who identified these topics. Educational programming and future exhibits would be well-received if these topics of interest were addressed in ways that appeal to a wide range of visitors, particularly if age-specific programming was offered. Further, educators in different aquariums should attempt to identify learning interests of visitors to their particular institution, as some of the less frequently reported learning interests may not be a major focus of current programming but could be used to engage visitors in the future.

Visitors, as a whole, provided interview responses that demonstrated increased learning during their visit. These learning responses were described as Factual, Conceptual, Observational, Emotional/Affective or Species Awareness. The proportion of each type of
learning gain varied by group type. For example, children tended to define learning more broadly than adults, giving answers such as, “I learned that it’s important to be with your friends” (male, 1st grade, group 60). Adult groups were more likely to report that they did not learn anything at the aquarium, or to equate learning with factual or conceptual acquisition. Also, children were likely to report learning through observation or physical manipulation of specimens while adults tended to report learning from conversations with educators or others within their group. Conversations between families tended to focus on prompting, where the adult within the group would prompt a child to provide a specific answer. These trends are discussed in more detail below.

Two group types constituted the bulk of respondents: Family groups with elementary school-aged children and social groups of college-aged young adults. Together, these two group types represented 67% of all responding groups (n=42). The answers provided by these two group types contained some interesting similarities and differences. As such, a more detailed discussion of each group type’s motivations, learning interests, and reported learning is provided below.

4.4.1 Family Groups With Elementary School-Aged Children. Family groups are probably one of the most commonly studied groups of aquarium visitors (Falk & Dierking, 1992/2011). This is likely because these groups represent a substantial portion of aquarium visitors; 35% of the individuals interviewed in this study were members of a family group with elementary school-aged children. The visit motivations, learning interests, and reported learning of family groups with elementary school-aged children are discussed below.

4.4.1.1 Motivations. The most common visit motivation category identified by family groups with elementary school-aged children was Packer’s (2004) *Learning and Discovery*. 
Children in these groups often said their family came to the aquarium because they wanted to see the animals: “I wanted to see the fish and how they move around” (female, 2nd grade, group 15). Some children identified specific animals they wished to see:

I just wanted to see lots of my favorite fish, the Megalodon shark, and sharks, and I like lots of sharks, and I wanted to come see all of my favorite types of sharks, and fish, and lots of things like the baby sharks in there, and the jellyfish…. And the alligators (male, kindergarten, group 21).

Sharks and jellyfish were mentioned most often in this type of answers. These groups saw the aquarium visit as a chance to view the typically unseen aquatic inhabitants. According to Brunner (2005), aquariums initially flourished, in part, due to individuals’ interest in “simulating, gazing at, and observing the exotic world of the ocean in an artificial environment” (p. 8). Although close examination of a shark may today seem commonplace, aquarium staff and educators should recognize the novelty of such an experience and the appeal it may have to visitors, particularly family groups with elementary school-aged children.

Family groups with elementary school children were the most likely of any group type to consider the aquarium visit as part of a homeschool or explicitly educational experience. Given by almost a quarter of family groups with elementary school children, these responses were also included in Packer’s (2004) Learning and Discovery category. In two of these groups, the parents had identified a specific learning task for the children to accomplish during the visit. One adult male said, “we come here every month, so… just our regular trip to learn and draw the creatures that we see” (group 43). Trowbridge and Wandersee (1997) acknowledged the importance of direct observation in scientific reasoning and knowledge acquisition, emphasizing the use of illustrations as a focal point for observation-based lessons. From the remainder of this group’s interview, it was apparent that the practice of drawing had encouraged the child, a boy in 1st grade, to hone his observation skills. Fenichel and Schweingruber (2010) considered
observation to be an integral part of the third *Strand of Informal Science Learning*: “Engaging in Scientific Reasoning” (p. 27). Thus, this group’s *Learning and Discovery* (Packer, 2004) motivation had potential to enhance the child’s understanding of science and scientific processes.

Occasionally, parents identified the visit as part of an educational or *Learning and Discovery* (Packer, 2004) experience: “we homeschool, so it’s part of our homeschooling” (female, adult, group 19), while the children in the group saw the visit simply as something fun to do. In family groups with elementary school-aged children, the children were more likely than adults to emphasize the idea of having fun as a motivation to visit the aquarium: “we have been here a lot of times before and we thought it was cool and lots of fun” (female, 5th grade, group 3). This response epitomizes a *Passive Enjoyment* (Packer, 2004) visit motivation, and was echoed by more than half of all family groups with elementary school-aged children (Table 4.4).

Many family groups with elementary school-aged children emphasized having fun as a desirable facet of the aquarium visit. At the end of each interview, groups were invited to share additional information about their visit; of the groups who elected to provide additional information, half stated they had fun or enjoyed the visit. The interview excerpt below shows one parent’s *Passive Enjoyment* (Packer, 2004) visit motivation:

**Interviewer:** Why did you come to the aquarium today?
**Female 1 (Adult):** Spur of the moment trip. It’s a beautiful day. We live about two and a half hours away. We’ve been wanting to come, so we just decided to come. (group 53)

This group saw the trip as simply something fun to do on a beautiful day, without any mention of the potential for learning. When invited to share additional information about their visit, the same group reported:
Female 2 (3rd grade): This is probably the coolest one [aquarium] I’ve been to, because it, the location, it’s like right on the beach, and it has a lot of fish…
Female 1 (Adult): … We had a lot of fun. It was a good experience. (group 53)

As shown in these excerpts, this group described fun and enjoyment both as visit motivations and as visit outcomes. However, this group also demonstrated meaningful learning gains during the remainder of the interview, particularly related to exhibits that are continuously staffed by educators and volunteers. This group was not an anomaly; each family group that identified Passive Enjoyment (Packer, 2004) as a primary visit motivation could also demonstrate concrete learning gains. Enjoyment and learning were not seen as mutually exclusive motivations or outcomes of the aquarium visit. These findings support Packer and Ballantyne’s (2004) assertion that aquarium visitors seek “an experience in which education is entertainment, discovery is exciting, and learning is an adventure” (p. 68, emphasis in original).

4.4.1.2 Interests. Family groups with elementary school-aged children were most interested in seeing and learning about sharks (Tables 4.5 & 4.6). Tunnicliffe and Scheerosi (2009) found that visitors were often drawn to “big and dangerous animals” (p. 19). This was certainly the case with family groups; 91% of family groups mentioned sharks during their interview, either that they were interested in learning about sharks or that they had learned something about sharks. No other organism was mentioned as frequently as sharks by family groups.

Of the groups that expressed an interest in learning about sharks, most wanted to learn “all about them” (female, 5th, group 19). Others focused on the most “dangerous” part of sharks—the teeth: “I would like to touch a shark’s jaw” (female, 2nd grade, group 38) and “[I wanted to see] the Megalodon jaws” (male, 3rd grade, group 60). Another visitor described the extinct Megalodon: “It was a shark but huge with big teeth” (male, 4th grade, group 14). The
size of sharks was also commonly discussed among these groups: “I’d be interested in learning about, like, how big sharks can grow and stuff” (male, 2nd grade, group 26). Visitor interest in sharks could be used as a starting point to discuss conservation efforts, as shark stocks are in decline worldwide—a fact many visitors may find surprising (Dobson, 2008).

Another animal these groups found interesting was the jellyfish; 27% of family groups were interested in seeing jellyfish on their visit and 18% were interested in learning about jellyfish on a future visit. One child was particularly interested in learning about the jellyfish because they exhibit unusual behaviors and life histories: “I wanna see how [jellyfish] see and eat and swim and stuff” (male, 5th grade, group 4). Another young visitor also expressed interest in learning about the jellyfish: “I would want to learn about how jellyfish move and how they get around” (female, 2nd grade, group 15).

One of the most striking commonalities among family groups with elementary school-aged children was the curiosity they showed; children and adults alike asked questions about what they experienced during their visit. This curiosity-driven questioning should be seen as a positive outcome, as sparking interest and curiosity about science and science concepts is a primary goal of many informal science education centers (Fenichel & Schweingruber, 2010; Kisiel & Anderson, 2010). More than three-quarters of family groups had questions during or after their visit, as shown in the following excerpt:

Interviewer: Did you all have any questions that weren’t answered today?
Boy 1 (2nd grade): When did the Megalodon go extinct?
Boy 3 (4th grade): Where is the octopus?
Boy 2 (6th grade): When was this aquarium founded?
Interviewer: Okay, those are all really good questions. Any others?
Boy 3 (4th grade): Oh… how did fish and sharks get into the giant tank?
Boy 1 (2nd grade): How did you find all of your animals?
Girl 1 (3rd grade): How do they get the poisonous snakes in the tank? (group 1)
These questions were asked in rapid order and the children seemed particularly interested in the capture, transport, and care of the animals they viewed at the aquarium. While some might suggest that the answers to these questions may not lead to in-depth, canonical scientific knowledge or understanding, Falk (2008) argued, “science education should be first and foremost about asking questions and striving to make meaning about natural phenomenon” (p. 246). Taking this perspective, more than three-quarters of the interviewed family groups had a meaningful science education experience that encouraged the formulation of questions.

Individuals’ questions often related to observations that surprised them or conflicted with their expectations. For example, a 5th grade girl questioned the aquarium’s decision to include sharks and fish in the same exhibit, based on her knowledge of the relationships between predators and prey: “Um, if you put—in that tank over there, there’s sharks with little fish. Wouldn’t they, like, eat each other or something?” (group 39). The peaceful coexistence of sharks and fish within the same tank was, for this visitor, surprising and memorable enough to warrant further thoughtful questioning. Allen (2004) suggests that such “problematic experience[s]” can lead to “genuine inquiry” in informal science education centers, as these apparent conflicts have the potential to spark meaningful conversations among visitors or between visitors and staff (p. S18).

Parents in these family groups were interested in speaking with the education staff and volunteers, often positively recounting their interactions: “the staff was very courteous and friendly; they always go out of their way to help answer our questions if we have any.... and we usually do have a lot of questions” (male, adult, group 43). Other parents said, “they learned a lot at the touch tanks because there’s actually people there” (female, adult, group 1) and “I liked the volunteers talking about the sea shells, though. She was very patient, and I learned a lot from
her that way” (female, adult, group 26). These quotes suggest that speaking with staff members and volunteers had the potential to increase learning for children and adults. This view was shared by the children, who saw the education staff as experts: “I asked her what the biggest shells in the world were, and she said that there was, like, really big clam shells, like bigger than the... table” (female, 4th grade, group 26). Michael and Modell (2003) consider active discussions between teacher and student to be crucial in enhancing science understanding. Thus, education staff and volunteers should be encouraged to engage visitors in conversations, particularly about topics and organisms that visitors find interesting. However, to further the institution’s educational mission, these conversations may need to evolve from “he [the volunteer] was like, ‘touch the crab, why wouldn’t you want to touch the crab?’” (female, 4th grade, group 44) to age-appropriate, meaningful discussions related to important themes and topics highlighted at the aquarium.

Although family groups with elementary school-aged children were usually interested in interacting with staff and volunteers and saw such interactions as positive opportunities for learning, one group (group 60) appeared to disagree:

Interviewer: Would you want to talk to someone?
Male 2 (1st grade): No, ‘cause that’s too chatty.
Male 1 (4th grade): I’d come right here and just look at everything.
Male 3 (3rd grade): Read, read!

Just under a quarter of all family groups with elementary school-aged children reported a desire to read about aquatic organisms: “I would like to read a book about it, ‘cause if you keep the book you can just keep rereading it, and rereading it, and rereading it” (female, 3rd grade, group 53). Another child said he would be interested in reading about the albino alligator because “I like reading” (male, 3rd grade, group 61). However, although children claimed to be interested in reading about the organisms, they did not appear to actually read the related information
presented at the aquarium. Family groups with elementary school-aged children rarely described learning through reading at the aquarium; almost all reported learning arose from conversations with education staff, direct observation of organisms, or handling of live specimens. This underscores the point made by Mortensen and Smart (2007): the strength of museum education lies in the opportunity for visitors to see and experience unique objects first-hand, rather than having to rely on two-dimensional text or graphics. However, the availability of age-appropriate texts, perhaps in the gift shop or online, could extend the learning experience for those visitors who express a desire to learn about aquatic organisms through reading.

4.4.1.3 Visitor Learning. Fenichel and Schweingruber (2010) and Bell and colleagues (2009) asserted that informal science education centers provide visitors with a unique opportunity to change the way they think about science. The sixth Strand of Informal Science Learning focuses on “Identifying with the scientific enterprise: coming to think of oneself as a science learner and developing an identity as someone who knows about, uses, and sometimes contributes to science” (Fenichel & Schweingruber, 2010, p. 27). This self-identification as a science learner was most apparent among family groups with elementary school-aged children; all of these groups reported learning something concrete during their visit. This was the only studied group type in which 100% of groups could identify a specific learning outcome at the conclusion of their visit. Thus, family groups with elementary school-aged children saw themselves as science learners and considered the aquarium visit to be a memorable learning experience.

Almost two-thirds of the family groups with elementary school-aged children provided Observational responses, reporting they learned about an animal through their senses, either by touching or watching the organism (Table 4.7). Informal science education centers, such as
aquaria, typically contain a plethora of three-dimensional objects that encourage observation and manipulation (Falk & Dierking, 1992/2011; Mortensen & Smart, 2007). These types of concrete experiences “produce a rich blend of all the senses” and may lead to increased learning (Zull, 2002, p. 150).

Children often described touching an animal, either in the touch tank or during an educator-led program. Prior research showed that handling live animal specimens could lead to cognitive and affective learning among young children (Sherwood et al., 1989); the current study supports this conclusion. When asked what they learned at the aquarium, one family group with elementary school-aged girls (group 38) replied:

Girl 1 (3rd grade): Well, we’re not really done doing it. We just came to see the jellyfish and then we’re going to go back and redo everything.
Girl 2 (Kindergarten): Yeah, and do some other fun things and see some fun things.
Girl 3 (Kindergarten): Yeah, and we touched a jellyfish!
Interviewer: You did?
Girl 2 (Kindergarten): Yeah, at the jellyfish show.
Interviewer: What did it feel like?
Girls 2 & 3 [in unison]: SLIMY!
Girl 2 (Kindergarten): And jiggily.

Immediately following this tactile experience, the girls rushed to the larger jellyfish tank to observe the animals. The older girls also sought out additional information about the organism they touched:

Girl 1 (3rd grade): I read about, um, jellyfish a little bit.
Interviewer: What did you read about them?
Girl 1 (3rd grade): Well, there was a poster and I don’t really know how to explain it. I knew that jellyfish, some could sting you and hurt you… and…
Girl 4 (2nd grade): And some can’t. Moon jellies [can’t].

Borun and Dritsas (1997) found that multi-modal exhibits—those that appealed to different learning styles and knowledge levels—were highly conducive to family learning. In this case, the entire learning experience, rather than a single exhibit, was multi-modal as the group
touched, observed, and read about the jellyfish. The initial tactile experience was critical, as it propelled the rest of the learning experience; these girls did not mention jellyfish as an animal they were interested in seeing or learning about on a future visit, but excitedly recounted what they had learned as a result of feeling such a strange animal. Prior research suggests that the learning resulting from use of multiple senses, as occurred in this group, can be particularly memorable and, thus, should be encouraged by educators (Allen, 2004; Borun et al., 1997; Borun & Dritsas, 1997).

Visual observations often focused on the size of animals and objects. After examining a replica of Megalodon shark jaws, a kindergarten boy (group 21) said, “Um, I learned that the Megalodon shark tooth is that big” and held up his hands in an approximate of the shape and size of a tooth. Another visitor spent time speaking with a volunteer and looking at a 4-month old loggerhead sea turtle hatchling:

Well, I learned that, they don’t grow very fast cause they, I learned cause I come here. The one that was four months old was like that big, and when they’re born, they’re maybe that big [shows with hands]. So they, so they, um, don’t grow very fast. (female, 3rd grade, group 53)

The size of marine organisms was a topic that half of the surveyed family groups with elementary school-aged children found interesting: eight groups reported learning about the size of one or more animals and 3 groups had additional questions about the size of animals, particularly sharks and whales. “Do whales, um, are some of them smaller than a school bus?” asked one kindergarten girl who, earlier in the interview, compared the extinct Megalodon shark’s size to that of a school bus (group 22). Many of these groups attempted to connect the abstract concept of extreme size to concrete items with which they came into contact on a regular basis. These types of connections are the cornerstone of meaningful science learning (Ausubel, 2010; Mintzes & Wandersee, 2005).
Although all family groups with elementary school-aged children reported learning during their visit, half of these groups gave answers that were incomplete or simply incorrect. The following excerpt from a 5th grader’s interview shows that she understood a concept, but did not remember crucial details:

Girl (5th grade): I learned the difference between the skates and the stingrays.  
Interviewer: Okay, and what is that difference?  
Girl (5th grade): I think… the one, I don’t remember, one has a barb that can sting and one doesn’t (group 3)

Another interview with a 4th grade girl showed a similar lack of details: “There was this one turtle that was near extinct but I don’t know their name” (group 44), and an interview with a 4th grade boy revealed confusion about nictitating membranes: “Oh, um, [I learned] that alligators change their eyelids underwater” (group 1).

Some might argue that, in these and similar cases, small, incorrect details are less important than the larger, correct ideas of morphological differences, species extinction, or adaptations. However, researchers have determined that these types of misconceptions can be enduring and highly resistant to change (Mintzes & Wandersee, 2005; Sahiner, 1987). It is of paramount importance that educators provide complete and accurate scientific explanations whenever possible. Otherwise, this responsibility could fall on parents and other visitors who may have their own misconceptions:

Boy (5th grade): [I learned] that shells actually are living, I think. Some aren’t living.  
Adult female: Oh yeah, the shells upstairs that you can touch.  
Boy (5th grade): Yeah, some are meat-eaters, that’s cool.  
Adult female: Some shells are meat-eaters, some shells are vegetarians…. Some shells have, like, drills in their tongues. (group 4)

Presumably, these visitors meant that the shells they touched were produced by living snails that displayed the described characteristics. However, both parent and child had misconceptions that,
unless corrected, are likely to persist over time (Fenichel & Schweingruber, 2010; Mintzes & Wandersee, 2005).

Parental misconceptions appeared to be rare, however. In this study, parents were more likely to correct a child’s misconceptions in an effort to help him or her learn:

Interviewer: What did you touch in there [the touch tank]?
Girl (3rd grade): Starfish and the sea urchins. The sea urchins were really cool cause if you put your hand on them for too long they start sucking your finger in.
Interviewer: Oh my. Was that the sea urchin or the sea anemone?
Girl (3rd grade): I think the sea urchin.
Adult Female: The anemone was soft. Remember the urchin was the pointy one.
Girl (3rd grade): Ohhh, the sea anemone then. (group 53)

Parents often acted as “Facilitators” (Falk, 2009), encouraging their child to expand on given answers. According to Falk (2009), Facilitators are interested in helping others learn and have fun; Facilitating Parents “like to ‘brag’ about having taken their children to a museum, and about all the things their children learned” (Falk, 2009, p. 195). In 9 of the 22 studied family groups will elementary school-aged children, parents prompted their children with questions or statements such as, “Think about the Megalodon thing we watched” (male, adult, group 22); “What did you learn?... Oh, what did we touch?” (male, adult, group 46); and “How about how long they [sea turtles] live?” (female, adult, group 53). These Facilitating Parents (Falk, 2009) felt that it was important for their child to be able to demonstrate concrete learning after the visit, but rarely reported learning anything new or significant themselves. Briseño-Garzón, Anderson, and Anderson (2007) also found that adults in family groups did not view themselves as science learners, and instead emphasized their role in helping younger group members learn. However, Briseño-Garzón and colleagues (2007) reported that adults in family groups engaged in learning behaviors and should be treated as independent learners.
In this study, adults in family groups who reported learning typically expanded upon topics described by their children, often adding facts, correcting concepts, or prompting their children for more details. Only 2 of the 22 groups contained adults who reported learning about a topic independently of the children in their group. One parent demonstrated a combination of independent adult learning and parental prompting:

Adult Male: We learned that reticulated moray eels, or eels, can swim pretty fast and they’re very good at hiding. [turns to child] What did you learn about one of the sharks we saw with the skull? Remember that, in the eel cave? What shark was that… the dusky shark—what was the difference in its teeth? (group 43)

The child, a boy in 1st grade, then provided an Observational response regarding the dusky shark’s teeth. This exchange allowed both the parent and child to present themselves as science learners who had deepened their understanding about marine organisms during the aquarium visit.

In only one group did the parents act as truly independent learners rather than as facilitators:

Adult Male: There was that fish with the spots…
Adult Female: The red drum and why the spots are on its tail to mistake them for the eyes and stuff.
Boy (5th grade): Yeah.
Interviewer: Okay. So, why is that?
Boy (5th grade): Um… the, um…
Adult Male: The red drum have spots on their tails, and it’s so larger fish will mistake which side its head is, so they don’t know where the eyes are.
Interviewer: Okay… Do you know if other fish have the same kind of thing?
Adult Male: There are several, yeah, that have spots like that. Also, I learned that, uh, copperheads and corn snakes can live together. I didn’t know that.
Adult Female: True. Yeah. A bunch of the venomous snakes- I saw that all different kinds were in the same tank and I didn’t know that was possible, so yeah. (group 42)

In this group, the parents presented themselves as science learners and did not use prompting to help the child demonstrate his own learning gains. This was atypical of family groups with elementary school-aged children; the highlighted interaction between the two adults more closely
mirrored intellectual discussions that occurred between social groups of college-aged young adults, as described in later sections.

As mentioned previously, all studied family groups with elementary school-aged children reported learning at the aquarium. Often, learning gains were described by younger members of the group and supported or prompted by older members of the group. Researchers have encouraged informal educators to treat all individuals within family groups as science learners (Briseño-Garzón et al., 2007; Falk & Dierking, 1992/2011). However, this study has suggested that parents are more likely to act as facilitators than independent learners. It is likely that parents assume a facilitating role for a variety of reasons that are yet unknown; more research is required regarding independent parental learning within family groups.

**4.4.2 Social Groups of College-Aged Young Adults.** College-aged young adults tended to visit the aquarium in small groups of peers rather than with family members. These individuals represent a substantial portion of the visitors at the studied aquarium; 32% of the individuals interviewed in this study were college-aged young adults. However, little is known about the visit motivations, learning interests, and reported learning of college-aged young adults; this group is vastly understudied in the literature.

4.4.2.1 Motivations. Social groups of college-aged young adults viewed their aquarium visit primarily as a *Leisure* activity. Half of these groups said they were looking for something fun to do for the day and a trip to the aquarium sounded enjoyable. Responses that focused on enjoyment and entertainment were coded as *Passive Enjoyment* (Packer, 2004; Table 4.2); this type of motivation was more prevalent among social groups of college-aged young adults than any other type of group. College-aged visitors often viewed the aquarium visit as a contrast to their daily routines, offering explanations such as, “[we] just had a day off, wanted to do
something different” (female, college, group 5) or “she goes back to school on Monday, so we’re just coming to the beach and hanging out” (male, college, group 35). These quotes also highlight the groups’ Social Contact visit motivations. Over a third of college-aged groups described a Social Contact motivation, stating they wanted to spend time with their companions or they came because their companion enjoyed aquariums.

At the same time, college-aged visitors often cited a general interest in topics covered at the aquarium: “I just like the marine life, definitely. Just the beach and everything” (female, college, group 48) and “I like fish and I like underwater things” (female, college, group 2). Individuals said they were “really fascinated by seeing different things” (male, college, group 10) and their visit offered an opportunity for closer examination of the aquarium inhabitants. This focus on seeing the “fascinating” animals up-close was expressed by 55% of all college-aged young adult groups, as shown in the following quote: “It’s a wonderful way to see the nature that we normally wouldn’t get to see in the ocean… it’s a wonderful way to be able to be up front with them” (male, college, group 48). Many college-aged visitors expressed excitement at simply observing the animals, emphasizing the uniqueness of such an experience. These responses aligned with Packer’s (2004) Learning and Discovery motivation category, which focuses on novel experiences, feelings of excitement, and expansion of interests or knowledge. Learning and Discovery motivations were reported most frequently by all groups, including social groups of college-aged young adults.

4.4.2.2 Interests. College-aged young adult groups were most interested in seeing sharks during their visit, saying, “I like the destruction of the sharks” (male, college, group 48) and “I wanted to see more sharks, even though I’m terrified [of them]” (female, college, group 10). The second most interesting organism to see, according to these groups, was the jellyfish. One
college-aged male explained, “I just like the jellyfish. Like, how they look and they’re so
distinct from everything else. I’m just really curious; there are lots of questions you can ask
about jellyfish. Like, one is, ‘Do they have eyes?’” (group 10). These responses support
Tunnicliffe and Scheersoi’s (2009) assertion that visitors are drawn to “dangerous” animals (p.
19).

Although 45% of college-aged groups reported they were interested in seeing sharks,
only 25% reported they would be interested in learning more about these animals on a future
visit. Similarly, 40% of college-aged groups wanted to see jellyfish and only 10% wanted to
learn more about them at a later date. This disconnect may be explained, in part, by the
emphasis these groups placed on simply observing the animals. As discussed previously, 55% of
college-aged groups stated that they came to the aquarium because it was a great place to see the
“fascinating” animals up-close. A much smaller percentage of visitors provided visit
motivations that emphasized learning about the same animals at the aquarium. Since the visit
motivations of these individuals were concentrated on seeing the animals rather than learning
about them, it is not terribly surprising that the visitors would express an interest in seeing sharks
and jellyfish more often than an interest in learning about them.

Groups also expressed a desire to learn more about native species: “what I’d be interested
in is, uh, like where would you normally run into these things? Like, which ones are
predominantly in our area?” (male, college, group 48). Interestingly, one main focus of this
aquarium is native species of aquatic wildlife; the vast majority of the animals on display can be
seen in and around the state’s water bodies (J. Metzler-Fiorino, personal communication,
October 11, 2012). This emphasis was lost on visitors, who questioned where one might see
sharks and fish outside of the aquarium. Another group expressed an interest in ecosystems and
species interactions: “Maybe like how they all interact maybe? Like, the whole ecosystem perhaps… like, start with the basics like coral reefs and the smaller organisms, and then go into the bigger fish, like the whole chain” (male, college, group 8). At the studied aquarium, there are a number of tanks that take “the whole ecosystem” approach, but the interconnectedness of species may not be emphasized in a way that resonates with visitors. The education staff may feel that these overarching themes are implicit within the exhibits and related texts, but these college-aged visitors did not recognize the themes in which they expressed an interest. These implicit themes must be made explicit for naïve visitors; they are interested in learning about these themes but do not recognize their presence in the exhibits.

4.4.2.3 Visitor Learning. When asked what they learned during their visit, one in every five groups said they didn’t learn much because, “I’ve been here before so a lot of it I already knew” (female, group 13) or “[I didn’t learn] so much today because I was here fairly recently” (female, group 25). These repeat visitors saw the aquarium as static and unchanging; once they had been a few times, there was not any new information left to learn. However, visitors thought the exhibit inhabitants might change, which led this visitor to emphasize the viewing experience over the learning experience: “I’ve been here probably 20-30 times. So, every time I come, it’s the same thing over and over. But, I mean, I love coming because you see something new—there might be a new fish every time you come” (male, group 35). Interestingly, the aquarium staff was in the process of adding new exhibits to the viewing area, most of which were not yet open at this time.
Some college-aged groups felt that the presented information was too basic for them to learn anything new, as shown in the following excerpt from group 24:

Interviewer: What did you learn today at the aquarium?
Male: Uh, [we] really just kind of saw everything. It’s funny, the plaques don’t really give you too much scientific information, I guess, it’s more just about, like, how cool they look and how cool they swim around…
Female: Yeah, probably more oriented toward, um, you know, teaching kids things.
Male: Yeah, definitely.
Female: Yeah, but it’s fun just being able to see it.

These college-aged young adults felt that the aquarium was focused primarily on teaching children to appreciate the unique animals on display, with little emphasis on content that was challenging for—or meaningful to—people their age. This view was not uncommon among college-aged visitors; 20% mentioned that the aquarium would be a good place for children. One female said, “I definitely want to bring our friend’s kids here” (group 34) and another female, describing a new program on sharks, said, “that would be interesting, especially for, like, young kids coming in” (group 27).

As one might expect, some college-aged young adults disagreed with this view. One college-aged male reported that a staff member spoke with his group and rid them of a common misconception: “It’s kind of cool to be able to come in, think one thing, and even at our age, find out that there’s a whole lot more to learn” (male, group 48). Overall, college-aged young adults did learn at the aquarium. More than half of the college-aged groups said they learned one or more facts, such as “that one particular shark in there only grows, won’t grow anywhere past human size” (male, group 55). These factual responses were typically superficial; individuals often could not expand upon them to any significant extent when pressed.

Slightly less than half of college-aged groups also provided observation responses, such as “The starfish were a lot rougher than I thought. I thought they were going to be smooth, but
they weren’t” (male, group 10). These observations were often focused on organisms in the touch tank, either how they felt or looked. Sherwood and colleagues (1989) found that handling live specimens increased learning among elementary-school children, but this study suggests that handling and close examination of live organisms can be a memorable learning experience for older individuals as well.

A greater percentage of college-aged groups provided conceptual answers than any other group type. These conceptual responses were more sophisticated and detailed than factual responses, and often covered topics such as extinction, habitat destruction, and conservation. Interestingly, conceptual responses were rarely given by a single individual in a group; these responses were often built through dialogue between two or more group members. Typically, group members would expand upon each other’s answers, providing extra details and “filling in” information their companions left out. This was in contrast to family group dialogues, where parents would often prompt children to provide more details on a specific topic of the adult’s choosing. The following excerpt shows three college-aged visitors (group 31) discussing reptile ecology:

Interviewer: What did you learn today at the aquarium?
Male 2: That there are albino alligators. [all chuckle]
Interviewer: OK. Do you remember anything specific about the albino alligators?
Male 2: Well, they don’t normally survive in the wild.
Female: She’ll be like, what, twelve feet. Twelve feet, is that what they said? Yeah. Something about twelve feet big and she is six years old. That’s all I remember.
Male 2: She can be up to seventy? She can live to be up to seventy, is that what they said?
Male 1: Yes, and if they put her in a warmer environment she could be up to eighteen feet but they stop eating because of the temperature.
Female: The cold.
Male 2: We paid attention.

These three young adults repeatedly looked to their companions for confirmation on the information they were providing, asking “is that what they said?” and nodding when others
added a fact to the discussion. Another college-aged group (group 32) discussed toxicity, a form of defense among marine organisms, as shown below:

Interviewer: What did you learn today at the aquarium?
Male: I learned, I mean various animals and organisms that were like, you know, toxic. They produce toxins.
Female: Yeah, like the lionfish. I didn’t know that was so toxic.
Male: Yeah, that was pretty much the most interesting thing that I learned.

These back-and-forth exchanges highlight the social nature of learning among college-aged young adults. According to Michael and Modell (2003), young adults are most likely to remember science concepts if they are engaged in active, thoughtful discussions, either amongst themselves or with an educator. However, Martin (2004) reported that these scientific discussions did not often arise spontaneously during a visit to an informal science education center. Instead, discussions are often instigated by an educator or through the visitor’s use of educational materials (Mortensen & Smart, 2007; Pedretti, 2004).

It was obvious that many of the conceptual responses were influenced, at least in part, by the visitors’ interactions with education staff and volunteers. Conceptual responses usually pertained to exhibits or programs that were continuously staffed by educators or volunteers: the touch tank, the albino alligator enclosure, and live animal programs. These groups often indicated that they had spoken with a staff member, which suggests that college-aged young adults will engage educators and volunteers in conversations in order to gain additional knowledge related to what they see and think about at the exhibits. One college-aged male described his experience viewing the albino alligator, nicknamed “Luna”: “I liked the way they did with Luna where there’s a knowledgeable person just hanging out for when you come over and then there’s Luna. I really liked that” (group 31).

Taken together, these results suggest that learning among college-aged young adults may be enhanced if facilitated by an educator or an educational material that encourages discussion
between individuals. These discussions should be focused around content that the visitors find interesting and intellectually challenging, not simply “for, like, young kids coming in” (group 27). Repeat visitors may be further challenged if this content changes regularly, as new learning opportunities might rid these visitors of the notion that the aquarium is static, unchanging, and unable to help them learn about science and the ocean.

4.5 Conclusion

Researchers have suggested that an individual’s visit motivations and learning interests can impact the learning that occurs during a visit to an aquarium or a similar informal education venue (Dohn, 2011; Falk, 2009; Falk & Dierking, 2011/1992; Falk, Moussouri, & Coulson, 1998; Simon, 2010). Although some research exists regarding visit motivations (Falk, 2009; Falk et al., 1998; Packer, 2004; Packer & Ballantyne, 2002; Rounds, 2004), few researchers have examined visitors’ specific learning interests. However, if aquariums are to become “respected educational institutions where people can spend an hour and come away having learned some canonical science” (Allen, 2004, pg S18), visitors must feel engaged in the educational experience. Falk (2009) noted that a “one size fits all” approach to informal education is not particularly appropriate or desirable. Gowin (1981) also encouraged educators to provide lessons and educational materials that are age-appropriate and knowledge-appropriate, something that is rarely done in aquaria and other informal learning environments (Allen & Gutwill, 2009; Ash, 2003; Falk, 2009). To enhance visitors’ engagement and potential learning, educators must make an effort to design exhibits, signage, and programs that are age-appropriate and address visitors’ motivations and learning interests—crucial information that can be gained through studies such as this one.
This study examined visit motivations and learning interests of a wide variety of visitor groups and demonstrated that these may vary based on group composition. As one might expect, family groups with young children have motivations and interests that differ from social groups of adults without children. Examining an array of group types within a single study, using identical methods, illuminated similarities and differences between different types of visitor groups. In particular, the differences described in this study underscore the need for research on a variety of group types, including understudied groups such as college-aged young adults. This study demonstrated that the motivations, interests, and experiences of college-aged young adults do not mirror the experiences of family groups—the most commonly studied group in informal education. Given that college-aged young adults constitute a substantial percentage of visitors to the aquarium under study, and probably others, this lack of research suggests that the needs of this group are not likely to be adequately understood or addressed at aquaria. More research is necessary if researchers and informal educators are to understand the experiences of this understudied, yet important, group.

Aquaria currently have a reputation for serving a specific subset of learners, as shown in this excerpt from an interview with two college-aged young adults:

Interviewer: What did you learn today at the aquarium?
Male: Uh, [we] really just kind of saw everything. It’s funny, the plaques don’t really give you too much scientific information, I guess, it’s more just about, like, how cool they look and how cool they swim around…
Female: Yeah, probably more oriented toward, um, you know, teaching kids things.
Male: Yeah, definitely.
Female: Yeah, but it’s fun just being able to see it.

These adults, like others in this study, suggest that the information provided at the aquarium is geared towards children and families, leading them to believe there are few learning opportunities for adults. This common problem led Briseño-Garzón and colleagues (2007) to
urge informal educators to recognize and treat adults as independent learners, rather than simply as facilitators for other, younger individuals. By recognizing and addressing the motivations and interests of social groups of older individuals, such as college-aged young adults or adults without children, aquaria can potentially begin to change public perception about the availability of learning opportunities for adults at these science education centers. This is of paramount importance, as research has suggested that adults construct most of their scientific knowledge through informal science learning experiences (Falk & Dierking, 2010).

Due to the idiosyncratic nature of learning and the multitude of intrinsic and extrinsic factors that can influence a visitor’s experience, the results of this study are not generalizable to all visitors in all settings. However, informal educators can view the conclusions from this study as a guide as they attempt to design appropriate and memorable educational opportunities for a wider variety of visitor group types. This study provided novel insights regarding the visitor experience in aquaria, particularly of college-aged young adults. As discussed throughout this article, further research is needed if educators are to fully understand the visit experience and learning of all of the visitors to their institution.

4.6 References


Chapter 5. Increasing Family Conversations in Aquaria Through Use of VIP Discussion Guides

5.1 Literature Review

In the 1980’s and 1990’s, science education researchers often found themselves embroiled in an “education versus entertainment” debate when discussing learning at informal science education centers. Questions arose regarding the educational effectiveness of zoos, aquariums, botanical gardens, and nature centers—did these places provide the public with worthwhile educational opportunities, or were they simply a fun distraction from everyday life? More recently, researchers have effectively abandoned the notion that education and entertainment exist as an exclusive dichotomy; Spock (2006) said, “the muddling and unhelpful effects of the entertainment-versus-education… debates are a distracting irritant” (p. 169). The research of Falk, Moussouri and Coulson (1998) suggested that individuals at informal science education centers viewed education and entertainment as important, relevant, and, ultimately, compatible visit motivations. This view was supported and expanded by Packer and Ballantyne (2010), who asserted, “the educational and entertainment aspects of the visit are not only compatible, but synergistic” (p. 27). As a whole, visitors expect to have an enjoyable and educational experience; this is especially true at an aquarium, which visitors see as a place where the act of learning itself is fun (Packer & Ballantyne, 2010).

The experience of “learning for fun” (Packer, 2006, p. 329) in an informal environment may be especially important for family groups, particularly those with elementary school-aged children. Riedinger (2012) said, “family visits to informal learning environments provide opportunities to learn together, interact, engage in conversations, and learn more about one another” (p. 125). Research has shown that interesting and meaningful science experiences in early childhood can lead to increased interest in science, greater engagement in science learning,
self-identification as a science learner, and more elaborate understandings of important science concepts as the individual ages (Ash, 2002; Bell, Lewenstein, Shouse, & Feder, 2009; Falk & Dierking, 2010; Fenichel & Schweingruber, 2010). Children, especially younger children, are dependent on parents and other caregivers to provide these meaningful science-learning experiences (Fenichel & Schweingruber, 2010). Often, children look to adults for interpretation of complex information (Fenichel & Schweingruber, 2010); Crowley and Callanan (1998) stated, “much of what [children] learn about their world they learn in the context of parent-child interactions” (p. 17). Informal science education centers offer families an intellectually safe space for these parent-child interactions, full of exhibits that are “novel, stimulating, evidence-rich, multisensory, and fun” (Allen, 2004, p. S17). Further, a visitor’s learning choices are supported “without any teachers forcing learners to do something unappealing, without curricular constraints, without testing or accountability” (Allen, 2004, p. S17-S18). The very nature of this type of learning (free from grades, testing, or potential failure) allows visitors to engage in educational activities in an environment where pressure to succeed is low and learning is fun.

Learning, including learning that occurs in informal education centers, is highly idiosyncratic and potentially difficult to measure. Rennie and Johnston (2004) reminded educators that learning is personal, is contextualized, and takes time. However, researchers have published evidence that learning does actually occur in informal science education centers. For example, Sherwood, Rallis, and Stone (1989) found that students who handled live horseshoe crabs and sea stars displayed short- and long-term cognitive and affective gains. Falk and colleagues (1998) found that visitors’ motivations influenced their learning; individuals with high education motivations showed significant conceptual learning and individuals with high entertainment motivations showed significant vocabulary development and an increase in overall
understanding of the topics on display. Years later, Falk and Dierking (2010) summarized their own work and that of other researchers interested in visitor learning:

The majority of visitors significantly increase their conceptual understanding of science on a variety of levels—basic information, breadth, and depth of understanding—immediately following a visit, and for most of these individuals this understanding persists and grows for two or more years after the experience. (Falk & Dierking, 2010, p. 488)

More recently, Poarch (Chapter 4, Table 4.7) found that 100% of interviewed family groups with elementary school-aged children reported learning something during their visit to an aquarium, though only 59% began the visit with an expectation of learning. This suggests that in an aquarium, learning may occur unintentionally on the part of the visitor—almost as a side effect of the fun experience. Additionally, these learning outcomes, as identified by visitors themselves, may not look like the learning outcomes we have come to expect from school-based learning experiences. According to Allen (2002), conceptual learning-talk, defined as “cognitive interpretations of whatever was being attended to in the exhibit” (p. 275), most closely resembles traditional cognitive knowledge acquisition. Allen (2002) encouraged researchers to examine conceptual learning-talk among social and family groups, but also acknowledged that other learning outcomes could be equally valid. Storksdieck, Ellenbogen, and Heimlich (2005) identified some of these alternative outcomes, in addition to traditional factual knowledge, that can serve as evidence of learning: incidental learning outcomes, general or broader outcomes, and re-affirmation outcomes. The National Research Council’s report, Learning Science in Informal Environments, supported the research of Storksdieck et al. (2005), stating that outcomes could “include a broad range of behaviors,” “be unanticipated,” “become evident at different points in time,” and “occur at different scales” (Bell et al., 2009, p. 76-77). Taken together, these various outcomes paint a broad picture of learning in informal science education centers—a
picture that is unique to and shaped by the individual learner and the experience he or she has at the center.

Without set curricula or explicit learning goals, informal education centers typically offer visitors a unique learning experience; as learners, these visitors have a large degree of flexibility regarding the topics they attend to, the exhibits they interact with, and the extent to which they engage with educators and other visitors. These decisions are often shaped by an individual’s interests, prior knowledge, self-identity, and experience visiting informal education institutions (Ash, 2002; Falk, 2009; Falk & Adelman, 2003; Falk & Dierking, 1992/2011; Rounds, 2004). However, these individual experiences do not occur in a vacuum; the interests, prior knowledge, self-identity, and experience of others within the visitor’s social or family group also impact the nature of the visit (Ash, 2003; Briseno-Garzon, Anderson, & Anderson, 2007; Falk, 2009; Falk & Dierking, 1992/2011). This may be particularly relevant in family groups, as one group member may take primary responsibility for directing the course of the visit. Parents may assume this role, or they may elect to support a child’s decisions (Ash, 2002).

It is reasonable to assume that some, if not all, of family groups visiting an aquarium are open to the possibility of learning during the visit experience. Children or adults can act as drivers of knowledge exchange during the visit depending on the depth and breadth of expertise they possess regarding the exhibit topics and themes (Ash, 2002). Adults often fulfill this role, asking children questions, reading labels, providing explanations, and making explicit connections between exhibits and prior experiences (Allen, 2002; Ash, 2002). However, other researchers have found that parents can be uncomfortable with this role, unsure of how to best support learning among various family members (Schauble et al., 2002). These researchers
suggested focusing on “helping the helpers,” providing adults with educational materials or instruction that help them support children’s learning (Schauble et al., 2002, p. 449).

The act of supporting another, less knowledgeable individual’s learning is often referred to as “scaffolding.” Although there are many definitions or examples of scaffolding in education today, Wood, Bruner, and Ross (1976) originally defined scaffolding as:

[a] process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult “controlling” those elements of the task that are initially beyond the learner’s capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence. (p. 90)

In a formal education setting, scaffolding is often performed by the teacher or perhaps a tutor—someone seen as an “expert” due to their stronger knowledge base (Mintzes & Wandersee, 2005; Wood et al., 1976). In informal environments, this expert role is often held by the person most knowledgeable about the presented content, but this person may not be an expert in the truest sense of the word. This person is typically a parent or older individual within a group, though children can also play the expert role (Ash, 2002). Informal institutions may take the expert’s place in scaffolding, by providing materials that customize, clarify, or modify the presented information in a way that assists the visitor as she makes sense of her experience (Pedretti, 2004; Zimmerman, Reeve, & Bell, 2010).

One scaffolding technique educators often use is asking thought-provoking questions to spark meaningful discussions, or dialogues between “experts” and “novices.” Michael and Modell (2003) posit that engaging the novice in an in-depth conversation allows the more knowledgeable individual to gauge the novice’s understanding, potentially illuminating misconceptions and allowing for conceptual clarification. Additionally, back-and-forth exchanges allow groups to construct meanings that integrate their current experience into their existing mental models, which are shaped by each individual’s background knowledge and prior
experiences (Michael & Modell, 2003; Mintzes & Wandersee, 2005). Often, a family or social group visiting an aquarium will share a set of common prior experiences, from which they can draw examples or make connections.

In addition to helping groups make sense of their experience, Pedretti (2004) argued that conversations can encourage deep thinking about and lasting interest in science and science concepts. However, informal educators must present opportunities for this dialogue to occur (Pedretti, 2004), particularly by presenting “interesting and complex” material for family groups to discuss (Ash, 2002, p. 389). Martin (2004) stated, “we know that scientific discourse is not likely to arise spontaneously” during informal science education experiences (p. S73). Instead, educators at informal science education centers should attempt to purposefully scaffold this discourse or dialogue between visitors. Mortensen and Smart (2007) found that use of free-choice worksheets focused on observation of objects increased curriculum-related or science-related conversations during school field trips. Similarly, Pedretti (2004) found, “extensive scaffolding (i.e. through science center educational guides…) significantly enhances visitor experiences and the making of meaning” (p. S43). Thus, the educational mission of an informal science education center, such as an aquarium, could be furthered through the use of appropriate educational materials that encourage scientific dialogue between visitors and enhance meaning-making.

The quality of these educational, scaffolding materials is of paramount importance; presented information should be interesting to the visitors, appropriate for visitors’ ages and knowledge levels, and applicable to the educational mission of the venue. Additionally, these materials should be designed in a manner that is supported by current research in formal and informal education. This study examined the impact of educational materials, called the
Visitors’ Interpersonal (VIP) Discussion Guide, on family groups’ aquarium experience and reported learning. The VIP Discussion Guide contained questions that encouraged families to engage in science-based conversations during the visit because an increase in “learning-talk” has the potential to increase cognitive gains (Allen, 2002, p. 245). Interviews and observations of families utilizing the VIP Discussion Guide were contrasted with interviews and observations of families who did not use the VIP Discussion Guide. Use of the VIP Discussion Guide did, in fact, increase the number and complexity of science-based conversations between family members while also encouraging a fun, pleasurable, and memorable experience for the entire family.

5.2 Methods

This study was part of a larger, multi-year research project concerned with visitors’ aquarium experiences and related learning. The primary question guiding this research was, “How does the use of educational materials, designed to address visitors’ interests, motivations, and background knowledge, affect the experience and learning of aquarium visitors?”

This project began with the creation of a new type of educational material, called the Visitors’ Interpersonal (VIP) Discussion Guide, as described in Section 5.2.1. Through the use of interviews, observations, and document analysis, the researcher sought to determine how using the VIP Discussion Guide affected the visit experience of family groups with elementary school-aged children. Similar interviews and observations with families who did not use the VIP Discussion Guide served as comparisons and provided representations of typical family experiences at the aquarium. This qualitative case study focused on 4 sub-questions:

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?
2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?

3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?

4) What factors affect visitors’ responses to using educational materials (VIP Discussion Guides)?

5.2.1 Creation of Educational Materials. The educational materials used in this study—the VIP Discussion Guides—had a two-fold purpose. The primary purpose was to encourage meaningful science-based dialogue between group members. The secondary purpose was to serve as an orientation guide for new or infrequent visitors.

The VIP Discussion Guide was two-sided; each side contained a map of half of the aquarium, which was surrounded by open-ended discussion questions (Appendix E). The map was taken from the aquarium’s website with permission. Utilizing the aquarium map as the base of the VIP Discussion Guide allowed visitors to locate specific exhibits, restrooms, elevators, and the post-visit interview site. Research has shown that providing this type of orienteering information can reduce cognitive load and museum fatigue (Bitgood, 2009). Without needing to worry about orienting themselves or locating important areas, visitors are able to focus the majority of their energy on content comprehension (Bitgood, 2009).

In an effort to increase science-based conversations among family groups, a total of 18 open-ended discussion questions were arranged around the periphery of the aquarium map. Seven exhibits, or clusters of exhibits, were selected to serve as the focal points for 14 of the 18 questions. One to three questions related to each exhibit or cluster of exhibits and an arrow connected each question set to applicable exhibits. Four questions did not pertain to specific
exhibits. Instead, these four questions asked visitors to recall prior experiences and contemplate the importance of the ocean. Some exhibits, such as the alligator enclosure, were selected based on prior research (Study 1.B, Chapter 4) in which family groups with elementary school-aged children identified future learning interests. Other exhibits, such as the freshwater predator exhibit, were selected for their content and applicability to important science concepts.

Sustained dialogue between individuals, particularly dialogue that includes questioning, hypothesis generation, and purposeful linking to prior knowledge, can greatly increase science comprehension (Ash, 2002; Allen, 2002; Falk & Dierking, 1992/2011; Michael & Modell, 2003; Pedretti, 2004; Simon, 2010). Questions on the VIP Discussion Guide were formulated in an effort to initiate this type of dialogue among family groups with elementary school-aged children. Thus, these questions were open-ended, asking visitors to recount personal experiences, compare organisms, observe behaviors, share knowledge, brainstorm ideas, or imagine hypothetical scenarios. The VIP Discussion Guide did not include an answer key; variations between groups of individuals guaranteed that each conversation generated by a VIP Discussion Guide question would be unique to that group of individuals. During this study, groups were assured that there was not a single “right” answer to each discussion question.

Questions were generated by the researcher and were influenced by her prior work in aquariums, knowledge of important science concepts, and experience designing discussion questions for graduate-level university courses. The questions were then vetted by a senior researcher/educator and modified for clarity. Additionally, these questions were tested in a pilot study at the research location and further adapted due to a change in exhibits. As shown in Appendix G, each question addressed one or more of the following: a specific visitor interest (as
identified in Study 1.B, Chapter 4), an *Ocean Literacy Principle* (OLN, 2009), and/or a *Strand of Informal Science Learning* (Bell, et al., 2009; Fenichel & Schweingruber, 2010).

5.2.2 Setting and Participants. This research occurred at an aquarium on the coast of North Carolina. Data collection occurred over two four-day periods (Thursday, Friday, Saturday, and Sunday) in January 2013. These 4-day periods were selected because visitation is highest on these days during the winter months (J. Zazzali, personal communication, October 14, 2012).

This research focused on family groups with elementary school-aged children. For this study, a family group was defined as an intergenerational unit composed of one to two adults and two to three children in elementary school (approximate ages 5-11). Groups with children appearing to be younger than five years old were not approached for participation in this study. A total of nine groups participated in this study; one group elected not to participate due to hyperactivity of the three children in the group. A single adult was present in five groups and a pair of adults was present in the remaining four groups. Eight of the groups contained two children and one group contained three children. The sample contained more male children (n=13) than female children (n=6). All children were enrolled in school in kindergarten through 4th grade. The mean age for all children was 7.2 years and there was no difference between mean age for male and female children. Six groups utilized the VIP Discussion Guide (VIP groups) and three groups did not use the VIP Discussion Guide (comparison groups).

5.2.3 Data Collection: Pre-Visit Interviews. Pre-visit interviews took place shortly after the visitors entered the aquarium but prior to the first exhibit. The researcher approached groups who appeared to fit the criteria for inclusion, informed the group of the study procedures and benefits, and asked for the groups’ participation.
Individuals who agreed to participate were asked to read and sign the appropriate consent form. Individuals under 18 were asked to read and sign the assent form, or if the individual was unable to read, a parent/guardian was asked to read the assent form to the child. Parents or guardians were also required to sign a consent form stating that the researcher was allowed to interview adults and children within their family group. Participants were informed that the interviews were audio recorded with their permission, and that they would be observed during their visit, but no identifying information was connected to the audio recordings or observations. In addition, the researcher attempted to reassure visitors that there were no “wrong” answers to the interview questions and no “expected” behaviors for the observations.

Participants were interviewed within family groups as group dynamics are likely to shape the visit, the interview, and interview responses. Children under the age of 18 were only interviewed with a parent or guardian present. The pre-visit interview consisted of seven questions and took between 1 min and 4 min to complete (2.6 min average). These questions solicited demographic information (age/grade, hometown, number of prior visits) as well as visitor motivations and interests. Visitors were encouraged to expand upon others’ answers during this interview and efforts were made to gather information from all participants.

After completion of the pre-visit interview, participants in the intervention groups (VIP groups) were given a copy of the VIP Discussion Guide, a clipboard, a writing utensil, and verbal instructions for usage. Instructions for usage were also printed on the front of the VIP Discussion Guide. Participants were informed that the VIP Discussion Guide contained questions intended to spark conversations at a number of exhibits throughout the aquarium. The participants were informed that they were not obliged to answer all of the questions on the VIP Discussion Guide, only those that they found interesting or intriguing. Participants were also
informed that they might be observed from a distance and to ignore the researcher if they spotted her during the observations. The researcher asked participants to circle questions they discussed. At this time, participants were also informed of the post-visit interview location, which was marked on the VIP Discussion Guide, and were reminded they would receive a $10 gift card in exchange for completing the post-visit interview.

Participants in the comparison groups were instructed to conduct their visit as they normally would on a typical visit. Comparison groups did not receive a VIP Discussion Guide. However, these participants did receive a printed map of the aquarium with the post-visit interview location clearly marked. Again, participants were informed that they might be observed from a distance and to ignore the researcher if they spotted her during the observations. Participants were asked if they had any questions and were reminded that they needed to complete the post-visit interview in order to receive their $10 gift card.

5.2.4 Data Collection: In-Visit Observations. Participating groups were discretely observed from a single vantage point during their visit. This semi-hidden vantage point allowed the researcher to quietly record verbal field notes using an audio recorder and fill out the observation protocol (Appendix L). From this location, the researcher had a clear view of the two exhibits under observation; these exhibits are in close proximity and are often viewed in short succession. The first exhibit had an open-air top and three large viewing windows, which allowed visitors to examine a replica of a salt marsh bank. Organisms in the tank included diamondback terrapins, minnows, small spadefish, and other brackish-water fishes. This exhibit did not have any related questions on the VIP Discussion Guide. According to the aquarium’s Education Curator, this tank is under-utilized because visitors are often drawn to the touch tank, which is the neighboring exhibit and the second exhibit under observation. The touch tank is a
horseshoe-shaped exhibit with a viewing window on one side. The exhibit’s low wall allows visitors to reach into the tank, giving them access to stingrays, urchins, anemones, horseshoe crabs, and sea stars. This area is continuously staffed by volunteer educators who are tasked with supervising the handling of live animals, engaging visitors in conversation, and answering visitor questions. There were two questions on the VIP Discussion Guide that encouraged visitors to think deeply about and discuss their experience at the touch tank.

The first visitor engagement measure during the observation was time spent at each of the two target exhibits. Bell et al. (2009) reported that “the amount of time spent in an exhibition is a good quantitative indicator of visitors’ use of a gallery space or exhibit element” (p. 72) but encouraged researchers to use additional measures to gauge the quality of the visitors’ experience. The researcher started a stopwatch at the conclusion of the pre-visit interview. The amount of time elapsed between the pre-visit interview and the first group member’s stop at one of the target exhibits was recorded. This research used Serrell’s (1997) definition of a stop: “both feet planted on the floor, visitor’s head or eyes pointing in the direction of the element for two to three seconds or more” (p. 112). The time between the first group member’s stop and the last group member’s exit from the exhibit was recorded as “total group time.” Each exhibit had a “total group time,” although all members of the group may not have been present for the entire duration of that time.

The second visitor engagement measure included identification of learning-related behaviors in an observation protocol checklist (Appendix L). A checklist of learning-related behaviors was constructed a priori based on observations during the pilot study and research conducted by Borun, Chambers, Dritsas, and Johnson (1997) and Bitgood (2010). These learning-related behaviors suggested potential for learning among group members and included
actions such as “touch object briefly,” “point to animal/object,” “listen to staff or other visitors,” and “talk to companion.” For a complete list of learning-related behaviors, see the observation protocol (Appendix L). If one or more group members displayed a learning-related behavior, the corresponding behavior was checked on the protocol. Additionally, all observed learning-related behaviors were verbally noted in the audio-recorded notes by the researcher.

The third visitor engagement measure included overheard portions of visitor conversations. Although it was impossible to hear all conversations between family groups due to the acoustics in the exhibit hall and ambient noise, some portions were loud enough to be overheard. Typically, these conversations included loud, excited utterances as a visitor experienced something novel or surprising. Allen (2004) said that visitors who experienced novel or unexpected outcomes were more likely to remember the learning experience itself; thus, these loud, excited conversations were worth noting. Upon overhearing a portion of a conversation, the researcher repeated the visitor’s words verbatim into an audio recording device, while also identifying the speaker and describing any accompanying physical actions.

Total group time, learning-related behaviors, and overheard conversations or exclamations provided the researcher with quantitative and qualitative data that more fully portrayed the family group’s experience at the selected exhibits. This information was also used to support or refute claims made by the families during post-visit interviews.

5.2.5 Data Collection: Post-Visit Interviews and Document Collection. All groups participated in a short, semi-structured interview at the conclusion of their visit. The location of the interview was marked on the VIP Discussion Guide and the maps provided to the comparison groups. The post-visit interview consisted of 10 questions (Appendix M) and took between 3.75
min and 9.5 min to complete (M = 6 min). Visitors were interviewed with others in their family group and were encouraged to expand upon each other’s answers.

During the post-visit interview, groups utilizing the VIP Discussion Guide were asked to recount interesting or memorable conversations they engaged in during their visit. Bell et al. (2009) contended that analyzing visitor conversations is “an important method for assessing scientific knowledge and understanding in informal environments” (p. 63). Instead of analyzing all conversations, this research examined only the conversations the visitors deemed important, as these were most likely to be remembered after the conclusion of the learning experience (Falk & Dierking, 1997). Visitors were also asked how the use of the VIP Discussion Guide affected their visit. At the end of the interview, VIP groups were asked to return their VIP Discussion Guide; all groups returned the guide.

Visitors in the comparison groups, who did not use the VIP Discussion Guides, were also asked to recall interesting or memorable conversations. Instead of describing how use of the VIP Discussion Guide affected their visit, these groups were asked how the use of the provided map affected their visit. This line of questioning allowed the researcher to determine if orientation aides (present on the map and the VIP Discussion Guide) had more or less of an impact on the visit experience than did learning aides (present only on the VIP Discussion Guide).

At the conclusion of the post-visit interview, participating groups were thanked, given additional contact information, and presented with a $10 gift card to the aquarium gift shop.

5.2.6 Data Analysis: Transcription. All interview audio files were transcribed verbatim by the researcher and trained assistants using QuickTime audio program and Microsoft Word. Observation notes were transcribed using Dragon Dictate for Mac 2, a speech recognition program designed for Macintosh computers. The researcher checked all typed transcripts of
interviews and observation notes against primary audio files to assure accuracy of the
transcriptions. No identifying information was included on any transcripts; each participant was
identified only by group number, gender, and grade/age. Transcription assistants did not have
access to additional personal information provided by participants.

5.2.7 Data Analysis: Coding and Interpretation. To assist with data analysis, the
researcher created a data-logging sheet (Appendix N). The left half of the data-logging sheet
listed all questions on the VIP Discussion Guide with corresponding “mark” and “recall” check
boxes. During the interviews, groups were asked to circle or otherwise mark questions on the
VIP Discussion Guide that they spoke about during the visit; a check was placed in the “mark”
box corresponding to questions the visitors marked as discussed. If, during the post-visit
interview, the group mentioned a specific question or related topic, the “recall” box for that
question was checked. This section was only utilized for VIP groups and was not filled out for
comparison groups.

Also on the left side of the data-logging sheet was a list of learning-related behaviors
(LRB), described earlier in the Data Collection: In-Visit Observations section. Since two
exhibits were under observation, the list of LRB contained two columns—one for the salt marsh
tank and another for the touch tank. If an LRB was marked on the observation protocol or
described in the researcher’s field notes, the box corresponding to the LRB and the exhibit at
which it occurred was checked. This section also contained space to record the time spent at
each exhibit and the total visit time, rounded to the nearest quarter-minute. This section was
utilized to record information for VIP and comparison groups.

The other half of the data-logging sheet contained spaces in which the researcher could
list the topics described by the visiting group during their post-visit interview. All topics
discussed by one or more group members during the interview were listed on the data-logging sheet. Relevant details were included under each topic. Use of the data-logging sheets allowed for organization of the large amount of qualitative data collected.

To answer each of the four sub-questions guiding this study, the researcher engaged in inductive content analysis of the data-logging sheets, interview transcripts, and field note transcripts to look for prevalent patterns (Patton, 2002). This inductive analysis sought to “determine what is there, to discover how components are related, to determine what people think about a situation” (Guba, 1978, p. 41) and consisted of four phases. Guba (1978) suggested that researchers first read through all content and look for recurring regularities, which “form the basis for an initial sorting of information” (p. 53). This first phase is known as coding for convergence (Patton, 2002) and, for each question in this study, resulted in a list of potential patterns. After the initial sorting, the second step in this analysis included a “verification phase” to test the “utility, scope, and inclusiveness of [the] category system” (Guba, 1978, p. 54). Here, the data-logging sheets and transcripts were reviewed to determine how well the identified patterns described the data.

The third phase of this analysis examined divergence, which Guba (1978) described as a “fleshing… out” (p. 57) of the categories. Another review of the data-logging sheets and transcripts allowed the researcher to sort interview responses into the patterns identified during the first two phases of analysis. This sorting was accomplished primarily by “extension” and “bridging” as described by Guba (1978, p. 59). Participant responses and observational field note segments were emphasized if they added new information to the identified patterns, bridged between existing patterns, suggested a new pattern, supported recognized patterns, expanded or explained information gathered from other participants, exemplified a pattern’s core meaning, or
disputed identified patterns (Guba, 1978, p. 59-60). Group numbers and specific quotes relating to or refuting each pattern were written in the researcher’s notebook. This resulted in an extensive list of supported patterns that could potentially provide insight regarding the four sub-questions guiding the study.

The final stage of analysis reduced this extensive list to a manageable narrative, which is included in this chapter. Guba (1978) called this stage “prioritizing” and suggested a number of considerations one might contemplate in determining which patterns to include in the final report. The main prioritizing considerations used in this study include:

- **Salience**, which refers to the frequency by which respondents identified a specific pattern. If multiple groups expressed similar responses to interview questions that supported a specific pattern, it is reasonable to assert that the identified pattern represents the experience of these individuals—if not fully, then at least adequately.

- **Credibility**, which refers to how realistically participating individuals feel the patterns explain their experience. Patterns with a core meaning that was provided by participants’ own insightful responses were considered especially credible and were thus emphasized in the narrative.

- **Uniqueness**, which refers to patterns or responses that were vastly different from other patterns or responses. These different “takes” on the questions at hand provided a new way of looking at the relevant information and thus deserved to be included in the final narrative. In this study, family group 7’s experience using the VIP Discussion Guide was particularly unique and is discussed in detail in later sections.

After “prioritizing,” patterns were interpreted in the text. Supporting and deviant cases were discussed and answers to the sub-questions were proposed. An additional review of the data-
logging sheets and transcripts was completed after this interpretation to ensure the final manuscript provided a realistic and honest depiction of the participants’ experiences.

5.3 Results and Discussion

This research examined the impact of new educational materials, the VIP Discussion Guide, on the visit and experience of family groups with elementary school-aged children. As mentioned previously, 4 sub-questions guided this study; the results from these sub-questions are discussed individually below.

5.3.1 Sub-Question 1: How Do Visitors Use Provided Educational Materials (VIP Discussion Guides) During Their Visit? The VIP Discussion Guide was designed to spark science conversation among visiting family groups with elementary school-age children. Self-guided tours can be customized by individual visitors based on their needs and visit motivations (Norris, 2009). Thus, the VIP Discussion Guide provides visitors with guidance, but still allows for personal choice—a key component of informal education.

All participating groups used the questions on the VIP Discussion Guide to initiate science-based conversations. A trend emerged during the in-visit observations: Once inside the salt marsh gallery, the adults in the VIP groups would examine the VIP Discussion Guide. It appeared that they were locating their group’s position on the map (often pointing to the map) and silently reading the pertinent questions to themselves. As mentioned previously, there were zero questions on the VIP Discussion Guide related to the salt marsh tank and two questions related to the touch tank—both exhibits were within the observation area. Typically, as the groups approached the touch tank, adults did not immediately read the questions to the family group. Instead, adults initially encouraged children to examine or touch organisms within the tank, referring to the VIP Discussion Guide after the tactile experience. At this point, visitors
were often overheard talking about questions on the VIP Discussion Guide; these conversations seemed to extend the length of the stop at the touch tank.

Although all groups used the VIP Discussion Guide to spark dialogue between family members, the way in which the VIP Discussion Guide was used varied. The majority of family groups (5 of 6) structured their visit around the guide, answering most or all of the questions. A single group entered the aquarium with a specific visit motivation; this group used the guide to successfully fulfill that motivation.

Groups who used the VIP Discussion Guide to dictate the course of their visit often supplied vaguely defined visit motivations during the pre-visit interview. When asked why they came to the aquarium, individuals within these groups gave the following responses: “because we wanted to” (male, 2nd grade, group 2); “to look at the fish and stuff” (female, 1st grade, group 5); and “I like to see animals and stuff” (male, 4th grade, group 6). These groups could identify organisms within the aquarium that they were interested in seeing or learning more about, but the overall expectation for learning was typically ill-defined: “[we’re going to learn about] schools of fish and stuff” (male, 3rd grade, group 1). These groups were comprised of repeat visitors who were aware of the learning opportunities at the aquarium but unsure as to how to fully utilize these opportunities.

Thus, the adults in these groups relied heavily on the provided VIP Discussion Guide to stimulate learning conversations. Adults were overheard saying, “there’s a question over here!” (male, adult, group 2) and “come over here so we can answer these questions” (female, adult, group 1). Visitors in groups 1 and 2 reported that they answered 100% of the questions on the VIP Discussion Guide; visitors in group 5 reported speaking about 94% of the questions and wrote short answers to these questions on the guide. Visitors, especially younger visitors,
seemed to view the VIP Discussion Guide as a challenge or a game; during the post-visit interview, a 2nd grade boy from group 2 excitedly reported, “We got all the stuff!”

One group (group 7) entered the visit with a very specific visit motivation and utilized the VIP Discussion Guide in a way that supported that visit motivation. According to the adult male, this group “came to look at the fish, the touch tank, the fossil dig, and the outdoor playground that just got built.” This group—an adult male, a female child in 4th grade, and a male child in 2nd grade—had visited the aquarium approximately 100 to 150 times previously, conducting quick visits “once or twice a week” (male, adult, group 7). Thus, the group was very familiar with the aquarium exhibits and said they wanted to learn about “how the horseshoe crabs feel…. and the stingrays” (male, adult, group 7).

Unlike the rest of the VIP groups, this family did not attempt to answer most or all of the questions on the VIP Discussion Guide; group 7 elected to answer five of the 18 questions present on the VIP Discussion Guide. After the pre-visit interview, this group walked directly to the touch tank, ignoring the majority of the exhibits in the freshwater gallery. However, the group did discuss one question in the freshwater gallery related to reptiles, perhaps because the exhibits related to this question were easily seen on the group’s path to the touch tanks or perhaps because—as mentioned in the post-visit interview—the group had encountered a snake earlier that day on their way to the aquarium. Group 7 also discussed the two questions related to the touch tank, which, as mentioned earlier, was the primary driving force behind this particular visit. Finally, the group answered two questions regarding previous visits to the beach, a pastime they excitedly talked about during the post-visit interview.
5.3.2 Sub-Question 2: When Using Provided Educational Materials (VIP Discussion Guides), How Do Visitors Interact With Their Social Group, Educators, and Exhibits?

Learning in informal environments is socially mediated; one visitor’s learning is affected by interactions with other individuals, such as group members or educators (Falk & Dierking, 1992/2011). Additionally, visitor learning is based upon the physical space in which it occurs; in an aquarium, this physical space is dominated by exhibits. Thus, an educational intervention in an aquarium should be evaluated based upon how it affects visitor interactions with others in the social group, educators, and exhibits within the physical space.

Use of the VIP Discussion Guide increased science-based conversations among visiting family groups. The majority of VIP groups (4 of 6) explicitly linked the VIP Discussion Guide to increased interaction and conversation among group members. A 4th grade male in family group 6 said, “The questions make you think,” and an adult male in the same group responded, “yeah, we had more interaction, probably, about what we were looking at.” This was supported by observation data: At the touch tank, visitors in the VIP groups could often be overheard discussing their observations and science concepts such as protection. Visitors in the comparison groups were rarely overheard discussing science concepts in-depth; these visitors’ touch tank observations were also more topical and less detailed than those in the VIP groups.

During the post-visit interviews, visitors in the VIP groups were more likely to recount detailed science-based conversations than their comparison group counterparts. These recalled science-based conversations often related directly to topics on the VIP Discussion Guide. A 2nd grade boy in family group 2, for example, expanded on a concept from the VIP Discussion Guide: counter-shading and its importance for predator evasion:
Adult: I thought it was interesting about the counter-shading, and you talked about the counter-shading before you ever saw that question, didn’t you?
Child 1 (male, 2nd grade): Yeah.
Interviewer: Yeah? What did you say about the counter-shading?
Child 1 (male, 2nd grade): Um, I read it in a book… they have it because if a bird was trying to go over and it was dark on top and the bird wouldn’t know if it was the fish it was after, or if it was just darkness at the water.
Interviewer: You’re right!
Child 1 (male, 2nd grade): And if there was a bigger fish from under the water looking up, they wouldn’t know if that was the fish they were trying to eat or if that was just the lightness of above.

This family group obviously spent time discussing this topic, sharing information they already knew and relating it to the organisms they were viewing. Although this child had discussed the concept prior to viewing the related question on the VIP Discussion Guide, presence of the topic on the guide emphasized its importance and validated the child’s role as the “expert” on this topic (Ash, 2002).

In the comparison groups, visitors typically remembered talking with others in their groups about surprising observations:

Interviewer: What do you think you’ll remember most about your visit today?
Adult 2 (female): The different types of fishes, and the mouth.
Child 2 (male, 1st grade): Yeah, there’s one over there, something comes out of his mouth every time he breathes in and out, so we noticed that.
Interviewer: Interesting.
Adult 2 (female): What else? You noticed one that had kissy-lips. It was like… he looked funny, huh?
Child 2 (male, 1st grade): It was like this… [mimicked fish] (group 8, comparison)

This type of conversation, driven by personal observations, should not be downplayed or ignored; Fenichel and Schweingruber (2010) reminded educators that observation is an important skill and a crucial component of the scientific process. Both comparison groups and VIP groups talked about their observations of different organisms in the aquarium. However, visitors in VIP groups tended to extrapolate from their observations, challenging others in their family group to offer explanations for observed phenomenon. While at the touch tank, family group 4 (VIP
group) felt a horseshoe crab and commented on how hard the shell felt. The group members then discussed potential benefits of having a hard shell, finally deciding that such a shell could protect the horseshoe crab from predators. Similar extrapolations were not observed within comparison groups. This suggests that using the VIP Discussion Guide prepared visitors for these types of conversations and encouraged visitor to ask “how?” and “why?” questions based on their own first-hand observations. Asking and answering these types of questions is a key component of doing science as well as learning science, and should be encouraged in informal environments (Bell et. al, 2009).

Additionally, adults in the VIP groups were more likely to model science conversations than adults in the comparison groups. This occurred both during the visit and in the post-visit interviews. The following excerpt, from a post-visit interview with family group 4, exemplifies parental modeling and prompting seen among VIP groups:

   Adult female: Oh, and we talked about, um, if there were no sharks, what would happen?  
   Child 1 (female, 1st grade): The ocean would be crowded.  
   Adult female: Would it be crowded with healthy other animals?  
   Child 3 (male, 4th grade): No.  
   Adult female: No, because the shark takes care of the sick stuff, right?  
   Child 1 (female, 1st grade): Yeah  
   Child 3 (male, 4th grade): And the dead.  
   Adult female: Yep, and the dead stuff, so that’s something to think about.

Research has demonstrated that these types of parent-child interactions can play a critical role in enhancing children’s science understanding and science appreciation in informal environments (Crowley et al., 2001). The parental modeling above serves as a type of scaffolding (Wood et. al, 1976) for the child’s understanding. This scaffolding interaction was in itself scaffolded by use of the VIP Discussion Guide; the parent selected a question from the guide and helped the children make sense of the presented information.
Conversely, there was not an apparent difference between how VIP groups and comparison groups interacted with educators. One of the tanks under observation—the touch tank—is almost continuously staffed by volunteer educators, who are expected to monitor handling of live organisms, provide directions for safe handling, and answer visitor questions. All groups but one (family group 3—comparison group) spoke with educators at the touch tank. These conversations between visitors and educators were typically basic, focusing on identification of organisms or proper handling techniques. However, visitors occasionally treated the touch tank educators as an expert resource. A 2nd grade boy in family group 2 (VIP group) observed a horseshoe crab’s actions and asked an educator, “Why do the horseshoe crabs bury in the sand? Is it trying to hide? In the wild it seems like there would be lots of things that would try to eat it…” The discussion then focused on animal defenses and predator/prey relationships. The questions on the VIP Discussion Guide did not focus on these topics at the touch tank, so it is possible that the boy’s question arose organically—without the influence of the VIP Discussion Guide. However, as argued previously, simply utilizing the VIP Discussion Guide may have encouraged a learning mindset and a willingness to engage others with “how?” or “why?” questions.

Speaking with an educator or listening to an education presentation was memorable for visitors in the VIP and comparison groups. Regardless of whether or not they used the VIP Discussion Guide, visitors could recount specific details and “big picture” ideas after speaking with knowledgeable education volunteers at the albino alligator enclosure—another exhibit that is continuously staffed—or after listening to an educator’s presentation on live animals. Additionally, visitors from VIP groups and comparison groups reported asking questions of the staff and educators when a topic was unclear. This suggests that the use of the VIP Discussion
Guide did not expressly change the way visitors interacted with educators. However, there is a possibility that using the VIP Discussion Guide encouraged visitors to view the visit as more of a learning experience and ask more in-depth questions; this possibility should be examined in future research.

Use of the VIP Discussion Guide affected the ways in which visitors utilized exhibits—particularly exhibits with corresponding questions on the guide. One quantitative measurement of visitor engagement is time spent at an exhibit (Bell et al., 2009). Groups using the VIP Discussion Guide spent an average of 7.4 min at the touch tank (range = 3.75-10.5), while comparison groups spent an average of 2.4 min at the touch tank (range = 1.25-3.0). A number of factors may influence total time a group spends at an exhibit. However, given that all VIP groups talked about one or more VIP Discussion Guide questions at the touch tank, the threefold increase in time spent between comparison groups and VIP groups can confidently be attributed to use of the VIP Discussion Guide.

At the touch tank, an exhibit with corresponding questions on the VIP Discussion Guide, visitors in the VIP groups engaged in more learning-related behaviors than their comparison group counterparts. VIP groups demonstrated between 15 and 17 learning-related behaviors (M = 16) at the touch tank; comparison groups displayed between 6 and 15 learning-related behaviors (M= 11) at the touch tank. This trend was not seen at the salt marsh tank, an exhibit without corresponding questions on the VIP Discussion Guide. At the salt marsh tank, VIP groups engaged in 2 to 11 learning-related behaviors (M = 7.5) and comparison groups demonstrated between 7 and 13 learning-related behaviors (M = 9). This suggests that the higher number of learning-related behaviors by VIP groups at the touch tank is not due to an intrinsic difference between these groups (e.g., VIP groups just happen to be more talkative than
comparison groups). Rather, the difference between comparison and VIP groups in the number of learning-related behaviors at the touch tank can be attributed to thinking and talking about relevant questions on the VIP Discussion Guide.

5.3.3 Sub-Question 3: How Does Using Provided Educational Materials (VIP Discussion Guides) Affect Visitor Learning? According to participants, use of the VIP Discussion Guide increased learning during the aquarium visit. This claim was supported during post-visit interviews: VIP groups recalled talking about more science topics than comparison groups. Further, VIP groups provided more detailed explanations of learned science concepts than comparison groups. Some VIP groups felt that one or more topics on the VIP Discussion Guide would be the most memorable part of their visit, but many of the VIP and comparison groups asserted that touching live organisms was more memorable.

Fenichel and Schwiengruber (2010) claimed that a critical component of informal education is the opportunity to encourage visitors to self-identify as science learners. Therefore, the groups’ perception of the learning experience is worth examining. VIP groups felt they learned more while using the VIP Discussion Guide during this visit than they had on previous visits. A female adult in group 1 (VIP group) said, “For me, I think that we did learn a lot more coming this time because we—with the questions. I thought it was very helpful. Very helpful, I thoroughly enjoyed it.” Comparison groups, on the other hand, felt that they had not learned much during the visit. When asked what they talked about, group 8 (comparison group) said:

Adult Male: I don’t know, what all did we talk about?
Male Child (4th grade): Not much.

This was similar to the responses from group 9 (comparison group):

Interviewer: What else did you all talk about today?
Male Child (4th grade): Um, just the shark. [laughed]
Interviewer: Just the shark?
Adult Male: We really didn’t care about anything else. [all laughed]
These comparison groups were, ultimately, able to describe some science concepts, but they were less likely than VIP groups to identify themselves as science learners at the aquarium. Thus, use of the VIP Discussion Guide encouraged visitors to perceive themselves as science learners and view the aquarium as a space where one could learn about important science concepts.

There are a variety of ways to determine if learning has occurred at an informal science education center, but Falk and Storksdieck (2005) encouraged researchers to examine both the breadth and depth of visitor responses. Breadth refers to the variety of topics an individual learns about; depth is related to the complexity of the learner’s explanation of these topics (Falk & Storksdieck, 2005). Interviews with the VIP groups revealed these visitors had, as a whole, attained greater breadth and depth of learned concepts than their comparison group counterparts.

VIP groups reported discussing an average of 5.3 distinct science concepts during their visit; comparison groups only recalled discussing an average of 4.0 science concepts. It is important to note that these numbers refer to the topics visitors reported talking about, rather than an exact count of the conversations visitors actually engaged in during the visit. More than half of the VIP groups felt that using the VIP Discussion Guide encouraged them to think about and talk about a wider variety of topics: “I do enjoy this. This questionnaire gives you other things, other ideas to talk about while you’re at the touch tank or whatever” (adult male, group 7, VIP). This participant was a frequent visitor to the aquarium, claiming to have visited between 100 and 150 times prior to the study. Falk and Dierking (1992/2011) suggested that frequent visitors already know how to find what they are looking for, are content to skip portions of the museum that do not hold their interest, and focus instead on areas that do interest them. The VIP
Discussion Guide may be particularly important for frequent visitors, as it could allow them to view the aquarium and exhibits in a new, interesting way.

Perhaps more striking than the difference in the number of conversations is the difference in the depth of conversations. Individuals in VIP groups routinely provided more detailed explanations of science concepts than did individuals in comparison groups. For example, a 2nd grade boy in family group 2 expanded on a concept from the VIP Discussion Guide: the role of snakes and alligators in an ecosystem.

Alligators and snakes are important. I think the alligators are important because if there weren’t any there, then there might be too much fish and they would eat all the bugs and stuff that other animals needed to eat to survive and then those other animals would go extinct, so then it would make it, and then animals that preyed on THOSE animals would go extinct because they had none of that and it’d make a big chain reaction, and there’d be no life. (male, 2nd grade, group 2)

Although this may seem somewhat simplistic, it is a valid explanation for a 2nd grade student to provide regarding the role of top predators in food webs. A question on the VIP Discussion Guide encouraged this family to examine live reptiles, brainstorm ideas, share prior knowledge, and come up with a reasonable explanation or answer. Thus, the depth of the boy’s response was influence by the VIP Discussion Guide question and the family’s resulting conversation.

Visitors in the VIP groups tended to have the most detailed recollections of conversations when these conversations related to topics on the VIP Discussion Guide. Very rarely did visitors in VIP groups recall information from exhibit signage.

Comparison groups also did not recall much information from exhibit signage; if anything, these groups were frustrated that signage did not provide the information they were seeking. Comparison groups expressed a desire to learn about animal identification, as is common among aquarium visitors. Tunnicliffe (2008) asserted that visitors often spend time locating and naming organisms within an exhibit; in some cases, this may be seen as a critical
portion of the visit. This identification typically results in conversations that are short, topical, and only tangentially related to important science concepts. However, these identification-based conversations were considered unsatisfactory by comparison groups; two adults from group 9 (comparison group) described the difficulties they encountered in their learning:

Adult Female: One thing, I saw fish that, that you don’t know what they are. There are no labels. There’s nothing to tell you what you’re looking at. Like, we saw the sea horses and there’s this awesome shrimp-like crustacean. I don’t know but we fell in love with him.

Adult Male: He looked like he had a mustache, a spiky mustache.

Adult Female: Yeah, we fell in love with him, we took his picture, we have no idea what he was. We looked up on the thing and he wasn’t up there. His friends were up there, but he wasn’t and we were just like, “Hmm… what is he? He’s awesome, we love him, he has no name.” Yeah, um…

Two-thirds of comparison groups stated they were unable to learn the name of organisms due to a lack of appropriate signage identifying the animals. One VIP group voiced similar concerns, but most VIP groups did not. This suggests that the VIP Discussion Guide encouraged visitors to move beyond simple identification of organisms and focus instead on challenging information or “canonical science” (Allen, 2004, p. S18).

Near the end of the post-visit interview, visitors were asked to choose which portion of their visit would be most memorable. One 4th grade girl in family group 7 (VIP group) said, “That part [points to VIP Discussion Guide]. The active part.” Other VIP groups selected one or more topics on the VIP Discussion Guide as the most memorable portion of their visit:

Interviewer: What will you remember most about your visit today?
Male (3rd grade): Uh, about the jellyfishes. [laughs]
Interviewer: About the jellyfish? Okay.
Male (3rd grade): They’re my favorite animal. (group 1, VIP group)

Earlier in the post-visit interview, this participant had said that this visit was different from other visits because “I learned an extra—a few other things like how jellyfish could actually kind of see things” (male, 3rd grade, group 1). The question set described by this child was included
purposefully due to stated interests of this age group, as identified in Study 1.B (Chapter 4). The participant referenced this question set three times during the post-visit interview, suggesting that the questions related to his “favorite animal” were, indeed, memorable.

Handling live animals was seen as a memorable highlight for many groups—VIP and comparison alike, as shown by this exchange with family group 4 (VIP group):

Female adult: What was the best part about the visit today?
Male child (Kindergarten): Petting sharks!

This supports prior research (Dohn, 2011; Falk, Koran, & Dierking, 1986; Sherwood et al., 1989) that emphasized the importance of handling live organisms during an informal learning experience. The memorability of handling live organisms does not detract from the potential importance of educational materials such as the VIP Discussion Guide. Conversely, this supports using educational materials like the VIP Discussion Guide in conjunction with live animal handling; pairing science-based conversations with an unforgettable tactile experience can lead to increased learning (Bell et al., 2009).

5.3.4 Sub-Question 4: What Factors Affect Visitors’ Responses to Using Educational Materials (VIP Discussion Guides)? Prior to the start of this study, the researcher expected that visitors would offer a variety of responses to using the VIP Discussion Guide. Based on visitor responses from Study 1.B (Chapter 4), personal experiences, and published research (e.g. Briseño-Garzón et al., 2009; Dohn, 2011; Falk, 2009; Falk & Dierking, 1992/2011; Packer & Ballantyne, 2002), the researcher anticipated that visitor experiences and responses to using the VIP Discussion Guide might be shaped by a variety of factors. This included factors within Falk and Dierking’s (1992/2011) personal context—such as age (adult vs. child), prior knowledge, number of previous visits, or entering visit motivations and interests—and factors within Falk and Dierking’s (1992/2011) social context—such as family dynamics.
However, the data did not support this supposition. Although the above factors did vary between family groups and likely influenced the nature of each group’s visit, these factors did not influence visitor responses to using the VIP Discussion Guide. All visitors in VIP groups responded positively to use of the VIP Discussion Guide during their visit and emphasized the opportunity for learning using the guide. For example, a 3rd grade boy in group 1 said he liked “that I got to learn a bunch of things” during the visit. The adult leading this group agreed, stating, “For me, I think that we did learn a lot more coming this time because we—with the questions. I thought it was very helpful…. I thoroughly enjoyed it” (group 1).

Further, all VIP groups expressed a desire to use a similar guide with different talking points on their next visit, as shown in the following excerpt:

Interviewer: If there was another self-guided tour and it was about something completely different, would you guys be interested in using it?
Child 2 (male, Kindergarten): Yes.
Child 1 (male, 2nd grade): Sure!
Interviewer: Sure? Why do you think so?
Child 2 (male, Kindergarten): Because it would be cool.
Child 1 (male, 2nd grade): Because I like to learn new things. (group 2)

The following excerpt shows one visitor’s response to using the VIP Discussion Guide and the likelihood that her group would choose to use a similar guide on a future visit.

Female (adult): We had questions but we read and we learned about which ones were shiny and which ones weren’t, right? And the noses on the different ones, we would read about it. We loved having this.
Interviewer: Oh really?
Female (adult): Yes, that made a big difference.
Interviewer: Okay. Well, can you tell me a little bit about why it made a difference?
Female (adult): It made us really pay attention, instead of just wandering around. Just looking and reading, it made us think…. So we really enjoyed this. I think it’s a great tool and I think it’s something that should be incorporated.
Interviewer: Well, great. That was one of my other questions: if we had a different discussion guide about different topics, same kind of thing, would you guys be interested in using it?
Female (adult): Oh yes, definitely! Something like, when you entered, that you could pick up and use each visit—we would definitely do it. We liked it a lot. (group 5)
This positive reaction regarding use of the VIP Discussion Guide and proclivity towards using the VIP Discussion Guide in the future was seen across all groups, regardless of any factors that may have differed between them.

5.4 Conclusion

Families visit aquaria and other informal science education centers for a variety of reasons. At the North Carolina Aquarium at Fort Fisher, families with elementary school-aged children recognized the aquarium both as a leisure destination and an educational institution; they expected to have fun and learn something new on the visit (Study 1.B, Chapter 4). However, visitors—including parents—may not know how to best use the aquarium’s resources to enhance their understanding or their children’s understanding (Schauble et al., 2002; Zimmerman, Reeve, & Bell, 2010). Researchers have encouraged the investigation and production of educational materials that could assist visitors in making meaning during their visit, particularly by scaffolding science-based conversations among visitors (Allen, 2002; Ash, 2002; Pedretti, 2004; Schauble et al., 2002; Woods et al., 1976; Zimmerman et al., 2010). This study investigated the use of the VIP Discussion Guide by family groups with elementary school-aged children and the effects the guide had on the overall visit experience, visitor conversations, and potential learning.

Use of the VIP Discussion Guide increased science-based conversations amongst participating family groups. Visitors within the VIP groups recalled discussing an average of 5.3 distinct science concepts during their visit and visitors within comparison groups only recalled discussing an average of 4.0 science concepts. Further, VIP groups provided recollections that contained more depth and detail than their comparison group counterparts. During observations
of an exhibit with corresponding questions on the VIP Discussion Guide, VIP groups engaged in more learning-related behaviors and spent more time at the exhibit than did comparison groups.

Perhaps more important was how visitors viewed their own learning at the aquarium while using the VIP Discussion Guide. Visitors felt that they “got to learn a bunch of things” (male, group 1) because the VIP Discussion Guide “gives you more, um, stuff to think about” (male, 4th grade, group 6). Repeatedly, visitors in VIP groups self-identified as science learners at the aquarium; self-identification as a science learner was identified as a key Strand of Informal Science Learning that informal institutions should strive to address (Bell et al., 2009, p. 46). Visitors often saw this enhanced learning as enjoyable, stating they had fun while using the VIP Discussion Guide to learn:

Child 2 (male, Kindergarten): I liked it [the VIP Discussion Guide] because it was fun.  
Interviewer: It was fun?  
Child 1 (male, 2nd grade): I liked it because I got to answer questions… it was fun too.  
Child 2 (male, Kindergarten): I liked it because it was interesting.  
Child 1 (male, 2nd grade): Me too.  
Interviewer: So it was interesting and fun? That’s great to know.  
Child 2 (male, Kindergarten): And I liked it because it was about science. (group 2)

This quote highlights an important aspect of the VIP Discussion Guide: Questions on the VIP Discussion Guide were formulated based on interests of visiting family groups with elementary school-aged children, as identified in prior research (Study 1.B, Chapter 4). As such, the questions were highly likely to be interesting to family groups visiting in the future. This was seen repeatedly during post-visit interviews as participants described questions and concepts they thought were particularly interesting. Simon (2010) encouraged designers to determine and address visitor interests, rather than asking visitors to “[consume] content that is pushed out indiscriminately by the institution” (p. 37).
This study found that family groups with elementary school-aged children are looking for a fun, educational experience when they visit the aquarium, and appreciate materials that assist them in achieving these dual goals of learning and having fun.

Adult (male): This card would be cool, like, in a folder, like you could grab it before you went into the aquarium and then a place for it when you left.
Interviewer: Okay. Why do you say that?
Adult (male): Because we come here, like I said, a lot, and this would be very—I think it would be very educational and very neat for kids.
Child 1 (female, 4th grade) Because every time we come back we might have a different answer! (group 7)

This group, and all other VIP groups, enjoyed using the VIP Discussion Guide and expressed a desire to use another guide on a future visit.

The VIP Discussion Guide exemplifies a new type of educational material—one based on empirical research regarding visitor needs and interests. The VIP Discussion Guide has been shown to have significant potential to increase science-based conversations among family groups, which is highly likely to lead to memorable, meaningful learning. This low-cost, versatile, self-guided tour handout could easily be replicated and reworked to address a wide variety of topics and visitor interests. However, the emphasis on learning through dialogue should be kept at its core, as visitors appreciated the opportunity to talk with and learn with others within their family group. By adopting materials such as the VIP Discussion Guide to encourage visitors to engage in thoughtful conversations about the current exhibits, aquarium educators can repurpose existing exhibits in a way that will increase science-based conversations, increase learning, and increase excitement among adults and children alike.

5.5 References


Chapter 6. Use of VIP Discussion Guides in an Aquarium Increases Science-Based Conversations Among Social Groups of College-Aged Young Adults

6.1 Literature Review

Although their form and function have changed considerably throughout history, aquaria have existed for centuries. Brunner (2003) described early fish-keeping as a hobby of royalty in China dating back to the 10th century. Private aquaria became popular in Europe during the 1850’s; improvements in filtration, aeration, and understanding of fish biology made fish-keeping an attractive pastime among the Victorian bourgeoisies (Clary & Wandersee, 2005). The popularity of private aquaria in the 19th century led to the emergence of public aquaria in European and American cities (Brunner, 2003; Kisling, 2001). Typically, these aquaria were integrated into well-established zoological parks, as stand-alone aquaria at this time often did not generate adequate admission-based income to offset the cost of constructing and maintaining aquatic exhibits (Brunner, 2003). In general, early zoos and aquariums were seen as a type of menagerie—an establishment concerned with showcasing strange or exotic organisms, with little emphasis on education (Brunner, 2003; Kisling, 2001). However, some individuals saw the potential for education in these spaces. Rossmässler, a German scholar and lecturer of natural science, saw the early aquarium as “a means for… the democratization of knowledge and society” (Brunner, 2003, p. 60).

Today, providing educational opportunities for the public is a priority for most, if not all, public aquaria in the United States and elsewhere (Kisling, 2001). Institutions accredited by the Association of Zoos and Aquariums (AZA) are encouraged to uphold goals of “caring for wildlife and wild places [and] educating and engaging public, professional, and government audiences” (Association of Zoos and Aquariums [AZA], 2009). Educators associated with AZA are charged with providing engaging educational opportunities that allow the public to connect
with animals and the natural world in a manner that encourages personal conservation-based actions (AZA, 2009). Researchers and educators involved with the Ocean Literacy Network encouraged aquariums to design programs that focus on increasing Ocean Literacy, which refers to how an individual impacts the ocean and how the ocean impacts the individual (Ocean Literacy Network [OLN], 2011). And still other stakeholders assert that aquaria and other informal science education centers have an obligation to teach about the nature of using and doing science, as described by the *Strands of Informal Science Learning* (Bell, Lewenstein, Shouse, & Feder, 2009; Fenichel & Schweingruber, 2010). Falk and Dierking (2010) argued, “free-choice learning experiences represent the single greatest contributors to adult science knowledge,” therefore decisions regarding educational content in aquariums can have serious implications for public understanding of science (p. 489).

In an effort to educate the public, aquarium staff have embraced a variety of programs and educational materials. Self-guided tour handouts are one commonly used form of educational material. Norris (2009) attributed the popularity of self-guided tour handouts to their relatively low cost and high potential for visitor engagement and learning. These types of materials provide visitors with guidance and important information, but also allow visitors to choose which information to attend to—an important facet of informal education (Norland, 2005).

However, the content and design of these educational materials are of paramount importance; content and design decisions should be supported by research in both formal and informal education (Davidsson, 2009; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). The research described in this article was grounded in the theoretical framework of Human Constructivism, as described by Novak, Mintzes, and Wandersee (2005). The three main tenets
of Human Constructivism seem particularly relevant to informal education: *human beings are meaning makers, the goal of education is the construction of shared meanings, and shared meanings may be facilitated by the active intervention of well-prepared teachers* (Mintzes & Wandersee, 2005, p. 47-51, emphasis in original). Mintzes and Wandersee (2005) reminded educators that this shared meaning-making is an active process in which individuals work together to construct knowledge and enhance understanding. Often, this includes sharing prior knowledge or previous experiences, raising questions or discussing misunderstandings, and integrating new knowledge or first-hand experiences into existing cognitive frameworks (Ausubel, 2010; Mintzes & Wandersee, 2005; Novak & Gowin, 1984).

Meaning-making may be enhanced if learners are actively involved in thoughtful dialogue. Michael and Modell (2003) discussed the role of dialogue in teaching at the university level; engaging learners in dialogue allows the educator to determine the extent of the learners’ understanding. This dialogue, according to Michael and Modell (2003), should compel learners to provide in-depth explanations that illuminate and clarify their mental models. Armed with information on the learners’ mental models, an educator can then redirect the dialogue to support further understanding (Gowin, 1981; Michael & Modell, 2003; Novak & Gowin, 1984). In the absence of an educator, learners—particularly college-aged learners—can still assist each other in learning through dialogue. It is likely that two or more learners will have different levels of understanding about and prior experience with a topic. This differentiated knowledge can lead to scientific discussions amongst learners (Ash, 2003), particularly if learners are provided with some sort of prompt or “conversation starter.”

Guided, science-based conversations may be especially important in informal learning environments, as they allow visitors to construct their own meanings with the input of others.
from their social group. Typically, individuals visit an aquarium to have an enjoyable—and potentially educational—experience with others in their family or social group (Packer, 2006; Packer & Ballantyne, 2004). Conversing with others is a natural part of the visit for many groups, and Pedretti (2004) determined that within-group dialogue can encourage deep thinking about and lasting interest in science and science concepts. Allen (2002) found that museum visitors engaged in learning-talk at 83% of the exhibits at which they stopped. This suggests that visitor conversations are likely to revolve around the content presented at an informal science education center. Martin (2004) was less optimistic, contending that “scientific discourse is not likely to arise spontaneously” during informal science learning experiences (p. S73). Thus, educators should design materials that assist visitors in the initiation of these science-based conversations; this type of assistance is often referred to as scaffolding (Wood, Bruner & Ross, 1976). Pedretti (2004) found that “extensive scaffolding (i.e. through science center educational guides…) significantly enhances visitor experiences and the making of meaning” (p. S43).

Meaning-making may be further enhanced if these scaffolding tools or educational materials pose open-ended questions that stimulate science dialogue among visitors. Questions can persuade visitors to think deeply about an important concept, particularly if this concept relates to observable objects or organisms (Simon, 2010). Rather than asking closed-ended, detail-oriented, “only one right answer” questions, Simon (2010) suggested posing personal or speculative questions to stimulate robust conversations. Personal questions ask an individual to relate the material to prior experience, “What is your favorite part of a trip to the beach? Why?” Speculative questions encourage the learner to use objects and evidence to compose creative, imaginative responses. Aquarium visitors could be asked the speculative question, “How would your life be different if you were a shark?” In both types of questions, visitors are invited to
share their own thoughts, feelings, and memories. Personal and speculative questions individualize the learning, which can make the experience more meaningful for the learner (Simon, 2010).

At the same time, these personal and speculative questions, and the resulting discussions, must be of interest to the learner in order to be truly meaningful and memorable (Ash, 2002; Simon, 2010). Falk and Needham (2011) concluded that visitors often ignored information that they considered boring or irrelevant. Instead, these researchers found that visitors were more likely to attend to information they found interesting or that they “sort of already knew” about (Falk & Needham, 2011, p. 10). Allen (2004) considered this flexibility to be an important strength of informal education. However, this freedom of choice poses a problem for educators designing discussion-based materials: How can we ensure visitors find our materials interesting and, thus, worth using? Simon (2010) declared that educators should begin the material design process by “mapping out audiences of interest and brainstorming the experiences, information, and strategies that will resonate most with them” (p. 35).

This study examines the impact of a new type of educational material, the Visitors’ Interpersonal (VIP) Discussion Guide, which was designed by the researcher to arouse and address visitors’ interests and increase science-based dialogue among college-aged young adults visiting the aquarium. The creation of the VIP Discussion Guide was guided by the theory of Human Constructivism (Novak, 2010; Novak, Mintzes & Wandersee, 2005) and informed by research on visitor interests, learning, and conversations (Allen, 2004; Ash, 2003; Falk & Adelman, 2003; Falk & Dierking, 1992/2011; Falk & Needham, 2011; Simon, 2010; Study 1.B, Chapter 4). Further, the VIP Discussion Guide was customized to address the needs and interests of college-aged young adults at the target aquarium, as identified in earlier research
(Study 1.B, Chapter 4). Through the use of pre-visit interviews, during-visit observations, post-visit interviews, and document analysis, the researcher determined how college-aged young adults used the VIP Discussion Guide during their visit and the extent to which the VIP Discussion Guide impacted visitor conversations and related learning.

6.2 Methods

College-aged young adults are an understudied group in aquarium education research. The visit motivations, interests, and educational needs of college-aged young adults have the potential to be different from more frequently studied groups, such as families or school groups. Part of a larger, multi-year research project, this study examined the ways in which college-aged young adults utilized innovative educational materials during an aquarium visit and the related effects on visitor engagement, science-based conversations, and meaningful learning. The primary question guiding this research was, “How does the use of educational materials designed to address visitors’ interests, motivations, and background knowledge, affect the experience and learning of aquarium visitors?”

The first step in this study involved the creation of a new type of educational material—the Visitors’ Interpersonal (VIP) Discussion Guide—as described in later sections. The second step examined the impact of the VIP Discussion Guide through interviews, observations, and document analysis. Pre-visit interview questions sought to determine visit motivations, visitor interests, and number of prior visits. Post-visit interview questions asked participants to recall conversations they had during the visit, discuss the impact of the VIP Discussion Guide on their visit (if applicable), and determine visitor interest in using a similar VIP Discussion Guide on a future visit. Interview responses and observations of social groups of young adults using the VIP Discussion Guide were compared to interview responses and observations of comparison groups.
not using the VIP Discussion Guide. These comparison groups did not participate in any additional educational intervention, thereby serving as a model for the “typical” experience of college-aged young adults at the aquarium. This qualitative case study was guided by 4 sub-questions:

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?
2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?
3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?
4) What factors affect visitors’ responses to using educational materials (VIP Discussion Guides)?

6.2.1 Creation of Educational Materials. The purpose of the VIP Discussion Guide was two-fold: 1) to serve as an orientation guide for new or infrequent visitors, and 2) to encourage meaningful dialogue between visitors related to important science concepts.

To assist with orientation, each side of the VIP Discussion Guide featured a map of half of the aquarium (Appendix F). The map used for this purpose was taken from the aquarium’s website; the map (but not the VIP Discussion Guide) is available to the public for free. The map allowed visitors to locate specific exhibits, restrooms, elevators, and the post-visit interview site. Providing this type of information has been shown to reduce cognitive load and museum fatigue (Bitgood, 2009), thereby allowing visitors to focus the majority of their energy on content comprehension.
In an effort to increase science-talk among visitors, open-ended discussion questions were included around the periphery of the aquarium map (Appendix F). Seven exhibits, or clusters of exhibits, served as focal points for these questions; two or three primary questions pertained to each selected exhibit or cluster of exhibits. An arrow connected question sets to applicable exhibits. One set of questions did not pertain to specific exhibits. These questions encouraged visitors to synthesize the entire visit experience by contemplating the importance of the ocean. Some exhibits, such as the alligator enclosure, were selected in response to college-aged visitors’ stated interests during prior research (Study 1.B, Chapter 4). Other exhibits, such as the hurricane exhibit, were selected for their content and applicability to important science concepts (Appendix F).

Questions on the VIP Discussion Guide were formulated to initiate conversation among visitors, as prior research demonstrates that asking, contemplating, and talking about important science concepts can greatly enhance science comprehension (Allen, 2002; Ash, 2002; Michael & Modell, 2003; Pedretti, 2004; Simon, 2010). As such, questions on the VIP Discussion Guide were open-ended, typically asking visitors to recount personal experiences, compare organisms, observe behaviors, share knowledge, brainstorm ideas, or imagine hypothetical scenarios. Given the idiosyncrasies of individuals and groups, it was reasonable to assume that each conversation generated by a VIP Discussion Guide question would be unique. As a result, the VIP Discussion Guide did not include an answer key; after the pre-visit interview, groups were assured that there was not a single “right” answer to each discussion question.

Questions were generated by the researcher and were influenced by her prior work in aquariums, knowledge of important science concepts, and experience designing discussion questions for graduate-level university courses. The questions were then vetted by a senior
researcher/educator and modified for clarity. Additionally, these questions were tested in a pilot study at the research location and further adapted due to a change in exhibits. As shown in Appendix H, each question addressed one or more of the following: a specific visitor interest (as identified in Study 1.B, Chapter 4), an Ocean Literacy Principle (OLN, 2009), and/or a Strand of Informal Science Learning (Bell, et al., 2009; Fenichel & Schweingruber, 2010).

6.2.2 Participants. This research examined the visit experience of a convenience sample of college-aged young adults (approximate ages 18-26) visiting an aquarium. Ten groups (22 individuals total) elected to participate in this study. One group declined to participate, stating that they were simply not interested in being part of a research study during their visit. Although the visitors in this study are referred to as “college-aged,” participation was not restricted to students enrolled in a college or university. In this study, 73% of participants were current students or recent graduates; 27% of participants were not pursuing a college degree. There were more female participants (n= 14) than male participants (n= 8).

Groups were asked to participate if they 1) appeared to be between the target ages of 18 and 26; 2) arrived in a group of two or three individuals; and 3) were not part of a larger group containing young children or older adults. Ten groups elected to participate in this research: Seven groups used the VIP Discussion Guide (hereafter referred to as VIP groups) and three groups did not (hereafter referred to as comparison groups). The majority of groups (8 of 10) visited as a pair and two of 10 groups included three individuals. Finally, all participants were over the age of 18.

6.2.3 Data Collection. Data collection occurred over two separate four-day periods (Thursday, Friday, Saturday, and Sunday) in January 2013. These periods coincided with winter break for many of the universities near the target aquarium. Visitors who appeared to fit the
selection criteria (as described in the Participants section) were invited to be part of this research prior to entering the first exhibit area. Groups were informed of the research goals, study procedures, expected time commitment, and compensation offered for full participation (a $10 gift card to the aquarium gift shop). Further, groups were asked to participate in two audio-recorded interviews (a pre-visit interview and a post-visit interview) and informed that they might be observed from a distance during their visit. The researcher attempted to reassure visitors that there were not any “right” answers to interview questions or “expected” behaviors during observations. Groups who agreed to participate were asked to sign appropriate consent forms and were designated as VIP or comparison groups. Immediately following the consent process, groups were engaged in the pre-visit interview.

6.2.3.1 Data Collection: Pre-Visit Interviews. Participants were interviewed with others in their social group, as group dynamics are likely to shape the visit, the interview process, and interview responses. The pre-visit interview consisted of six questions and lasted between 1 min and 2.5 min ($M = 1.45$ min). The pre-visit interview collected information on visit motivations, visitor interests, and visitor demographics (such as educational background, number of previous visits, and hometown). Efforts were made to solicit information from all participants and visitors were encouraged to expand upon the responses of others within their group.

At the conclusion of the pre-visit interview, VIP groups were given a copy of the VIP Discussion Guide, a clipboard, and a writing implement. The researcher explained how to use the VIP Discussion Guide, encouraging participants to mark and discuss questions they found interesting or intriguing. Participants were reminded that they were not required to discuss all of the questions on the VIP Discussion Guide. Finally, the researcher helped visitors locate the site
of the post-visit interview, which was clearly marked on the VIP Discussion Guide, and were reminded they would receive a $10 gift card in exchange for completing the post-visit interview.

Comparison groups were not given a VIP Discussion Guide. Instead, these groups were offered a map of the aquarium, which is available online and free to the public. Comparison groups were also informed of the post-visit interview location, which was marked on the provided maps. Again, participants were informed that they might be observed from a distance and to ignore the researcher if they spotted her during the observations. Participants were asked if they had any questions and were reminded that they needed to complete the post-visit interview in order to receive their $10 gift card.

6.2.3.2 Data Collection: In-Visit Observations. The researcher selected a single, semi-hidden vantage point for in-visit observations. This space permitted the researcher to discretely observe two exhibits concurrently, quietly record verbal field notes into an audio recorder, and fill out the observation protocol (Appendix L). The first exhibit under observation—the salt marsh tank—provided visitors an opportunity to examine a replica of a salt marsh bank; the exhibit had an open-air top and three large viewing windows. Organisms in the tank included diamondback terrapins, minnows, small spadefish, and other brackish-water fishes. Two questions on the VIP Discussion Guide pertained to this exhibit, as the aquarium’s Education Curator considered this tank to be under-utilized by visitors.

The second exhibit under observation was the invertebrate touch tank. This horseshoe-shaped exhibit had a viewing window on one side and was bordered by a low wall, which allowed visitors to reach into the tank. This gave visitors access to stingrays, urchins, anemones, horseshoe crabs, and sea stars. Volunteer educators were stationed at this exhibit and were tasked with supervising the handling of live animals, engaging visitors in conversation, and
answering visitor questions. The VIP Discussion Guide did not contain questions pertinent to this exhibit. Observation of this exhibit allowed the researcher to determine how VIP groups interacted with each other, the exhibits, and educators if not prompted to engage in conversation by the VIP Discussion Guide questions.

Three visitor engagement measures were examined during these observations: time spent at an exhibit, identification of learning-related behaviors, and conversation snippets. The researcher decided to record the first visitor engagement measure, time spent at each target exhibit, due to Bell and colleagues’ (2009) suggestion that “the amount of time spent in an exhibition is a good quantitative indicator of visitors’ use of a gallery space or exhibit element” (p. 72). At the conclusion of the pre-visit interview, the researcher started a stopwatch. Elapsed time was recorded as visitors entered the observation area. This research used Serrell’s (1997) definition of a stop: “both feet planted on the floor, visitor’s head or eyes pointing in the direction of the element for two to three seconds or more” (p. 112). The researcher noted the time at which the first group member stopped at the exhibit of interest and when the last group member left the exhibit; the elapsed time was recorded as “total group time.” To simplify data analysis, all total group times were rounded to the nearest quarter-minute (:00, :15, :30, :45).

Bell et al. (2009) also encouraged researchers to use additional, supplemental measures to gauge the quality of the visitors’ experience. The second visitor engagement measure focused on the identification of visitors’ learning-related behaviors (LRB). The researcher constructed a checklist of LRB a priori, based on observations during the pilot study and research conducted by Borun, Chambers, Dritsas, and Johnson (1997) and Bitgood (2010). Examples of LRB include “touch object briefly,” “seek or share information,” and “talk to companion.” These identified LRB have the potential to increase learning among group members (Bitgood, 2010;
Borun et al., 1997). LRB were checked on the protocol if displayed by one or more group members. The researcher also verbally noted observed behaviors in audio-recorded field notes. Each LRB was checked only once if displayed by a group member, but were verbally noted each time they occurred.

The third visitor engagement measure included notation of portions of visitor conversations. Due to the acoustics in the exhibit hall and ambient noise, it was impossible to hear all conversations between group members. However, some conversation segments could be overheard. Typically, these segments were comprised of loud, excited utterances as a visitor experienced something novel or surprising. Allen (2004) said that visitors who experienced novel or unexpected outcomes were more likely to remember the learning experience itself; thus, these loud, excited conversation snippets were worth noting. When a conversation segment was overheard, the researcher spoke into an audio recorder and identified the speaker, repeated the visitor’s words verbatim, and described accompanying physical actions.

The researcher was able to gather quantitative and qualitative data by recording total group time, learning-related behaviors, and portions of overheard conversations. This data illustrated differences between the visits of VIP groups and comparison groups. Further, this information was used to support or contradict claims made by college-aged participants during post-visit interviews.

6.2.3.3. Data Collection: Post-Visit Interviews and Document Collection. At the conclusion of their visit, groups participated in a short, semi-structured interview at the location marked on both the VIP Discussion Guide and the comparison groups’ maps. The post-visit interview consisted of 10 questions and lasted between 3 min and 11 min ($M = 5.68$ min). As
with the pre-visit interview, all members of the group were interviewed together and individuals were encouraged to expand upon the answers of others within their group.

During the post-visit interview, both VIP groups and comparison groups were asked to recall interesting or memorable conversations in which they engaged during the visit. Bell et al. (2009) contended that analyzing visitor conversations is “an important method for assessing scientific knowledge and understanding in informal environments” (p. 63). Instead of analyzing all conversations, this research focused solely on conversations deemed important by visitors, as these were most likely to be remembered after the learning experience (Falk & Dierking, 1997). Visitors were also asked to report any additional information learned during the visit.

VIP groups were asked how using the VIP Discussion Guide affected their visit; comparison groups were asked how using the provided map affected their visit. Both the VIP Discussion Guide and the map contained orientation aides, but only the VIP Discussion Guide contained learning aides (in the form of questions). By asking how the provided materials impacted the visit, the researcher was able to determine the extent to which orientation aides and learning aides shaped the visit experience. VIP groups were asked to return their VIP Discussion Guide at this time.

The researcher thanked participating groups at the conclusion of the post-visit interview. Participating groups were given additional contact information and presented with a $10 gift card to the aquarium gift shop.

6.2.4 Data Analysis: Transcription. Audio files of all interviews and observations were transcribed verbatim by the researcher. After completion of transcription, the researcher re-checked all typed transcripts against primary audio files to ensure accuracy of the transcriptions.
Identifying information was not included on any transcripts; each participant was identified by group number, gender, and speaking position within the group.

**6.2.5 Data Analysis: Coding and Interpretation.** Data analysis began with the creation of a data-logging sheet (Appendix N). This data-logging sheet listed all questions on the VIP Discussion Guide with corresponding “mark” and “recall” check boxes. If the group marked a question on the VIP Discussion Guide, indicating they spoke about the question during their visit, the “mark” box was checked. If the group mentioned a specific question or corresponding topic during the post-visit interview, the “recall” box for that question was checked. This section was not utilized for comparison groups.

The data-logging sheet also contained a list of learning-related behaviors (LRB), which are described earlier in the *Data Collection: In-Visit Observations* section. This list of LRB contained two columns, one for the salt marsh tank and another for the touch tank. If a LRB was described in the researcher’s field notes or was marked on the observation protocol, the box corresponding to the LRB and the exhibit at which it occurred was checked. The time spent at each exhibit and the total visit time were also recorded, rounded to the nearest quarter-minute. This section was used to record LRB and time measurements for VIP and comparison groups.

The right side of the data-logging sheet contained spaces to list topics discussed by each group during the post-visit interview. Space below each topic heading allowed the researcher to include pertinent details provided by the group. Each topic received a score of 1 to 4 based on the depth and accuracy of participants’ responses. A score of “1” denoted a limited understanding or brief mentioning of a topic. A score of “4” denoted advanced understanding of a particular topic and typically represented inclusion of prior knowledge, new information, and scientifically accurate reasoning. Topic discussions with a score of “4” were considered
exemplary and were rare—seen only in one group. All groups’ responses were analyzed and scored within a single working session. The responses were then reanalyzed and rescored a few days later, without reliance on prior scoring. Scores from these two separate scoring sessions were compared; any discrepancies between scores were investigated and resolved. A third review was conducted across groups to ensure all responses assigned a particular score provided comparable depth and detail. Table 6.1 provides examples of topics receiving scores of 1, 2, 3, and 4.

Table 6.1. Examples of Scored Visitor Responses

<table>
<thead>
<tr>
<th>Score</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male: Um, the jellyfish—I like the jellyfish.</td>
</tr>
<tr>
<td></td>
<td>Female: It’s interesting that they have no brains or anything like that.</td>
</tr>
<tr>
<td></td>
<td>(group 2, comparison)</td>
</tr>
<tr>
<td></td>
<td>Female 1: He was just telling us about the sharks over there.</td>
</tr>
<tr>
<td></td>
<td>Female 2: People actually have them as pets….</td>
</tr>
<tr>
<td>2</td>
<td>Female 1: He was telling us about their teeth, about how they don’t really grow that much and that’s why we can touch them—that’s why they’re not bad to touch.</td>
</tr>
<tr>
<td></td>
<td>Female 2: When they grow bigger, their stripes go away. (group 7, VIP)</td>
</tr>
<tr>
<td></td>
<td>Male: I thought it was interesting, with the alligators. Just, I never really thought about the albino alligator, how it can’t survive in the wild, since—I figured its camouflage would be terrible, but also the fact that it can’t really be exposed to sunlight, as a cold-blooded animal… I had never really thought about that. (group 5, VIP)</td>
</tr>
<tr>
<td>3</td>
<td>Female 1: We were debating about how a blue whale could live on land.</td>
</tr>
<tr>
<td></td>
<td>Female 2: Yeah, definitely! Thinking about a land whale. I mean, the biggest thing that I could think of was, what—an elephant? [Female 1: Yeah.] Or a giraffe. I mean, giraffes aren’t really that big, they’re just long but yeah, talking, thinking about how a whale would actually move on land, all that mass, that’s kind of… that was interesting to think about.</td>
</tr>
<tr>
<td>4</td>
<td>Female 1: And how it’s probably only feasible for it to be so big because it’s torpedo-shaped and it doesn’t really have that much gravity pull in the water, so it wouldn’t take so much effort to be big in the ocean as to be on land. Also, I was thinking, because it has more volume to travel in, as opposed to just across land, it can go up, down, there’s more, like, space in the ocean. (group 4, VIP)</td>
</tr>
</tbody>
</table>
In addition to organization of the data using the data-logging sheets, an inductive content analysis of the data-logging sheets, interview transcripts, and field note transcripts was conducted (Patton, 2002). To answer each of the four sub-questions guiding this study, prevalent patterns were investigated. This inductive content analysis consisted of four phases as described by Guba (1978). The first phase involved reading through all of the generated content, looking for recurring regularities. These recurring regularities, according to Guba (1978) “form the basis for an initial sorting of information” in coding for convergence (p. 53). This resulted in a list of potential patterns, which were then subject to the second phase, known as “verification,” which tested the “utility, scope, and inclusiveness of [the] category system” (Guba, 1978, p. 54). Here, the data-logging sheets and transcripts were reviewed to determine how well the identified patterns described the data.

Analysis continued with the third phase, which examined divergence (Guba, 1978). Within this phase, the data-logging sheets and transcripts were reviewed and interview responses were sorted into the patterns identified during the two phases described above utilizing “extension” and “bridging” as described by Guba (1978, p. 59). Participant responses and observational field note segments were emphasized if they added new information to the identified patterns, bridged between existing patterns, suggested a new pattern, supported recognized patterns, expanded or explained information gathered from other participants, exemplified a pattern’s core meaning, or disputed identified patterns (Guba, 1978, p. 59-60). Group numbers and specific quotes relating to or refuting each pattern were written in the researcher’s notebook. This resulted in an extensive list of supported patterns that had significant potential to provide insight regarding the four sub-questions guiding the study.
This extensive list was reduced during the final phase of analysis, called “prioritizing” (Guba, 1978, p. 54). Prioritizing allowed the researcher to focus on a smaller number of relevant patterns, thereby making sense of the copious data generated during the study. Guba (1978) listed a number of considerations a researcher might refer to when determining which patterns to include in the final summation of results. The four main prioritizing considerations used in this study include:

- **Salience**, which refers to the frequency by which respondents identified a specific pattern. If multiple groups expressed similar responses to interview questions that supported a specific pattern, it is reasonable to assert that the identified pattern represents the experience of these individuals—if not fully, then at least adequately.

- **Credibility**, which refers to how realistically participating individuals feel the patterns explain their experience. Patterns with a core meaning that was provided by participants’ own insightful responses were considered especially credible and were thus emphasized in the narrative.

- **Uniqueness**, which refers to patterns or responses that were vastly different from other patterns or responses. These different “takes” on the questions at hand provided a new way of looking at the relevant information and thus deserved to be included in the final narrative.

- **Heuristic value**, which refers to information that suggests new areas of research or provide surprising insights. In this study, participants’ reactions to a specific subset of questions on the VIP Discussion Guide were unexpected, warranting interpretation and further investigation. (Guba, 1978, p. 55)
After prioritizing, patterns were interpreted, supporting and deviant cases were discussed, and answers to the sub-questions were proposed. An additional review of the data-logging sheets and transcripts was completed after this interpretation to ensure the final manuscript provided a realistic and honest depiction of the participants’ experiences.

6.3 Results and Discussion

6.3.1 Sub-Question 1: How Do Visitors Use Provided Educational Materials (VIP Discussion Guides) During Their Visit? At the conclusion of the pre-visit interview, VIP groups were told they were not required to discuss all questions on the VIP Discussion Guide, only those they found interesting or intriguing. VIP groups followed these instructions, electing to answer between two and 12 of the 19 questions on the VIP Discussion Guide. The number of questions (out of 19) answered by each group is shown in Table 6.2.

Table 6.2. Number of VIP Discussion Guide Questions Answered by Each VIP Group

<table>
<thead>
<tr>
<th>VIP Group Number</th>
<th>Total Questions Answered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. The VIP Discussion Guide contained 19 questions. Groups 2, 6, and 8 were comparison groups.

One participant stated, “we tried to use as much of it as possible” (male, group 5). This group discussed a total of 10 questions, selecting questions from six of the eight question sets. Two groups utilized only the front of the double-sided VIP Discussion Guide: “I actually forgot there was a back,” said one participant (male, group 3). As a result, these groups (group 3; group 7) discussed the fewest questions (2 and 4 questions, respectively; Table 6.2).
The remaining five groups who selected questions from both sides of the VIP Discussion Guide said they used the guide to focus their attention: “It made me pay attention. Like, it makes you pay attention to where you need to look and stuff” (female, group 1). Another group extended this idea from simply looking to thinking about important information: “I think it was nice, just to have an idea of what to be thinking about when you look at stuff. Like, that was pretty helpful, I thought” (male, group 5). These groups placed a greater emphasis on the topics and exhibits highlighted on the VIP Discussion Guide, considering these topics and exhibits to be more important—or more worthy of attention—than those not covered on the VIP Discussion Guide.

For some groups, the VIP Discussion Guide helped to focus their attention by providing new topics and ideas for discussion:

Female 1: Um, I never would’ve thought about these things unless, like there was a question… unless someone was giving me the question.
Female 2: Yeah, it made us, like, pay more attention to the information (Female 1: Yeah) instead of just look at it and “oh, that’s pretty.”
Female 1: And we compared a lot of things to, like, what we’ve seen and where we’re from and stuff like that. (group 10)

A visitor from another group provided a specific example of an interesting question related to a topic she had not contemplated previously:

Female 1: Yeah, I liked that it—like, my favorite was the question about how would, um, a whale, or an animal a whale’s size live on land. I thought that was a good question, because I haven’t really thought about it that way before, like why ocean creatures are bigger, but now that I think about it, most of the time they are like, way bigger.
Female 2: Yeah.
Female 1: Well, not most of the time, but they have the capacity to be bigger. (group 4, VIP)

Visitors in VIP groups seemed to enjoy the increase in focus, attention, and discussions that they attributed to the VIP Discussion Guide. One participant said, “It [the VIP Discussion Guide] gave the visit, like, more of a purpose” (female, group 10).
Two of the groups (groups 3 and 7) specifically mentioned using the VIP Discussion Guide as an orientation aide: “It showed us where we were” (female, group 7). Another group also valued the map included on the VIP Discussion Guide, stating, “I definitely looked around, looked for where the exhibits were, a little bit. We actually found a few we missed in the first area” (male, group 3). This participant reiterated how much he appreciated the orientation aspect of the VIP Discussion Guide near the end of the interview: “Um, it was a good reference to look back at and see where we were and, ah, what exhibits we may have missed or different sides to them” (male, group 3). Interestingly, the groups who emphasized their reliance on the VIP Discussion Guide to locate their position within the aquarium discussed the fewest number of questions and only examined the front of the VIP Discussion Guide, as discussed earlier. Additionally, these were the only two groups that did not explicitly credit the VIP Discussion Guide questions with increased or more focused attention. Conversely, groups that described increased attention as a result of using the VIP Discussion Guide did not mention using the guide as an orientation aide, though it would be reasonable to assume they did—at least in part.

As mentioned previously, VIP groups were encouraged to answer only the questions that interested them; given that the groups were composed of individuals with a variety of interests, it was reasonably assumed that question selection would vary between groups. For the most part, this assumption held true and groups selected different questions based on their interests. However, a surprising trend emerged during data analysis: All groups chose to utilize a specific question set and all groups chose not to utilize another, different question set. Descriptions of these questions sets, differences between the sets, and potential explanations for their use or non-use are provided below.
The question set discussed by all groups related to alligators. Groups were encouraged to examine two enclosures—one with typical American Alligators (*Alligator mississippiensis*) and another with an albino specimen of *Alligator mississippiensis*—and discuss observed differences between the animals. One question asked visitors to extrapolate from these observations, brainstorming how those differences might affect the albino alligators’ ability to survive in the wild. The final questions in this question set asked visitors about their prior experiences: “Have you seen an alligator in the wild? What kind of habitat was it in?” Visitors from all groups spent time thinking about alligators outside of the aquarium, including where the animals might be seen and the animals’ survival requirements. Two groups (group 1, group 5) jotted notes from their conversations on the VIP Discussion Guide, and these notes suggest in-depth, fairly sophisticated discussions. During the post-visit interviews, the majority of VIP groups (6 of 7 groups) emphasized the conversations they engaged in at the alligator exhibits, discussing concepts such as thermal regulation, reptilian characteristics, predation, camouflage, recessive genes, and albino organisms in general. In all cases, the groups’ recall of this topic was more detailed and scientifically accurate than any other topic they recalled during the interview.

There are a number of potential explanations for the popularity of this question set among all VIP groups. To begin, this was the first question set visitors encountered as they entered the aquarium (Appendix F). Perhaps groups were willing to discuss this question set due to the short amount of time that elapsed between their agreement to participate and viewing of the first exhibit. Falk, Koran, Dierking, and Dreblow (1985) and Serrell (1997) found that visitor attention was highest and most focused at the beginning of the visit, decreasing steadily after approximately 20 to 30 minutes. This decrease in attention is often referred to as museum fatigue (Davey, 2005). There is some debate regarding causes of museum fatigue (Bitgood,
2009), but this noticeable decrease in attention has been reported repeatedly in the literature (Allen, 2004; Davey, 2005; Falk & Dierking, 1992/2011; Falk et al., 1985). Perhaps visitors discussed this first question set because they had not yet succumbed to museum fatigue.

The second possible explanation is more simple: perhaps these college-aged visitors were truly interested in alligators. In an earlier study, 25% of social groups of college-aged young adults wanted to see an alligator and 5% of college-aged groups wanted to learn more about the alligators (Study 1.B, Chapter 4, Tables 4.5, 4.6). Additionally, this earlier study revealed that college-aged visitors remembered facts and observations related to alligators at the conclusion of their visit. This suggested that the alligator exhibits were appealing to college-aged visitors and had the potential to hold visitors’ interest for the duration of a short, science-based conversation. The researcher created the alligator question set with this in mind, crafting questions that encouraged visitors to examine the alligators—something visitors in this age group were already interested in doing at the aquarium.

The third potential explanation relates to the resources available to aid visitors in their discussion of this question set. As described earlier, this question set incorporated two distinct exhibits; both exhibits contained accompanying text labels. Additionally, the albino alligator exhibit was continuously staffed by knowledgeable volunteer educators who were responsible for answering visitor questions and sharing pertinent information. Post-visit interview responses revealed details about the albino alligator that were not provided on the VIP Discussion Guide, such as the location of nesting areas where albino alligators were found, and the impacts of specific hurricanes on these alligator nesting sites. These details suggest that visitors used a variety of available resources—the VIP Discussion Guide questions, exhibit signage, and knowledgeable education volunteers—to support and strengthen their science-based
conversations about alligators. Thus, the popularity of the alligator-related question set may have been due to the presence of an engaging volunteer educator. It is most likely, however, that the popularity of this question set was influenced by a combination of the above explanations, or even factors not discussed here.

On the other extreme, there was one question set not used by any of the VIP groups. This question set encouraged visitors to examine inhabitants of the largest exhibit in the aquarium; this showcase exhibit housed bonnethead sharks, green moray eels, a loggerhead sea turtle, and a variety of fish species. The question set at this exhibit pertained to the practice of scientific research. Here, visitors were asked to brainstorm potential research questions related to the exhibit’s inhabitants that a marine biologist might attempt to answer. Additionally, visitors were asked to think about the type of evidence needed to answer these research questions. A number of causes could contribute to the unpopularity of this question set and are described below.

Unlike the popular alligator question set, this scientist question set was near the end of the aquarium visit. Davey (2005) might suggest that the lack of attention could be attributed to museum fatigue; perhaps visitors chose not to discuss this question set because they were mentally exhausted from answering earlier questions. However, the researcher is wary of this explanation, as many visitors elected to discuss question sets that related to exhibits encountered even later in their visit. In fact, five of seven groups answered later question sets. Thus, the avoidance of this question set was likely due to a factor other than museum fatigue.

A second difference between this question set and the alligator question set relates to specific visitor interests. While the creation of the alligator question set was directly influenced by previously identified visitor interests, the scientist question set was only tangentially influenced by visitor interests. In earlier research, social groups of college-aged young adults
expressed delight at examining this showcase exhibit, which encouraged the researcher to choose this exhibit as the visual focus of a question set (Study 1.B, Chapter 4). The corresponding questions were influenced by *Strands of Informal Science Learning (SISL)*, particularly Strands 3, 4, and 5 (Bell et al., 2009; Fenichel & Schweingruber, 2010). These strands encourage educators to elucidate the scientific enterprise, expanding visitors’ understanding of how scientists conduct scientific research. However, in this earlier research, college-aged visitors did not mention a specific interest in the practice of science. Since groups elected not to discuss this question set, even though they expressed an interest in the exhibit to which it related, it is highly probable that the content of these questions was unappealing to these college-aged groups. This outcome supports Simon’s (2010) advice to educators: “Respond to participants’ questions and thoughts instead of pushing your own agenda” (p. 158).

Another difference between the alligator question set and the scientist question set was the presence of volunteer educators. Typically the showcase exhibit is only staffed during specific education programs, such as the twice-daily dive shows. This means that if an educator-led program is not occurring at this exhibit as visitors pass by, visitors were unlikely to interact with a knowledgeable educator or volunteer at this location—unlike at the albino alligator exhibit, as discussed earlier. During post-visit interviews, visitors did not add additional details from this location as they had from the alligator exhibit. This suggests that visitors did not, in fact, speak with educators or volunteers at this location. Participants might have been more willing to reflect on this question set’s content if they had encountered a knowledgeable volunteer or educator who could assist in facilitation of this discussion.
6.3.2 Sub-Question 2: When Using Provided Educational Materials (VIP Discussion Guides), How Do Visitors Interact With Their Social Group, Educators, and Exhibits?

Visitors in VIP groups credited the VIP Discussion Guide with increasing conversations amongst members of their social group. Typically, these conversations addressed material they had not contemplated previously. One male said, “it [the VIP Discussion Guide] got us talking about, like, other stuff that we might not have talked about” (group 9). Another group suggested that the material presented on the VIP Discussion Guide directed the course of their conversations: “I would say most of our in-depth discussion probably worked off the questions on the guide, for the most part” (male, group 5). The visitors’ perceived increase of in-depth conversations was supported by the interview data: VIP groups recalled discussing an average of 5.6 topics (range: 2-9) and comparison groups recalled discussing an average of 4.7 topics (range: 3-6). It is important to note that these numbers do not represent all conversations in which visitors engaged at the aquarium. Rather, these numbers correspond to the variety of topics participants remembered at the conclusion of their visit; these recalled conversations are of paramount importance as they are the most likely to be remembered for months and years later (Falk & Dierking, 1997). In addition, the conversations recounted by VIP groups were more detailed and more scientifically accurate than their comparison group counterparts, as discussed in later sections.

Use of the VIP Discussion guide appeared to have little impact on how visitors interacted with the aquarium’s educators. Most of the college-aged visitors, in VIP and comparison groups alike, did not place a heavy emphasis on speaking with educators. Some VIP groups preferred to be more self-sufficient, choosing not to ask educators for clarification:
Male: Well, we were wondering how they [American alligators] regulated their depth, if it was letting out air or in air, that kind of stuff.
Interviewer: Did you find an answer to that, or were you just thinking about it amongst yourselves?
Male: Just thinking about it amongst ourselves. (group 3, VIP)

Other groups considered the educators to be a useful resource during their visit: “It [the VIP Discussion Guide] was fun and you got to read what you wanted to read. And then the few people that, like, were around kind of told you about the stuff here and it was interesting to have those people here to kind of inform you” (male, group 1). In some cases, it was obvious that visitor-educator conversations had occurred, as visitors recalled details not available on the VIP Discussion Guide or textual exhibit labels. One VIP group recalled speaking with an educator regarding sea turtles and the hatchling rescue program at the aquarium—a topic not discussed on the VIP Discussion Guide:

Female 1: We talked about turtles, about how they’re very rare to live to adulthood—a lot don’t live to adulthood. Like 1 in 1000 or 5000 or something like that. It was really rare.
Female 2: They were keeping this one until it got probably about this big [held hands approximately a foot apart].
Female 1: Yeah, they have 3 of them. (group 7, VIP)

This VIP group’s recalled conversation was similar to a comparison group’s recalled conversation with an educator in both content and depth:

Male 2: Sea turtles. I learned a little bit about them—how long they live…
Female: Yeah, how big they get.
Male 2: and the program here. She said we don’t know too much about them but she said they may be able to live up to like 600 years old or something like that. That’s pretty cool.
Female: She said like 80 to 100.
Male 1: Yeah. 600 may be a little exorbitant. (group 2, comparison)

Thus, the use of the VIP Discussion Guide did not seem to directly impact visitors’ interactions with educators in either a positive or negative manner.
In regard to visitor interactions with the exhibits, VIP groups claimed that using the VIP Discussion Guide allowed them to explore the aquarium at their own pace, while also encouraging them to take additional time to contemplate each exhibit’s inhabitants and implications. One participant emphasized the flexible, free-choice nature of the guide: “I enjoyed it, I mean, because you get to, like, walk around and look at whatever you want. You don’t have to follow a whole group” (male, group 1). This autonomy is a critical feature of informal learning—learners are allowed to choose which information to attend to and which information to ignore (Allen, 2004; Norland, 2005; Simon, 2010). At the same time, almost half of the VIP groups (3 of 7) felt that use of the VIP Discussion Guide encouraged them to spend more time on the entire visit, as well as at individual tanks. One female stated, “I feel like if we didn’t have this [the VIP Discussion Guide], we would’ve gone, like, so fast…. It makes you think” (female 1, group 10).

Repeat visitors were particularly vocal about this increase in time and attention at exhibits:

The other thing I liked about it [the VIP Discussion Guide], just, like, times I’ve been before, I’ve kind of just like skipped through exhibits, but it just kind of, the way it walked you through it, I was more likely to stop and look at every exhibit. (Male, group 5, VIP)

Another repeat visitor had expressed a similar experience with the VIP Discussion Guide:

It [the VIP Discussion Guide] made us talk… made us actually pay attention to stuff that, like, last time I just looked over when I was here. You know, you just walk through and you’re like, ‘Oh, that’s cool. Next thing.’ You know? It made you—made me—like, stop and actually look. (Female, group 9, VIP)

Similarly, a visitor from group 4 (VIP group) said, “Well, I paid more specific attention to, like, individual things in the larger tanks. Before, I was just like, ‘oh, lots of pretty fish!’” The following quote from a comparison group provides an interesting contrast:
Female: You just casually walk through really fast. You just look at it and then you go, you don’t…
Male: It’s more of an image thing, you don’t really learn- unless you read the thing, but reading takes time and in this day and age, it’s so easy to just do it without reading a poster, you know, so… (group 8, comparison)

The quantitative data, in the form of time measurements, support these assertions: VIP groups did, on average, spend more time at both observed exhibits and have a longer overall visit, which was measured from the end of the post-visit interview to the start of the pre-visit interview (Table 6.3).

Table 6.3. Comparison of Time Spent at Observed Exhibits; VIP v. Comparison Groups

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIP: Salt Marsh</td>
<td>0:15</td>
<td>3:15</td>
<td>1:45</td>
</tr>
<tr>
<td>Comparison: Salt Marsh</td>
<td>1:00</td>
<td>1:00</td>
<td>1:00</td>
</tr>
<tr>
<td>VIP: Touch Tank</td>
<td>3:00</td>
<td>8:00</td>
<td>5:00</td>
</tr>
<tr>
<td>Comparison: Touch Tank</td>
<td>1:45</td>
<td>5:00</td>
<td>3:30</td>
</tr>
<tr>
<td>VIP: Overall</td>
<td>32:30</td>
<td>1:31:30</td>
<td>57:15</td>
</tr>
<tr>
<td>Comparison: Overall</td>
<td>46:45</td>
<td>59:30</td>
<td>52:15</td>
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Another strength of informal education centers is the abundance of three-dimensional objects available for visitor examination (Mortensen & Smart, 2007). For this reason, researchers often discourage over-reliance on textual labels or other two-dimensional objects that are not unique to informal science education centers (Falk, Koran, & Dierking, 1986; Mortensen & Smart, 2007). Heeding this advice, questions on the VIP Discussion Guide focused on observation of organisms, recollection of previous experiences, and contemplation of hypothetical scenarios. Yet some groups sought out additional details from exhibit placards to strengthen and inform their discussions. One VIP group said that due to the questions on the VIP Discussion Guide:
Female: We read more plaques.
Male: Yeah, definitely read more plaques, which was nice. (group 5, VIP)

In contrast, comparison groups who were not using the VIP Discussion Guide vocalized distaste for reading at the aquarium: “we didn’t really take the time to read... we’re more watchers” (male, group 6). A participant from another comparison group admitted, “I’m guessing he [her companion] read things. I just looked at them and took pictures. I didn’t really read them or pay attention; I just like looking at them” (female, group 8). This disparity between VIP and comparison groups suggests that the VIP Discussion Guide questions could encourage visitors to more fully utilize existing resources such as text-based exhibit labels, even though the guide was not designed with this specific outcome in mind.

Reading exhibit signage was one of the learning-related behaviors (LRB) noted during in-visit observations. VIP groups claimed to engage in more LRB during their visit and the observation data supported this assertion. At the salt marsh tank—an exhibit with a corresponding VIP Discussion Guide question set—visitors in VIP groups displayed an average of 10 LRB (range: 7-15). Comparison groups demonstrated an average of 7.3 LRB (range: 4-9). This trend also held for the touch tank—an exhibit without corresponding questions on the VIP Discussion Guide. At the touch tank, VIP groups engaged in an average of 13.4 LRB (range: 12-17) and comparison groups displayed an average of 11.7 LRB (range: 9-13).

Some might argue that these numbers indicate an underlying difference between VIP groups and comparison groups: Perhaps VIP groups had an intrinsic drive to learn and engage in LRB at the aquarium that comparison groups did not. However, interview responses from VIP and comparison groups did not reveal this type of intrinsic differences. Instead, VIP groups stated that using the VIP Discussion Guide encouraged them to “pay more attention” (group 10), “read more” (group 5), “think a little bit more in-depth” (group 4), “talk” (group 9), and “learn
more” (group 7), suggesting that use of the VIP Discussion Guide might be responsible for the observed difference in LRB between the VIP and comparison groups. And, since VIP groups displayed a higher number of LRB at exhibits with and without corresponding questions, it is reasonable to suggest that the VIP Discussion Guide had a positive impact on visitors’ learning-related interactions with the aquarium’s exhibits—even exhibits not directly tied to VIP Discussion Guide questions.

6.3.3 Sub-Question 3: How Does Using Provided Educational Materials (VIP Discussion Guides) Affect Visitor Learning? Visitors in VIP groups felt that using the VIP Discussion Guide led to more thoughtful, science-based discussions and increased learning during the visit. A male participant in group 1 (VIP group) said: “I felt like it helped me use my brain more [laughed] instead of just like, ‘that’s cool, that’s cool, whatever’…. I actually thought about the stuff throughout the whole tour.” Another VIP Group (group 7) provided similar comments:

Female 2: I actually learned something instead of just staring.
Female 1: Yeah, instead of just looking around at them.
Female 2: I actually thought about it more. (group 7, VIP)

During the pre-visit interview, visitors in this group said they were unsure as to what they might learn during their visit, stating, “We never really learn anything at [a different, nearby aquarium]” (group 7, VIP group). Yet, at the post-visit interview, both groups 1 and 7 said they “actually thought” about the presented information, as if this was uncommon or surprising for an aquarium visit.

Other visitors also contrasted their experience using the VIP Discussion Guide and the experience they expected to have at an aquarium: “[Without the VIP Discussion Guide] we would’ve just been like, ‘oh my God, it’s so cute!’ [all laughed] and we like, we got kind of in-depth about it” (female 1, group 10). VIP groups repeatedly credited the VIP Discussion Guide
with increased thoughtful attention and in-depth conversations. This, in turn, led to deeper understanding of the concepts covered on the VIP Discussion Guide; participants said they learned more during their visit due to VIP Discussion Guide-based conversations.

These visitor impressions were supported by interview data: VIP groups reported discussing more topics and provided more detailed explanations than did comparison groups. During the post-visit interview, all groups were asked, “What was the most interesting thing you talked about today?” Comparison groups appeared surprised by this question; one comparison group responded:

Male: Um…
Female: … talked about? [confused tone] (group 8, comparison)

After additional contemplation, comparison groups recalled discussing an average of 4.7 topics (range: 3-6). VIP groups more readily supplied answers to the interview question, quickly recalling an average of 5.6 topics (range: 2-9). As mentioned previously, VIP groups provided more detailed responses than their comparison group counterparts; three examples are described below and clearly illuminate the differences between VIP groups’ learning and comparison groups’ learning.

Alligators were seen as intriguing by all of the groups in this study. Every VIP group indicated that they discussed the alligator question set on the VIP Discussion Guide and in post-visit interviews, 6 of 7 VIP groups described conversations related to alligators. Each of the 3 comparison groups mentioned alligators during the post-visit interviews. The following interview excerpts demonstrate the depth of comparison groups’ learning about alligators:

Female: I loved the alligator; I went back to see it again. I never—I mean, I’ve seen alligators, but I’ve never had the opportunity to see one so close. It was really cool.
Interviewer: Was there anything important about the alligator that you remember talking about?
Female: Um, I liked his hands and his eyes. I don’t know. (group 6, comparison)
This answer suggested that group 6 (comparison group) did not spend much time actually talking about the alligator. Group 8 (comparison group) seemed to have a slightly more in-depth conversation regarding the alligators:

Female: We argued whether or not the alligators were real.
Male: Yeah. She thought the alligators were real and then I tapped on the tank.
Female: We took a picture and their eyes closed and then they opened back up. I thought they were fake though…. I just thought they weren’t real because you would see their body move up and down when they were breathing, but I didn’t see that. But then his eyes opened and closed, so… (group 8, comparison)

Although this group engaged in a discussion regarding whether or not the alligators were alive, this conversation contained little canonical science content.

In comparison, VIP groups spent quite a bit of time comparing and contrasting typical American alligators and an albino American alligator specimen, focusing on characteristics that would impact the alligators’ ability to survive in the wild. A male from group 5 (VIP group) said:

I thought it was interesting with, with the alligators. Just, I never really thought about the albino alligator, how it couldn’t survive in the wild since, I figured its camouflage would be terrible, but also the fact that it can’t really be exposed to sunlight, as a cold-blooded animal—I had never really thought about that. Which is interesting! (group 5, VIP)

One participant said the VIP Discussion Guide “made us think a little more about, like, questions to ask” when speaking to volunteers or educators (female 1, group 7). As a result, this group queried an educator near the alligator enclosure, asking questions related to topics on the VIP Discussion Guide. The following excerpt shows the information visitors from group 7 (VIP) retained:

Female 1: I’ve never seen one [an albino alligator], because apparently this is the only one out of all three aquariums in NC that have them. I’ve never seen one before and I thought that was really cool.
Interviewer: Okay.
Female 1: And like how they can’t survive in the wild; all the ones that are alive today are in captivity.
Female 2: And the sunburn thing—they don’t really turn red, they just kind of tear up their skin…. What was it she was saying? About like, there was only- they tried to re-breed them or something—
Female 1: But they’re having trouble re-breeding them, yeah
Female 2: It’s like normal alligators that have them.
Female 1: That have the gene, that have them. And apparently during Hurricane, I think she said Katrina, the two that they kept finding the eggs from are separated, so they couldn’t have them anymore. (group 7, VIP)

In conversations with others in their social group or with educators, VIP groups reportedly discussed albinism, camouflage, thermal regulation, genetics, and general survival requirements of alligators. The recalled conversations on these topics were more sophisticated and contained more scientifically factual information than the topics discussed by comparison groups, as described earlier. This strongly suggests that—through the use of the VIP Discussion Guide—VIP groups learned more about alligators than did comparison groups.

Another example of enhanced learning by VIP groups relates to the geographic distribution of observed organisms. The vast majority of organisms at the studied aquarium are found in local riverine and marine water bodies (J. Metzler-Fiorino, personal communication, October 11, 2012). According to the Education Curator, this curatorial decision was purposeful and is considered to be an important driving theme at this aquarium that may be missed or overlooked by visitors (J. Metzler-Fiorino, personal communication, October 11, 2012). Almost half of the VIP groups (3 of 7 groups) discussed this idea during the post-visit interview and none of the comparison groups mentioned it. One visitor from group 5 (VIP group) said:

We talked about the native fish…. to me, it was a little surprising, with the exotic colors, because I’ve gone scuba diving before and when I went, you could hardly see anything—I didn’t see anything like that when I went. So it was kind of interesting just to see some of the more exotic-looking fish that I really didn’t know were native to this area, so I thought that was pretty interesting. (group 5, VIP)
This visitor had visited the aquarium approximately 5 to 10 times prior to this study and had not made this connection previously. Another repeat visitor from group 4 (VIP group) was also surprised to realize that the organisms on display could be found locally:

It [the VIP Discussion Guide] does make you think a little bit more in-depth aside from just being astounded by all of the pretty things. It makes you think about the individual occupants of the tank, and, like, I know I keep saying this, but I am so astounded that most of the things live nearby. I did not know that. That’s cool! (group 4, VIP)

But this concept was not only deemed important by repeat visitors—first-time visitors also recognized the value of highlighting local species. When asked what she would remember most about the visit, one female participant from the state of Delaware replied, “Just, like all the stuff here is from North Carolina. Since I’m not from here, I didn’t know a lot of that stuff” (group 10). Additionally, this visitor said she felt that her visit to the aquarium had been a good introduction to the state’s aquatic environments.

Given that comparison groups did not recall discussing that the majority of the animals were local to the region, it seems that the Education Curator’s concerns were valid: The implicit emphasis on local species was not being recognized by casual visitors (J. Metzler-Fiorino, personal communication, October 11, 2012). However, when the message was mentioned explicitly on the VIP Discussion Guide in a way that encouraged visitor conversations, participants were “so astonished” (group 4) to learn that the majority of animals could be found in and around the state of North Carolina. This supports Allen’s (2004) assertion that important themes should be discussed explicitly in educational programming and exhibit signage to help visitors grasp these underlying key concepts.

A third example of enhanced learning due to use of the VIP Discussion Guide concerns information about the introduction of exotic, invasive organisms and their impact on local species and habitats. Conservationists consider invasive species to be a major threat to
biodiversity (Primack, 2008; Wilson, 2002); institutions concerned with promoting conservation have been encouraged to address this topic. At this aquarium, exhibit signage does relay information about the effects of exotic and invasive organisms, but interviews with comparison groups suggested that visitors did not make these connections or recognize the importance of this topic. None of the comparison groups mentioned exotic, invasive organisms or their effects on biodiversity.

Almost half of the VIP groups (3 of 7 groups) reported talking about exotic, invasive organisms during their visit, brainstorming mechanisms of introduction, possible impacts on native species and the feasibility of potential eradication programs. Two groups wrote notes from their conversations on the VIP Discussion Guide and these notes revealed sophisticated, scientifically accurate thoughts. For instance, when asked how exotics might have been introduced to the state’s coastal waters, these VIP groups noted: “personal aquariums, tanker ballasts, travel as plankton” (group 5) and “tsunami, people brought them over” (group 1). Current research regarding transport of exotics supports these groups’ answers (Primack, 2008; Wilson, 2002). Further, these groups understood how the introduction of exotic or invasive species could impact local habitats, by “occupying native species’ niches” (group 5) and through “competition with other creatures” (group 1). All of the written notes by these two groups suggest that participants engaged in in-depth, science-based discussions related to exotic or invasive species.

One VIP group’s recalled conversation on exotics was particularly noteworthy, as it embodied critical components of meaningful learning. During the post-visit interview, participants in group 4 (VIP) remembered pondering a question on the VIP Discussion Guide,
relating the question to their own prior experience and to information from nearby but unrelated exhibit signage:

Interviewer: What else did you all talk about today?
Female 1: Ah, we were trying to, for this question about the exotic fish, we were trying to figure out how the exotic fish would’ve got to North Carolina, and we thought maybe people brought them as pets, but I don’t know if they would’ve populated so much if they were just as pets.
Female 2: And I, I mean, I’ve had fish before as pets and I know that, you know, often they die—just you trying to get them into the tank, just the shock of different temperatures and things. And it’s hard for me to think about people, you know, oh, releasing fish into the wild and them actually surviving the temperature shock and all that. Like, how do they live? But some of them must have…
Female 1: Sometimes, sometimes you’d be shocked. Like, in Belgium, we have these green parrots that, um, a poacher released thinking they’d all die in the winter, and now they have tons of green parrots just randomly in Brussels, Belgium. So…
Female 2: Now we have lots of exotic fish that populate the coast of, of our lovely state and I, I did not know that. And I cannot think how they got here besides pet trade. Although, we did see that thing about the lobster.
Female 1: Yeah, we were thinking, like, maybe they came from Florida somehow. [laughed] (group 4, VIP)

In this example, the visitors obviously gave a lot of thought to the prompting question, “How do you think these exotics got to the coast of NC?” The group’s first hypothesis related to the pet trade; they debated the merits of this answer, with each female providing evidence from their own experiences with issues surrounding fish survival and knowledge about establishment of exotic populations in another country. This group also offered a second plausible scenario, based on information from nearby exhibit signage describing the spiny lobster’s northward migration from Florida. Armed with this new information, the group suggested that the exotics also might have traveled “from Florida somehow” (female 1, group 4). This discussion resulted in new learning, as one female stated she was previously unaware of the exotic fish living along the coast. Interestingly, the two explanations derived by the visitors are commonly found in scientific literature on the spread of exotic or invasive species—especially the lionfish (Pterois volitans), an invasive species highlighted at the aquarium (Schofield, 2010).
Novak (2010) described Ausubel’s concept of meaningful learning as “a process in which new information is related to an existing relevant aspect of an individual’s knowledge structure” (p. 59). By actively engaging in conversations that related the new information presented at the aquarium to their prior experiences and understandings, this group—and other VIP groups—demonstrated potential for meaningful learning. Meaningful learning often leads to longer retention of learned material and increased ability to relate learned material to novel concepts or problems (Novak, 2010). Researchers have found that scaffolding through the use of advanced organizers and educational materials can encourage meaningful learning (Mintzes & Wandersee, 2005; Pedretti 2004). VIP groups seemed to understand this intuitively; participants felt that VIP Discussion Guide-led conversations increased learning and this was viewed as a positive outcome. In the excerpt below, one visitor explicitly connected the VIP Discussion Guide to increased discussion and enhanced learning:

I think that it [the VIP Discussion Guide] is something helpful to have with you. I really don’t see how it could hurt to have things like this. Because, it's just helpful with discussion. Because, that… I mean, for me personally, it helps me learn things if I can talk about it some. So I think it’s a good idea. (male, group 5, VIP)

6.3.4 Sub-Question 4: What Factors Affect Visitors’ Responses to Using Educational Materials (VIP Discussion Guides)? Informal education researchers contend that each visitor’s experience is unique, shaped by a myriad of personal, social, and physical factors (Falk, 2009; Falk & Adelman, 2003; Falk & Dierking, 1992/2011; Falk & Storksdieck, 2005). The participants in this study were no exception; group visits varied based on the idiosyncrasies of group members. However, all visitors responded positively to the VIP Discussion Guide, saying that they enjoyed using the guide: “I liked it a lot!” (female, group 10). As discussed earlier, visitors also felt that it helped them to learn new information and concepts. All VIP groups expressed an interest in using another VIP Discussion Guide on a future visit, particularly if
additional topics and concepts were presented: “we already did this one, so a new one—it might be more stuff!” (male, group 1). The overwhelmingly positive response from visitors did not vary due to any observable differences between groups. Yet some differences did exist between groups and these differences seemed to have an impact on the visitors’ use of and perceived gains from the VIP Discussion Guide. The observed trends—related to college attendance, number of prior visits, and willingness to speak with educators—are discussed below.

Of the seven VIP groups, five were currently enrolled in college or had recently graduated. Two groups were not enrolled in college; individuals in these groups were employed at local military bases. As a whole, groups enrolled in college discussed more VIP Discussion Guide questions ($M = 9.6$) than groups not attending college ($M = 3.5$). This was a surprising outcome; the researcher did not anticipate these differences prior to data analysis. There are a number of explanations for this discrepancy, but one plausible explanation relates to familiarity with these types of questions. University-level courses often ask students to engage in critical thinking about a specific topic, a skill too often overlooked in high-school classrooms (Falk, 2008). Groups attending college found the questions to be interesting, thought-provoking, and “good” (female 1, group 4). On the other hand, a participant not attending college said, “some of these questions I just didn’t care for” (female, group 9). Familiarity with these types of questions from college courses may have encouraged discussion of a greater number of questions among college students. Conversely, groups not attending college may have been less familiar, and therefore less comfortable, with the type of questions presented on the VIP Discussion Guide. It is also possible that visitors not attending college were uninterested in the topics presented on the VIP Discussion Guide. Further research is needed to explore these possibilities.
Additionally, VIP groups of college students recalled more in-depth conversations ($M = 6.6$) than did VIP groups not in college ($M = 3$). Again, there are a number of potential explanations for this difference. One relates to prior knowledge about the topics covered on the VIP Discussion Guide. Perhaps college students have more experience with biology and other science content, as it is not uncommon for colleges and universities to encourage or require students to enroll in science courses. In some instances, it was obvious that participants enrolled in college utilized information learned during their university studies to inform their conversations at the aquarium:

Female 1: Oh, we talked about the jet…
Female 3: Jet-skiing, like, how it breaks apart the… what’s it called?
Female 1: The estuaries and the banks. How, like, it erodes and stuff and I remember, because in my environmental class, my lab… that’s, like, the whole thing we talked about the whole time, is how, like, the beaches are eroding and, like… the sand’s getting closer and closer to the houses and stuff like that and the beaches are, like, slowly disappearing. We talked about that a little bit [today]. (group 7)

Without access to university-level science courses, participants not in school may not have possessed adequate content knowledge to feel comfortable engaging in discussions related to topics on the VIP Discussion Guide.

The majority of participants in VIP groups were first-time visitors, but 6 of 15 were repeat visitors to the studied aquarium. Both repeat and first-time visitors reported learning at the aquarium, but repeat visitors contrasted learning during this visit and on prior visits, stating that use of the VIP Discussion Guide during this visit increased learning. During the pre-visit interview, one repeat visitor expressed her expectations for learning during the visit:

Interviewer: What do you think you might learn about today?
Female: I don’t know. I’ve been here so many times… I don’t think there’s anything I can. [laughed] (group 9)

The other repeat visitors did not offer similar comments during this study, but this feeling of “already knowing everything” may be prevalent among some repeat visitors (Study 1.B, Chapter
4). However, repeat visitors did learn at the aquarium, claiming that the VIP Discussion Guide encouraged them to slow down and talk more about important topics. As discussed in the Sub-Question 3 section, repeat visitors expressed surprise at learning about specific concepts and themes they had missed on prior visits. This was especially prominent when visitors discussed local species: “I know I keep saying this, but I am so astounded that most of the things live nearby. I did not know that. That’s cool!” (female 2, group 4). This suggests that repeat visitors may benefit if a number of VIP Discussion Guides covering a variety of topics are made available, as this would allow these repeat visitors to use the familiar space in a new way.

As described in an earlier section (Sub-Question 2), use of the VIP Discussion Guide did not seem to impact visitors’ exchanges with educators; VIP groups and comparison groups interacted with educators in similar ways. However, it was interesting to note that the presence of educators—and the willingness of participants to talk with educators—affected how some participants utilized the VIP Discussion Guide. One VIP group’s visit appeared to be more strongly influenced by their exchanges with education staff and volunteers than by questions on the VIP Discussion Guide. This group (group 7) elected to discuss only 4 of the 19 questions on the VIP Discussion Guide—the fewest of any of the VIP groups enrolled in college. Yet the limited use of the VIP Discussion Guide questions did not translate into limited learning; this group recalled discussing 7 topics, which is higher than the VIP groups’ total average of 5.6 topics.

The majority of group 7’s recalled conversations (6 of 7) resulted from speaking with an educator or volunteer. One female in this group said, “We talked mainly to the people [who work here],” later saying, “every question we had, they had an answer for.” This suggests that members of group 7 were comfortable asking questions and engaging educators in conversations.
This participant also said, “I think it [the VIP Discussion Guide] makes us, like, learn more—it makes us ask more questions.” This could be seen through the group’s discussion on alligators, as the recalled conversation related to both the VIP Discussion Guide question and information relayed by an educator. In this group’s experience, the VIP Discussion Guide acted as a scaffold for their discussions with educators rather than as subject matter for conversations amongst group members. Thus, in the presence of educators and among groups willing to engage these educators, the VIP Discussion Guide may be used as a secondary educational tool that supports visitor-educator conversations.

6.4 Conclusion

The VIP Discussion Guide has evidenced a potential to increase visitor learning among social groups of college-aged young adults at aquaria by scaffolding science-based conversations. In this study, college-aged visitors using the VIP Discussion Guide recalled discussing an average of 5.6 topics, compared to an average of 4.7 topics discussed by comparison groups. Further, these topics were described with more depth and scientifically-accurate details by VIP groups than comparison groups. Visitors in VIP groups consistently connected the content of the VIP Discussion Guide questions to their prior knowledge and experiences, talking about their understandings with members of their social group and asking knowledgeable staff for clarification when necessary. These actions are precursors to meaningful learning (Ausubel, 2010; Novak, 2010) and were rarely seen among comparison groups. The author argues that the VIP Discussion Guide served as a scaffolding tool to assist VIP group members in meaningful learning. One participant stated, “It [the VIP Discussion Guide] made me think more specifically about how humans affect the ocean, as opposed to just going, ‘oh, those are pretty’” (female 1, group 4). This comment epitomizes desired learning outcomes at an
aquarium, according to the Ocean Literacy Network (OLN, 2011a) and the Association of Zoos and Aquariums (AZA, 2009b). This participant insinuated that without the use of the VIP Discussion Guide and her group’s resulting conversations, she would not have contemplated the relationship between humans and the ocean.

Not only did visitors in VIP groups learn more, these visitors also enjoyed learning with the VIP Discussion Guide. All of the VIP groups stated they would be interested in using another VIP Discussion Guide on a future visit, suggesting that visitors are interested in learning during their trip to the aquarium and appreciate materials that assist with this goal. As mentioned earlier, one participant recognized the role of dialogue in learning and the ability of the VIP Discussion Guide to increased science-based conversations at the aquarium:

I definitely think that it [the VIP Discussion Guide] is something helpful to have with you. I really don’t see how it could hurt to have things like this. Because, it’s just helpful with discussion. Because, that, I mean… for me, personally, it helps me learn things if I can talk about it some… So I think it’s a good idea. (male, group 5).

Specifically, visitors liked that the VIP Discussion Guide allowed them to explore the aquarium at their own pace, focusing only on the questions and exhibits that piqued their interest. This allowance of choice was crucial to visitor engagement; visitors contrasted the free-choice nature of the VIP Discussion Guide with the forced-choice nature of school, emphasizing their delight with the flexibility of learning with the guide. “Honestly, at first, I thought, I was like, this is like school and I hate school. But, like, it wasn’t. Because I love stuff like this, so I thought it was fun” (female 1, group 10).

Comparison groups also expressed an interest in using a scaffolding tool like the VIP Discussion Guide during their next visit. During the post-visit interview, comparison groups were asked, “Imagine for a moment that somebody made a self-guided tour that had different questions you all could discuss as you were going through the aquarium. Would you be
interested in using something like that on your next visit?” All of the participants in comparison groups responded affirmatively. Comparison groups made positive assumptions about using the described self-guided tour that paralleled VIP groups’ experiences: The potential for enhanced learning through discussions and the ability to move at one’s own pace and choose which information to attend to. One male from comparison group 2 said, “Yeah, that would probably make me remember more information about each animal.” Another comparison group had the following exchange in response to this interview question:

Male: You’d probably be able to learn more [female: yeah] and interact with the actual fish better. You know, like—
Female: [Without a guide] you just casually walk through really fast. You just look at it and then you go, you don’t…
Male: It’s more of an image thing. You don’t really learn—unless you read the [text labels], but reading takes time and in this day and age, it’s so easy to just do it without reading a poster, you know, so…
Female: So you could, like, ask questions and be interactive with them, so yeah, that would—I would actually really like that.
Male: Yeah. (group 8, comparison)

And finally, one female said, “yeah, I like self-guided things.... because you can—I’m assuming you can move at your own pace and just ask questions as you go. You don’t have to, like, listen to somebody ramble…” (group 6). These assumptions made by comparison groups were strikingly similar to positive responses VIP groups gave regarding their experiences using the VIP Discussion Guide.

This suggests that visitors are interested in using the VIP Discussion Guide in the future outside of the research situation. This supports Packer and Ballantyne’s (2004) assertion that aquarium visitors are seeking an experience where “education is entertainment, discovery is exciting, and learning is an adventure” (p. 68, emphasis in original). Additionally, college-aged visitors are interested in learning through discussions with others in their social group, utilizing materials that provide guidance but promote choice, in a manner that is comfortable, interesting,
and non-threatening. The VIP Discussion Guide fit these criteria and encouraged enjoyable, meaningful learning among visiting groups of college-aged young adults.

It is important to note that although a scaffolding tool such as the VIP Discussion Guide can enhance learning among visitors, this tool should not replace trained and skilled education staff or volunteers. Visitors in VIP groups recalled more concepts and details related to exhibits that had a pertinent question on the VIP Discussion Guide and an educator on-hand willing to talk about the exhibits’ inhabitants. In these situations, visitors could—and did—use multiple resources to inform their learning conversations; the VIP Discussion Guide often served a supporting role in these visitor-educator conversations, helping visitors to think of questions to ask educators. The results from this study suggest that the VIP Discussion Guide may be particularly useful during times when visitor-educator conversations are less prevalent, such as during times of higher visitor attendance, at smaller exhibits without educator presence, or among groups that are less comfortable engaging educators in conversations.

Two important considerations regarding the VIP Discussion Guide questions emerged during this study and should be noted for future research. The first consideration pertains to visitors’ ease of locating questions on the guide and the related objects or exhibits. Visitors need to be able to quickly and easily identify pertinent information; if they are not able to do this, visitors will likely ignore these questions, as seen in the following comment by one male:

We tried to use as much of it as possible. I think really the only one that we didn’t use was the whale… because we just didn’t see the stuff for the whale one down here. (group 5, VIP)

The second consideration pertains to visitor interests and question content. As discussed earlier, one question set was ignored by all groups and this may have been because visitors simply were not interested in the content of the questions. Although the questions were designed with visitor
interests in mind and were successfully pilot tested prior to this study, visitors’ apparent distaste for this question set was not recognized until after the conclusion of data collection.

In the current research literature, there is a dearth of information on learning by college-aged young adults in informal environments. This study is a step towards addressing that gap and demonstrates that college-aged young adults are interested in learning during a visit to the aquarium. Further, college-aged visitors are willing to engage in meaningful learning if provided with fun, supportive, interesting, and easy-to-understand scaffolding tools. Visitors in this age group responded positively to tools that encourage conversations with others in their social group. Future research should examine the effectiveness of a variety of questions and topics in encouraging dialogue and enhancing learning among visiting social groups of college-aged young adults. Additionally, more research is necessary regarding the intrinsic and extrinsic factors that influence learning by college-aged young adults in informal environments.

6.5 References


Chapter 7. General Conclusions

7.1 Purpose of Study and Research Questions

The purpose of this two-part qualitative case study research project was to determine how the use of the VIP Discussion Guides affected the experience and learning of aquarium visitors. The VIP Discussion Guides were designed to address the needs, interests, motivations, and background knowledge of two group types (family groups with elementary school-aged children and social groups of college-aged young adults) as identified in the first study and described in Chapter 4. Three sub-questions guided the first phase of this research project and the answers to these questions are discussed in Chapter 4:

1) Why do individuals choose to visit an aquarium?
2) What are visitors interested in learning about at an aquarium?
3) What do visitors report learning during a visit to the aquarium?

The answers to these three questions influenced the design of two VIP Discussion Guides, one applicable to family groups with elementary school-aged children and another for social groups of college-aged young adults. The impact of using these VIP Discussion Guides was determined in the second phase of this project through answering these four sub-questions:

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?
2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?
3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?
4) What factors affect visitors’ responses to using educational materials (VIP Discussion Guides)?

The answers to these four sub-questions are discussed in Chapter 5 for family groups with elementary school-aged children and in Chapter 6 for social groups of college-aged young adults. Taken together, information gained from all seven sub-questions was used to answer the primary question guiding this research:

How does the use of educational materials, designed to address visitors’ interests, motivations, and background knowledge, affect the experience and learning of aquarium visitors?

Although this primary guiding question has been touched upon during discussion of the sub-questions in Chapters 4, 5, and 6, a more thorough elaboration is presented below in Section 7.4: Conclusions.

7.2 Methods

A full discussion of the methods used in this research project is contained in Chapter 3; a full explanation of the methods used in Studies 1.B, 2.B, and 2.C are included in Chapters 4, 5, and 6, respectively.

7.2.1 Methods: Study Sites. Studies 1.B, 2.B, and 2.C were conducted at the North Carolina Aquarium at Fort Fisher (NCA-FF) in Wilmington, North Carolina. This aquarium was renovated in 2002, expanding the exhibition area to 93,000 sq. ft. (North Carolina Aquarium at Fort Fisher, 2011). Visitors to NCA-FF can see over 300 species of terrestrial and aquatic organisms within three separate exhibit halls (North Carolina Aquarium at Fort Fisher, 2011; J. Metzler-Fiorino, personal communication, January 4, 2011). Annual visitation at NCA-FF is
approximately 420,000 individuals, with higher visitation during summer months and lower visitation during winter months (J. Zazzali, personal communication, October 14, 2012).

7.2.2 Methods: Samples. The sample in Study 1.B included 122 individuals in 63 groups. These 63 groups were categorized as either family group with pre-school-aged children (n=3), family group with elementary school-aged children (n=22), family group with secondary school-aged children (n=7), social group of college-aged adults (n=20), social group of adults not attending college (n=8), or adult group with family unspecified (n=3). Definitions of these group types are provided in Chapter 4.

Study 2.B examined the experience of nine family groups with elementary school-aged children. For this study, a family group included one to two adults and two to three children (approximate ages 5-11). A single adult was present in 5 groups and a pair of adults was present in the remaining 4 groups. Eight of the groups contained 2 children and one group contained 3 children. The sample contained more male children (n=13) than female children (n=6). All children were enrolled in school in kindergarten through 4th grade. The mean age for all children was 7.2 years and there was no difference between mean age for male and female children. Six groups utilized the VIP Discussion Guide and three groups did not use the VIP Discussion Guide.

The sample in 2.C included 10 social groups of college-aged young adults. These social groups were defined as two to three young adults (approximate ages 18-26) visiting the aquarium; a total of 22 college-aged individuals participated in this study. Although these visitors are referred to as “college-aged,” participation was not restricted to students enrolled in a college or university. In this study, 73% of participants were current students or recent graduates; 27% of participants were not pursuing a college degree. There were more female
participants (n= 14) than male participants (n= 8). Seven groups used the VIP Discussion Guide and three groups did not. The majority of groups (8 of 10) visited as a pair and two of 10 groups included three individuals. Finally, all participants were over the age of 18.

7.2.3 Methods: Data Collection. Data were collected in Study 1.B through semi-structured interviews, using a combination interview guide/standardized open-ended approach as described by Patton (1990). Participants were interviewed with others in their social and family groups or individually in the case of solitary visitors. Interviews were audio recorded and transcribed verbatim. Most of these interviews lasted between 4 and 6 minutes; the shortest interview lasted approximately 2 minutes and 30 seconds, the longest interview lasted approximately 7 minutes.

Studies 2.B and 2.C utilized identical data collection methods. All groups participated in a pre-visit interview of seven questions and a post-visit interview of 10 questions. Groups were also observed during their visit; the researcher examined three visitor engagement measures. These measures included time spent at an exhibit, identification of learning-related behaviors, and overheard conversation snippets. After completion of the post-visit interview, VIP groups were asked to return their marked VIP Discussion Guides, which served as another source of data to be used in document analysis.

Participants in Studies 2.B and 2.C were interviewed with others in their family or social group, as group dynamics were expected to shape the visit experience and the interview. Efforts were made to solicit information from all participants. All interviews and field notes were audio recorded and transcribed verbatim.

7.2.4 Methods: Creation of VIP Discussion Guides. The VIP Discussion Guides used in Studies 2.B and 2.C were created by the researcher and contained open-ended questions
related to specific exhibits and science concepts. These open-ended questions surrounded a map of the aquarium, which assisted in orientation, and were intended to spark science-based conversations among groups of visitors.

Question generation began with a review of each group type’s interests (family groups with elementary school-aged children and social groups of college-aged young adults) as identified in Study 1.B and described in Chapter 4. Once topics and exhibits of interest were identified, the researcher brainstormed potential age-appropriate questions, utilizing concepts from the Ocean Literacy Network’s *Ocean Literacy Principles* (Ocean Literacy Network, 2011a) and the National Research Council’s *Strands of Informal Science Learning* (Bell, Lewenstein, Shouse, & Feder, 2009; Fenichel & Schweingruber, 2010). Questions asked visitors to recount personal experiences, compare organisms, observe behaviors, share knowledge, brainstorm ideas, or imagine hypothetical scenarios. The questions were also vetted by a senior researcher/educator and modified for clarity. Additionally, these questions were tested in a pilot study at the research location and further adapted due to a change in exhibits. It is important to note that these questions were influenced by the researcher’s prior work in aquaria, knowledge of important science concepts, and experience designing discussion questions for graduate-level university courses.

The VIP Discussion Guide did not include an answer key; variations between groups of individuals guaranteed that each conversation generated by a VIP Discussion Guide question would be unique to that group of individuals. The VIP Discussion Guides used in Studies 2.B and 2.C are included in Appendix E and F, respectively.

**7.2.5 Methods: Data Analysis.** Coding of visitor responses in Study 1.B used two different methods. To examine visit motivations, learning interests, and self-reported learning,
the researcher coded for convergence, verified patterns, coded for divergence, and prioritized responses in four phases, based on the work of Guba (1978) and the explanations of Patton (2002). A second examination of visitor responses regarding visit motivations was accomplished using a modification of Packer’s (2004) coding scheme. Chapter 4 provides a complete description of the data analysis techniques used in Study 1.B.

Data analysis in Studies 2.B and 2.C began with the creation of a data-logging sheet, which allowed the researcher to record questions discussed, questions recalled, learning-related behaviors exemplified, time spent at exhibits, and topics discussed during post-visit interviews. An inductive content analysis of these data-logging sheets, interview transcripts, and field note transcripts was conducted in four phases (Guba, 1978; Patton, 2002). These phases included examining convergence, a verification phase, examining divergence, and prioritizing (Guba, 1978). The methods used in Studies 2.B and 2.C are discussed in detail in Chapters 5 and 6 respectively.

7.3 Findings

The following sections provide a summary of the findings of Studies 1.B, 2.B, and 2.C. For a full discussion of these findings, please see Chapters 4, 5, and 6, respectively.

7.3.1 Findings: Study 1.B. The first study in this two-part qualitative case study research project focused on visitors’ motivations, interests, and self-identified learning outcomes. Three sub-questions guided this first study:

1) Why do individuals choose to visit an aquarium?

2) What are visitors interested in learning about on a future visit to an aquarium?

3) What do visitors report learning during a visit to an aquarium?
A detailed analysis of the 3 sub-questions is presented in Chapter 4; an abridged summary is provided below.

Visitors from 63 groups were interviewed for this study; interview responses were examined by group type (family groups with pre-school children, family groups with elementary school-aged children, family groups with middle school-aged children, family groups with high school-aged children, social groups of college-aged young adults, social groups of non-college-aged adults, and adults with families unspecified). Two group types comprised the majority of all interviewed groups: Family groups with elementary school-aged children (n = 22) and social groups of college-aged young adults (n = 20). All other group types, combined, contained 21 groups. Due to these proportions, the responses provided by family groups with elementary school-aged children and social groups of college-aged young adults greatly influenced the overall trends seen among all group types. Given that these family and social groups were the most frequently represented group type, greater emphasis was placed on responses from these two group types.

Visitors were asked why they chose to attend the aquarium; the responses to this question were coded using a classification scheme derived by Packer (2004) and modified slightly for this study, as described in Chapter 4. Learning and Discovery was the most commonly identified visit motivation, given by 71% of all interviewed groups. Passive Enjoyment was the second most common response type, provided by 51% of all interviewed groups.

Visitor interests were gauged through responses from two interview questions: “Were there any animals in particular that you wanted to see today?” and “If someone designed a new program just for someone your age, what might you be interested in learning about next time you came to the aquarium?” Answers to these questions varied widely, with visitors providing 13
and 33 unique answers, respectively. However, visitors often mentioned different viewing interests and future learning interests.

Visitors from all groups were most interested in seeing sharks (51% of all groups), jellyfish (32%), turtles (22%), alligators (17%), and generic fish or “everything” (17%). Groups most frequently reported a desire to learn about sharks (30%) and mammals (21%) on a future visit. Other popular future learning topics provided by all group types were jellyfish (13%), turtles (11%), local species (10%), alligators (8%) and ecosystems (8%). Again, these were the 7 most common responses provided by groups. An additional 26 topics were suggested by visitors, but each of these 26 topics was mentioned by less than 8% of all groups.

Visitors were also asked to recall what they learned during their time at the aquarium. These responses were coded into 5 categories identified by the researcher: Conceptual, Emotional/Affective, Factual, Observational, and Species Awareness. These 5 categories are fully described in Chapter 4. Factual responses were the most common response type, provided by 60% of all groups. Observational answers were the second most common response type (48%). Conceptual responses were given by 32% of all groups and 22% of groups described increased Species Awareness. Emotional/Affective were the least common, given by only 10% of all groups.

As mentioned earlier, family groups with elementary school-aged children and social groups of college-aged young adults made up the majority of participants and their responses greatly influenced the overall trends mentioned above. It is not surprising that trends within each of these two group types closely followed the overall trends. However, there were some differences between these groups, and these are clearly explained within Chapter 4.
7.3.2 Findings: Study 2.B, Study 2.C. The second phase of this project consisted of two studies, which had identical methods and research questions but varied in regard to the samples and educational materials (VIP Discussion Guides). Study 2.B, as described in Chapter 5, examined how use of the VIP Discussion Guide affected the visit experience and learning of family groups with elementary school-aged children. Study 2.C, described in Chapter 6, examined the visit experience and learning of college-aged young adults in relation to use of a different VIP Discussion Guide. Both of these studies examined 4 sub-questions:

1) How do visitors use provided educational materials (VIP Discussion Guides) during their visit?

2) When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?

3) How does using provided educational materials (VIP Discussion Guides) affect visitor learning?

4) What factors influence visitors’ responses to using educational materials (VIP Discussion Guides)?

These sub-questions were fully answered for family groups and college-aged groups in chapters 5 and 6, respectively, and are discussed briefly below.

Chapter 5 discussed the results of Study 2.B, which examined how family groups with elementary school-aged children used the VIP Discussion Guide, and how this use affected the groups’ learning and visit experience. Interview responses and in-visit observations of groups utilizing the VIP Discussion Guide were compared to interview responses and in-visit observations of comparison groups who did not use the VIP Discussion Guide. The four sub-
questions listed above directed this study. A summary of the answers to these questions is provided below; a full examination was presented in Chapter 5.

How do visitors use provided educational materials (VIP Discussion Guides) during their visit? Family groups with elementary school-aged children often tailored their visit around the questions on the VIP Discussion Guide. Adults relied heavily on the VIP Discussion Guide to stimulate learning conversations. One group had visited the aquarium approximately 150 times prior to this study; this group entered the aquarium with a very specific visit motivation—to touch organisms in the touch tank. Although this group did not use all of the questions on the VIP Discussion Guide, they did answer questions that related to the touch tank and supported their visit motivation.

When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits? VIP groups reported an increase in interactions and science-based conversations amongst family group members. Adults in VIP groups were more likely to model science conversations than were adults in comparison groups. VIP groups and comparison groups interacted with educators in similar ways; family groups were willing to interact with educators and often remembered these interactions during the post-visit interview. Visitors in VIP groups spent more time at exhibits and displayed a greater number of learning-related behaviors than did their comparison group counterparts.

How does using provided educational materials (VIP Discussion Guides) affect visitor learning? Family groups with elementary school-aged children reported that using the VIP Discussion Guide increased learning during the visit. This was supported by interview data; VIP groups recalled talking about an average of 5.3 distinct science concepts and comparison groups
remembered discussing an average of 4.0 science concepts. Further, conversations recounted by VIP groups were more detailed than conversations described by comparison groups.

**What factors influence visitors’ responses to using educational materials (VIP Discussion Guides)?** Family groups with elementary school-aged children responded positively to using the VIP Discussion Guide; these positive responses did not vary due to any observable differences between the groups.

The third study of this research project (Study 2.C) examined the visit experience and learning of college-aged young adults visiting the aquarium in social groups. By comparing interview responses and in-visit observations of comparison groups and VIP groups, the researcher was able to infer the impact of using the VIP Discussion Guide on the visit experience and learning of college-aged VIP groups. A full discussion of the 4 sub-questions was presented in Chapter 6 and a summary is provided below.

**How do visitors use provided educational materials (VIP Discussion Guides) during their visit?** When using the VIP Discussion Guide, college-aged visitors answered only the questions they found interesting, as they had been instructed. Groups elected to use between 2 and 12 of the 19 questions present on the VIP Discussion Guide. Groups stated that the VIP Discussion Guide focused their attention, provided new topics for contemplation, assisted in orientation, and guided the majority of their in-depth conversations.

**When using provided educational materials (VIP Discussion Guides), how do visitors interact with their social group, educators, and exhibits?** College-aged visitors credited the VIP Discussion Guide with increased in-depth conversations amongst their social group; these perceived increases were supported by interview data. Interactions with educators were similar among VIP groups and comparison groups of college-aged young adults, suggesting that use of
the VIP Discussion Guide did not impact visitors’ interactions with educators. Visitors felt that use of the VIP Discussion Guide allowed them to explore the aquarium at their own pace, but encouraged them to spend additional time at exhibits, contemplating the inhabitants. This was supported by quantitative measurements of time spent at observed exhibits and overall visit time. College-aged visitors in VIP groups also demonstrated more learning-related behaviors than their comparison group counterparts.

How does using provided educational materials (VIP Discussion Guides) affect visitor learning? Overall, use of the VIP Discussion Guide resulted in more science-based conversations, greater cognitive engagement, and deeper learning among VIP groups than comparison groups. Visitors in VIP groups recalled an average of 5.6 topics of conversation (range: 2-9) and comparison groups recalled discussing an average of 4.7 topics (range: 3-6). VIP groups also recalled more in-depth conversations than the comparison groups. Further, college-aged visitors in VIP groups enjoyed using the VIP Discussion Guide and recognized its potential for increased learning.

What factors influence visitors’ responses to using educational materials (VIP Discussion Guides)? Visitor responses to using the VIP Discussion Guide were overwhelmingly positive and did not vary due to any observable factors. However, three factors did appear to impact visitors’ use of and perceived gains from the VIP Discussion Guide: college attendance, number of prior visits, and willingness to speak with educators. Each of these factors and resulting impacts were discussed in detail in Chapter 6.

7.4 Conclusions

The overarching question that guided this two-part qualitative case study was: How does the use of educational materials, designed to address visitors’ interests, motivations, and
background knowledge, affect the experience and learning of aquarium visitors? In short, use of the VIP Discussion Guides positively impacted the experience and learning of two vastly different types of visitor groups: Family groups with elementary school-aged children and social groups of college-aged young adults. The VIP Discussion Guides encouraged science-based conversations among group members, which led to more self-identified learning gains when compared to comparison groups who did not use the VIP Discussion Guide. Visitors in VIP groups were observed engaging in more Learning-Related Behaviors and spending more time at exhibits with corresponding questions on the VIP Discussion Guide.

Further, visitors in family groups and social groups enjoyed using the VIP Discussion Guide, crediting it with greater involvement, deeper discussions, increased learning, and an enhanced visit experience. All VIP groups were interested in using another VIP Discussion Guide on a future visit. This view was particularly prevalent among repeat visitors, who recognized that the VIP Discussion Guide provided them with new topics of conversation. Repeat visitors often expressed excitement when they realized there was something new for them to learn about at the aquarium—even though the topics on the guide were often touched upon in exhibit materials or docent-led conversations, the implicit themes identified by the education team were often lost on visitors. When these themes were made explicit in questions on the VIP Discussion Guide, visitors reacted in a positive manner, mentioning these topics repeatedly during the post-visit interviews.

Visitors used the VIP Discussion in a variety of ways to support their group’s interests and visit motivations. VIP groups appreciated that the VIP Discussion Guide allowed them to explore the aquarium at their own pace and select only the questions and topics that interested them for further discussion. However, visitors typically said that they found the questions and
topics on the VIP Discussion Guide interesting; this is likely because the questions were based on visitor interests of similar groups, as identified in Study 1.B (Chapter 4). Groups who entered the aquarium with a specific visit motivation (such as to view the touch tank, family group 7, Chapter 5) were able to use the VIP Discussion Guide in a manner that supported that visit motivation. The flexibility of this self-guided tour was often mentioned as a positive aspect during post-visit interviews. The VIP Discussion Guide provided visitors with guidance, offered new ideas for contemplation, but still allowed for visitor choice, which is a key component of informal education.

The VIP Discussion Guide represents a low-cost way to repurpose existing exhibits based on visitor interests and motivations to increase visitor conversations and learning yields. It allows educators to customize tours to address concepts deemed important by the institution or other researchers, but in a way that resonates with individual visitors. Visitors themselves are allowed to customize their experience with the VIP Discussion Guide based on their own needs, but still come away from the visit having gained some “canonical science” understanding (Allen, 2004, p. S18). This effectively eliminates the “constructivist dilemma” as described by Allen (2004); visitors are encouraged to learn about important science concepts, but are not forced or pressured into completing activities that compete with or go against the free-choice nature of the institution they have chosen to visit.

7.5 Limitations

Qualitative case-study research has inherent limitations, some of which apply to this project. One of the main concerns some researchers voice regarding qualitative research is the lack of generalizability from one situation to another, similar situation (Creswell, 2009). Since these studies focused on a single aquarium, a certain subset of visitors, and a certain month of the
year, it is likely that the results from these studies are most applicable to the groups studied. A similar study conducted at a larger institution with different exhibits, different visitation rates, and different subsets of visitors studied at a different time of year would likely provide different results from the ones presented within this paper. However, individuals involved in qualitative research will recognize that this is not necessarily a problem; the strength of qualitative research lies in its ability to adequately describe the themes and experience within a specific context (Creswell, 2009). Additionally, the results presented within these studies can provide a framework for other institutions to conduct studies applicable to their specific context—the results may actually prove to be quite similar!

A second potential limitation of qualitative research in general and these case studies in particular relates to sample size (Patton, 2002). These sample sizes in these studies were small compared to the aquarium’s annual visitation. Some might suggest that the experiences of the participating individuals and groups do not represent the experiences of the entire aquarium population. However, these individuals and groups were selected such that they represented a “typical case” at the aquarium (Creswell, 2007, p. 127) and were likely to provide insights into the visit experience of “typical” visitors. Additionally, Patton (2002) reminded readers, “the validity, meaningfulness, and insights generated from qualitative inquiry have more to do with the information richness of the cases selected and the observational/analytical capabilities of the researcher than with the sample size” (p. 245).

A third potential limitation of qualitative research concerns the idea of the researcher as the instrument of the research (Creswell, 2007; Patton, 2002). Patton (2002) recognized the subjective nature of qualitative research, noting, “the researcher is the instrument of both data collection and data interpretation” which, if the researcher is not careful, can skew the collection
of data as well as conclusions of the study (p. 50). There is a possibility that the researcher’s own experiences could have impacted the study. However, through meticulous record keeping, transparent methods, honest descriptive writing, and periods of self-reflection, the researcher has attempted to recognize and mitigate any potential negative impacts.

Another potential limitation to this work, and to qualitative research in general, relates to the phenomenon of participant reactivity. Patton (2002) said, “problems of reactivity are well documented” (p. 567) in qualitative research; simply participating in the research can influence the ways in which individuals act or respond to interview questions. Efforts were made to limit participant reactivity within this project; individuals were informed that there were not any “wrong” answers to interview questions or “expected” behaviors during observations. Additionally, participants were reassured that identifying information would not be connected to their responses in any way, thereby allowing them to speak freely. Guba and Lincoln (1981) suggested that participant reactivity might not be as detrimental to qualitative research as presumed. The researcher attempted to discern the potential impacts of participant reactivity, but these impacts were determined to be minimal.

A final limitation, specific to Studies 2.B and 2.C, relates to the assignment of groups into VIP or comparison groups, which dictated whether the group used a VIP Discussion Guide (VIP group) or did not (comparison group). Instead of adhering to a set schedule (e.g. 2 groups VIP, 1 group comparison, 2 groups VIP, 1 group comparison, etc.), the researcher decided to arbitrarily assign groups to either the comparison or VIP treatment. In most cases, at least one out of every three groups was designated as a comparison group, but in Study 2.B (Chapter 5), four groups in a row were designated as VIP groups and the next two were designated as comparison groups. This was an error on the researcher’s part. A more systematic assignment
of participating groups into VIP or comparison conditions, either by numbering or by characteristic matching, may have been more appropriate. However, since the designation was not based on any sort of inherent differences between groups, this method of sorting does not change or invalidate the conclusions made in this study.

7.6 Implications

The studies described in this dissertation focus on a single aquarium, a subset of visitor group types, and two versions of a novel educational material. However, the information gained from these studies has much wider implications and could be useful in other aquaria, in different types of informal learning experiences, or even in science classrooms. These broader implications are discussed below.

1) This dissertation highlighted the importance of understanding the personal factors (Falk & Dierking, 1992/2011) that may influence a visitor’s learning. A number of researchers have examined how a visitor’s interests, motivations, and prior knowledge may affect learning (Falk, 2009; Falk & Dierking, 1992/2011; Falk, Moussouri, & Coulson, 1998; Packer, 2004; Packer, 2006; Packer & Ballantyne, 2002; Rounds, 2004). The studies in this dissertation examined the personal factors (Falk & Dierking, 1992/2011) affecting visitors from multiple group types and using identical research methods across all group types. This allows for comparisons between group types and underscores the differences among groups and group types. The information contained within this dissertation provides justification for future research on the personal factors that influence individuals’ learning, in both formal and informal environments.

2) This dissertation describes a new way to categorize and examine visitor-identified learning outcomes (Chapter 4). The five categories of visitor learning responses include factual,
conceptual, observational, emotional/affective and species awareness, which allows a researcher to differentiate between more traditional outcomes (factual, conceptual, and species awareness) while also acknowledging other outcomes a visitor describes as learning (observational, emotional/effective). This paints a broader picture of visitor learning and can help educators determine if certain programs or presentations are leading to the desired outcomes.

3) This dissertation provides empirical evidence to support assertions that scaffolding is useful and perhaps even necessary in informal learning environments. Further, Chapters 5 and 6 demonstrate how the use of one type of low-cost scaffolding material (the VIP Discussion Guide) can increase science-based dialogue among visitors, resulting in enhanced learning.

4) As a whole, this dissertation provides a template and instructions on one way to conduct visitor research and a low-cost but engaging way to integrate research findings into educational materials. Although the VIP Discussion Guides were designed for a specific set of visitor group types, visitor needs, and available exhibits, these VIP Discussion Guides could serve as a model for institutions with different visitors, institutional needs, and exhibits.

As shown in earlier chapters, use of the VIP Discussion Guide resulted in increased learning yields among a variety of visitors. In addition, these visitors also enjoyed learning with the VIP Discussion Guide. This suggests that use of a similarly designed educational material could increase learning yields and enjoyment of visitors at a wide variety of informal learning environments.

Educators who feel their institution’s educational program has become stagnant would find that utilizing the VIP Discussion Guide could quickly and cheaply repurpose existing resources in a way that is fresh, engaging, and fun. Furthermore, by providing a variety of VIP Discussion Guides covering a wide range of topics, educators could help visitors recognize the
institution as a space with a plethora of learning opportunities, which could encourage learning through repeat visitation. This repeat visitation could, in turn, increase revenue from ticket sales.

### 7.7 Recommendations for Future Research

The first phase of this research project underscored the necessity for a better understanding of visitor’s interests and needs, as these were shown to vary by age and visitor group type. Suggestions for further research include:

1) An examination of the interests and needs of family groups with middle school-aged children, family groups with high school-aged children, and social groups of adults over college-age. Although an attempt was made to include individuals from these group types in the current study, the sample available representing these group types was small. Future research should address these groups in-depth, in addition to the group types studied in this research project.

2) This project included groups of individuals who had made the conscious decision to visit the aquarium. Future research could ask, what are the interests and needs of individuals electing not to visit an informal science education center? Can exhibits, programs, or educational materials be designed to encourage these individuals to visit and learn at an aquarium?

3) This project examined visitors in terms of group composition, namely family groups with children of different ages and social groups of adults without children. There are, however, a number of other factors that could be influencing the visit (Falk & Dierking, 1992/2011), and these should be examined. For example, do the visit motivations and interests of repeat visitors differ from first time visitors? How does this influence learning?

The second phase of this research project described the design of a new type of educational material (the VIP Discussion Guides) and the resulting impact on visitors’
discussions and learning. These studies concluded that use of the VIP Discussion Guides increased science-based dialogue among visitors and enhanced learning in an enjoyable manner, while still allowing visitors to choose which information to attend to. However, further research is still needed to strengthen these—and other—educational materials. Some recommended research ideas include:

1) Examining the appeal of different questions. As described in Chapter 6, one question set was not used by any college-aged visitors. Further research is needed to determine why visitors ignored this question set and what this might mean for the creation of other educational materials.

2) Further study on the effect of education level on visitors’ use of VIP Discussion Guides. As discussed in Chapter 6, visitors attending college utilized the VIP Discussion Guide in a different manner than college-aged visitors not enrolled in college courses. Further study is warranted: Were the visitors not enrolled in college uncomfortable with the format of the questions? The content? Learning as a visit outcome? Were there other factors at play? Or were the trends seen in this study a mere coincidence and not indicative of the overall population of young adults not attending college? Or, could the VIP Discussion Guides be tailored in a way that would better encourage conversation among young adults not attending college?

3) These studies examined two different VIP Discussion Guides—one that addressed the needs and interests of family groups with elementary school-aged children and another that addressed the needs and interests of college-aged young adults. However, there is potential for the development of a greater number of VIP Discussion Guides regarding different themes and topics that may interest these visitors. If visitors were allowed to select different VIP Discussion
Guides based on their interests during that particular visit, would this impact learning? Would this encourage repeat visitation?

4) The VIP Discussion Guides described in Chapters 5 and 6 were designed for family and social groups, not school groups on formal field trips. Future research could examine the feasibility of designing VIP Discussion Guides to address student interests and state or national curricular standards, and how these materials may impact the learning that occurs on school group field trips.

As mentioned previously, the information gained during this research project has significant potential to increase learning in a variety of settings, both formal and informal. The questions posed above demonstrate the myriad of learning opportunities available for further research; this is a promising field of study worthy of future perusal.

7.8 References


Appendix A. Ocean Literacy Principles (OLP)

The following Ocean Literacy Principles were described by the Ocean Literacy Network (OLN) and outline the overarching concepts an ocean-literate person should understand (Ocean Literacy Network, 2011a).

**OLP #1: The Earth has one big ocean with many features.** This principle addresses four main topics: properties of ocean water, geographic and geologic features, ocean circulation, and sea level (Strang & Tran, 2010, p. 66). Concepts include salinity, density, and pH (properties of ocean water); ocean basins, ocean floor features, and generation of Earth’s crust (geographic and geologic features); tides, waves, currents, and transportation of living things (ocean circulation); and global temperature change, plate tectonics, and change in relative sea level over time (sea level). More generally, students should recognize that the ocean covers approximately 70% of the planet’s surface and contains 97% of its water (OLN, 2011c). This water is circulated around the globe in a pattern that is dictated by the shape of ocean basins and driven by wind, tides, the Earth’s rotation, the sun, and water density differences. From a conservation standpoint, students should understand that although the ocean is large, it is finite and contains limited resources.

**OLP #2: The ocean and life in the ocean shape the features of Earth.** This principle also addresses four main topics: coastal erosion, plate tectonics, the rock cycle, and biogeochemical cycles (Strang & Tran, 2010, p. 67). Concepts include sedimentation: weathering, erosion, and deposition (coastal erosion); tectonic activity, continental plates, oceanic plates, subduction, and uplift (plate tectonics); sedimentation, marine fossils, and rock formation (rock cycle); elements in ocean water, carbon cycle, nitrogen cycle, and phosphorus cycle (biogeochemical cycles). More generally, students should understand that many rocks are
formed in the ocean and sand is composed of small pieces of animals, plants, rocks, and minerals (OLN, 2011d). This sand is formed primarily by land-based erosion, though some results from coastal erosion by waves. This principle does not have a strong conservation component, though educators could discuss human impacts on biogeochemical cycles.

**OLP #3: The ocean is a major influence on weather and climate.** Similarly, this principle addresses four main topics: weather and climate, the water cycle, global climate change, and consequences of global climate change (Strang & Tran, 2010, p. 67-68). Concepts include convection currents, ocean currents, and weather and climate patterns (weather and climate); precipitation, condensation, evaporation, and runoff (the water cycle); natural and human-based carbon dioxide inputs, ocean absorption of carbon dioxide, greenhouse gases, and photosynthetic organisms in the ocean (global climate change); and El Niño/La Niña cycles, changes in ocean circulation, ocean acidification, and rising sea level (consequences of global climate change). More generally, students should understand how the ocean stores and moves energy, heat, carbon, and water, as well as the effect this has on weather and climate (OLN, 2011e). From a conservation standpoint, students should understand how human activities alter established carbon cycles and the effect this alteration has on the ocean.

**OLP #4: The ocean makes Earth habitable.** This principle addresses two main topics: origins of life and oxygen production (Strang & Tran, 2010, p. 68-69). Concepts include necessity of water for life, fossil evidence, early life in the ocean, and theory of evolution (origins of life) and photosynthesis, respiration, decay, cyanobacteria and other photosynthetic organisms (oxygen production). More generally, students should understand that photosynthetic organisms play an important role in the oxygen/carbon dioxide balance, producing much of the oxygen in the atmosphere. Additionally, they should know that marine fossils provide evidence
that life originated in the ocean (OLN, 2011f). Although this principle does not have a strong explicit conservation component, students should understand how human actions impact the oxygen/carbon dioxide balance.

**OLP #5: The ocean supports a great diversity of life and ecosystems.** This principle addresses three main topics for all grade bands: primary production, diversity of ecosystems, and diversity of life (Strang & Tran, 2010, p. 69-70). For grade band 9th-12th, “diversity of life” is further broken down into four sub-topics: adaptations to environmental factors, life cycles and reproductive strategies, feeding behaviors, and phyletic diversity (Strang & Tran, 2010, p. 70). Concepts include photosynthetic organisms, chemosynthetic ecosystems, autotrophs, and upwelling (primary production); habitats, ecosystems, food webs, and adaptations to environmental conditions (diversity of ecosystems); and adaptations for living in the ocean, life cycles, and organism diversity (diversity of life). More generally, students should know that more major groups of organisms are found in the ocean than on land. Additionally, they should understand that ocean habitats are defined by environmental factors, which means that ocean life is not distributed evenly (OLN, 2011g). In terms of conservation, students should recognize that some regions in the ocean support more diverse and abundant life than any terrestrial habitat, and human actions greatly affect these hotspots of biodiversity (OLN, 2011g).

**OLP #6: The ocean and humans are inextricably interconnected.** This principle addresses five main topics: uses of the ocean, where people live, human impact on the ocean and atmosphere, the ocean affects weather and climate which impacts people, and responsibility and advocacy for the ocean (Strang & Tran, 2010, p. 71-72). Concepts include food resources, sources of oxygen, and renewable and non-renewable resources (uses of the ocean); human population distribution, transportation, and commerce (where people live); pollution,
overfishing, introduced species, global climate change, and eutrophication (human impact on the ocean and atmosphere); heat distribution, effects of changing weather and climate, and effects of natural disasters (the ocean affects weather and climate which impacts people); and sustainability, ocean education, marine protected areas and marine policies (responsibility and advocacy for the ocean). More generally, students should understand the ways in which the ocean impacts every aspect of their lives and how many of their actions impact the ocean. This principle has the strongest conservation message: humans have a responsibility to understand and protect the ocean and its resources (OLN, 2011h). Given that many aquariums emphasize conservation in their mission statements, this principle is particularly applicable to these informal science education centers.

**OLP #7: The ocean is largely unexplored.** This principle addresses four main topics: life on Earth depends on the ocean, people explore the ocean, ocean exploration requires collaboration, and ocean exploration requires technological innovations (Strang & Tran, 2010, p. 72-73). Concepts include requirements for life and scientific investigations (life on Earth depends on the ocean); ecosystem health, data collection, oceanic discoveries, and human impacts on the ocean (people explore the ocean); science careers, sustainability, and groups involved in ocean exploration (ocean exploration requires collaboration); and tools for exploration, data collection technology, physical properties of the ocean, and scientific models (ocean exploration requires technological innovations). More generally, students should understand that less than 5% of the ocean has been explored and exploration is necessary for a more complete understanding of the ocean, its system processes, and its resources (OLN, 2011i). From a conservation standpoint, actions towards conservation and sustainability should be informed by scientific knowledge; this knowledge is enhanced by ocean exploration.
Appendix A References


Appendix B. **STRANDS OF INFORMAL SCIENCE LEARNING (SISL)**

Strand 1  Sparking Interest and Excitement: Experiencing excitement, interest and motivation to learn about phenomena in the natural and physical world.

Strand 2  Understanding Scientific Content and Knowledge: Generating, understanding, remembering, and using concepts, explanations, arguments, models, and facts related to science.

Strand 3  Engaging in Scientific Reasoning: Manipulating, testing, exploring, predicting, questioning, observing, and making sense of the natural and physical world.

Strand 4  Reflecting on Science: Reflecting on science as a way of knowing, including the processes, concepts, and institutions of science. It also involves reflection on the learner’s own process of understanding natural phenomena and the scientific explanations for them.

Strand 5  Using the Tools and Language of Science: Participation in scientific activities and learning practices with others, using scientific language and tools.

Strand 6  Identifying with the Scientific Enterprise: Coming to think of oneself as a science learner and developing an identity as someone who knows about, uses, and sometimes contributes to science.

*Strands of Informal Science Learning (SISL) as described by Fenichel & Schweingruber, 2010, p. 27.*
Appendix C. Interview Protocol, Study 1.B

Date: ________________
Group ID: ________________

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Questions:

1. Why did you all come to the aquarium today?

2. Were there any animals you wanted to see in particular?

3. What did you learn today at the aquarium?
   
   i. Follow up: Do you remember reading anything, touching anything, seeing anything unusual?

4. Did you have any unanswered questions during your visit today?

5. If the aquarium offered new tours or new programs, just for someone your age, what would you want to learn about?

6. How would you want to learn about [topic]?
   
   i. Follow up: Would you want to read about it, listen to a podcast, watch a video, talk to someone, touch something…?

7. Is there anything else you’d like to share with me about your visit?
Appendix D. Institutional Review Board Documents

Application for Exemption from Institutional Oversight

A Complete Application Includes All of the Following:
(A) Two copies of this completed form and two copies of Parts B thru F.
(B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2).
(C) Copies of all instruments to be used.
(D) If this proposal is part of a grant proposal, include a copy of the proposal and all relevant materials.
(E) A Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB.
(F) IRB Security of Data Agreement. (http://research.lsu.edu/files/item26774.pdf)

Principal Investigator: Erika K. Poach
E-mail: epoach@lsu.edu
Phone: (925) 280-1694

Co-Investigators: Please include department, rank, phone, and e-mail for each.

Project Title: A qualitative examination of aquarium visitors' use of educational materials

Proposal? (yes or no) [ ] No [ ] Yes, LSU Proposal Number ____________________________

Also, if YES, either [ ] This application completely matches the scope of work in the grant
[ ] More IRB Applications will be filed later

Subject pool (e.g., psychology students): Aquarium visitors; Adults and family groups with children <18.

*Circle any "vulnerable populations" to be used: (children <18, mentally impaired, pregnant women, the aged, others). Projects with incarcerated persons cannot be exempted.

PI Signature ____________________________ Date 09/14/15 (no per signatures)

I certify my responses are accurate and complete. If the project scope or design is later altered, or if the study is conducted, I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study, if I use LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted ☒ Not Exempted [ ] Category/Paragraph ________________

Signed Consent Waived? Yes / ☒ No

Reviewer: ____________________________ Signature: ____________________________ Date 09/20/2015

LSU Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225-578-8692
F: 225-578-5983
info@lsu.edu
lsu.edu/irb
Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Erika Poarch successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 10/19/2011

Certification Number: 789940
**Please sign and submit this document with your IRB application**

Security of Data

Number: PS06.20

SECURITY OF DATA

PURPOSE

I certify that I have read and will follow LSU’s policy on security of data – PS06.20 (http://itsweb.lsu.edu/ITS_Security/IT_Policies/LSU/item614.html) and will follow best practices for security of confidential data (http://itsweb.lsu.edu/ITS_Security/Best_Practices/Sensitive_Data/item862.html)

This Policy Statement outlines the responsibilities of all users in supporting and upholding the security of data at Louisiana State University regardless of user’s affiliation or relation with the University, and irrespective of where the data is located, utilized, or accessed. All members of the University community have a responsibility to protect the confidentiality, integrity, and availability of data from unauthorized generation, access, modification, disclosure, transmission, or destruction. Specifically, this Policy Statement establishes important guidelines and restrictions regarding any and all use of data at, for, or through Louisiana State University. This policy is not exhaustive of all user responsibilities, but is intended to outline certain specific responsibilities that each user acknowledges, accepts, and agrees to follow when using data provided at, for, by and/or through the University. Violations of this policy may lead to disciplinary action up to and including dismissal, expulsion, and/or legal action. It is recommended that all personnel on your project be familiar with these policies and requirements for security of your data.

In addition it is recommended that PIs review any grant, non-disclosure/confidentiality agreement, or restricted data agreements before publishing articles using the data.

I certify that I have read and understand these policies

Name: [Signature]

Date: 9/4/2012
Appendix E. VIP Discussion Guide for Family Groups

The VIP Discussion Guide

As you walk through the aquarium, please take a moment to talk about the questions on this guide that interest you and the others in your group. Don’t worry—there aren’t any wrong answers! We just want you to think about some important science ideas on your visit today. Enjoy!

Ask the volunteer to help you touch the animals in the touch tank.

- Can you think of something in your house that feels like each animal you touched?
- What do you think your life would be like if YOU felt like an anemone or a horseshoe crab?

Lots of people might be scared of alligators and snakes, but they are important in the wild.

- Why do you think snakes and alligators are important?
Snakes, turtles, and alligators are reptiles, people are mammals. Reptiles and mammals have different features.
- What makes snakes, turtles, and alligators different from people? What covers their skin?
- How are snakes, turtles, and alligators like people? How do you think they breathe? Do you think they have a backbone?

Sometimes scientists work in teams to figure out the answers to really hard questions. Pretend your group is a team of scientists who were asked to carefully observe (look at) the animals in this tank.

- What does your group notice that other scientists might not?
- Which animal in this tank has the biggest mouth? The sliniest scales? The smallest fins?
Whales and dolphins are marine mammals. Look at the whale models above you. Some are counter-shaded, meaning that the underside of the animal's body is a lighter color and the top is a darker color.

- Have you seen any other animals today that are counter-shaded? Which ones?
- Can you think of how counter-shading might help protect the animal from predators?

Fish can't talk, so they have to use other sounds, smells, and movement to "talk" to each other. Watch some of the fish in this tank move.

- What do you think their movements might be "saying"?
- Can your family talk to each other like the fish do, by moving?

Check out those giant jaws! They're from the Megalodon shark, which went extinct about 2 million years ago. Extinct means that there are no more animals like that left on Earth. Some of the sharks alive today are in danger of extinction, too.

- What would happen if all of the sharks went extinct?
- What can you do to help keep sharks from going extinct?

Jellyfish don't have eyes like ours, but some have eyespots that help them tell the difference between light and dark. Close your eyes and wave your hand in front of your face. That's similar to what some jellyfish can see, including the moon jellyfish in this tank!

- What would life be like if you had eyespots like a jellyfish instead of your human eyes?

- Have you been to the beach before?
- What was your favorite part of going to the beach?

Why do you think the ocean is important?

- What do you think would happen if the ocean disappeared tomorrow?
The ocean is a major influence on weather and climate; warmer oceans lead to stronger hurricanes.

- Have you experienced one of the hurricanes discussed in this exhibit? What was it like?
- How many ways can you think of that hurricanes could impact people, animals, and the environment?

The VIP Discussion Guide
As you walk through the aquarium, please take a moment to talk about the questions on this guide that interest you and the others in your group. Don't worry—there aren't any wrong answers! We just want you to think about some important science ideas on your visit today. Enjoy!
Scientific evidence suggests that the blue whale is the largest animal to have ever lived on Earth. In fact, many marine (ocean-dwelling) mammals are larger than terrestrial (land-dwelling) mammals. Locate at the largest whale model above you.

- What difficulties might an animal of that size have if it lived on land?
- How could these difficulties be eliminated by a life in the water?

Imagine a marine biologist was interested in researching an organism in this tank and asked you to be her research assistant.
- Can you think of some research questions you might be interested in studying?
- What evidence would you need to collect to answer your questions?

Coral and other marine organisms shape the features of the Earth. When most people think of corals, they imagine tropical paradises of coral reefs. But, divers can find corals off the coast of NC!
- Have you seen a tropical coral reef before? Did those corals look like the corals in this tank?
- Coral reefs can support entire ecosystems. Why do you think fish might be attracted to coral reefs?
- In addition to the corals, did you know that almost all of the organisms in this aquarium can be found in the coastal waters of NC? Does this surprise you?

Many of the organisms in this section are exotic, meaning that natural or human actions have allowed them to live outside of their normal habitat.
- How do you think these exotics got to the coast of NC?
- What kinds of problems might exotics cause in their new habitats?
- Do you think efforts should be made to remove the exotics from the coast of NC? Why or why not?

- Why do you think the ocean is important?
- What do you think would happen if the ocean disappeared tomorrow?
VIP Discussion Guide Alignment for family groups with elementary school-aged children. Each “OLP” refers to a specific Ocean Literacy Principle as described by the Ocean Literacy Network (2011a, Appendix A). Each “SISL” refers to a specific Strand of Informal Science Learning as described by Fenichel and Schweingruber (2010, Appendix B). “Visitor Interest” was determined from visitor interviews during Phase 1; a topic was defined as interesting if one or more visitors mentioned it specifically when asked 1) Are there any animals in particular that you would like to see today?, 2) What did you learn during your visit today?, and 3) What would you be interesting in learning about on a future visit?

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Appendix H. VIP Discussion Guide Alignment for Social Groups of College-Aged Young Adults

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</table>

VIP Discussion Guide Alignment for social groups of college-aged young adults. Each “OLP” refers to a specific Ocean Literacy Principle as described by the Ocean Literacy Network (2011a, Appendix A). Each “SISL” refers to a specific Strand of Informal Science Learning as described by Fenichel and Schweingruber (2010, Appendix B). “Visitor Interest” was determined from visitor interviews during Phase 1; a topic was defined as interesting if one or more visitors mentioned it specifically when asked 1) Are there any animals in particular that you would like to see today?, 2) What did you learn during your visit today?, and 3) What would you be interested in learning about on a future visit?
Appendix I. Consent Forms

Project Title: A Qualitative Examination of Aquarium Visitors’ Use of Educational Materials
Principal Investigator: Erika K. Poarch

Family Group Consent Form

Study Title: A Qualitative Examination of Aquarium Visitors’ Use of Educational Materials
Performance Site: The North Carolina Aquarium at Fort Fisher, Kure Beach, NC
Investigator: Erika K. Poarch, Doctoral Candidate
School of Education, Louisiana State University
Phone: (225) 366-8328, email: epoarch@lsu.edu

Purpose of Study: This study seeks to determine how aquarium visitors use provided educational materials and the effect these materials have on the participants’ aquarium visit and related learning.

Subject Inclusion: Family groups with young children visiting the North Carolina Aquarium

Study Procedures: Groups will participate in a short pre-visit interview. During the visit, groups will be asked to use educative materials and may be observed from a distance. After the visit, groups will participate in a post-visit interview. Interviews will be audio-recorded, but no identifying information will be attached to the recording.

Benefits of the Study: Groups will be offered one $10 gift card after completion of both interviews. Also, participant responses may be used to improve educational materials offered at aquariums.

Risks: There are no known risks associated with participating in this study.

Right to Refuse: Participation is voluntary. Participants may choose to stop answering questions at any time without penalty. If participants choose to withdraw from this study, the answers provided will be discarded immediately.

Privacy: The results of this study may be published, but no names or identifying information will be included in the publication.

Signatures: This study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subjects’ rights or other concerns, I can contact Robert C. Mathews, Chairman, LSU Institutional Review Board, (225)578-8692, irb@lsu.edu, www.lsu.edu/irb.

I agree to participate in the study described above and acknowledge the researchers’ obligation to provide me with a copy of this consent form if signed by me.
I also agree to allow my child to participate if s/he assents.

Your Signature: ___________________________ Date: ____________

Your Name (Please Print): ___________________________

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University

274
Project Title: A Qualitative Examination of Aquarium Visitors' Use of Educational Materials  
Principal Investigator: Erika K. Poarch

Young Adult Consent Form

Study Title: A Qualitative Examination of Aquarium Visitors' Use of Educational Materials

Performance Site: The North Carolina Aquarium at Fort Fisher; Kure Beach, NC

Investigator: Erika K. Poarch, Doctoral Candidate  
School of Education, Louisiana State University  
Phone: (225) 366-8328, email: epoarc1@lsu.edu

Purpose of Study: This study seeks to determine how aquarium visitors use provided educational materials and the effect these materials have on the participants' aquarium visit and related learning.

Subject Inclusion: Groups of young adults (approx. age: 18-25) visiting the North Carolina Aquarium

Study Procedures: Groups will participate in a short pre-visit interview. During the visit, groups will be asked to use educative materials and may be observed from a distance. After the visit, groups will participate in a post-visit interview. Interviews will be audio-recorded, but no identifying information will be attached to the recording.

Benefits of the Study: Groups will be offered one $10 gift card after completion of both interviews. Also, participant responses may be used to improve educational materials offered at aquariums.

Risks: There are no known risks associated with participating in this study.

Right to Refuse: Participation is voluntary. Participants may choose to stop answering questions at any time without penalty. If participants choose to withdraw from this study, the answers provided will be discarded immediately.

Privacy: The results of this study may be published, but no names or identifying information will be included in the publication.

Signatures: This study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Chairman, LSU Institutional Review Board, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb.

I agree to participate in the study described above and acknowledge the researchers' obligation to provide me with a copy of this consent form if signed by me.

Your Signature: ____________________________ Date: ________________

Your Name (Please Print): ____________________________

Study Exempted By:  
Dr. Robert C. Mathews, Chairman  
Institutional Review Board  
Louisiana State University

Page 275
Appendix J. Child Assent Form

Project Title: A Qualitative Examination of Aquarium Visitors’ Use of Educational Materials
Principal Investigator: Erika K. Poarch

Research Project:
A Qualitative Examination of Aquarium Visitors’ Use of Educational Materials

Child Assent Form

I, ____________________________, agree to be in a study about what people do and learn at the aquarium. I do not mind if the researcher sees what my family does at the aquarium. I agree to answer questions about my trip to the aquarium, including what I think, what I feel, and what I learned today. I understand that it is okay for me to ask the researcher questions if I do not understand what she says. I can decide to stop being in the study at any time without getting in trouble.

Child’s Signature: ____________________________ Date: ____________

Child’s Name (Please Print): ____________________________ Age: ____________

Witness*: ____________________________________________ Date: ____________

*(N.B. Witness must be present for the assent process, not just the signature by the minor.)

Any questions related to this study may be directed to:
Erika K. Poarch
Doctoral Candidate
School of Education
Louisiana State University
Phone: (225) 366-8328, email: epoarch1@LSU.edu

Any concerns related to the child’s rights during this study may be directed to:
Institutional Review Board
Dr. Robert Mathews, Chair
203 B-1 David Boyd Hall
Baton Rouge, LA 70803
Phone: (225) 578-8692, email: irb@lsu.edu
lsu.edu/irb

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 4/11/2015
Appendix K. Pre-Visit Interview Protocol, Studies 2.B, 2.C

Date: ____________________
Group ID: ____________________

<table>
<thead>
<tr>
<th>Gender</th>
<th>Grade</th>
<th>Hometown</th>
<th># of Visits</th>
<th>ID code</th>
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</tbody>
</table>

Questions:
1) Why did you all come to the aquarium today?

2) Are there any animals you are particularly interested in seeing today?

3) What do you think you’re going to learn about today?

4) What grade are you in?

5) What city do you live in?

6) How many times have you been to this aquarium?
### Appendix L. Observation Protocol, Studies 2.B, 2.C

- **Date:** ____________
- **Group ID:** ________________

<table>
<thead>
<tr>
<th><strong>Salt Marsh</strong></th>
<th><strong>Touch Tank</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Start:</strong> __________</td>
<td><strong>Start:</strong> __________</td>
</tr>
<tr>
<td><strong>End:</strong> __________</td>
<td><strong>End:</strong> __________</td>
</tr>
<tr>
<td>□ Approach</td>
<td>□ Approach</td>
</tr>
<tr>
<td>□ Stop</td>
<td>□ Stop</td>
</tr>
<tr>
<td>□ Glance at (&lt; few seconds)</td>
<td>□ Glance at (&lt; few seconds)</td>
</tr>
<tr>
<td>□ View for a few seconds</td>
<td>□ View for a few seconds</td>
</tr>
<tr>
<td>□ Touch object briefly</td>
<td>□ Touch object briefly</td>
</tr>
<tr>
<td>□ Read text labels</td>
<td>□ Read text labels</td>
</tr>
<tr>
<td>□ Discuss content</td>
<td>□ Discuss content</td>
</tr>
<tr>
<td>□ Watch others</td>
<td>□ Watch others</td>
</tr>
<tr>
<td>□ Listen to staff or other visitors</td>
<td>□ Listen to staff or other visitors</td>
</tr>
<tr>
<td>□ Express positive emotional response</td>
<td>□ Express positive emotional response</td>
</tr>
<tr>
<td>□ Refer to past experiences</td>
<td>□ Refer to past experiences</td>
</tr>
<tr>
<td>□ Seek/share information</td>
<td>□ Seek/share information</td>
</tr>
<tr>
<td>□ Point to VIP Guide/map</td>
<td>□ Point to VIP Guide/map</td>
</tr>
<tr>
<td>□ Look at VIP Guide/map</td>
<td>□ Look at VIP Guide/map</td>
</tr>
<tr>
<td>□ Read VIP Guide/map to companion</td>
<td>□ Read VIP Guide/map to companion</td>
</tr>
<tr>
<td>□ Write on VIP Guide/map</td>
<td>□ Write on VIP Guide/map</td>
</tr>
<tr>
<td>□ Look at animal/object</td>
<td>□ Look at animal/object</td>
</tr>
<tr>
<td>□ Point to animal/object</td>
<td>□ Point to animal/object</td>
</tr>
<tr>
<td>□ Take picture of animal/object</td>
<td>□ Take picture of animal/object</td>
</tr>
<tr>
<td>□ Touch animal/object</td>
<td>□ Touch animal/object</td>
</tr>
<tr>
<td>□ Request companion’s attention</td>
<td>□ Request companion’s attention</td>
</tr>
<tr>
<td>□ Talk to companion</td>
<td>□ Talk to companion</td>
</tr>
<tr>
<td>□ Talk to staff</td>
<td>□ Talk to staff</td>
</tr>
</tbody>
</table>
Appendix M. Post-Visit Interview Protocols, Studies 2.B, 2.C

Post-Visit Interview Protocol (VIP Discussion Guide Group)

Date: ____________________
Group ID: ____________________

Questions:
1) What parts of the self-guided tour did you use today?

2) How did using the self-guided tour affect your visit?
   a. Follow up: How was this visit different from previous visits?

3) What was the most interesting thing you talked about today?
   a. Follow up: Can you elaborate on that?
   b. Follow up: Why is that important?
   c. Follow up: What made that the most interesting thing you talked about?

4) What else did your group talk about during your visit?
   a. Follow up: Did you talk to each other about information included in the self-guided tour?
   b. Follow up: Can you tell me why you talked about those topics?

5) Aside from what you’ve already told me, is there anything else you learned today?
   a. Follow up: Do you remember seeing anything, touching anything, or hearing anything special?
6) Did you have any questions that weren’t answered during your visit today?

7) What do you think you’ll remember most about your visit today?

8) Would you be interested in using a different self-guided tour on your next visit?
   a. Follow up: Why or why not?

9) What did you like about the self-guided tour?

10) Is there anything else you would like to share with me about your visit today?
Post-Visit Interview Protocol (No VIP Discussion Guide)

Date: ________________
Group ID: ________________

Questions:

1) What was the most interesting thing you talked about today?
   a. Follow up: Can you elaborate on that?
   b. Follow up: Why is that important?
   c. Follow up: What made that the most interesting thing you talked about?

2) What else did your group talk about during your visit?

3) Aside from what you’ve already told me, is there anything else you learned today?
   d. Follow up: Do you remember seeing anything, touching anything, or hearing anything special?

4) Imagine that someone designed a self-guided tour that contained questions for visitors to discuss as they walked through the aquarium. Would you be interested in using this kind of self-guided tour on your next visit?
   e. Follow up: Why or why not?

5) What do you think you’ll remember most about your visit today?
6) Did you have any questions that weren’t answered during your visit today?

7) Is there anything else you would like to share with me about your visit today?
Appendix N. Data-Logging Sheets, Studies 2.B, 2.C

**Family Group #_____**

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<tr>
<td>Scientist 2</td>
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<td>Reptiles 2</td>
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<td>Reptiles 3</td>
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<td>Touch Tank 1</td>
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<td>Touch Tank 2</td>
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<td>Ocean 1</td>
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<tr>
<td>Ocean 2</td>
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| Topic 2:       | (Score:        |
| Topic 3:       | (Score:        |
| Topic 4:       | (Score:        |
| Topic 5:       | (Score:        |
| Topic 6:       | (Score:        |
| Topic 7:       | (Score:        |

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<td>Touch object</td>
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<td>Read text</td>
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<tr>
<td>Seek/share info</td>
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### College Group 

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### Behavior SM TT

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<td>Refer to past</td>
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<tr>
<td>Talk to group</td>
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<tr>
<td>Talk to staff</td>
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</tbody>
</table>

**Topic 1: **

**Topic 2: **

**Topic 3: **

**Topic 4: **

**Topic 5: **

**Topic 6: **

**Topic 7: **
Vita

Erika K. Poarch fell in love with the ocean at a young age. She attended the University of North Carolina at Chapel Hill for her undergraduate degree, earning a Bachelor’s of Science in Environmental Science with a minor in Marine Science in December of 2006. After graduation, she worked as an informal educator at an aquarium and a nature center in North Carolina. Here, she realized the potential to educate others on topics she was passionate about in a manner that was fun, engaging, and memorable. While attending Louisiana State University during her doctoral studies, Erika K. Poarch published articles in peer-reviewed journals, presented at national conferences, engaged in educational outreach programs for school-aged children, and co-taught a graduate-level course. In addition to her courses in science education, she has also completed graduate hours in biology, oceanography and coastal studies.

After completion of the doctorate, Erika K. Poarch plans to return to the world of informal science education. Her research interests revolve around making informal science education more educational and engaging for the average visitor.