Science and Mathematics Education Centre

Visitor Engagement and Learning Behaviour in Science Centres, Zoos and Aquaria

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: **September 20, 2014**

Abstract

Informal science environments such as science centres, zoos and aquaria, contribute to society's science education infrastructure and provide lifelong learning opportunities for people to engage with science and scientific issues. Although workshops, demonstrations, outreach and other programs complement the science centre, zoo and aquarium visit, interactions with exhibits arguably make up the most significant part of the visitor learning experience. Investigating the learning impact of those exhibits is challenging and various methodologies and tools have been developed and applied over the last few decades. The Visitor-Based Learning Framework (Barriault & Pearson, 2010) currently provides science centre practitioners with an assessment tool that is methodologically rigorous yet feasible to implement and its use generates insights into the impact exhibits have on the visitor learning experience. The framework has the potential to become a practical learning and exhibit assessment tools for practitioners across informal science learning settings, including zoos and aquaria. Thus, it was the goal of this study to build on the strengths the Visitor-Based Learning Framework as an exhibit assessment tool by observing and listening to visitors interacting with each other and with exhibits in zoos and aquaria, with the intention of increasing the framework's validity and applicability across settings. This research investigated two questions: First, how can the Visitor-Based Learning framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention; and second, what is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

A mixed-method, three-phased research design was used in this investigation. Participants in the study were visitors to a science centre, two zoos and two aquaria, during peak summer seasons. Video recordings and field observations were made as visitors engaged with pre-selected exhibits at each of the five research sites and quantitative and qualitative analyses were performed on the data from all three phases of the study. Phase 1 of the study served as a trial of the data collection methods and confirmed the effectiveness of the Visitor-Based Learning Framework in a science centre setting. In Phase 2, the Framework was applied to zoo and aquarium video data

to assess its suitability for assessing learning in these settings. The qualitative analysis of visitors' behaviours and dialogue as they engaged with live animal exhibits was based on a socio-cultural constructivist approach to learning and focused on finding evidence of meaning making. This analysis informed the modifications made to the Visitor-Based Learning Framework and resulted in a revised framework that reflects the learning experience with live animal exhibits in zoo and aquarium settings. In Phase 3 of the study, the reliability, validity and useability of this revised exhibit assessment tool was demonstrated and improved by applying the Revised Visitor-Based Learning Framework to new data, and by field-testing it with test-coders.

In answering Research Question 1, this study identified learning behaviours that are reflective of a visitor learning experience with exhibits that is less physical, involves social and reflective interactions, and is focused on live animals. To answer Research Question 2, the modified descriptors of learning behaviours in the Revised Visitor-Based Learning Framework describe the nature of the learning processes that occur in Initiation, Transition and Breakthrough levels of engagement when visitors experience live animal exhibits in zoos and aquaria. The Revised Visitor-Based Learning Framework provides researchers and zoo and aquarium practitioners with a valuable tool to assess the learning impact of live animal exhibits through observable behavioural indicators. This study's results contribute to our understanding of the impact that live animal exhibits have on visitors in settings like zoos and aquaria. Although research in this field has shown that visits to these institutions on the whole can have an impact on the people's attitudes towards and perceptions of wildlife and conservation, the findings from this study raise important questions about the learning opportunities offered by live animal exhibits. Implications for further research include the potential for the Revised Visitor-Based Learning Framework to assist zoo and aquarium practitioners in improving exhibit learning opportunities, capitalizing on the affective nature of the visitor experience with live animals to scaffold visitor learning and enable Breakthrough levels of engagement. Researchers are encouraged to explore the potential relationship between Breakthrough learning behaviours and conservation awareness.

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Chapter 1
Introduction

"Learning involves change in knowledge and understanding; capabilities and skills; ways of thinking – values, feelings and attitudes; and/or ways of acting – behaviours. It is a lifelong process that occurs in many different environments." (Krishnamurthi & Rennie, 20014, p. 1).

The concept of learning in general, and science learning in particular, is most often associated with the formal education system, conjuring up ideas of teachers, classrooms, and tests. However, over the last three decades there has been a growing interest by learning researchers in the occurrence, contribution and nature of learning outside of the formal education system and its role in the wider science education infrastructure. The role of informal educational institutions, such as science centres, science museums, zoos and aquaria has become prominent in the overarching societal goal of engaging the public in science to enhance the scientific literacy of our citizens (Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003; NRC, 2009; Rennie, 2014; Rennie, Feher, Dierking, & Falk, 2003). Arguably, the importance of science literacy has never been greater. From global environmental and climate change issues to many of the personal lifestyle choices we make in our everyday lives, understanding the science of the situation is essential for making informed and evidence-based decisions. Declining science literacy rates (Miller, 2010; Wyatt & Stolper, 2013) and low enrolment in science degrees have been lamented by many science education professionals (Osborne & Dillon, 2008). Although these trends have put the spotlight on formal education systems, many researchers, academics and experts have been calling for a better understanding of the impact of learning science in informal settings and the role that informal science learning environments can play in improving the levels scientific literacy, and in engaging the public in science and scientific ways of thinking (Falk et al., 2012; NRC, 2009; Stocklmayer, Rennie, & Gilbert, 2010). Consequently, researchers in this field are investigating the impact that visits to science centres, museums, zoos and aquaria have on people's attitudes towards, understanding of, and engagement in science.

1.1 Defining Informal Science Settings

It is now well established that science learning is not confined to the walls of a classroom or the formal education system. The lifelong, continuous learning of science occurs in all manner of informal environments and in many aspects of our everyday lives (Falk & Storksdieck, 2010; Falk, Storksdieck, & Dierking, 2007; NRC, 2009). From television programs and conversations at the dinner table to a science centre visit or an afterschool program, a variety of terms has been used to refer to the type of context where science learning is not dictated by curriculum. For example, the phrases "leisure settings" (Falk & Storksdieck, 2010), "informal learning environments" (NRC, 2009), "free choice settings" (Falk & Dierking, 2000), and "out-of-school settings" (Rennie, 2014; Rennie et al., 2003), all describe a learning context where personal interests and motivation play a significant role in determining the learning experience. The National Research Council's Committee on Learning Science in Informal Environments produced a consensus report in 2009 (NRC, 2009) in which informal science settings are defined as including "learner choice, low consequence assessment, and structures that build on learners' motivations, culture, and competence" and create a "safe, non-threatening, open-ended environment for engaging with science" (NRC, 2009; p. 47). In short, there are important qualitative differences in the learning contexts of informal and formal settings. These differences centre around the degree of choice people have when engaging in learning, including what they engage with and with whom. The focus of the present study will be on the informal science contexts that NRC (2009) refer to as "designed spaces", where visitors choose to engage with science and scientific concepts based on their interests and motivations, specifically science centres or museums, zoos, and aquaria.

1.2 Learning in Science Centres

The interactive, multi-dimensional experience in science centres is non-sequential, and typically involves manipulating exhibit components and engaging in social interactions. Visitors choose to interact with and invest their energy in understanding exhibits that appeal to their interests and motivations and making meaning from those interactions is highly dependent on visitors' prior knowledge and previous experience. The informal and individualized nature of the science centre

experience makes it difficult to assess or measure learning. Methodologies used in formal settings that measure only cognitive gains are not well suited for this environment where people come to experience science at their leisure, based on their interests and needs (Rennie & Johnston, 2004). Assessments of the learning impact of a visit to a science centre need to consider the multiple outcomes of such a visit that are shaped by the sociocultural, personal and physical contexts of that learning experience.

Researchers have been designing studies to capture evidence of the multiple ways that learning occurs in science centres for at least the last 30 years. Early research focused on measuring cognitive gains in scientific knowledge as evidence for learning. For example, Borun, Chambers, and Cleghorn (1996) developed measures of learning based on the learning goals of exhibits and found a strong relationship between learning levels and observable behaviours. Falk, Moussouri, and Dierking (1998) also showed an increase in specific scientific knowledge as a result of interactions with exhibits. However, an improved understanding of the complexities of learning, and the particular learning contexts of informal science environments have led researchers to move beyond assessing cognitive gains as evidence for learning to investigate the affective and social dimensions of visitor learning. For example, in her analysis of visitors' conversations, Allen (2002) found that affective responses (expressions of feelings like pleasure, intrigue/surprise) were common types of "learning talk". Rennie and Johnston (2007a) found that adult visitors reported an increase in their interest in and awareness of science and technology after visiting a science centre. Studies investigating families and other groups in science centres have demonstrated the importance of the sociocultural dimension of learning and many have shown that visitors make meaning of the science in exhibits through dialogue and exchanges based on their shared experiences and knowledge (see Ellenbogen, Luke, & Dierking [2007] for a review).

Visitor engagement has been described as a precursor to learning in science centre settings. Rennie et al. (2003) recommended that understanding learning "requires that the precursors to engagement, as well as engagement itself be investigated" (p. 113). Csikszentmihalyi and Hermanson (1995) had contributed to that understanding by identifying the "flow" experience and the significance of engagement in building meaning from experience in museum settings. Stocklmayer and Gilbert (2002) investigated the effects of a science centre visit on people's

awareness of science and technology, and concluded that "the engagement and subsequent interactions with exhibits.... are determined by the prior experience and understanding of the visitor" (p. 842). Any attempt at describing and understanding the visitor learning experience in science centres needs to consider all of these influences and pre-cursors to learning. Building a framework that captures the visitor learning experience as they engage with exhibits in a science centre setting was the goal of Barriault's (1998) Visitor-Based Learning Framework.

1.2.1 The Visitor-Based Learning Framework

The Visitor-Based Learning Framework (VBLF) (Barriault, 1998) was developed based on observations of visitor interactions with exhibits in science centres and visitor interviews. The Framework was applied and modified as an evaluation tool at Science North (a science centre in Sudbury, Canada), and its current form is found in a recent publication (Barriault & Pearson, 2010). It consists of seven learning behaviours that describe three engagement levels as visitors interact with science exhibits (see Table 1.1). The engagement levels are Initiation, Transition, and Breakthrough. Each of these engagement categories is based on types of behaviours and concrete examples of visitor – exhibit interactions. For example, Breakthrough behaviours are identified as *Referring to Past Experiences*, *Seeking and Sharing Information* and becoming *Engaged and Involved*. Labelling these behaviours as part of the learning process is consistent with the constructivist literature on learning in informal settings (Hein, 1998; Leinhardt, Crowley, & Knutson, 2002; Rennie, 2007) and with the more recent sociocultural perspectives of learning in science centres (Davidsson & Jakobsson, 2012). It is important to note that these learning behaviours and engagement levels are a proxy for learning and an indication of engagement. Together, they serve as an assessment tool that measures the potential learning impact of the exhibits being observed. In other words, the occurrences of learning behaviours indicate that the conditions and opportunities presented by the exhibit are conducive to engaging visitors in a learning experience.

Over the past 10 years, the test framework has been used successfully for assessing the learning impact of exhibits at Science North as well as in several other science centres (Barriault, Pisani, & Henson, 2011; Harkins, 2011; Schliessmann & Ohding, 2009; Visscher & Morrissey, 2010) and it has provided science centre staff with a valuable tool to improve the visitor experience (Barriault, Pink, & Henson,

2011; Harkins, 2011). However, the effectiveness of the tool has not been proven in other informal science environments such as zoos and aquaria.

Table 1. 1 The Engagement Levels and Learning Behaviours of the Visitor-Based Learning Framework Based on Barriault and Pearson (2010).

Engagement Level	Learning Behaviours
Initiation	*1. Doing the activity.* *2. Observing the exhibit or other visitors engaging in the activity.*
Transition	*3. Repeating the activity.* *4. Expressing emotional response in reaction to engaging in the activity.*
Breakthrough	*5. Referring to past experiences while engaging in activity.* *6. Seeking and sharing information.* *7. Being engaged and involved: testing variables, making comparisons, using information gained from activity.*

1.3 Learning in Zoos and Aquaria

The visitor experience in science centres, zoos and aquaria can be described as similar in that these institutions share common goals and missions: engaging visitors in learning about science and the physical and natural world. Zoos and aquaria have an additional goal for their visitors: that they gain a better understanding of issues surrounding wildlife and conservation of the environment in which the animals live (AZA, 2011a). Researchers have examined the impact of zoos and aquaria on visitor perspectives and attitudes towards environmental and conservation issues and have found that visitors tend to question or rethink their current attitudes towards conservation and wildlife as a result of their visit (Briseno-Garzón, Anderson, & Anderson, 2007; Packer, 2004). One of the major findings from a large study published by the Association of Zoos and Aquariums, was that "visits to accredited zoos and aquariums prompt individuals to reconsider their role in environmental problems and conservation action, and see themselves as part of the solution" (Falk, Reinhard, et al., 2007; p. 3) . These authors recommended a variety of assessment methods to AZA members. However, the challenges associated with implementing

complex investigations remain insurmountable for most institutions, yet the need for zoos and aquaria to ascertain whether or not their exhibits promote learning remains of utmost importance. It can be argued that practitioners such as the program and exhibit staff in zoos and aquaria need a more practical way to assess the impact of exhibits and an assessment tool like the VBLF could help fill this need.

The VBLF was devised for use in science centres and, as noted above, works well in assessing the impact of exhibits on visitor learning in that setting. It has not however been tried or tested in zoos and aquaria where the focus of the visitor's attention is on live animals and where the nature of the exhibits is different. Physical interactivity is a typical characteristic of science centre exhibits but it is not common in zoo and aquarium exhibits. Instead, the live organism in its designed habitat is emphasized and accompanying labels point out interesting facts, stories and environmental issues; a contrast with the usual labels in science centres that contain instructions on how to manipulate exhibit components. The visitor experience with zoo and aquarium exhibits consists mainly of observations and conversations with others, but in science centres, visitors interact with objects and may even manipulate variables to affect an outcome. As a result of the nature of these differences in exhibits, it is unlikely that the VBLF in its present form would succeed at assessing the learning impact of exhibits in the zoo or aquarium. However, it is important to ask if there are observable behavioural and conversational indicators of engagement and learning in zoos and aquaria, and if so, whether or not these observable indicators could be incorporated into the existing framework, thus enabling a practical means for assessment of learning in these places. This study will build on the strengths of the VBLF by observing and listening to visitors interacting with each other and with exhibits in zoos and aquaria, with the intention of increasing the framework's validity and applicability across settings. This investigation also intends to provide a broader platform than just science centres for understanding the nature of the learning that occurs when visitors engage in learning behaviours in these settings. While the VBLF currently provides science centre practitioners with an assessment tool that is methodologically rigorous yet feasible to implement, and although its use generates insights into the impact of exhibits on the visitor learning experience, two important questions require investigation:

1. How can the Visitor-Based Learning framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention?
and
2. What is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

1.4 Overview of Research Design and Methods

Answering these research questions requires a three-phased approach to data collection and data analysis. First, before applying and testing the VBLF in different informal science learning settings, it was important to assess the generalizability and validity of the existing VBLF in another science centre, considering that the framework has been mostly applied in one science centre, Science North. Visitors interacting with selected exhibits were video recorded and the video data analysed using the VBLF. A software tool called Studiocode, designed to enable the efficient capturing, coding and analysis of video data, assisted in the analysis of all video data in the study. Its use will be described fully in Chapter 3. In addition to assessing the generalizability and validity of the framework, this first phase served as a trial of the methods and ethical protocols for the data collection procedures to be carried out in the other phases of this research.

The second phase of the research focused on applying the VBLF in a zoo and an aquarium setting (Zoo 1 and Aquarium 1) and the framework was assessed for its suitability as a tool to assess the learning impact of zoo and aquarium exhibits. Video recorded data of visitors at selected live animal exhibits were analysed, and visitor learning behaviours coded using the VBLF, while observations of whether or not the framework reflected the nature of the learning experience in zoos and aquaria were noted. The data analysis revealed that the VBLF did not adequately capture the learning experience in these settings, so the framework was revised and modified, using observational notes and transcripts of dialogue to identify learning behaviours that were not described or captured by the VBLF. These data were analysed using the iterative process of constant comparison described by M. B. Miles and Huberman

(1994) and by Patton (2002) to identify emergent themes of learning behaviours not described and therefore not able to be captured by the VBLF. This analysis guided the development of a revised learning behaviours framework that would more accurately reflect the learning experience in zoos and aquaria. The resulting Revised VBLF completed Phase 2 of this research.

Phase 3 of the research was based on the result of the work in Phase 2. Thus, a Revised VBLF was applied to new video recorded data from two new environments, Zoo 2 and Aquarium 2, and tested for its fit and ability to capture the potential learning impact of zoo and aquarium exhibits. Video data of visitors engaging with selected live animal exhibits was analysed using a revised VBLF to reveal whether or not it effectively captured and accounted for all of the visitor learning behaviours observed. The objective of revising the VBLF was to create a robust, reliable and practical assessment tool for zoo and aquarium practitioners to assess the learning impact of their live animal exhibits. Consequently, it was important to field test the framework using "test-coders" to evaluate its reliability and usability. Results from the test-coders were used to refine the framework and contribute to the production of valid and usable final learning assessment tool appropriate for zoo and aquarium exhibits.

1.5 Significance of this Research

This research is significant for four reasons. First, it is important to the field of informal science learning to better understand the learning processes visitors engage in when interacting with exhibits and the Revised VBLF will assist with this purpose. Through qualitative and quantitative analyses of video data of visitors engaging with exhibits in science centres, zoos and aquaria, observable indicators of learning will be identified and assigned to engagement levels within the exhibit assessment framework.

Second, this study intends to increase the rigor of research and evaluation for understanding and assessing learning across informal science learning settings. Testing the original VBLF in a new science centre setting will demonstrate its reliability and improve its generalizability for use in those settings. Additionally, applying the framework to zoo and aquarium settings will reveal its effectiveness at capturing the visitor learning experience with live animal exhibits and lead to a

revised version that accurately reflects the types of learning behaviours visitors engage in while observing and discussing live animal exhibits.

Third, the results of this study will have implications for zoo and aquarium practitioners by providing them with a practical yet robust methodological framework of behavioural and conversational indicators that makes it relatively easy and affordable to assess the learning impact of their exhibits. This, in turn, will provide them with data that can assist with exhibit evaluation and, if necessary, modification to improve the learning impact of exhibits. A Revised VBLF can provide insights into what visitors are actually doing while they are engaged at a live animal exhibit, while revealing potential gaps in the learning experience provided by the exhibit.

Finally, this research will contribute to the cultivation of a community of practice and to the bridging of the gap between research and practice in this field (Moss & Esson, 2013; Reading & Miller, 2007; Sanford, 2010). Although research in this field has shown that visits to zoos and aquaria on the whole can have an impact on the people's attitudes towards and perceptions of wildlife and conservation, this study's results will contribute to our understanding of the particular impact that live animal exhibits themselves have on a visitor's learning experience.

1.6 Overview of Thesis

In this introductory chapter, relevant research and literature were briefly reviewed to contextualize this study within its field of research. A summary of this study's methodology was described and the significance of this research was presented. In Chapter 2, literature and past research will be reviewed to situate the present study within what is currently known and understood about learning science in informal settings. Previous studies conducted in science centres, zoos and aquaria will also be discussed as they relate to the goals and objectives of the present study. The VBLF (Barriault, 1998; Barriault & Pearson, 2010) will be presented in detail as it forms the basis of this project. This will lead to Chapter 3, the Method section, where the three phases of the research project are described. Attention is given to the research sites, the selection and the descriptions of exhibits and research participants. Details of the data collection and analysis methods are explained, including the rationale for choosing to collect video data for this research and the ethical protocols for this form of data collection. The results for Phase 1 of this research, in which the

VBLF is applied to a science centre setting to assess its reliability and validity and serves as a trial for the data collection methods and ethical protocols, are also presented and discussed.

The focus of Chapter 4 is Phase 2 of the research. Here, the VBLF is applied to video data from a zoo and an aquarium setting (Zoo 1 and Aquarium 1) to assess whether or not the framework's learning behaviours effectively capture the learning experience of visitors engaging with live animal exhibits. The findings from Phase 2 of this research are presented and the implications of these results will be discussed with respect to the suitability of the VBLF to assess the learning impact of zoo and aquarium exhibits. A revised VBLF is proposed based on the findings of Phase 2.

Phase 3 of the research is described in Chapter 5. This includes the application of a revised VBLF to new video data that will have been collected from Zoo 2 and Aquarium 2. As a result of this application, the effectiveness and validity of a revised VBLF at capturing visitor learning with live animal exhibits can be evaluated and discussed. Chapter 6 also includes the findings of having "test coders" use the Revised VBLF to reveal its usability and reliability as a practical exhibit assessment tool. In Chapter 6, the challenges and complexities of using coding software and a coding framework are discussed in relation to the usability and reliability of a revised VBLF as a practical exhibit assessment tool in science centres, zoos and aquaria. In Chapter 7, this study, its research design, methodology and findings are summarized in relation to this investigation's research questions. Furthermore, critical reflections on the study's limitations as well as the implications of the findings for practitioners and researchers are discussed. Concluding remarks are given at the end of Chapter 7.

Chapter 2
Literature Review

In this chapter, informal science learning settings are defined and the existing literature on the nature, contexts and significance of learning in informal science settings, as well as the variety of methods used in assessing learning in these settings, are reviewed. The particular characteristics of science centres and the goals and uses of the VBLF in assessing the learning impact of exhibits in science centres will also be discussed. The differences between the science centre visitor experience and the zoo or aquarium visitor experience are highlighted. Following a review of the literature on the learning impact of zoos and aquaria, the chapter concludes with the identification of the research needs of this field, and this present study's research questions.

2.1 Learning in Informal Science Settings

Early research into learning in informal science settings often led to disappointing findings with little evidence that learning occurred in these environments (R. Miles & Tout, 1992). However, the theoretical underpinnings and methodologies of these studies were rooted in traditional or behaviourist definitions of learning and focused primarily on assessing cognitive gains made by visitors as a result of their visit (R. Miles & Tout, 1992). In the 1990's, researchers began to call for a broader understanding of learning, suggesting that learning experiences in general, and in informal environments in particular, were more complex than those reflected by the behaviourist paradigm and required new theoretical assumptions about learning (Falk, 2007). In particular, constructivist and socio-cultural theories were seen as more relevant and reflective of the free choice learning experience of visitors in science museums, zoos and aquaria (Falk, 2007), since learning in settings such as these is highly personalized, socially constructed and appeals to visitors' motivations, interests, previous experience and prior knowledge. Many researchers have studied learning in informal science settings and there is general agreement that the context is very different to the learning context that occurs within more traditional school environments or formal education (see for example: Anderson, Storksdieck, & Spock, 2007; Bell, Bricker, Tzou, Lee, & Van Horne, 2012; Bell et al., 2009; Falk &

Dierking, 2000; Hein, 1998, Rennie, 2007; Rennie & Johnston, 2004; 2007b). In the following sections, the constructivist and socio-cultural theoretical approaches to learning will be discussed in relation to learning in informal science environments. The important and relevant contexts that influence learning in free choice science settings, such as the personal, socio-cultural and physical contexts of learning, and the cumulative, longitudinal nature of learning will also be examined to illustrate the current understanding of learning in this field.

2.1.1 Constructivist and Socio-Cultural Perspectives

The highly personalized and voluntary nature of the learning experience in informal settings has compelled researchers to examine learning through different theoretical lenses. A shift in the theoretical perspectives of science education researchers occurred in the 1990's from primarily behaviourist approaches to constructivist ideas and conceptual frameworks for understanding and describing learning (St. John & Perry, 1993). It is now well accepted by learning psychologists and informal science education researchers that people are not the passive recipients of knowledge but are in fact, active learners who make meaning from their interactions with their environment by building on their past experiences and prior knowledge (Dierking et al., 2003; Hein, 1998; Rennie & Johnston, 2004). Well-rooted in the Piagetian tradition of active exploration to learn, and greatly influenced by Vygotsky's socio-cultural theory (Dierking, 1996; Russell, 1999), constructivism and socio-cultural theories have become the primary theoretical traditions applied to understanding science learning in out-of-school settings. In her review of research over the 10 year period from 1997 to 2007, Phipps (2010) noted that 48% of the studies drew on constructivist theories and that 54% identified sociocultural perspectives as conceptual frameworks. From a constructivist perspective, learning is described as making meaning from our experiences through social interactions, references to prior knowledge and experiences, motivation and personal interests (Hein, 1998). Thus, learning in informal environments is best captured and described by constructivist-based theoretical frameworks and research over the last few decades has shown that free-choice, personal interests, motivation, prior knowledge, past experience (Stocklmayer & Gilbert, 2002), social interactions and personal background (Siegel, Esterly, Callanan, Wright, & Navarro, 2007), all play important roles in meaning making during visits to informal institutions. Studies that have

highlighted these influences on learning in informal environments will be explored further in the following sections. This understanding of learning has implications for the methods used to assess learning in informal settings and those implications will be discussed later in the chapter.

2.1.2 Free Choice and the Contextual Model of Learning

The term "free-choice science learning" was conceived and promoted by John Falk and Lynn Dierking to address the implication that learning within an informal setting is somehow a different process solely as a function of the physical space (Falk, 2001). Thus, "free choice science learning" is meant to reflect the unique characteristics of the learning that traditionally occurs outside of school, that is "non-sequential, self-paced and voluntary" and to recognize "the socially constructed nature of learning – the interchange that goes on between the individuals and his or her socio-cultural *and* physical environment" (Falk, 2001; p. 3, original emphasis). Falk (2001) also argues that the more neutral term "free choice" does not evoke negative or positive values towards schooling as use of the term "informal" may.

This definition of free choice science learning carries with it the theoretical underpinnings of the constructivist and socio-cultural approaches to learning, which align with the goals of researchers investigating learning in informal science environments. Falk and Dierking (1992, 2000, 2013) are also the creators of the "Contextual Model of Learning" (CML) which describes the complexities of learning in informal environments in a framework that reminds us of the factors that affect learning. The CML identifies three overlapping contexts, the personal, socio-cultural, and physical contexts, that influence a visitor's learning experience in museum settings and conceptualizes learning as the integration and interaction of these three contexts over time Falk and Dierking (2000, 2013). This theoretical framework has been widely adopted and considered by many as a seminal work in understanding the factors associated with the learning that occurs in informal settings (Rennie, 2014). The CML is a useful framework that can be used to explore the nature of learning in informal science environments.

2.1.3 Personalized Learning

According to constructivism, making meaning from experience is the foundation of the process of learning. Learning is highly personalized and relies on

prior knowledge and prior experience to build new knowledge (Hein, 1998; Roschelle, 1995). In free choice learning environments, making connections to previous knowledge and past experiences enables visitors to incorporate new information into their existing schemas, essentially constructing their own understanding of their experience (Roschelle, 1995). The important role of prior knowledge and experience in learning science is especially appreciated and discussed in science education where building on one's understanding is crucial in forming new science concepts (Scott, Asoko, & Leach, 2007; Stocklmayer & Gilbert, 2002). Visitors in a zoo, aquarium or science centre, will inevitably make meaning of an interaction with an exhibit by drawing on their personal life experience and on their pre-existing knowledge. Sometimes referred to as a 'hook' or a 'point of entry' in exhibit design, informal science educators and designers appeal to this prior knowledge and previous experience to help visitors build their understanding of an exhibit's science concepts (Allen, 2004).

A visitor's choice to engage with, and perhaps learn from, available educational opportunities in a science centre, zoo or aquarium depends on a variety of personal characteristics such as motivation, personal interests, and level of cognitive development Falk and Dierking (2000, 2013). Thus, visitors will each have a unique learning experience within the informal science institution and will construct his or her own meaning based on their individual engagement patterns with those learning opportunities (Rennie & Johnston, 2007b). Motivation and personal interests are related to emotion, or the affective domain, and greatly influence learning in informal contexts. Czsikszentmihalyi and Hermanson (1995) refer to the influence that intrinsic motivation has on learning in informal science environments because visitors are free to choose learning experiences that reward them with feelings of enjoyment and pleasure. A person's motivation for engaging with a particular informal science institution or exhibit is driven by their personal interest in the topic being conveyed by that exhibit (Falk & Dierking, 2000; Rennie, 2007). Referring again to Falk and Dierking's CML, their discussion of the personal context reminds researchers of the influence of motivation, interest and affect on learning in these settings. Recently, Falk (2006, 2009) proposed identity-related motivations for attending science museums and other similar institutions suggesting that these also play a role in the learning experience of visitors. Several studies have applied the identity-related motivation survey and have shown a relationship between identity-related motivations

and learning in informal settings (Falk & Storksdieck, 2010; Rowe & Nickels, 2011; Storksdieck & Stein, 2007).

2.1.4 Socio-Cultural Context of Learning

Science centres, zoos and aquaria are social places where families and social groups gather to have an educational or entertaining experience, or a mixture of the two (Packer, 2004). Parents in particular have educational goals in mind when taking their children to informal science environments and often play a facilitator role in the learning experience of their children (Szechter & Carey, 2009). It is now well understood and widely accepted that learning is a social activity and takes place within a socio-cultural context (for comprehensive discussion see Astor-Jack, Kiehl Whaley, Dierking, Perry, & Garibay [2007] and Martin [2007]). In the last decade, researchers in the field of informal science learning have focused much attention on understanding the influence of social and cultural contexts on learning in free choice settings (Davidsson & Jakobsson, 2012; Ellenbogen et al., 2007). The work of Vygotsky (1978) laid the foundation for understanding learning as mediated and influenced by cultural and social contexts and, as of the late 90's, researchers have recognized the suitability of socio-cultural theory for learning in informal environments.

Visitors make meaning of their experiences through conversations and dialogue with staff, family members, friends and other visitors. These social interactions enable visitors to build new knowledge based on their shared language, values, beliefs and experiences (Ellenbogen et al., 2007). There is now an extensive body of literature on family learning in informal science environments and the research has revealed how, through conversations, families construct meaning together by using shared knowledge and experiences (Ash, 2003; Briseno-Garzón et al., 2007; Crowley et al., 2001). More recently, Rowe and Kisel (2012) analysed video data of families interacting at a touch tank in an aquarium setting. They found that families engaged in scientific reasoning through their conversations and their actions as a social group. Docents or explainers in informal settings can contribute to the social context of a visitor's learning experience by engaging visitors in dialogue, scaffolding on visitors' prior knowledge and experience to help them make meaning of their interactions with exhibits, even though research has shown that explainers frequently miss opportunities to do so (Kisiel, Rowe, Vartabedian, & Kopczak, 2012).

Furthermore, exhibit characteristics that encourage social interaction among visitors have been shown to engage visitors in learning activities more so than exhibits that do not (Gutwill & Allen, 2010; Tisdal & Perry, 2004).

2.1.5 The Physical Environment

Learning is contextualized not only within one's personal and socio-cultural contexts, but learning takes place somewhere. The physical context influences how or the extent to which learning occurs (Falk & Dierking, 2000; 2013). Science centres, zoos and aquaria provide safe, comfortable and stimulating physical environments that contribute to the potential for learning (NRC, 2009). Exhibit designers, landscape architects, and informal science education practitioners have long taken into consideration the impact that the physical characteristics of an environment have on visitor engagement. From way-finding signs to exhibit labels and from lighting to seating (McLean, 1993), effective use of these physical elements of the free choice learning environment ensures that visitors are not left frustrated, tired and without the energy to engage fully in the learning opportunities offered by the venue (Serrell, 2006). A recent example can be found in a study by Ross, Melber, Gillespie and Lukas (2012), whose research showed that visitors spent more time in a naturalistic zoo setting and moved more slowly through the space that in more traditional structures at a zoo. The amount of time spent paying attention to exhibits is often used as a proxy for assessing learning (Serrell, 2010), thus comfortable physical environments influence how visitors take advantage of learning opportunities in informal science settings.

2.1.6 Learning is Cumulative and Takes Time

As researchers have unravelled and described the processes of learning, it has become clear that learning takes time. People need time to draw connections with their past experiences and prior knowledge to make meaning of new experiences (Falk & Dierking, 2013; Rennie, 2014; Stocklmayer & Gilbert, 2002). Science centre visitors may, for example, connect their experience with a stem cell exhibit with a news item they see weeks after their visit, which in turn may trigger a greater interest and motivation to learn more about stem cell science. Measures of learning in informal settings immediately following a visit often reveal few "new" cognitive gains because of the lifelong nature of learning but some studies have shown strong

indications that visits to informal science institutions reinforce or extend visitors' current knowledge as they choose to engage with what they find personally relevant (Falk & Needham, 2010; Rennie & Williams, 2006). As suggested by Rennie (2014), studies such as these highlight "the importance of these places in continuing the process of lifelong learning for adults" (p. 498).

2.2 Science Centres

Science centres are characterized by their interactive, hands-on exhibits which differentiate them from the traditionally more passive museum whose primary mission is conservation of artefacts. Many traditional science museums in the United States and Europe have incorporated interactive exhibits and engaging visitor experiences, such as those found in science centres, and although some make the distinction between a science museum and science centre, most researchers and authors use the terms interchangeably to mean the same type of visitor experience. It is generally agreed that the first science centres, the Exploratorium in San Francisco in 1969 and the Ontario Science Centre, also in 1969, grew out of great social and political need to improve the science literacy of the general population, and of school children (Friedman, 2010). The exponential growth and success of science centres since then is testament not only to the popularity of the hands-on experiences they offer, but also, some would say, to the vital role they play in the broader infrastructure of free-choice science education (Falk & Needham, 2010; Lewenstein, 2001).

The Association of Science and Technology Centres offers this description for science centres and their mission:

> **Furthering public understanding of science through experiential learning** *is at the heart of the science center mission. Science centers offer rich resources for lifelong learning, providing meeting places for citizens and the research community, supporting schools, and contributing to the cultural and economic vitality of their communities.* (ASTC, 2014, original emphasis)

As part of a Wellcome Trust report, Lloyd, Neilson, King and Dyball (2012) identified the common themes in the mission statements of science centres from the United Kingdom and these included: "make science more enjoyable and interesting

for audiences", "inspiring a general interest in and engagement with science", "inspiring participants to find out more about science", "informing audiences about science/helping increase understanding", "changing participants' attitudes to science" and "raising awareness of STEM issues and the importance of science" (Lloyd et al., 2012, p. 18) . During successive Science Centre World Congresses (SCWC, 2008, 2011, 2014), leaders of science centres from around the globe developed Declarations which represent a consensus view of the goals and vision for science centres and their audiences. Common themes across the Toronto, Cape Town and Mechelen Declarations are: the importance for science centres to continue developing the most effective methods for engaging diverse audiences with science and technology; enabling learners to become engaged with scientists and current research; and empowering people through raised awareness of the impact of science and technology in their everyday lives and local communities.

Science centres are places within communities that can build a sense of belonging and engage their citizens in exploring the wonders of science in a non-threatening environment. Alan Nursall (2006), former Science Director at Science North in Sudbury, Ontario, Canada, has compared the role of the science centre in a community to that of the ice hockey arena, a metaphor particularly relevant for Canadians. Ice hockey is the national sport and every community in the country has a hockey arena, not because Canadians all aspire to become professional hockey players, but because it is embedded in the leisure time and the culture of Canadian communities. The hockey arena stands as a testament to the importance of hockey in our collective social and cultural identities. Nursall (2006) argues that a science centre in a community plays a similar role by conveying the message that science contributes to and is part of the social and cultural fabric of that community. He posits that most visitors are not visiting a science centre to become scientists, but to enjoy, explore and have fun with the concepts, discoveries and processes of science.

2.2.1 Assessing the impact of science centres

Research looking at the impact of science centres in their communities is contributing to our understanding of the role they play in building a science culture. For example, in their comprehensive longitudinal study involving the California Science Center, Falk and Needham (2010) found that 45% of the adults in the of Los Angeles, California community had visited the science centre since 1998 and that, by

extrapolating this finding to include children, it is likely that 60% of the residents of L.A. have visited. Furthermore, the results from this study strongly suggest that the California Science Center has had a direct and significant impact on the "science learning, interests, and behaviours of a large subset of the L.A. community" (Falk & Needham, 2010, p. 11). Although, as pointed out in recent discussions (Anderson et al., 2007; Rennie, 2014), most research focused on the learning impacts of science centres is not longitudinal and despite the challenges that come with investigating learning in informal settings (Brody, Bangert, & Dillon, 2007; Dierking et al., 2003; Rennie & Johnston, 2007b) there is a growing body of evidence showing that visitors to science centres and museums do indeed learn and that these interactive learning settings have a prominent place in the world of informal science education (NRC, 2009; Rennie, 2014) .

2.2.2 Assessing the Learning Impact of Science Centre Exhibits

For many years, measuring visitors' learning that resulted from interactions with hands-on exhibits was done through pre-post tests of factual knowledge, that is, the content intended by the designers of the exhibits (Stocklmayer & Gilbert, 2002). The limitations of these methods at capturing the complexities of learning have since been acknowledged in appreciation of the variety of learning outcomes resulting from interacting with science exhibits (Stocklmayer & Gilbert, 2002). Researchers have looked for evidence of learning through observations of visitor behaviours and used proxies such as approaching an exhibit, time spent interacting with the exhibit, and reading labels as indicators of visitor learning (Boisvert & Slez, 1995; Serrell, 1997). These learning-associated behaviours have been shown to correspond to higher levels of information recall about exhibits and exhibit content (Boisvert & Slez, 1995; Serrell, 1997). Based on a meta-analysis of many studies, Serrell (2010) has suggested that "spending more time overall, talking about exhibits and reading texts aloud to each other are three highly predictive behaviours for learning in exhibitions" (p. 2). In a study examining family learning in science museums, Borun, Chambers and Cleghorn (1996) developed more specific learning-related behaviours based on the learning goals of exhibits in the study. These researchers found that levels of learning increased when families engaged in asking or answering a question, commenting on or explaining the exhibit, and reading the text silently or aloud (Borun et al., 1996).

Researchers have also explored the relationship between exhibit design and visitor learning behaviours, showing that characteristics such as small, highly interactive exhibits with opportunities for social interaction are more likely to engage visitors for longer periods of time (Boisvert & Slez, 1995; Borun & Dritsas, 1997). Other researchers, like Sandifer (2003), showed that open-ended exhibits with technological novelty increased the amount of time visitors spent engaged with an exhibit. Allen (2004) proposed essential design characteristics, such as immediate apprehendability, physical interactivity, conceptual coherence and diversity of learning needs, to ensure maximum learning opportunities for the visitor. Research at the Exploratorium in San Francisco often focused on observable visitor behaviours to measure the impact of different exhibit characteristics and styles on visitor learning (Gutwill & Allen, 2002; Gutwill & Humphrey, 2005). The important role of signage on the learning impact of exhibits has also been demonstrated (Gutwill, 2007; Hohenstein & Tran, 2007; McManus, 1987).

Observing visitors' behaviours as a methodology to understand visitor learning has evolved over the years to include more in-depth analysis of visitor conversations. For example, in her analysis of visitor conversations, Allen (2002) described "perceptual talk" as a significant part of the learning process. She identified this perceptual talk as: identification, naming, pointing out a feature, and quoting from a label. Of particular interest for the present study, Allen's (2002) investigation focused on visitor conversations as they interacted the *Frogs* exhibition which included 23 terrariums of live frogs and toads. Allen (2002) found that exhibits containing live animals evoked more learning-talk (conversations showing evidence of learning) than the physically interactive exhibits. Leinhardt and Knutson (2004) described effective learning conversations in museums as including listing or identifying features, analysis (trying to figure out how the features work), synthesis (using features beyond the exhibit and immediate environment to understand their current experience) and explanation (using examples from personal experience or causal examples to understand the current experience with the exhibit). Leinhardt et al. (2002) devoted an entire book to exploring conversations to better understand learning in museums. More recently, Atkins, Velez, Goudy, and Dunbar (2009) analysed observational data and visitor conversations to study the impact of different types of exhibit labels on visitor learning. The researchers found that exhibit labels and associated materials dramatically influenced the kinds of activities and patterns of

conversations families engaged in while interacting with the exhibit. Researchers agree that analysing conversations is an effective means of assessing meaning making in families and it is widely used in family learning research (Ellenbogen et al., 2007).

Sanford (2010) refers to the work of Leinhardt and Knutson (2004) in her literature review and points out that, although conversational data contributes beyond what observation alone can obtain, collecting it is a resource and effort intensive method. Sanford (2010) also argued that combining data collection methods could lead to a more in-depth understanding of learning in informal science settings. Thus, her investigation of family learning and exhibit characteristics combined three methods of inquiry; the frequently used learning indicators of time spent at an exhibit, exhibit engagement, and interpretive talk. Her conclusions suggested that used independently, assessments of time spent, engagement, and interpretative talk, are limited in what they reveal about the learning experience at interactive exhibits but that together, these indicators reveal a more complete picture of family learning. Sanford (2010) also demonstrated how looking at all three indicators might help evaluators think about "how exhibit characteristics can influence the potential learning opportunities in informal settings" (p. 67). Of particular relevance for the present research, Sanford (2010) defined engagement as "the extent to which the family used the exhibit as the designer had intended" (p. 73) and used three engagement levels to reflect the degree of engagement.

Sanford's (2010) study contributed to the development of useful learning assessment tools in this field and responded to calls for documenting diverse methodological approaches to the evaluation of learning in informal science settings (NRC, 2009). Understanding the visitor learning experience and developing a practical assessment tool for science centre practitioners were goals identified by Barriault (1998) and led to the development of the VBLF (Barriault & Pearson, 2010) which is described in the following section.

2.2.3 Visitor-Based Learning Framework in Science Centres

In 1998, the VBLF was developed to investigate the science centre learning experience from a visitor's point of view. Most of the literature on visitor learning in science centres at the time was based in museum research or focused primarily on the learning goals set out by exhibit designers (Barriault, 1998). Due to the personal and individualized nature of the visitor learning experience, Barriault (1998) employed

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qualitative and naturalistic methodologies, such as observations and open-ended interviews, to better document and analyse how visitors learned as they interacted with science centre exhibits. The qualitative observational and interview data were analysed in conjunction with data collection in a continuous, iterative process to reduce, code and refine the data. This successively evolving interpretation of data allowed categories and sub-categories to emerge from observed patterns of behaviour, leading to the identification of learning-associated behaviours and clusters of behaviours that reflected increased levels of engagement (Barriault, 1998). The investigation resulted in an initial framework that identified seven discrete learning behaviours arranged in three "depth of learning" categories that reflect the level of engagement involved in the experience (Barriault, 1998, p. 42). These categories were labelled "Initiation", "Transition" and "Breakthrough" (Barriault, 1998, p. 42) to capture the levels of meaningful interaction indicated by the learning behaviours. Although the learning behaviours did not always occur sequentially, the levels of engagement grouped the behaviours in a sequential pattern that suggested increasing cognitive involvement on the part of the visitor. The data also revealed that a rich learning experience with an interactive exhibit would include many, if not most, of the framework's learning behaviours (Barriault, 1998). In the following paragraphs these engagement levels and the learning behaviours within them are briefly described to provide context for the present study.

Initiation

The Initiation level of engagement describes the first two kinds of learning behaviours visitors engage in when encountering a science centre exhibit: *Doing the Activity* and *Spending Time Watching Others Engaging in Activity*. Whether they turn a handle, pick up a ball or dig in sand, *Doing the Activity* quickly, in passing, or completely and thoroughly, visitors are taking the first steps towards a meaningful learning experience. At this basic level of engagement, visitors use the exhibit as it was intended, or observe someone else interact with the exhibit, and discover the outcomes of those actions. When visitors engage in *Initiation* learning behaviours, they are making quick or in-depth judgements about whether or not the exhibit appeals to their personal interests and motivations, or to the interests of others in their group. Visitors may not yet be committed to become deeply involved in the learning

experience, but initiation activities provide the entry point to explore further learning opportunities presented by the exhibit.

Transition

The Transition level of engagement groups together behaviours that indicate the visitor is becoming more involved and more committed to the learning experience presented by the exhibit. Visitors may be *Repeating the Activity* to master the exhibit's function or out of curiosity, motivation and interest to see the outcome of the action again. Visitors *Expressing Positive Emotional Response,* through smiles, verbal outbursts or laughter as they interact with an exhibit, are engaging affectively, an important part of the process of learning. In essence, visitors in *Transition* level activities are learning through repeating their actions, expressing positive emotions and demonstrating some eagerness and motivation to further engage in the learning opportunities offered by the exhibit.

Breakthrough

The learning behaviours in the Breakthrough engagement level reflect a deeper, more involved experience, one in which the visitor is interested, motivated and takes full advantage of an exhibit's learning opportunities. It becomes evident at this level of engagement that the visitor is committed to a meaningful learning experience. The first learning behaviour in the Breakthrough level of engagement is *Referring to Past Experiences while Engaging in the Activity*. This describes the visitor who makes meaning of his or her interaction with an exhibit through relevant prior knowledge, experiences and contexts. Some visitors may make observations of similarities and differences between new information and previous knowledge. Others may make a connection to real life experiences while interacting with an exhibit. *Seeking and Sharing Information with Others* is the second learning behaviour within the Breakthrough level of engagement. It reflects the social dimension of the learning experience during which visitors exchange ideas with each other, ask questions or share experiences and knowledge to make meaning of an exhibit's content. Family groups or groups of friends build meaning together through their shared experiences and culture. Others may engage in seeking and sharing knowledge with the science centre's staff or others around them. The *Engaged and Involved* learning behaviour reflects a visitor's active construction of meaning through inquisitive and exploratory actions such as experimenting, testing different variables, hypothesizing and looking

for various outcomes. Visitors who are *Engaged and Involved* are highly motivated and intellectually involved with the learning opportunities of the exhibit.

The Initiation, Transition and Breakthrough levels of engagement were developed empirically, based in observational and interview data from science centres. They grouped clusters of learning behaviours that reflect an increasing level of visitor engagement and, as a result, an increasing depth of learning experience. Consequently, the framework was positioned by Barriault (1998) as an effective assessment tool for science centre practitioners to evaluate the potential impact of exhibits on visitor learning. The VBLF was successfully applied as an exhibit evaluation tool at Science North, a science centre in Ontario, Canada over several years (Barriault & Kneller, 2004; Waltenbury, 2005), and became instrumental in providing science centre staff with evidence of the learning impact of exhibits. By observing and coding visitor behaviours as they interacted with exhibits, staff determined whether or not an exhibit elicited Breakthrough levels of engagement. Low levels of Breakthrough learning behaviours for an exhibit revealed that improvements were needed. For example, in two internal studies by Barriault and Kneller (2004) and Waltenbury (2005), some exhibits in the Human Machine temporary exhibition performed poorly by engaging less than 20% of visitors in Breakthrough learning behaviours. Recommendations for exhibit improvements were made to increase the exhibits' learning opportunities (Barriault & Kneller, 2004). These recommendations were taken into consideration when the Human Machine exhibition was relocated in the science centre as a permanent installation called The Body Zone. Some of the exhibit changes resulted in more visitors engaging in Breakthrough behaviours (Waltenbury, 2005).

As a result of its use in the science centre, the framework was refined and elaborated to create a comprehensive model, aimed at assisting science centre practitioners in assessing and improving the potential learning impact of exhibits. Barriault and Pearson (2010) introduced the Visitor Engagement and Exhibit Assessment Model (VEEAM) as a tool to evaluate the potential impact of exhibits on visitor learning. Their paper extended the framework into a relational model that describes and predicts relationships between exhibits, visitors and observable learning behaviours in science centres. The VBLF from Barriault and Pearson (2010) is found in Table 2.1 and the VEEAM is shown in Figure 2.1. The VEEAM includes the framework of observable learning behaviours and the arrangement of those behaviours into learning related categories (Table 2.1, represented by section 2 in

Figure 2.1), a visual representation of the level of engagement elicited by an exhibit (Visitor Engagement Profile, section 3 in Figure 2.1), and indicates relationships where intervention might increase visitor engagement with an exhibit (Experience Modification, section 4 in Figure 2.1). The practical application of this model in the science centre setting has empowered program and exhibit staff at Science North, encouraging a culture of evaluation and research and providing a valuable feedback loop to improve the visitor experience (Barriault, Pink, et al., 2011). A strong research program at the science centre, based on the use of the VBLF, has produced evaluation reports for most of their large exhibitions (one example can be found in Barriault, Pisani, & Henson, 2011). Other researchers and science centre practitioners have also used the framework to evaluate the learning impact of exhibits and to train their staff in identifying visitor learning behaviours (Harkins, 2011; Schliessmann & Ohding, 2009; Visscher & Morrissey, 2010).

The value of the VBLF is embedded in its attention to visitor engagement. By grouping observable learning behaviours into levels that indicate increasing levels of engagement, the framework reflects what some researchers argue is an important precursor to learning: engagement. As early as 1995, Csikszentmihalyi and Hermanson emphasized the significance of engagement in the learning process. More recently, Stocklmayer and Gilbert (2002) found that visitor engagement and interactions with exhibits were determined by visitors' prior knowledge and understanding and concluded that "the engagement of the individual is key" (p. 856). In her most recent review on science learning in informal settings, Rennie (2014) suggested that "if exhibit(ion)s are to be designed to promote learning, they must provoke engagement from visitors; a two-way dialogue that can communicate the science story desired to be told" (p. 125). The VBLF captures visitor engagement by identifying learning behaviours that become increasingly involved, suggesting that the visitor is establishing a meaningful connection to the experience offered by the exhibit. The VBLF reflects many of the conceptualizations of science learning described by the Committee on Learning Science in Informal Environments as Strands of Informal Science Learning (NRC, 2009). For example, Strand 1: Developing Interest in Science, describes learners in informal science environments as experiencing "excitement, interest, and motivation to learn about phenomena in the natural and physical world" (p.43). The behaviours described in Transition and Breakthrough levels of engagement capture the NRC's (2009) conceptualization of

Strand 1. Breakthrough levels of engagement and the associated learning behaviours reflect higher, more complex social, affective and cognitive dimensions of the learning process. Strand 3 of the NRC (2009) addresses a conceptualization of learning that is Engaging in Scientific Reasoning, which also describes this more complex dimension of learning and includes asking and answering questions, manipulating, testing, exploring and predicting.

These Breakthrough levels of engagement are more desirable because they indicate a more committed visitor who is engaged in a learning experience with an exhibit. It is important to recognize however, that not all exhibits are designed to elicit Breakthrough engagement, nor should they be (Barriault & Pearson, 2010). In addition to exhibits designed specifically for interaction and high engagement, an exhibition or a floor of conceptually coherent exhibits is also likely to offer exhibits that simply pique visitors' interest or entice them because they are simply beautiful to look at!

The VBLF has been successful in the science centre setting at capturing visitor learning behaviours as they engage physically with interactive exhibits, in groups, with families or on their own. In 2010, Science North's researchers applied the framework to evaluate the learning impact of live animal exhibits before and after a large renewal project (Barriault & Pink, 2011). The learning behaviours of the VBLF were modified slightly to account for the difference in the nature of visitor experience with live animal exhibits versus with typical interactive science centre exhibits. Although the evaluation proved to be very useful for the science centre, it was concluded the learning behaviours and descriptions of visitor activity in the framework did not accurately reflect or fully capture the visitors' learning experience with live animal exhibits (K. Pisani & A. Henson, personal communication, December 15, 2011) . This is not surprising given that the framework is rooted in science centre data, and that an interaction with a live animal exhibit does not typically involve any physical interactivity or manipulation of exhibit elements. Similarly, the visitor experience in zoos and aquaria centres on live organisms and their designed habitats, and assessing the learning impact of such exhibits requires a more careful examination of that visitor experience.

Table 2.1 The Visitor-Based Learning Framework from Barriault and Pearson (2010).

Engagement Levels and Learning Behaviours	Types of Activity
Initiation	
1. Doing the Activity	• In passing, not done completely; • Doing the activity somewhat completely; • Doing the activity completely without further exploration or testing variables.
2. Spending time watching others engaging in activity or observing the exhibit	• Looking at the exhibit working, or someone doing the activity; • Watching the exhibit or person using exhibit with expressed interest in the activity; • Interested in learning outcome or in learning the activity; visitor does the activity after observing.
Transition	
3. Repeating the activity	• Doing the activity two to three times to attain desired outcome, to master exhibit's function; • Enjoyment of the outcome; • Changing the variables once looking for a difference in outcome, becoming engaged and involved.
4. Expressing positive emotional response in reaction to engaging in activity	• Smiling, pleased with exhibit; • Stronger signs of enjoyment such as laughter, verbal reference to enjoyment; • Obvious signs of eagerness to participate, excited disposition.
Breakthrough	
5. Referring to past experiences while engaging in the activity	• Reference to past experience with exhibit or science centre; • Simple reference to comparable experience in visitor's life; • Reference to comparable experience in their life as well as making comparisons an deductions based on observations of similarities and differences.
6. Seeking and sharing information	• Calling someone over to look at exhibit, or to ask them to explain an exhibit, asking questions to staff or family member without lengthy discussion or exploration of topic; • Reading signage, having conversations about exhibit and related science with staff or family member/friend; • Sharing experience with others by explaining the exhibit to them, giving them details about gained information and observations; discussions and staff or family member/ friend.
7. Engaged and Involved: Testing variables, making comparisons, using information gained from activity	• Engaging in inquisitive behaviour, exploratory actions such as repeating the activity several times, reading signage, asking questions; remaining on task for 2-3 minutes • Concentration and motivation are obvious; doing the activity as a means to an end, or meeting a challenge; length of interaction significant, 3 to 5 minutes; outcome or result of activity important; • Experimenting, testing different variables, looking for different outcomes; engages in discussion with others (visitors or staff) about the various outcomes; experience "flow"; involved in activity for long period of time ie. more than 5 minutes.
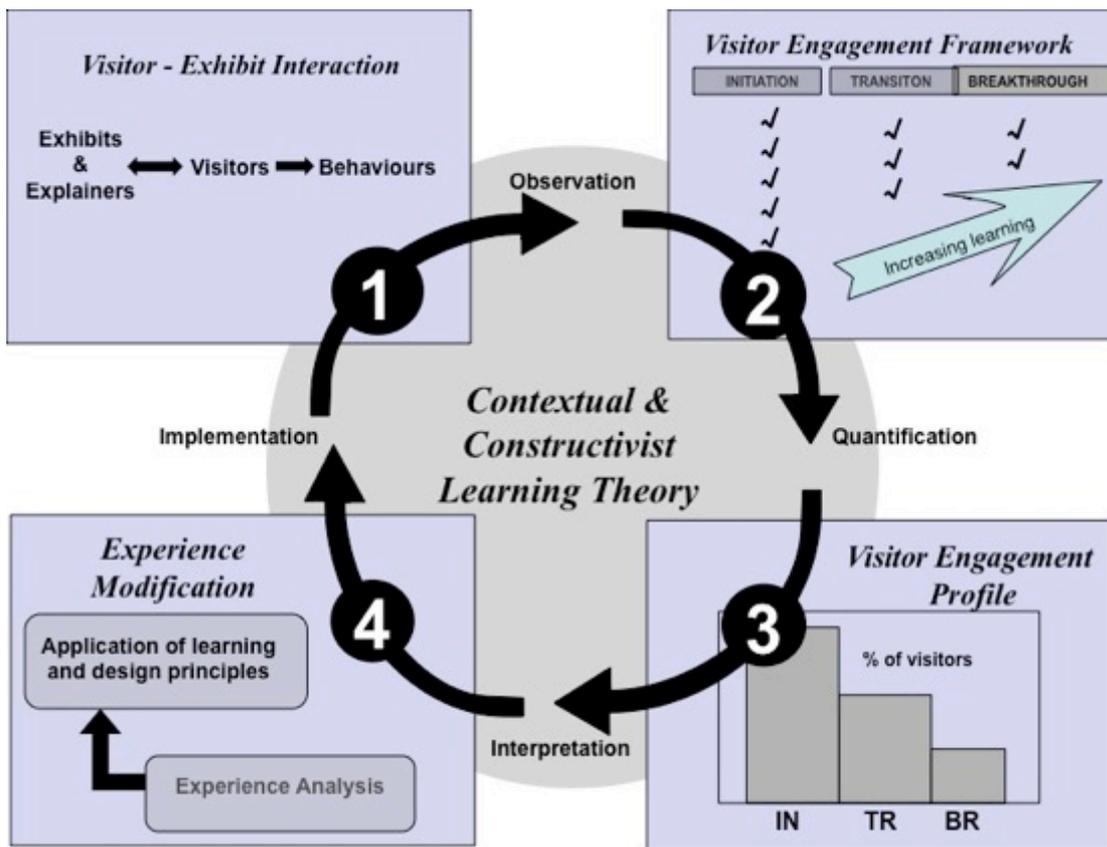
Figure 2.1 The Visitor Engagement and Exhibit Assessment Model based on Barriault & Pearson (2010).

2.3 Zoos and Aquaria

The environments of zoos and aquaria are an important kind of informal science learning setting available to the public (Clayton, Fraser, & Saunders, 2009; Jensen, 2014; Lindemann-Matthies & Kamer, 2006; NRC, 2009; Packer & Ballantyne, 2010; Rennie, 2014). Science centres, zoos and aquaria share common goals and missions of engaging visitors in learning about science and the physical and natural world. Zoos and aquaria have the additional goal of helping their visitors gain a better understanding and appreciation of issues surrounding wildlife and conservation (AZA, 2011a). In their vision statement for zoos and aquaria, The World Zoo and Aquarium Conservation Strategy includes: "The educational role of zoos and aquariums will be socially, environmentally and culturally relevant, and by influencing people's behaviour and values, education will be seen as an important conservation activity" (World Association of Zoos and Aquariums, 2005, p. 35). Of particular importance in

the context of the present research are the differences in the visitor experience between zoos or aquaria and science centres. The exhibits in zoos and aquaria focus primarily on living organisms, from insects, plants and birds, to large mammals and fish, in habitats that closely resemble where they are found in nature. Hands-on exhibits are much less common in these institutions and this differentiates the nature of the learning experience from that of a typical science centre visit.

The appeal of zoos and aquaria is well documented in the literature (Frost, 2011) and is supported by the large number of people who visit them each year. The Association of Zoos and Aquariums (AZA, 2014) estimates that over 175 million people visit zoos and aquaria across North America annually, and Australian adults visit zoos at similar levels as libraries and major sports events (Crilley, 2011). Despite their popularity, zoos and aquaria can be seen as controversial because of the nature of their collections, live animals. Many people, including high profile conservationist Jane Goodall (CBCNews, 2014), special interest and advocacy groups, strongly believe that as a society, we should no longer be holding animals in captivity for the entertainment pleasure of humans, or for the breeding programs (Hutchins, 2007). Advocates, staff and leaders of zoos and aquaria, however, strongly argue for the educational and conservation value of these institutions (Adelman, Falk, & James, 2000; AZA, 2011a; Briseno-Garzón et al., 2007; Falk, Reinhard, et al., 2007) and some point to the need for more mission-related research that can provide evidence of the impacts of zoo and aquarium visit (Luebke & Grajal, 2011). As a result, some of these institutions have partnered with researchers to study the impacts of zoo and aquarium visits on people's attitudes and understanding about animals, biology, ecology, and conservation issues.

2.3.1 Assessing the impact of zoos and aquaria

In 2007, the AZA published a report highlighting the postitive impacts of zoo and aquarium visits (Falk, Reinhard, et al., 2007). Some of the results worth noting from this multi-institutional study are that visitors believe that zoos and aquaria play an important role in the conservation education, that visits to accredited zoos and aquaria help people see a role for themselves in finding solutions to environmental problems and conservation actions (Falk, Reinhard, et al., 2007). Some other researchers have found that visitors tend to question or rethink their current attitudes towards conservation (Clayton et al., 2009), increase their conservation knowledge

(Adelman et al., 2000), as well as learn in the cognitive, social and affective domains when visiting a zoo or an aquarium (Briseno-Garzón et al., 2007; Clayton et al., 2009; Myers, Saunders, & Birjulin, 2004). Other studies however have revealed that visitors themselves view a visit to the zoo or the aquarium as primarily for enjoyment, a day out with family and friends, with the potential for learning something new (Clayton et al., 2009; Crilley, 2011; Linke & Winter, 2011; Packer & Ballantyne, 2010; Tofield, Coll, Vyle, & Bolstad, 2003) and that visits do not necessarily contribute to behavioural changes in visitors, despite having an immediate impact on their knowledge and attitudes towards wildlife and conservation (Adelman et al., 2000; Briseno-Garzón et al., 2007; Smith, Weiler, & Ham, 2011). Even though visitors' motivations and agendas may not always include learning about conservation, habitat diversity and animal biology, most researchers in this field agree that zoos and aquaria are an important part of informal science environments and can contribute to engaging the public in scientific understanding and raising awareness of conservation issues (Adelman et al., 2000; Briseno-Garzón et al., 2007; Clayton et al., 2009; Lindemann-Matthies & Kamer, 2006; Rowe & Kisel, 2012; Wyles et al., 2013). Greater awareness of and more positive attitudes towards conservation issues are part of the multiplicity of learning outcomes possible during zoo and aquarium visits. Arguably, engagement with live animal exhibits make up the most significant part of the visitor's overall zoo and aquarium learning experience and studies investigating the nature of the that engagement are needed to better understand the impact of the exhibits themselves.

2.3.2 Assessing the Learning Impact of Zoo and Aquarium Exhibits

Similar to science centre settings, measuring or assessing the learning impact of exhibits in zoos and aquaria can be difficult and resource intensive (Luebke & Grajal, 2011). Early research focused on identifying the elements of live animal exhibits that impacted visitor staying time, as an indirect measure of visitor interest and learning. For example, Bitgood, Patterson, and Benefield (1988) identified the level of activity of the animal, the size, proximity and visibility of that animal, the presence of an infant animal, and a naturalistic habitat as factors that influenced the length of time visitors stayed at an exhibit. These findings have since been supported by other studies (Margulis, Hoyos, & Anderson, 2003; Moss & Esson, 2010; Tofield et al., 2003). In a comprehensive, multi-site study, Ross et al. (2012) found that

visitors spend more time in and moved more slowly through the naturalistic African ape exhibit, than within a more traditionally structured exhibit. These authors make compelling arguments for the important role that the physical context plays in the learning impact of live animal exhibits (Ross et al., 2012).

A recent exploratory study by Luebke and Matiasek (2013) focused on the potential relationship between visitor's predispositions and their affective and cognitive responses to live animal exhibits in a zoo setting. The study's quantitative methods involved a survey instrument to capture visitor self-reported emotions, reflections and cognitive gains as they experienced live animal exhibits. The results revealed that emotional responses and opportunities for reflection were key experiences for visitors, and the authors suggest that affective connections with animals and their natural habitats may encourage visitors towards pro-environmental attitudes and behaviours. Understanding the affective context of visitor learning through live animal exhibits was the focus of a study by Myers et al. (2004). These researchers investigated the emotional dimensions of learning as a result of viewing live animal exhibits at zoos, highlighting that the affective context significantly contributes to fostering positive attitudes, to meaning making and thus, to the learning potential of live animal exhibits. While viewing a gorilla, an okapi and a snake live-animal exhibits, visitors were asked to respond to a survey that measured various emotional states. Myers et al. (2004) found that the experience of viewing live animals at the zoo frequently ellicited "sense of beauty, respect, wonder, peacefulness, special privilege, caring and attraction" in visitors, across all animals (p. 315).

Live animal exhibits are sometimes complemented by interactive elements such as touch screens or touch tables which are similar in nature to science centre exhibits. Studies have shown that these types of interactive experiences have an impact on visitor learning and promote socially constructed meaning making among family or group members. For example, Lindemann-Matthies and Kamer (2006) investigated the impact of touch tables (moveable carts with interpretative material like a skull, feathers and furs) on visitor learning in an exhibit about bearded vultures. Visitors who engaged with the touch tables, in addition to viewing the live bearded vultures in the exhibit, retained more information about the biology and conservation of these animals compared to visitors who only had access to posters and labels. A video study by Kisiel et al. (2012) also explored the impact of an interactive experience as a complement to a live animal exhibit, but in an aquarium setting where

visitors physically interacted with marine species in a touch tank. Through analyses of family interactions and dialogue, this study revealed that families engaged in scientific reasoning through making, challenging and confirming claims, applying prior knowledge, making and testing predictions and through constructing arguments (Kisiel et al., 2012). Evidence that interactive opportunities in zoos and aquaria stimulate a rich learning experience for visitors is not entirely surprising given the research that has demonstrated such results in science and museum settings. However, what seems to be lacking in the zoo and aquarium learning literature are assessments of visitor learning as they engage in viewing, observing and discussing live animal exhibits.

Although some researchers assert that behaviourist measures such as attraction (percentage of visitors who stop to view the exhibit) and interest (the duration of the stay) are, at the very least, indicators of learning potential of live animal exhibits (Moss & Esson, 2010; Ross & Gillespie, 2009), few studies have closely examined visitor learning behaviours and conversations for further and more direct evidence of the learning impact of these exhibits. One such study was conducted by Clayton et al. (2009) with the purpose of understanding visitors' response to animal exhibit experiences as learning opportunities, visitors' use of animals to facilitate social interactions relevant to the educational mission of the zoo, and visitors' sense of connection with the animal, including positive emotions. The researchers did this by analysing visitor conversations through the use of a pre-determined list of comment categories. Over 70% of the visitors made comments that were coded as Descriptive or Declarative, meaning that when engaging at a live animal exhibit, most visitors described the animal, made a comment about its appearance or behaviour, its location or what it was doing. The other most common comments (made by between 20% and 25% of visitors) were coded as Making Inferences about the animal's state of mind, intentions, family relationships; Seeking Information; and Positive Responses to the animal. These codes are similar to those identified by Tunnicliffe and her colleagues in studies of live animal exhibits, natural history dioramas and animatronic dinosaurs.

Early work by Tunnicliffe (1996a, 1996b) investigated school children's spontaneous comments to better understand children's learning with animals. She compared comments elicited by live animals in a zoo setting to those elicited by preserved specimens in a natural history museum setting (Tunnicliffe, 1996a) and to animatronic exhibits of dinosaurs (Tunnicliffe, 1996b). These studies revealed that

children's learning conversation followed the same pattern across all three types of animal exhibit, and included naming (the animal, body parts), observations and interpretation of behaviour (even for the static animals in the museum exhibits), and affective comments about the animal, indicating interest and intrinsic motivation (Tunnicliffe, 1996b).

More recently, Tunnicliffe and her colleagues (Reiss & Tunnicliffe, 2011; Tunnicliffe & Scheersoi, 2010) investigated the impact of dioramas on visitor learning in natural history museum settings, using conversational data to understand visitor meaning making. Although dioramas are static exhibits, they are designed to tell an ecological or biological story by including water, rocks, plants and other physical features to place the animal specimen in a naturalistic setting and can be valuable tools for developing biological interest (Reiss & Tunnicliffe, 2011). As a result of their investigations, Tunnicliffe and Scheersoi (2010) identified a four-stage response to natural history dioramas: "Identify–Interest–Interpret–Investigate". Interestingly, and of particular relevance to the present research, these studies showed that the patterns in visitor conversations are similar to the patterns found when visitors observed live animals and animatronic dinosaurs, as revealed by Tunnicliffe's earlier studies (Tunnicliffe, 1996a, 1996b, 2000): naming animal and body parts (comparable to Identify), observing and affective responses (comparable to Interest), and interpretation and comparing to humans (Interpret). Investigate, as described by Tunnicliffe and Scheersoi (2010), begins with "careful observation, identification of common features and seeing patterns" (p. 205) as the basis of biological study. Clayton et al. (2009) described similar patterns in their findings by coding visitor comments as Descriptive or Declarative, Making Inferences, Seeking Information and Postive Responses.

Ash and her colleagues (Ash et al., 2007) investigated "biological talk" in a marine science centre environment by applying and further developing a comprehensive tool to analyse family conversations as they engaged with marine-themed exhibits. The Tool for Observing Biological Talk Over Time (TOBTOT) "categorizes dialogue into major biological themes and subthemes, allowing researchers to document the ebb and flow of collaborative biological talk" (p. 1582). The superordinate categories of "Staying Alive", "Characterizing" and "Ecological Interdependence" have detailed subcategories and themes and together, allowed the researchers to analyse "much of the actual dialogue" (p. 1585). These a priori

categories were based on a classroom form of this dialogic tool to evaluate biological sense-making in children's conversations. Ash et al. (2007) used the results of the analyses to produce TOTBOT-generated graphs that revealed the frequency of biological themes in family dialogue, elicited by four exhibits. The Touch Tank generated the most biologically themed conversation among the family members, a finding similar to the more recent study on touch tanks by Rowe and Kisel (2012). The Rocky Reef exhibit, which featured a live shark also generated biological talk among family members, although not as frequently as the Touch Tank exhibit (Ash et al., 2007)

Noticeably, many of the categories resemble the four-stage responses to dioramas identified by Tunnicliffe and Scheersoi (2010) and the categories proposed by Clayton et al. (2009). For example, Ash and colleagues (2007) described Characteristics (CH) as "asking a question or making an observation (…) trying to figure out *what* something is, or how it relates to other things" (p. 1586). Subcategories within CH include Common Name and Classification. These codes describe the same type of dialogue as Tunnicliffe and Scheersoi's (2010) "Identify" response and the Descriptive or Declarative response described by Clayton et al. (2009).

In summary, a number of studies have demonstrated that zoo and aquarium visits have an immediate positive impact on people's awareness, attitude and knowledge about wildlife and conservation issues. However, research into the learning impact of live animal exhibits is still in its formative stage. Some studies have shown the impact of exhibit design elements such as naturalistic settings or the presence of active animals on visitor holding time. Other studies have shown the importance of the emotional dimension of the live animal exhibit experience. Research by Clayton et al. (2009), Tunnicliffe (1996a, 1996b), Tunnicliffe and Scheersoi (2010), and Ash et al. (2007) revealed common patterns of learning in conversations or biological talk as visitors engaged with different animal exhibits, from static dioramas displaying animal specimens, to interactive touch tanks. It is important to note that the Clayton et al. (2009) study is the only one that focused on the visitor learning experience with live animal exhibits typical of zoos and aquaria and that the learning behaviours they identified were pre-determined. Most studies investigating the interactions of visitors at live animal exhibits focused on conversation analysis, using predetermined lists of codes to determine what learning

was occurring. It can be argued that by using a predetermined list of codes, there is the potential for losing flexibility during analyses, and consequently, decreasing the researcher's ability to capture unexpected learning behaviours. Therefore, it seems sensible to use data from zoos and aquaria to build the codes, ensuring that most learning behaviours are accounted for and captured by an instrument that assesses an exhibit's learning impact. These are the advantages building codes from empirical data, such as those developed by Tunnicliffe (1996a, 1996b), Tunnicliffe and Scheersoi (2010) and by Barriault (1998) with the VBLF. It appears evident that more research is needed to assess the learning potential of live animal exhibits and that this research should be rooted in empirical, observational data collected in zoo and aquarium settings.

2.4 Goals and Purpose

The VBLF was developed and applied successfully in science centre settings as a practical tool for assessing the potential impact of exhibits on visitor learning. It can be argued that such a tool would be a valuable addition to the methodologies currently used to assess learning in zoos and aquaria since very few studies investigating the impact of live animal exhibits on visitor learning have been conducted. There are sufficient common characteristics across science centres, aquaria and zoos that the literature often refers to them as one type of informal science learning setting. However, as demonstrated in this chapter, there are important differences in the nature of the exhibit experiences in these settings that would lead to differences in visitor learning behaviours and conversations. Considering these differences, it is unlikely that the VBLF in its current form would effectively assess the learning impact of live animal exhibits. Nevertheless, it is important to ask if there are observable behavioural and conversational indicators of engagement and learning during visitor interactions with live animal exhibits. The patterns of learning conversations investigated by Clayton et al. (2009) and Ash et al. (2007) in a zoo and an aquarium setting suggest that there may be observable indicators of engagement and learning. If so, it would be important to ask whether or not these observable indicators can be incorporated into the existing VBLF, resulting in a revised framework and practical exhibit assessment tool for zoo and aquarium practitioners.

The VBLF currently provides science centre practitioners with an assessment

tool that is methodologically rigorous yet feasible to implement. It has never been applied to live animal exhibits in zoo and aquarium settings although its use has generated insights into the learning impact of live animal exhibits in a science centre setting. Thus, two important questions require investigation and they form the basis for the research presented in this thesis.

1. Can the Visitor-Based Learning Framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention?

and

2. What is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

Revising the VBLF for use in aquaria and zoos will illuminate the types of learning behaviours and dialogue visitors engage in while observing and discussing live animal exhibits. Thus, this study will address a need in this field by providing a robust methodology for assessing the processes of learning across free-choice science settings, a need identified by informal science learning researchers (Dierking et al., 2003; NRC, 2009; Rennie, 2007). In addition, informal science practitioners have expressed the need to understand of the learning impact of exhibits to better inform design, and to ensure that visitors can indeed learn from engaging with the exhibits (Sanford, 2010). If tested and revised to be applied across settings, a robust tool such as the VBLF could provide researchers and practitioners with a tool to assess the success of those exhibits at engaging visitors in learning experiences. Furthermore, it is important to understand the nature of the Breakthrough learning behaviours as they occur in zoo and aquarium settings because they are windows into the processes of meaning making. Since the original framework was created from science centre data, and because zoos and aquaria have the additional goal of enhancing visitors' understanding of conservation and wildlife issues, this study needs to reveal characteristics of Breakthrough level learning behaviours and conversations, and how they are achieved in zoo and aquarium settings.

Chapter 3
Research Design and Phase 1

This chapter provides an outline the research questions for the project, the research design chosen for this study, and the details of the methodology needed to answer the research questions. The characteristics ideal for potential research sites and the types of subjects needed in the study are discussed and an overview of data collection procedures, including ethical protocols used in the study, and the proposed data analysis methods are described. Finally, Phase 1, the pilot study for this research, will be explained and set the context for the next phases of research.

As previously discussed in the introduction and the literature review, further investigation is needed to gain a better understanding the visitor learning experience as proposed by the VBLF since the original framework was created from science centre data, and tested only in one science centre, Science North. Furthermore, since zoos and aquaria have the additional goal of enhancing visitors' understanding of conservation and wildlife issues, and since zoo and aquaria visitor experiences are rarely as interactive as those found in science centres, more needs to be understood about what Breakthrough behaviours and conversations look and sound like, and how they are achieved, in these settings.

The study is designed to answer the following research questions:
1. How can the Visitor-Based Learning framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention?
and
2. What is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

3.1 Research Design

3.1.1 Research stages

In order to answer the research questions, the study was carried out in three phases, with each informing the next phase. First, it was important to validate the

VBLF in another science centre to ensure that it was at least generalizable to other science centres before testing it in a different kind of institution. Thus, Phase 1 of the study was designed for two purposes; first to check that the VBLF was generalizable, and second, to serve as a trial of the method of data collection and of the ethical protocols needed to collect that data.

Phase 2 also had two purposes. First, it involved applying and testing the existing framework in a zoo and an aquarium setting while noting whether or not the existing framework adequately captured aspects of the learning experience. Second, the nature of the learning experience in these settings was further analysed to assess the potential for the existing framework to be refined and modified to better reflect the learning behaviours of visitors in zoos and aquaria.

Assuming that the framework could be modified according to observable learning behaviours in Zoo 1 and Aquarium 1, then Phase 3 of the research project was designed to apply and test a context-specific, revised and modified learning behaviours framework to a new set of data collected in a different zoo and a different aquarium setting than in Phase 2.

3.1.2 Choice of a Mixed-Method Approach

To best capture and understand the nature of the visitor learning experience in science centres, zoos and aquaria, the research design for this study requires both naturalistic, interpretative inquiry and quantitative methodologies. Therefore, a mixed-method research design was used for this project.

The quantitative part of the research project involved collecting and analysing data according to the established framework of learning behaviours. More specifically, the data collected by video recorded observations of visitor interactions with carefully selected exhibits were coded using the pre-determined learning behaviours from the VBLF (Barriault, 1999; Barriault & Pearson, 2010) in order to validate the framework's applicability across other science centre settings. This type of quantitative analysis results in the calculation of percentages of visitors engaged in the learning behaviours described in the framework and produces Visitor Engagement Profile graphs for individual exhibits. This approach was applied to science centre data in Phase 1 of the study, as well as to zoo and aquaria data in the first part of Phase 2. The quantitative approach also allows for cross-comparison with science

centre data and reveals potential gaps in the framework at capturing zoo and aquaria visitor learning experiences.

Phase 2 of the study also involved revising and modifying the established framework of learning behaviours to the zoo and aquarium setting and that required a qualitative approach to data collection and analysis. The rich qualitative data produced by naturalistic inquiry was needed to identify learning behaviour patterns in these settings as well as to deepen the understanding of the learning that occurs during a visitor's interactions with an animal habitat and with others around the exhibit. The naturalistic approach used in the study involved field notes taken in the institutions as well as observations of those interactions in the video recorded data. Consequently, the analysis of data collected is based on a socio-cultural, constructivist approach to learning where learning and engagement are social and collaborative, and are reflective of people's past experience and knowledge. Qualitative data about visitor behaviours also enabled the identification of pre-cursors to meaning making and signs that learning is occurring by basing the data analysis in the constructivist approach to learning.

3.2 Research Sites

Three kinds of research sites were needed: a science centre to achieve Phase 1 of the study and a zoo and an aquarium for each of Phases 2 and 3.

3.2.1 Choosing the research sites

The institutions selected for the study were chosen to complement the aims of the research by having excellent reputations for high quality and engaging visitor experiences. The Association for Science and Technology Centres (ASTC), the Association for Zoos and Aquariums (AZA) and Canada's Accredited Zoos and Aquariums (CAZA) have members that are required to adhere to their association's criteria for excellence in informal science learning (ASTC, 2011; AZA, 2011b; CAZA, 2014). As all three associations list their member institutions on their websites, those webpages were used as a reference tool when choosing the research sites for this project.

It was necessary for the chosen institutions to have sufficient visitor numbers during their summer season to ensure a steady stream of visitors attending the exhibits

to enable efficient data collection. An annual attendance of over 400,000 visitors would indicate that the peak summer tourist season would have enough visitors interacting with exhibits to guarantee a sample size of at least 100 visitors per exhibit in a reasonable time of data collection. The chosen institutions also needed to be willing to participate in the study and to facilitate the procedures for data collection on their site. And finally, it needed to be cost effective for the researcher to travel to the chosen research sites.

3.2.2 Contacting and visiting the research sites

Most institutions in Canada and the US that carry out visitor research and exhibit evaluation are members of The Visitor Studies Association (VSA). Potential contacts for the chosen institutions could be identified through the VSA's conference participant list because staff who attend this conference would be involved in the type of research that involves understanding visitors and exhibits or programs. An initial email for a contact person was prepared to introduce the researcher, explain the general purpose of the research project and ask the contact if the institution would be interested in participating as a research site for data collection. Appendix 3A shows a generic email text sent to potential research sites. A follow up phone call was planned with interested institutions to answer questions about the research project, and to set up an initial site visit to meet with staff and view the layout of the exhibits or animal habitats. This step was necessary to discuss the details of the data collection procedures, including the institution's comfort with the proposed methods. A site visit also provided the opportunity to plan the data collection with the institution contacts, to decide on the best locations for data collections, to view the physical layout of the exhibits and anticipate any challenges that might arise on site during data collection.

3.3 Choosing Subjects

To gain a deeper understanding of the visitor learning experience in science centres, zoos and aquaria, the target population for this study needs to be general visitors to these informal science settings. Typical visitors to these institutions are local and visiting families with children, with higher percentages of non-locals during the peak summer visitation season. Other groups include adult tourists and older adult tour groups, both local and from abroad. The samples of visitors included in this study

will have chosen to visit the science centre, zoo or aquarium on the day that data collection occurs. Furthermore, they will have freely chosen to interact with the exhibits where data are being collected, having been made aware of the research being conducted at that time. Ethical considerations for this type of data collection will be described in Section 3.7.

3.3.1 Phase 1: Testing the framework in a different science centre

To test the validity of the VBLF in a science centre setting in the Phase 1 pilot study, it was decided that 100 people needed to be observed interacting with one pre-selected exhibit. This was considered sufficient to assess the fit of the framework and compare patterns with previous studies since, using theVBLF for a decade at Science North, it was found that data saturation invariably occurred by 100 visitors. Video data were also recorded at two additional pre-selected exhibits to test the production quality of the video and audio data collected however, the learning behaviours of visitors in these videos did not need to be analysed, as explained later.

3.3.2 Phase 2: Applying and revising the framework in zoo and aquarium settings

Applying the VBLF in zoo and aquarium settings will require observing more visitors than are recommended for the science centre setting in which the framework was originally developed. Since the framework had not been applied to these settings in the past, it was important to have at least 200 subjects participate in each of the zoo and the aquarium settings. Therefore, in Phase 2, 200 visitors who choose to interact with two pre-selected live animal exhibits (100 visitors per habitat) at an aquarium, and 200 visitors who choose to interact with two pre-selected live animal exhibits (100 visitors per exhibit) in a zoo was considered a sufficient sample for this part of the study. If time permitted, video data could be collected at an additional exhibit, increasing the number of participants in this phase of the study

3.3.3 Phase 3 - Testing a revised framework in zoo and aquarium settings

Phase 3 of the research project was designed to test a modified, context-specific learning behaviours framework on a new sample of visitors in a different zoo and aquarium than in Phase 2 of the study. The sample of visitors was obtained in the same manner as in Phase 2, that is, 200 visitors who choose to interact with two pre-selected live animal exhibits at an aquarium (100 visitors per habitat), and 200 visitors

who choose to interact with two pre-selected live animal exhibits (100 visitors per exhibit) in a zoo.

3.4 Selecting Exhibits

The exhibits chosen to be included in this study were selected in collaboration with each institution's contact for the research project. Visitors who engaged with these exhibits made up the sample of subjects discussed in Section 3.3 of this chapter. In selecting the exhibits, the following criteria were considered:

- the physical location in the science centre, zoo or aquarium is amenable to video recording visitors with minimal disruption to the visitor experience
- the exhibit is popular with visitors to ensure a high number of visitors for successful data collection
- the content and interactivity of the exhibit is representative of interactive science centre exhibits in general; or, the live animal exhibits are representative of typical zoo and aquarium exhibits.

3.5 Data Collection

Video recording of visitors interacting with exhibits is a data collection method that ensures that the entirety of the visitor experience is captured while visitors are in camera view. Video footage of visitors interacting with exhibits were collected at each of the research sites until a minimum of 100 visitors were recorded interacting at each of the pre-selected exhibits. The researcher's experience at Science North suggested that this would take between one and two hours of recording for each exhibit, and the actual recording time in this study varied between 1.5 and 2.5 hours.

The choice of video recording as the data collection method was made cautiously because of issues of privacy and security. However, there are accepted ways of accommodating those concerns, as is discussed in Section 3.7 of this chapter, and it is the best means to gain the information sought. The quality and richness of the video data provide much greater opportunity to assess the learning process taking place at exhibits by allowing repeated viewings for cross-checking coding of dialogue and behaviours. In addition, having 10 years of experience using both live observation and video data collection at Science North, the researcher has found that collecting

video of visitor learning behaviours and dialogue is the most reliable and accurate means of collecting observational data.

With permission from and collaboration with the contacts from the research sites, a tripod-mounted camera and microphone were placed near each exhibit included in this study. Consideration was given to the location and positioning that yields the best view of the visitors' faces and the sounds of their voices, with minimal disruption to the exhibit interaction. Signs were used to alert visitors to the data collection. Details of these and other ethical considerations are outlined in Section 3.7 of this chapter.

3.6 Data Analysis

The large amount of video data collected for this research will require computer-based software tools to capture, manage, categorize and analyse the numerous video files generated.

3.6.1 Studiocode Video Analysis Software

Studiocode is a video analysis software tool designed to enable the efficient capturing, coding and analysis of video data. The software allows the user to easily review video footage through a timeline, create a coding window based on the information and results required for the research project, and to tag or label video footage for efficient retrieval and analysis. It is important to note that the software does not come with pre-made coding windows. The user or researcher creates these based on the needs of their research.

Figures 3.1 and 3.2 are screen shots of the Studiocode software features used for this research project. Figure 3.1 shows a video file above its timeline on the computer screen. Each video file that is imported into the software automatically opens its own timeline, which is permanently linked to that video.
Within the timeline, individual rows represent individual visitors in the video. Along an individual timeline (representing a visitor's row), there are instances of learning behaviours and demographic information. This information populates the timeline rows as the user clicks on the code and label buttons in the coding window, seen in Figure 3.2. When these instances of learning behaviours are coded they are

embedded into the video file. Learning behaviours and demographic information are represented and captured by the "Code" buttons on the right side of the coding window, while individual visitors are represented and captured by the visitor identification "Label" buttons on the left side of the coding window. For example, there are "Code" buttons for age categories and gender. All the learning behaviour from the framework such as *Doing the Activity* and *Acknowledge Relevance* are also "Code" buttons. On the left side of the coding window, each visitor is captured using a "Label" button, which the researcher creates and names to correspond with what is seen on the video recording. Each visitor identification label includes a letter-number combination like "V22" and a simple description like "Woman with red purse white t-shirt" to help the researcher track each subject in the video. Studiocode also has an export feature that enables the coded data, in this case learning behaviours instances and demographic information by visitor, to a matrix as seen in Figure 3.3. The information in the matrix can be rearranged to export to Microsoft Excel for graphing and statistical analysis.

3.6.2 Phase 1 – Learning behaviours in a science museum

The video data collected at Science Centre 1 were uploaded as video files directly into a computer and into the coding software "Studiocode" to be analysed. This analysis allows coding of visitor learning behaviours and dialogue as they interact with the exhibit and with other visitors. The coding window of behaviours used for Phase 1 were based on The VBLF of learning behaviours in the science centre setting. This analysis was able to assess the validity of the framework for other science centre settings by ascertaining if all learning behaviours observed in this setting were accounted for by the behaviours in the framework.
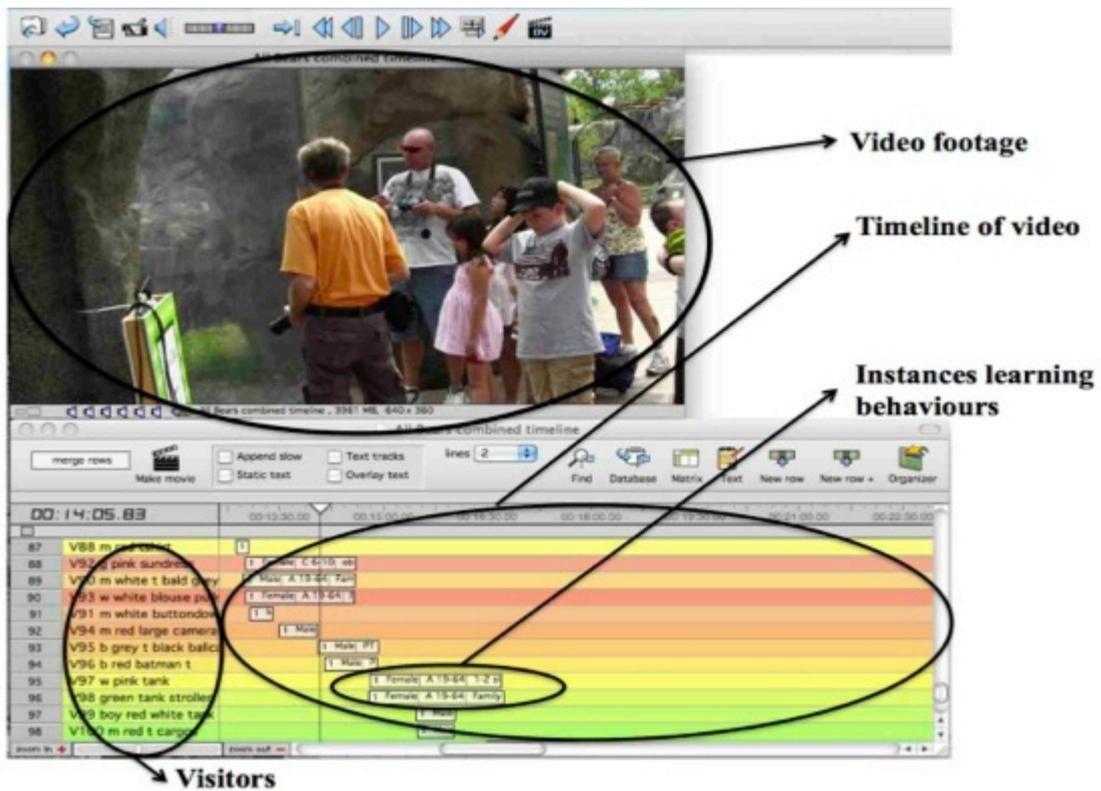
Figure 3.1 Screen shot of video footage and timelines as they appear in Studiocode, the video analysis software.
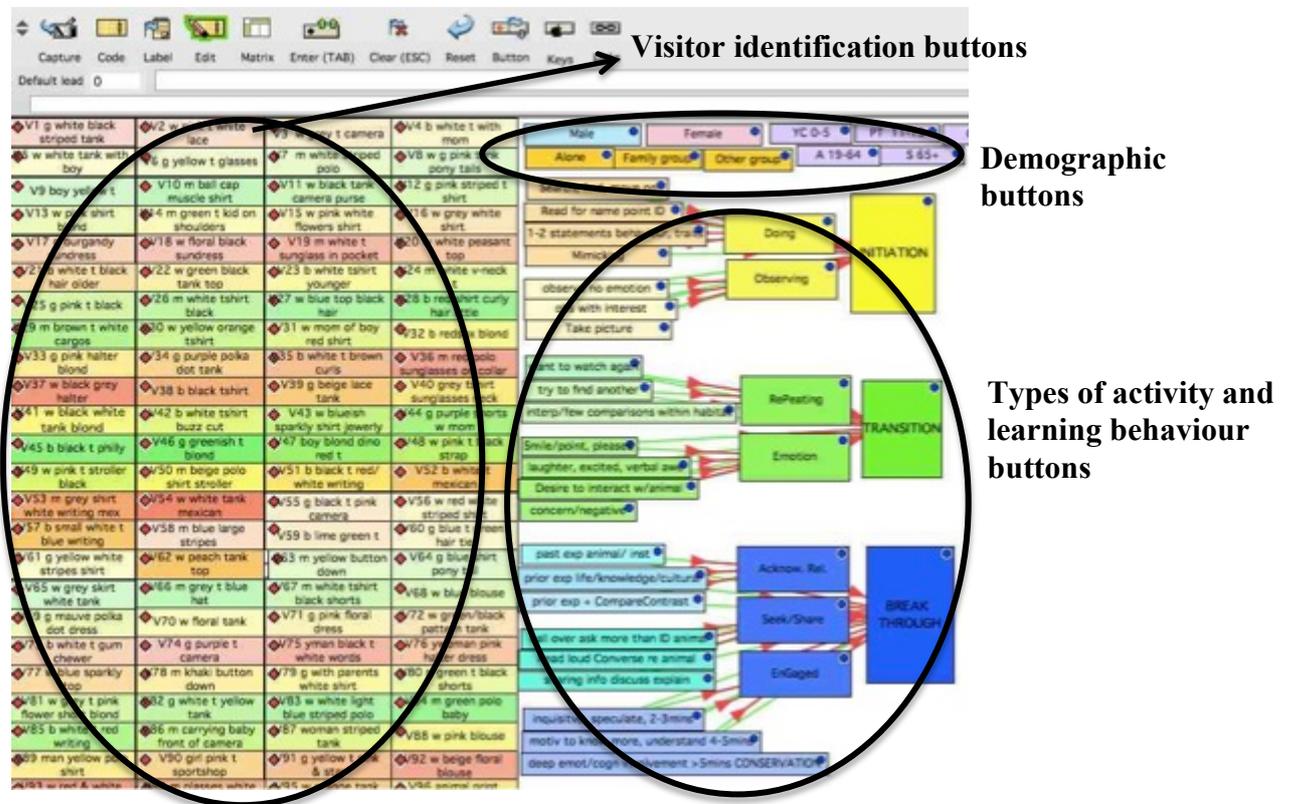
Figure 3.2 Code window of learning behaviours created in Studiocode video analysis software.
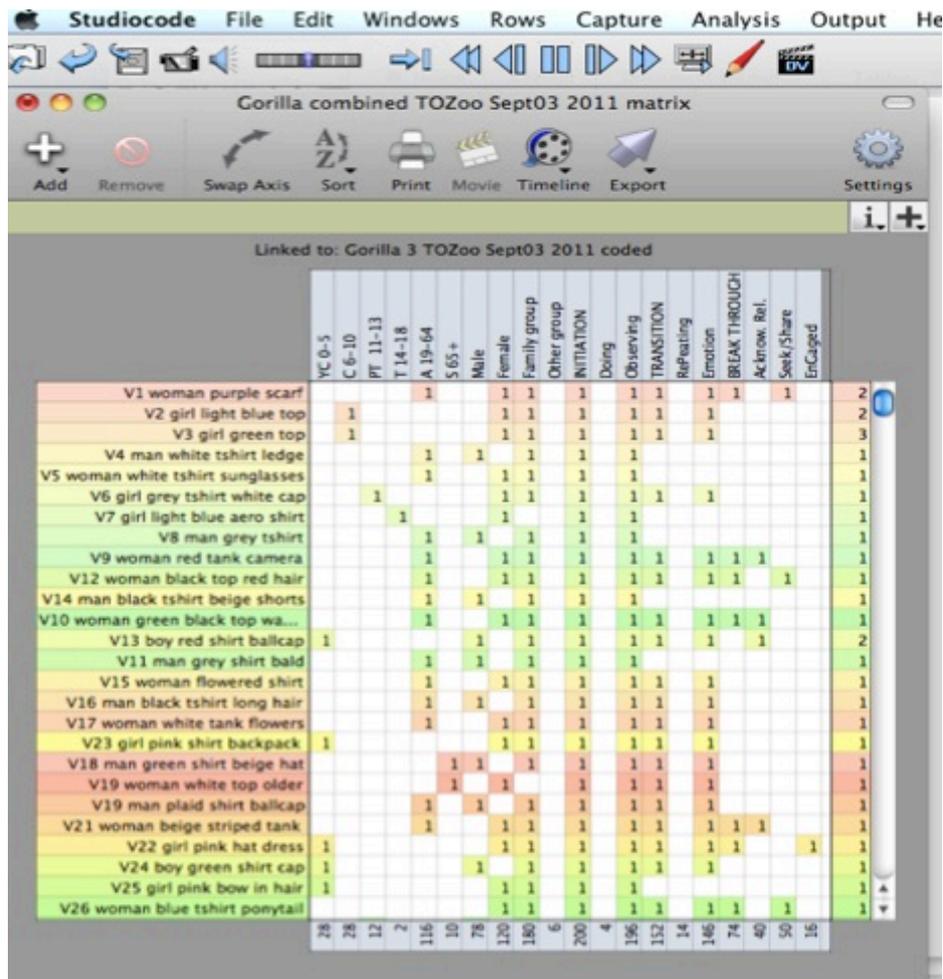
Figure 3.3 Example of a matrix created in Studiocode.

3.6.3 Phase 2 – Learning behaviours in Zoo 1 and Aquarium 1

The video data collected at Zoo 1 and Aquarium 1 were also uploaded as video files directly into a computer and analysed using the Studiocode coding software. The first analysis of the data collected in Zoo 1 and Aquarium 1 was coded using the VBLF of learning behaviours to assess its applicability in these informal learning settings.

The qualitative data collected in Zoo 1 and Aquarium 1 took the form of observational notes and transcripts of dialogue derived from personal observations of visitor behaviours. These data were gathered and analysed in synchrony with the quantitative data analysis in the second part of Phase 2, providing further opportunities to investigate the zoo and aquarium visitor learning experience, and to identify gaps in the VBLF as it is applied to these informal learning settings. These data were analysed using the iterative process of constant comparison described by M.

B. Miles and Huberman (1994) and by Patton (2002), to identify emergent themes to produce new codes and categories of learning behaviours. This analysis was guided by the underlying goal of understanding the learning and meaning-making visitors are engaged in when they are observing, discussing and interacting with a live animal exhibit. The analysis was also guided by the existing learning behaviours from the VBLF. The outcome of these analyses was a draft revised visitor learning behaviours framework that is applicable to zoos and aquaria.

3.6.4 Phase 3 - Learning behaviours in Zoo 2 and Aquarium 2

As in Phases 1 and 2, the video data collected at Zoo 2 and Aquarium 2 was uploaded as video files directly into a computer and analysed using the Studiocode coding software. These data were coded using the draft revised framework of learning behaviours developed in Phase 2 in order to assess its effectiveness at capturing the learning experience in zoos and aquaria.

3.7 Ethical Considerations

In preparation for the site visits at participating institutions, it is necessary to have a detailed data collection procedure in place that adhered to the requirements of Curtin University's Human Research Ethics Committee (HREC). The sensitive nature of video recording visitors as they interact with exhibits was expected to concern the research site staff and all ethical considerations needed to be addressed for visitors from these institutions to participate in the study.

In order to ensure that visitors were informed about and could choose to participate, or not, in the video recording of their interactions at the exhibits, the protocols and procedures developed and published by Gutwill (2003) were implemented as described in Section 3.7.1. It was anticipated that each institution might require additional ethical approvals based on their research application requirements and that no data would be collected until all ethics considerations were met. Curtin University's *Application for the Ethical Approval of Research Project Involving Humans* was completed prior to planning the visits to research sites. Section 3.7.2 outlines the data collection procedures that were proposed to and approved by Curtin University's Human Research Ethics Committee on March 18, 2011 (certificate number RD-08-11).

3.7.1 Established ethical procedures

Researchers at The Exploratorium in San Francisco have been collecting data of visitors interacting with exhibits with video cameras for many years. As a result, they have established video recording data collection procedures and have tested them extensively to ensure that visitors are aware and informed as they are being recorded and choose to participate in a study. Joshua Gutwill's (2003) research showed the effectiveness of notification efforts at informing visitors of their involvement in research and that they were being video recorded. For example, 99% of visitors knew they were being video recorded and the remainder reported not feeling bothered at all, suggesting that risks of recording visitors against their wishes is very low (Gutwill, 2003). In addition, the most noticed or most effective means of communication was a sign at the entrance to the exhibit area and an additional sign that was placed on the exhibit itself. The data collection methods used in this study adhere to those outlined in Gutwill's (2003) study while taking into consideration the physical settings of each research site and any additional requirements made by the host institution. These data collection procedures are detailed in the following section.

3.7.2 Implicit consent procedure details

Posting research signs is the most crucial part of gaining what Gutwill (2003) calls "implicit consent" from visitors to participate in a study involving video recording their behaviour. A sign indicating that research and video recording was occurring in the museum, zoo or aquarium was posted at the entrance of each research site during the data collection period and included a version of this statement: "You may be video recorded in certain areas of the aquarium / zoo/ science museum today. Signs will be posted in the research areas that are being video recorded". The wording of the information and the inclusion of the institution's logo differed slightly depended on the input of the staff at each of the research sites. An additional sign and cordons were mounted around and beside the exhibit that was being video recorded. It is important to note that the camera and the microphone were in plain sight above or near the exhibit with an additional sign informing visitors that the camera was recording. The exact placement of the camera, the microphone and the research signs was discussed with each participating institution and finalized during the site visits.

As visitors entered or approached the exhibit being recorded, they were able to read a sign that contained the following information and options for not participating:

1. You are being video recorded right now.

2. RESEARCH IN PROGRESS NOW

3. WHEN? Audio and video recording of this exhibit will continue until "specified time". If you do not wish to be video recorded, please come back at a later time.

4. WHY? A researcher from Curtin University is collaborating with the "zoo / aquarium / museum" to better understand the effectiveness of this exhibit.

5. FOR QUESTIONS OR CONCERNS, PLEASE SEE A STAFF MEMBER OR GO TO THE ADMISSIONS DESK AND SOMEONE WILL HELP YOU.

6. Videos recorded for research will not be used for commercial or broadcast purposes.

The signs clearly stated "Research in Progress" and that the video recording was occurring at this moment. A similar sign was placed beside the exhibit itself if the physical layout of the area could accommodate it. As noted above, the actual wording of the information and the reason given for the research and video recording was discussed with each institution's representatives to ensure that all of their needs, concerns and requirements were addressed. Previous studies, like Gutwill's (2003), have shown that explicit signs of research activity have very little influence the behaviour of the visitors as they interact with the exhibits. In this study approximately ten children were noted playing towards the camera and these children were excluded from the data analysis. One adult was observed making faces towards the camera and was also excluded from the data analysis.

3.7.3 Issues of privacy

The visitors to the museums, zoos and aquaria research sites for this study were engaging in regular museum activities in a public place, so there were no issues of privacy since no personal information was collected for this study. In addition, any video footage of children under the age of 12 who were unaccompanied by an adult, were deleted before analysis began. This included children who visited the institution as part of an organized group such as a summer camp or a school group. Since it was not possible to ensure their parental consent for their participation in the study, these children could not be included in the sample. The information obtained through the video recordings was used only for research purposes. No names or identifying

information were collected and pseudonyms were used for the participating institutions in the reporting of the data.

3.8 Implementation

3.8.1 Research sites

Five informal learning institutions were selected according to the criteria in Section 3.2 to be research sites for this study. A contact person for each research institution was identified and contacted, following the procedures outlined in Section 3.2.2. Telephone discussions with these contacts resulted in each institution agreeing to participate in the research project provided they receive a report of the results for the data collected at their institution. Some institutions asked that the researcher present her study to members of their staff team.

Each institution assigned a staff member to work with the researcher on establishing the operational details of data collection on their site. Site visits and further discussions through emails and phone conversations led to decisions being made about research and ethics applications, which exhibits to included in the study, the wording, layout and logos on the research signs posted at the exhibits, the physical location of the camera and microphone around the exhibit areas and the dates and times the data collection would take place. The following paragraphs present details about each of the selected informal learning institutions that participated in this research project and the exhibits chosen for data collection.

Science Centre 1

Located in a large metropolitan city in the United States, this science museum opened in 1933. It is one of the largest science museums in the United States with over 35,000 artefacts in nearly 57,000 square metres of exhibit space. The museum is a long-standing member of ASTC. The annual attendance at this science museum is over one million visitors. Following the site visit, an interactive chemistry exhibit was chosen as the test exhibit.

Aquarium 1

This research site is a very well established aquarium, member of the AZA, and located in the centre of a large American city. Opened to the public since 1930, the aquarium today houses more than 32,000 animals in its different ecosystem

habitats that cover 44,640 square metres of exhibit space. Approximately 2 million visitors come to this aquarium every year. The three exhibits chosen for the research project were the Sea Otters exhibit, the Jellyfish exhibit and the Sharks and Fish exhibit.

Zoo 1

This zoo is a member of CAZA, is located on the outskirts of a large urban Canadian city and sees over one million visitors per year. Open since 1974, it is has an excellent reputation as Canada's premier zoo, with over 250 live animal exhibits on 284 hectares of park land. During the site visit, the Polar Bears exhibit and the Gorillas exhibit were chosen for this study.

Aquarium 2

Established in 1972, this AZA accredited aquarium is part of smaller American community that lies just outside a larger summer tourist destination. This 2,800 square metre aquarium includes five galleries of exhibits and receives approximately 400,000 visitors annually. The Turtles exhibit and the Sharks and Fish exhibit were chosen for data collection.

Zoo 2

Located in a suburb of a large metropolitan city in the United States, this AZA accredited zoo welcomes approximately 2.2 million visitors every year. With over 87 hectares of land, this zoo is home to 2,300 animals in a variety of habitats and exhibits. During the site visit, the Grizzly Bears exhibit and the Giraffes exhibit were chosen for this research project. Table 3.1 outlines the timeline, the stages of the study and their respective research sites.

3.8.2 Application to conduct research

Prior to collecting data, Aquarium 1 and Zoo 2 required a "Research Application External Request" form to be completed and approved by the institution. A copy of the application for Aquarium 1 can be found in Appendix 3B. The researcher worked with the contact person from each institution to accommodate their requirements for communicating the research to their visitors. All research sites required that the researcher wear a name badge to identify her association with the institution or with Curtin University during her time on their site, including Science Centre 1 which was the site for Phase 1 of this research.

Table 3.1 Research sites in the Data Collection Timeline by Phase of Study.

Timeline Research stages	April 2011 Site Visits	July 2011 Phase 1	July-Sept 2011 Phase 2	June-July 2012 Phase 3
Research Activity	Meet contacts Choose exhibits	Pilot study	a. Testing b. Revising framework	Testing Revised Framework
	Establish data collection procedures	Data collection	Data collection	Data collection
		Data analysis	Data analysis	Data analysis with revised framework
			Refinement of framework for zoo & aquaria	
Research Sites	Science Centre 1 Zoo 1 Aquarium 1	Science Centre 1	Zoo 1 Aquarium 1	Zoo 2 Aquarium 2

3.9 Phase 1 - Pilot Study at Science Centre 1

The data collection methodology for this research was extensive and complex. A pilot study was deemed necessary to ensure that the methodology was feasible and that it would produce the type of data required for the research project's ultimate research settings of zoos and aquaria. As previously explained, Science Centre 1 was chosen as a test site because it has an excellent reputation for high quality and engaging visitor experiences, is a member of the Association of Science and Technology Centers, is situated in a large city with a high and diverse population and receives over 1.5 million visitors annually.

The aim of this pilot study was to determine that:

- data could be collected effectively and successfully in a venue other than the science centre in which the framework was originally developed, tested and currently in use
- ethics requirements could be met in an other institution
- visitor behaviours would not be overly affected by the presence of the camera and microphone at the exhibit
- data collected would fit and confirm the validity of the learning behaviours identified in the VBLF

- characteristics and triggers in the learning experiences that lead to Breakthrough level behaviours can be identified through in-depth observation and analysis.

3.9.1 Procedures for Phase 1

Contact was established with Science Centre 1 through a search of the Visitor Studies Association 2010 Membership Directory[1]. The researcher is a member of the association, which encourages delegates to connect with each other to pursue common goals and projects. The Manager of Audience Research at Science Centre 1 was contacted through email and this research project was proposed. A working relationship was eventually established between the researcher and the Director of Science and Integrated Strategies. All arrangements were made through her to allow this research to be conducted on their site. Ethical protocols were acceptable to the institution with the exception of a few changes to the wording for the signs that was originally proposed by the researcher. Once both the researcher and the Director agreed upon the wording on signs, the science centre designed and made the signs that were posted near selected exhibits under study and at the entrance to the museum. In addition, the researcher and the Director from Science Centre 1 discussed which exhibits would meet the criteria for inclusion in this study.

Selected exhibits

The following exhibits were selected for this pilot study: The Chemical Reaction Table, the Granular Physics Brazil Nut Effect and the Friction Table. These exhibits were selected by the researcher, in collaboration with the institution's contact, for the following reasons:

- physical location in the science museum was amenable to video recording
- popularity of exhibits with visitors as suggested by institution staff, ensuring a high number of visitors for observation
- representative of interactive science centre exhibits in content and interactivity

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[1] The Membership Directory was provided to the delegates of the 2011 Visitor Studies Association conference.

At the Chemical Reaction Table exhibit (Figure 3.4), visitors use pucks to choose elements from a projected periodic table and pull them into a reaction lab to see what happens. They can bring in more atoms of the same element, throw new ones into the mix or start over. The table suggests combinations for visitors to try, helping them create compounds from water to sulphur dioxide. At the Granular Physics "Brazil Nut Effect" exhibit, a large circular object, surrounded by small white beads inside a clear-framed container is set in a shaker, then set in motion. When visitors turn on the motor to shake the container, the large object rises to the top. Visitors can manipulate a variety of containers with different sized objects to investigate the behaviour of other granular materials. The Friction Table exhibit allows visitors to investigate the force of friction and the variables that affect it. By pushing a variety of disks made from different materials and having different weights on a smooth surfaced table, visitors measure the distances these disks travel and compare the resulting distances across different disks.
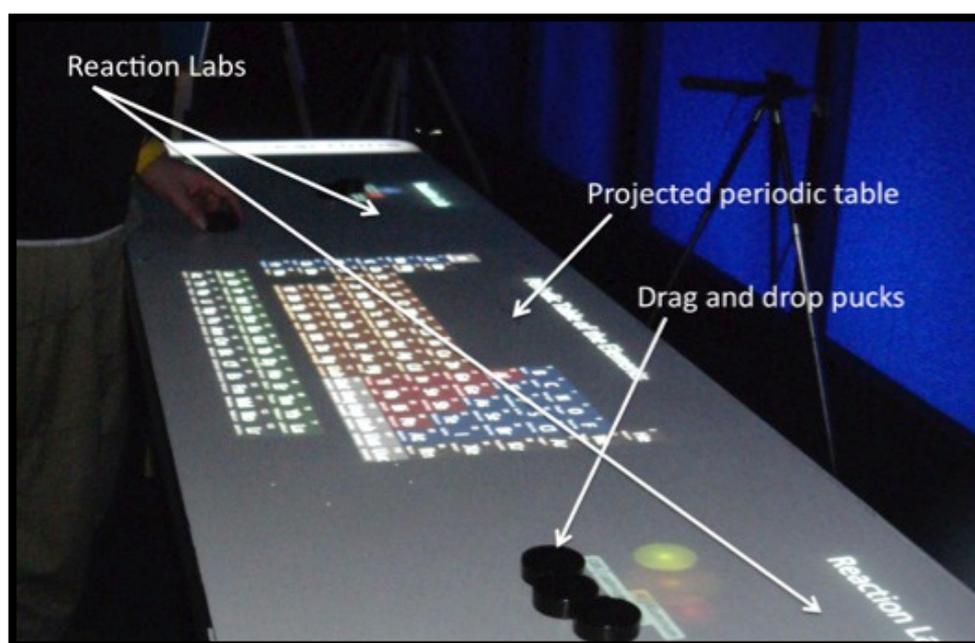
Figure 3.4 The Chemical Reaction Table exhibit at Science Centre 1.

Subjects

The sample of visitors in this pilot study consisted of self-selected science centre visitors, visiting during the summer tourism period, specifically on Saturday July 30th, 2011. Visitors who approached and interacted with the Chemical Reaction Table exhibit were included in the sample and a total of 100 hundred visitors were video recorded as they interacted with this exhibit. It is important to note that,

although video data were collected at the Granular Physics and the Friction Table exhibits, only the visitors who interacted with the Chemical Reaction Table exhibit were included as subjects in the assessment of the validity of the VBLF. The visitors who were captured on video while interacting with Granular Physics and the Friction Table exhibits were not included in that analysis, instead, the video data collected at those exhibits were examined only for their video and audio production quality. The data analysis procedures are described in the following section.

Thus, visitors who interacted with the Chemical Reaction Table exhibit became the sample for the pilot study. The visitors for this phase of the study were 62 males, 38 females, 36 children under the age of 18 years and 64 adults. Eighty nine visitors in the sample of 100 were visiting as part of a family or social group. The annual demographics for visitors to the science centre were not publicly available. However, based on information gathered about the visitor attendance in other similar science centres, it is likely that this sample is representative of the visitors who typically attend Science Centre 1. For example, the Exploratorium in San Francisco reports that 52% of their visitors are adults and 48% are children (Kahaner, 2010).

Data Collection

Visitors were initially observed interacting with the exhibits without the presence of the camera or microphone for approximately 20 minutes at each exhibit. This allowed the researcher to witness and note "normal" interactions with the exhibits and get a better understanding of how the exhibit performs before introducing the camera and microphone to the area. The tripod-mounted video camera and microphone were then placed in an ideal location near the exhibit, out of the main visitor path so as to not interfere with traffic flow and the interactivity of the exhibit.

Visitors were video recorded as they interacted with the exhibits, and with each other. In accordance with the approved ethical protocols needed for video recording visitors (Section 3.7 in this chapter), signs were posted at both ends of the exhibits, explaining to visitors that they were being video recorded as part of a study. A sign explaining that some exhibits would be video recorded for research purposes was also placed at the admissions desk in the entrance of the science centre. In the case where the camera was placed further from the large sign for optimum data collection, a smaller sign was taped to the camera itself. Figure 3.5 shows an example

of the placement of the camera, microphone and sign during data collection at the Granular Physics exhibit.

The researcher was identified with a name badge and stayed nearby during the duration of the data collection, until 100 hundred random visitors were captured on video for each exhibit. Visitors were never approached or interviewed during the data collection. In the case where a visitor approached the researcher, the protocol established was to answer any questions they may have about the research being conducted.
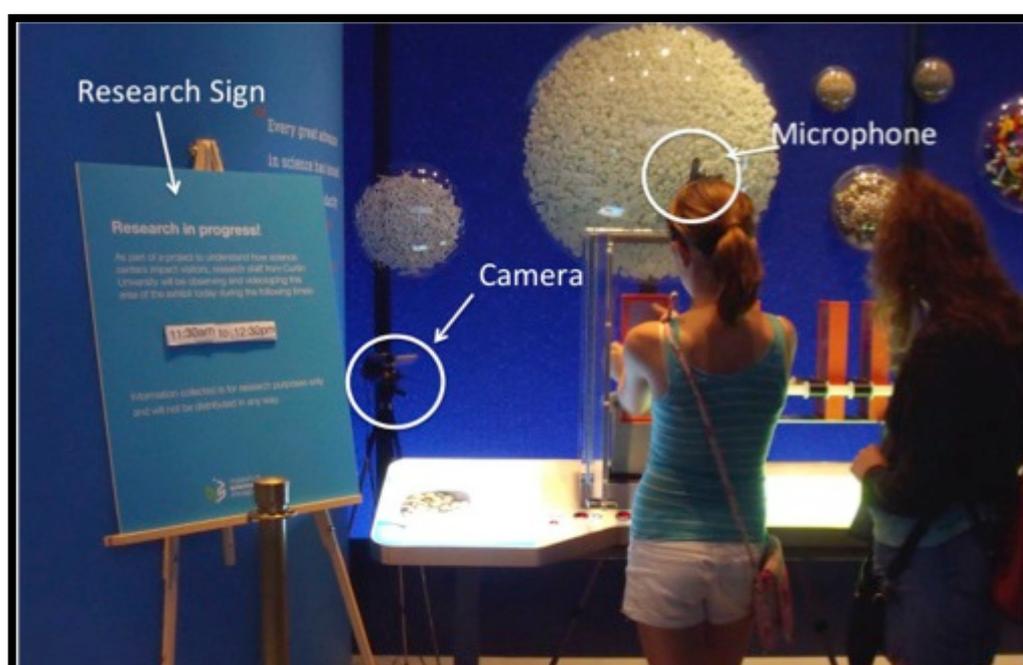
Figure 3.5 Data collection set up at the Granular Physics Brazil Nut exhibit.

Data Analysis

The video data collected at the Granular Physics "Brazil Nut Effect" and The Friction Table exhibits were analysed to determined the production quality of the video and audio recordings for its usability as data, and for the potential effects the camera, microphone and signs might have on visitor behaviours. The video data collected at The Chemical Reaction Table exhibit were analysed using the Studiocode coding software and the VBLF as shown in Table 2.1 (Chapter 2). The gender and the age of the visitor were coded, as well as whether or not the visitor was part of a family or social. The age of the visitors coded in the sample is based on an estimate made by the researcher. The types of activities and learning behaviours that visitors engaged in

while interacting with this exhibit were coded, tabulated and plotted to produce a Visitor Engagement Profile of the exhibit.

 A qualitative, more in-depth analysis was performed on all instances of Breakthrough learning behaviours to identify triggers and characteristics of the experience that lead to this engagement level. Dialogue and activities in each Breakthrough instance were transcribed and emergent themes were explored through an iterative process of cross checking across all Breakthrough instances. A scan of the observational notes are found in Appendix 3C. Box 3.1 shows an example of visitor behaviours that were coded as Breakthrough level engagement and lasted four minutes and 45 seconds. In this situation, "mom" refers to prior knowledge which, in the VLFB is categorized as Breakthrough behaviour.

Box 3.1 Example of a Breakthrough level visitor interactions at the Chemical Reaction Table

Boy at Chemical Reaction Table; Mom arrives

Mom: "Oh, now you have to add Oxygen, now you have to find Oxygen. So take the Oxygen and add it to the Hydrogen (reaction occurs) Huh! You get hydrogen peroxide! You can bleach your hair with that". *She ruffles his hair. Boy laughs and asks her for another reaction.* "How about you add two Oxygens and one Hydrogen. Aaaahh! You've made water."

Boy laughs and looks very pleased. "Wahoo! What if…. What if…. "

Mom: "These are the elements. If you add two Hygdrogens and one Oxygen you get water!"

Boy: "What if you put this and this?" *Tries his combination on the table.*

Mom: "No, that doesn't make anything. How about your try Sodium. Ok, now add ….."

Son: "How about that one." *Points to an element.*

Mom: No, no, I want Chlorine." *Searches table for it.* "Where's the Chlorine?

Boy: "There?" *pointing to an element.*

Mom: "Ok let's bring it over here and see. Do you know what that is?"

Boy: "What?"

Mom: "That's table salt!"

Boy: "Oooooh!" *smiles and laughs.*

NOTE: This interaction continues for an additional 2 minutes beyond this transcribed exchange.

3.9.2 Results for Phase 1

Effectiveness of the data collection method

The production quality of the video data collected at the Granular Physics Brazil Nut Effect and The Friction Table was assessed and considered acceptable in that the sound was clear enough to hear most visitor conversations and the researcher could clearly see the body language, lip movement and activities of the visitors. Approximately three quarters of the visitors noticed the signs that were posted and appeared to read at least part of the text explaining the purpose of the filming. No visitors expressed concerns about being video recorded and only one visitor out of 300 approached the researcher to ask questions about the study during the 6-hour period of data collection. The data also revealed that, although visitors initially noticed the camera and the signs, they proceeded to interact with the exhibits as expected. Usual interaction with the exhibits was noted earlier and no noticeable differences were observed in the interactivity once the camera and microphone were in place. Similarly, Gutwill (2003) reported that visitor interactions with exhibits were not noticeably affected by the presence of the camera.

Validity of Visitor-Based Learning Framework

The sample of visitors at the Chemical Reaction Table was subdivided according to their highest level of interaction, that is, those who reached the Initiation Level only, those who reached Transition only, and those who reached the Breakthrough Level. This captures the number of visitors who engaged at the Initiation Level then moved on without further interactions, those who engaged at the Transition Level without further interactions, and finally capturing those visitors who engaged at the Breakthrough Level with the exhibit. These data are compiled to produce the Visitor Engagement Profile (VEP) (Figure 3.6) for the Chemical Reaction exhibit. The graph shows the percentage of visitors who reached, as a maximum, each level of engagement. Over half of the visitors who interacted with the Chemical Reaction Table either made references to their previous experience or knowledge, sought for or shared further information with others, or tested variables, becoming involved in the activity for an extended period of time, or any combination of these. Figure 3.7 shows the number of visitors who engaged in of each of the learning behaviours within the Breakthrough engagement level. For example, the majority of

visitors engaging at the Breakthrough level spent time *Seeking and Sharing* information with others.
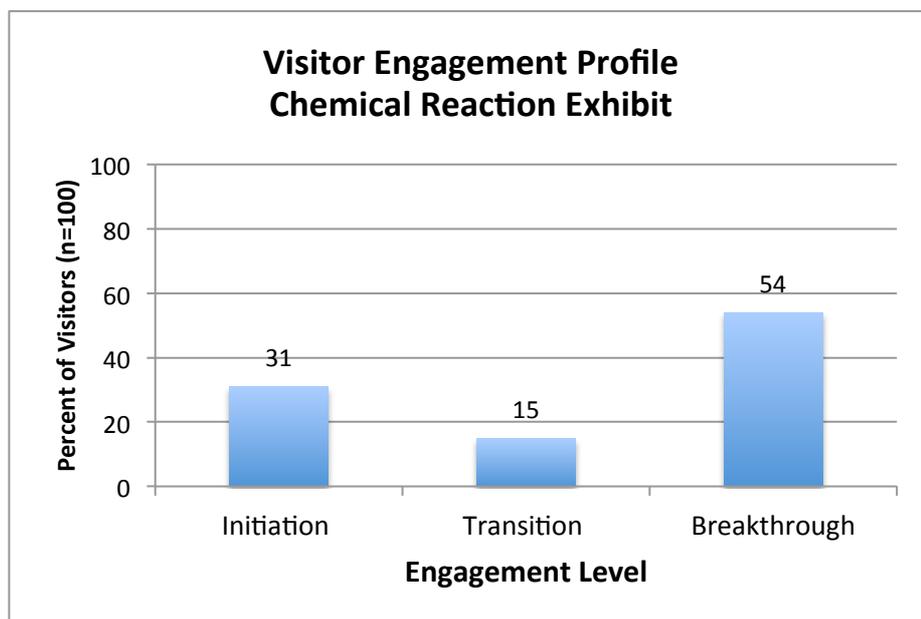
Figure 3.6 Highest level of engagement reached by visitors (%) at the Chemical Reaction exhibit in Science Centre 1.
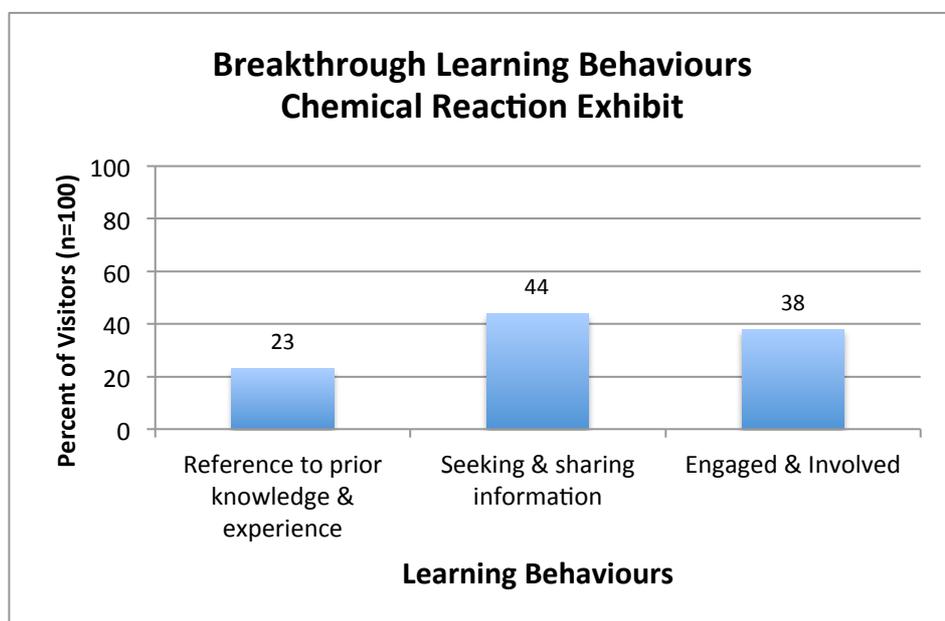
Figure 3.7 Percentage of visitors engaging in Breakthrough learning behaviours at the Chemical Reaction Exhibit in Science Centre 1.

Breakthrough level – Duration of interaction

In total, visitors interacted with the Chemical Reaction Table for an average of 3.02 minutes. Visitors who reached Breakthrough levels of engagement interacted with the exhibit for an average of 5.00 minutes. In a study that examined the holding times for 61 exhibits, Sandifer (2003) found that visitors spent an average of 1.6 minutes at individual exhibits. Thus, the above average holding time of this exhibit, combined with the finding that over half the visitors demonstrated Breakthrough learning behaviours, suggests that there are multiple learning opportunities offered by the Chemical Reaction Table exhibit, resulting in a more involved visitor learning experience. Further analysis of the visitor learning experience through qualitative analysis was conducted to determine elements of the exhibit experience that lead to Breakthrough levels of engagement and to the extended duration of the interactions.

Characteristics leading to Breakthrough learning behaviours

The qualitative analysis of all Breakthrough instances revealed themes and characteristics of the exhibit experience that lead to these Breakthrough learning behaviours and the results are outlined below.

- **Opportunities to relate to past experiences and knowledge:** Many visitors referred to their high school chemistry classes, remembered some chemical formulas and tested these with their families and friends. Statements such as *"Try to make some salt…. I know that one. It's NaCl", "Make water. That's easy. It's H_2O"* and*, "Let's start with Carbon, give me two"* demonstrate the immediate recognition that people experienced when attempting to create a chemical reaction.

- **Enabling social interactions**: The design of the table encouraged social interaction that most visitors took full advantage of by doing the activity with others. Conversations demonstrating the sharing of information included comments like: *"Wanna know about the things I know… if I can remember…"*, *"You can try anything you want really. Here, just mix any 2 and it will give you what you made. Wanna try?"* and, *"You add phosphate and tell me what happens"*.

- **"Early assured success"** is a concept proposed by (Allen, 2004) and describes the need for exhibits to provide relatively immediate success for visitors in order to engage them in a learning experience. This was certainly the case with the Chemical Reaction Table. Visitors were more likely to remain engaged in the

exhibit and continue on to Breakthrough learning behaviours if they produced a reaction with their first attempt. They also seemed willing to work on the exhibit for about 60 seconds without the result of a chemical reaction before giving up and moving on to another exhibit. Visitors who could not succeed at producing a chemical reaction within 30 to 60 seconds were more likely to walk away after engaging in only Initiation learning behaviours. As the results show however, more than half of the visitors did become motivated and interested enough to invest an average of five minutes in exploring the different possibilities presented by the exhibit.

- **Many opportunities and outcomes**: Visitors who engaged in Breakthrough level learning behaviours had multiple and varied interactions with the exhibit. There are literally thousands of possible chemical combinations to create chemical reactions at this exhibit and Breakthrough level visitors tested on average, four combinations.

The social nature of making meaning and learning means that visitors interacting around the exhibit engaged in conversations about the chemical reactions they were producing and the resulting products. It can be suggested that the ability to manipulate variables, test them and succeed, complemented by the ability to use previous knowledge and experiences, all combined to lead 54% of the visitors in Breakthrough level learning behaviours and to a relatively long interaction duration that averaged five minutes.

3.9.3 Conclusions for Phase 1

This pilot study confirmed that data collection method and the ethical procedures could be implemented successfully in another setting, that the type of data required for the larger study could be collected in other institutions, that the effect of the signs, camera and microphone have very little impact on visitor behaviours and that the framework effectively captures visitor learning behaviours in other science centre settings.

Coding visitor behaviours and dialogue in the data collected at Science Centre 1 revealed the robustness of the VBLF. All behaviours displayed by visitors, in relation to their interaction with the exhibit experience, could be accounted for and were adequately described by the activities and learning behaviours in the framework. The pilot study demonstrated the applicability of framework in other settings,

capturing the essence of the learning experience at the Chemical Reaction Table exhibit. Findings showed very similar patterns found in previous studies conducted with this framework at Science North, where the evaluation tool has been in use since 2008.

In return for allowing the researcher access to its exhibits and visitors, a report on the learning impact of the Chemical Reaction Table was prepared for Science Centre 1 and can be found in Appendix 3D. Staff at the science centre were particularly interested in understanding the visitor learning experience at this exhibit because they were considering making some modifications to extend the learning opportunities. The findings described in this chapter were included in the report to assist the staff and the designers of the Chemical Reaction Table in their project. The report was submitted to them in December 2012.

3.10 Summary of Chapter 3

In this chapter, a three-phased, mixed-methods research design was proposed to answer the research questions of this study. The rationale for selecting the research sites, the exhibits and the research participants was explained and an overview of the methods for collecting and analysing data for all three phases of the study were described. The ethical considerations required for the proposed research were outlined and previous work by Gutwill (2003) was described to support this study's video data collection methods. A synopsis of this study's three phases was also given.

As stated in Section 3.9, the two goals of the first phase of this research were to serve as a trial of the data collection methods for the other phases of the study, and to assess the validity of the VBLF by applying to science centre data collected from a different setting. The results of Phase 1 reported in this chapter demonstrated the effectiveness of the proposed data collection methodology and supported the use of the VBLF as valid instrument to assess the learning impact of exhibit in science centre settings. The next phases of the study will investigate the effectiveness of the VBLF in zoo and aquarium settings at capturing the visitor learning experience with live animal exhibits.

Chapter 4
Phase 2 Exploring visitor learning behaviours in zoos and aquaria

Chapter 3 reported that the learning behaviours described in the VBLF were validated in a science centre setting other than the one in which the Framework was developed. Further, the pilot study part of Phase 1 also provided evidence that the data collection method and the accompanying measures taken to ensure that visitors were fully informed about the research were both feasible and effective. In this next phase of the research project, the framework was applied to video data collected in Aquarium 1 and in Zoo 1 to assess whether or not it effectively captured the visitor learning experience in aquarium and zoo and settings. In this chapter, the data collection procedures for Aquarium 1 and Zoo 1 are described, together with details of the data collected, and an outline of the analyses performed on that data. Two methods of analysis occurred simultaneously in Phase 2 and will be described in the following sections. In the first part of Phase 2, the method was quantitative coding of learning behaviours as outlined in the Original Framework. In the second part of Phase 2, the methods involved qualitative, interpretative analysis of visitor behaviours and dialogue to identify potential gaps in the framework and patterns of learning behaviours in zoos and aquaria. The results of these analyses determined whether or not the existing learning behaviours framework needed be revised and modified to capture the visitor experience in zoo and aquarium settings and if so, the findings from this qualitative analysis would inform a revision of the existing framework.

4.1 Applying the Visitor-Based Framework in Aquarium 1 and Zoo 1

The following sections describe the procedures used to collect data at the Aquarium 1 and Zoo 1 research sites, the samples of visitors, the data collected, and the analyses performed. Site visits took place before data collection to select the exhibits that would be part of the study and to choose the locations for the camera, microphone and tripod in consultation with the contact person from each institution. The exhibit selection was guided by the criteria outlined previously in Chapter 3, Section 3.4. At Aquarium 1, the Jellyfish exhibit, the Sharks and Fish exhibit and the

Sea Otters exhibit were chosen and are described Section 4.1.1. The exhibits chosen at Zoo 1 were the Gorillas and the Polar Bears exhibits and they are described in Section 4.1.2.

4.1.1 Exhibits at Aquarium 1

Jellyfish exhibit

This temporary special exhibit at Aquarium 1 featured more than 10 different species of jellyfish in aquaria throughout the exhibition space. One of these jellyfish aquaria housing the Japanese Sea Nettle was chosen for this study because of its prominence in the exhibition space and the existing infrastructure to mount a camera and a microphone. Figures 4.1 and 4.2 show part of the special exhibition and the Japanese Sea Nettle aquarium exhibit. Signage about jellyfish, different species and their characteristics accompanied most of the individual aquaria. Figure 4.3 shows two examples of the signage near the Japanese Sea Nettles aquarium. The recent addition of this exhibition made it very popular with visitors and ensured successful data collection.

Figure 4.1 Entrance to the Jellyfish exhibition at Aquarium 1.

Figure 4.2 Japanese Sea Nettle exhibit at Aquarium 1.

Figure 4.3 Signage adjacent to the Japanese Sea Nettle exhibit.

Sharks and fish exhibit

This habitat is a large, 1,500 cubic metre aquarium that houses over 500 species of fish, rays, eels and coral. There are 20 sharks in this exhibit. The popularity and vast viewing area of the exhibit made it ideal for setting up a camera and microphone for data collection. Figure 4.4 shows the large viewing space visitors have at this exhibit while Figures 4.5 and 4.6 show the type of signage that accompanies the exhibit. The constant activity in the aquarium attracted many people to the viewing area and guaranteed large numbers of visitors for optimal data collection.

Figure 4.4 Sharks and Fish exhibit at Aquarium 1.

Figure 4.6 Signage mounted on wall adjacent to large aquarium explaining shark diet, habitat and other facts

Figure 4.5 Interactive computer screens as signage for Shark and Fish exhibit.

Sea otters exhibit

The habitat for the sea otters is a re-created cove, with rock faces, flat landings for the animals to sleep or feed and a 150 cubic metre salt-water pool for the otters to swim in. Visitors can get close to this pool to view the sea otters underwater and observe their natural behaviours. Figure 4.7 shows the entire Sea Otters exhibit while Figures 4.8 and 4.9 show two examples of the signage that visitors can read as they engage with this exhibit. The popularity of the very active sea otters and the large open space made this exhibit ideal for data collection.

Figure 4.7 Sea Otters exhibit at Aquarium 1.
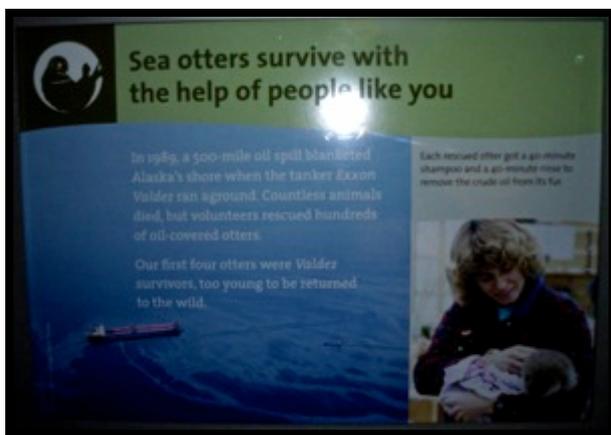
Figure 4.8 Signage found on the right of the viewing window at the Sea Otter exhibit.

Figure 4.9 Signage mounted on the walls of the Sea Otter exhibit, describing features of the animals.

4.1.2 Exhibits at Zoo 1

Gorillas exhibit

This exhibit is a very large, open area within a two-acre African pavilion at Zoo 1. Although it is partially indoors, the family of eight Western Lowland Gorillas spends most of its day in the outdoor portion of the habitat, using all the structures, trees, branches and the ground to move about the enclosure. A large silverback is the dominant male of the group with several females and offspring making up the rest of the family. This exhibit was chosen for its popularity with visitors and its easily accessed outdoor space. At the time of data collection, there were two young gorillas in the family who were tended to and cared for by one of the adult females. Figures 4.10 and 4.11 show the parts of Gorillas exhibit. A large signage board displayed next to the viewing area of the habitat outlined the family tree of the family of Gorillas.

Figure 4.11 Viewing area in front of the Gorillas exhibit at Zoo 1.
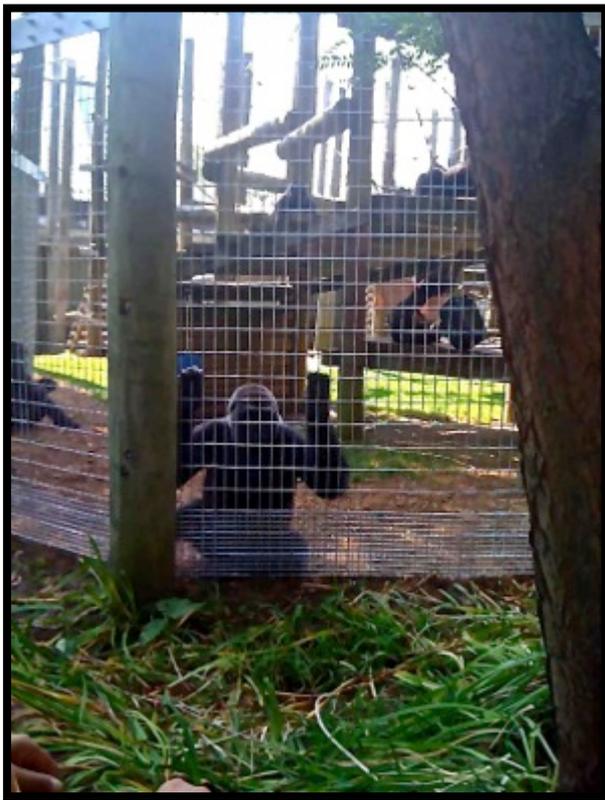
Figure 4.10 Part of the Gorillas exhibit at Zoo 1.

Polar Bear exhibit

Within a 10-acre Tundra pavilion is the five-acre, re-created tundra landscape that is home to the four Polar Bears at Zoo 1. This exhibit includes a very large pool,

grassy and rocky terrain, and a den with a viewing glass where visitors can get close to a sleeping Polar Bear. Figure 4.12 shows the large viewing glass at the entrance of the Polar Bear exhibit while Figures 4.13 shows a Polar Bear in the den area and Figure 4.14 shows the viewing window inside that den. This exhibit is very popular with visitors, has large viewing areas and can easily accommodate a camera and microphone set up, making it ideal for data collection.

Figure 4.12 The Polar Bears exhibit, part of the outdoor viewing area.

Figure 4.13 Polar Bear in the den as seen through viewing window.
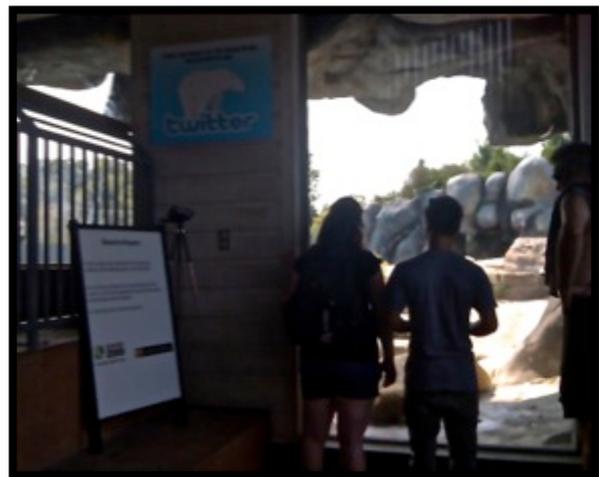
Figure 4.14 The Polar Bears exhibit viewing window.

4.1.3 Data collection procedures

Data collection at Aquarium 1 took place on Thursday July 28th, 2011, during the summer tourism period. At Zoo 1, data collection occurred on September 3rd, 2011, at the end of the summer tourism period. At both institutions, the camera and microphone were placed for optimal video recording at each of the selected exhibits, at different times throughout the day. With the assistance from each institution's staff, the camera and the microphone were placed as near to the exhibit as possible without obstructing it or disrupting the visitor experience. For the Jellyfish exhibit, for example, the decision was made to mount the camera above the aquarium being video recorded because a tripod on the exhibit floor obstructed passageways and was identified by staff as a safety concern. Figures 4.15 to 4.19 show examples of the camera and microphone set up for each exhibit.

Figure 4.15 Camera and microphone placed on top of the Jellyfish exhibit at Aquarium 1.

Figure 4.16 Camera and microphone at the Sea Otters exhibit at Aquarium 1.

At both institutions, a research sign was posted at the entrance next to the admissions desk for the duration of data collection. Two research signs were placed at the entrance to each exhibit area that was being filmed and, if not obstructive, a fourth research sign was placed on the camera's tripod or beside the exhibit itself. The wording on the signs for Aquarium 1 was decided with the institution's contact person, who also required that the signs carry Aquarium 1's logo, not Curtin University's logo. Similarly, the wording on the research signs was decided with the contact person at Zoo 1 and their logo, along with Curtin University's, was included on the signs.

Figure 4.17 Camera, microphone and research sign placed on the
right side of the Sharks and Fish exhibit, Aquarium 1.

Figure 4.18 Camera and research sign
placed at the Polar Bears exhibit, Zoo 1.

Figure 4.19 Camera and research sign placed in
front of the Gorillas exhibit, Zoo 1.

Zoo 1 staff requested that small A4 research signs be posted at various
locations throughout the zoo where guests would be most likely to see them, along
with the large poster sized research signs that were placed at selected exhibits. The
research sign used at Aquarium can be seen in Figure 4.17 and the research sign used
at Zoo 1 can be seen in Figures 4.18 and 4.19.

The data collection took place at different times throughout the day for each
exhibit. For example, at Aquarium 1, the Jellyfish exhibit was video-recorded in the
morning while the filming at the Sharks and Fish aquarium occurred in the first part
of the afternoon and the Sea Otters exhibit was video-recorded during the later part of

the afternoon. The Gorillas exhibit was filmed in the morning at Zoo 1 and the Polar Bears exhibit was video recorded in the early afternoon.

Once the signs, camera and microphone were in place, the camera was turned on to video record the activities of the visitors who approached and engaged with the selected exhibit. Data collection proceeded as previously described in Phase 1 of this research (Section 3.9). Only a few visitors (five in total) asked about the camera and the research activity. The researcher answered their questions accordingly, mostly explaining the purpose of the study and the use of the video footage as data exclusively for the purposes of this research.

4.1.4 Visitor Sample

Visitors who stopped to view the animals in their respective exhibits, in the camera's field of view and within the audio reach of the microphone, were included in this sample of the target population of aquarium and zoo visitors. Groups of children that were part of a camp program or were not accompanied by their parents were not included in the sample. One hundred visitors at each of the selected exhibits made up the sample of visitors that were observed and coded for learning behaviours in the video recording. The age of the visitors observed in the sample is based on an estimate made by the researcher. Infants and very young children were not coded unless they could be clearly understood, that is aged about three years old. Also, the researcher coded a visitor as part of a family group based on observations of the group and their conversations. Table 4.1 displays details of the sample of visitors at Aquarium 1 and Table 4.2 shows the same details for the visitor sample at Zoo 1.

Table 4.1 Sample of Visitors Observed at Each Exhibit at Aquarium 1.

Exhibit	Males	Females	Children (3-17 yrs)	Adults (18+ yrs)	Part of a family group
Jellyfish	34	66	57	43	77
Sea Otters	34	66	35	65	84
Sharks & Fish	53	47	50	50	65
Total (n)	121	179	142	158	226
Percentage	40	60	47.3	52.7	75.3

This sample can be said to be representative of the aquarium's visitors. An internal report from Aquarium 1, prepared in 2011 and shared with the researcher documented that during peak summer tourism, 61.5% of adult visitors are accompanied by children under the age of 18. This report also stated that 90% of the family groups have at least one male with them, and 94% of the family groups have at least one female (Aquarium 1, 2011). The sample of visitors captured for this study shows more females than males were captured by the camera as they interacted with the exhibits, and slightly more children than adults. This sample has an estimated 75.3 % of visitors as part of a family group.

The Zoo 1 visitor sample, shown in Table 4.2, was similarly representative of the zoo's usual visitors. According to documents published online by Zoo 1, 45% of their visitors in 2012-13 were between the ages of 0 and 12 years, while 55% were 13 years of age or older. Since the age categories recorded in these samples span different years than in the Zoo 1 report, it can be suggested that the number of visitors under the age of 18 would be similar to the demographics recorded by the zoo and therefore representative of the zoo's usual visitor demographics. Zoo 1 also reported that 58% of the adult visitors are accompanied by one or more children, reflecting the assumption that families are a major component of the zoo's visitors. An estimated 83% of this study's sample of visitors was found to be part of a family group. This is higher than the 58% reported by Zoo 1 and could be explained by the tendency for families to congregate around the viewing areas and thus be captured by the camera during data collection. Similar to the sample in this study, Zoo 1 reported online that 62% of their visitors are female.

Table 4.2 Sample of Visitors Observed at Each Exhibit at Zoo 1.

Exhibit	Males	Females	Children (3-17 yrs)	Adults (18+ yrs)	Part of a family group
Gorillas	39	61	35	65	90
Polar Bears	41	59	28	72	76
Total (n)	80	120	63	137	166
Percentage	40	60	31.5	68.5	83

4.1.5 Quantitative Data Analysis

All of the video data captured at Aquarium 1 and Zoo 1 were downloaded onto a computer and the video files were imported directly into Studiocode software for analysis. The video data for each animal exhibit at both institutions were analysed using the Original VBLF and Studiocode to code visitor learning behaviours and dialogue. This analysis was performed to evaluate the framework's effectiveness at capturing the learning behaviours in zoo and aquarium settings and to identify potential gaps in the framework for use in these settings.

As described in Chapter 3, Section 3.6, the video data are coded for learning behaviours using a coding window that is created in Studiocode. To recapitulate, instances of learning behaviours that fit the description outlined in the VBLF, are coded by clicking on the buttons that represent the visitor, the visitor's demographic information and the behaviour or behaviours that the visitor is engaged in. All of this information is embedded in the video file itself, and exported to a matrix for further analysis in Microsoft Excel. This was done for the three exhibits at Aquarium 1 and the two exhibits at Zoo 1, a total of five video recordings. Data analysis continued until 100 visitors were coded for each live animal exhibit at both institutions.

The learning behaviours data were then transferred to a Microsoft Excel spread sheet for further analysis. The sample of visitors was subdivided according to their highest level of interaction, that is, those who reached the Initiation Level only, those who reached the Transition Level only, and those who reached the Breakthrough Level. This captures the number of visitors who engaged at the Initiation Level then moved on without further interactions, those who engaged at the Transition Level without further interactions, and finally capturing those visitors who engaged at the Breakthrough Level with the live animal exhibit. The data are then compiled to produce Visitor Engagement Profile (VEP) graphs for each exhibit. These graphs show the percentage of visitors who reached, as a maximum, each level of engagement.

4.1.6 Aquarium 1 Results

Figures 4.20, 4.21 and 4.22 show the Visitor Engagement Profiles for the Jellyfish exhibit, the Sea Otters exhibit and the Sharks and Fish exhibit respectively. The differences that are immediately noticeable are that:

- most visitors at the Jellyfish exhibit (65%) engaged only at the Initiation Level,

- half of the visitors at the Sea Otters exhibit (50%) engaged in Transition behaviours,
- nearly an equal percentage of visitors engaged at all three levels of learning behaviours while viewing and interacting with the Sharks and Fish exhibit (38% Initiation, 32% Transition, 30% Breakthrough).
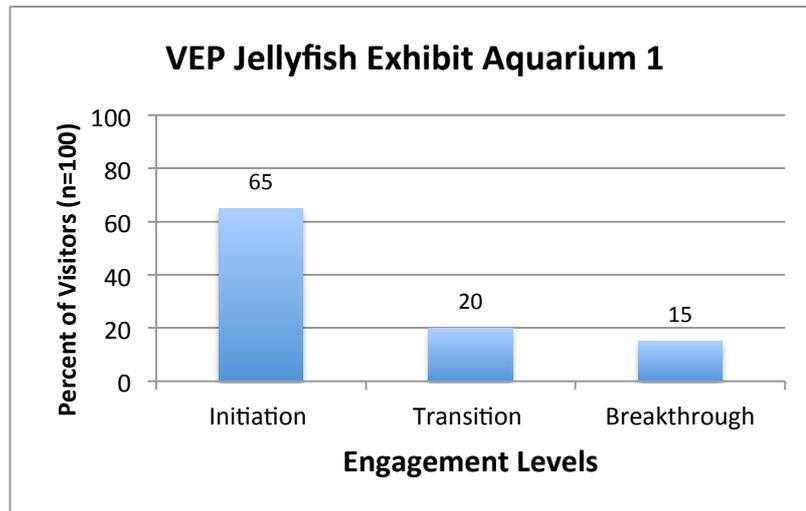
Figure 4.20 Highest level of engagement reached by visitors (%) at the Jellyfish Exhibit in Aquarium 1.
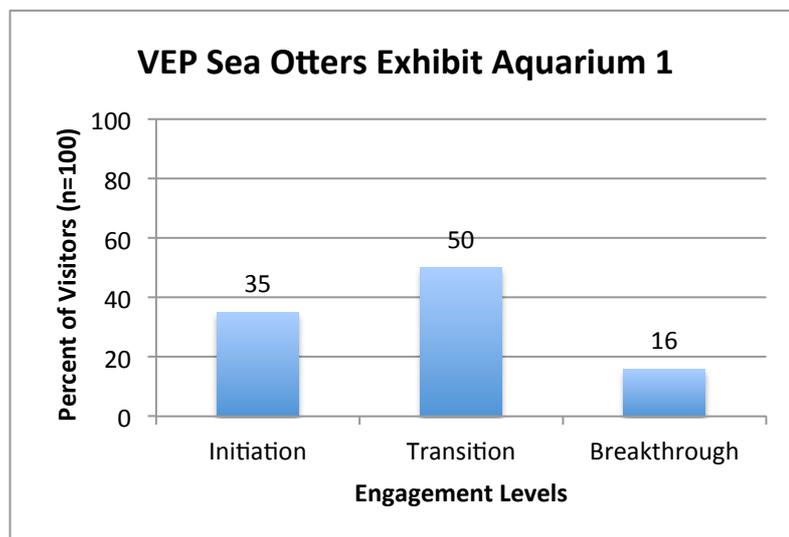
Figure 4.21 Highest level of engagement reached by visitors (%) at the Sea Otters Exhibit in Aquarium 1.
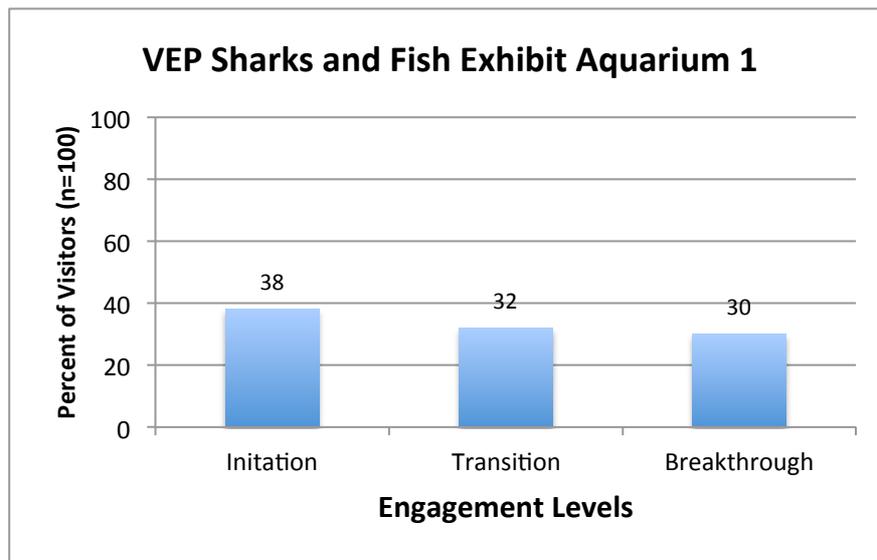
Figure 4.22 Highest level of engagement reached by visitors (%)
at the Sharks and Fish Exhibit in Aquarium 1.

Each of the exhibits presented visitors with varying levels of engagement opportunities and the framework was able to distinguish these levels between the exhibits. For example, many other Jellyfish aquaria surrounded the Jellyfish exhibit that is part of this study. All were illuminated and attractive and therefore competing for the visitor's attention. Parents and children alike would often say *"Let's keep going." "We'll find some bigger ones."; "I want to go see the next ones."* Not surprisingly, the majority of visitors engaged only in Initiation Level behaviours and moved on to view other Jellyfish exhibits nearby. The VEP for the Sea Otters exhibit shows that most visitors engaged in Transition types of behaviours, namely positive emotional responses through facial expressions and dialogue with family and friends. The sea otters were very active during the data collection, engaging visitors in observations and dialogue about the behaviour and physical traits of the otters. The Sharks and Fish exhibit has complementary interactive computers by the viewing area where visitors can engage in the identification of the fish they observe swimming by. This interactive element presented visitors with more opportunities to engage in Breakthrough behaviours as described in the framework.

4.1.7 Interpretation of Aquarium 1 results

The framework shows potential for capturing or assessing the visitor learning experience with live animal exhibits in an aquarium setting, but with some

modifications. Since the results of applying the framework to the visitor behaviours at Aquarium 1 showed that the majority of the visitors are not engaging in higher levels of meaning making while observing and discussing animal exhibits, one might conclude that animal exhibits do not provide opportunities for visitors to engage in deeper engagement and learning. However, closer observation of visitor behaviours suggested that the Original VBLF lacks behavioural categories and descriptions of activities that reflect the type of engagement that occurs with a live animal exhibit.

While coding learning behaviours using the framework, it became obvious, although not surprising, that many of the visitor behaviours and dialogue did not fit into the available categories of learning behaviours and types of activities. In other words, the descriptions associated with each of the learning behaviours in the framework were not an accurate reflection of what the visitors were doing and saying while they were experiencing the animal exhibit. The following paragraphs describe the types of activities and examples of behaviours that were observed that the Original VBLF failed to capture.

Initiation Engagement

Although most visitor learning behaviours in all three Aquarium 1 exhibits were coded as Initiation, the descriptions of those behaviours are not fully reflective of the visitors' experience with a live animal exhibit. In the Initiation Level, the Original Framework identifies the learning behaviours *Doing the Activity* and *Observing the Exhibit or Others Doing the Activity*. At live animal exhibits, like the Jellyfish or the Sea Otters, visitors did not have an opportunity to "do an activity" as they would have with an interactive in a science centre. In fact, the data analysis shows that no visitors engaged in "doing the activity" for either of these exhibits. Instead, visitors were searching for the animal, pointing to it, drawing other people's attention to it, observing and commenting on the animal's physical traits and behaviour, or taking a picture. It can be suggested that these behaviours represent an Initiation Level of engagement, similar to *Doing the Activity* and *Observing the Exhibit or Others Doing the Activity* with an interactive exhibit in a science centre.

Transition Engagement

The Transition Level of engagement refers to the affective aspect of the visitor's learning experience with an interactive exhibit. The visitors in the Aquarium 1 sample expressed very strong emotions towards the animals they were observing in the

exhibits and were coded as having displayed the learning behaviour of *Emotional Response* in the Transition Level of engagement. However, the strong display of emotion, whether it be affection or fear, was pervasive and the most common form of interaction visitors had with all the animal exhibits. For example, many visitors in the Jellyfish sample expressed awe and fascination through their facial expressions and words like *"They are beautiful!" "Amazing!" "Wow!"* and *"Spectacular!"*. In addition to these verbal cues, many visitors expressed a desire to interact or connect with the animal, either through physically coming into contact with the glass of the aquarium in the Sharks and Fish and the Jellyfish exhibits or by 'speaking' to the animals, like the Sea Otters. The descriptions of activities and behaviours in the Transition engagement level in the existing framework do not capture this heightened level of affective responses to the live animal exhibit.

With the live animal exhibits at the aquarium, visitors often looked for other types of animals within the habitat or more individuals of the same species, which can be coded as *Repeating the Activity*. Once again however, the descriptions and the types of activities found in the existing framework do not reflect this type of behaviour, referring instead to the act of doing the activity of an interactive exhibit more than once, hence becoming more engaged with the learning experience. It can be suggested that visitors become more engaged with the experience of an animal exhibit as they seek more animals within a habitat. The data analysis however shows that very few visitors engaged in *Repeating the Activity* as it is described in the framework.

Breakthrough Engagement

Breakthrough types of learning activities, as they are described in the framework, refer to a visitor's deeper cognitive engagement with the exhibit's content. Without the interactivity of a science centre exhibit, the descriptions of the Breakthrough behaviours fell short of capturing the nature of this higher order learning experience in Aquarium 1. For example, while some visitors referred to previous knowledge or experiences while viewing the live animal exhibit, these references were usually specific to the animal species they are observing, or to similar experiences at another institution with that animal in particular. And although visitors in Aquarium 1 engaged in social interactions to make meaning of the experience, these interactions were characterized by detailed discussions of what they observed

the animal doing, or items in the animal's habitat, and speculations about the reason for the animal's behaviour or physical traits. Inquisitive behaviours like the manipulation and testing of variables to produce different outcomes, as described in the Original VBLF, simply do not reflect the deeper cognitive experience one might have while observing an animal in its habitat exhibit.

It was necessary to take observational notes while coding the video data, to better understand and to capture the learning behaviours and types of activities that are not in the VBLF. This data collection and analysis is discussed further in Section 4.2. However, to illustrate how the existing framework does not capture Breakthrough engagement activities, Box 4.1 contains observational notes that describe a father and son interaction as they observed the Sea Otters Exhibit for nearly 15 minutes.

Box 4.1 Observational notes of visitors at Sea Otter Exhibit

> *Dad and son observing otters.*
>
> *Dad very involved in observing, describing and speculating about behaviour. Engages son in conversation about otter behaviour and they remain there for approximately 15 minutes, engaged in the activity of observing, describing and speculating.*
>
> *Dad: "They do the same thing over and over again. He goes over there, sticks his head up, comes back over here… "*
>
> *Son asks "What do they do that for?"*
>
> *Dad: "See, he just did it again. He does his routine, let's watch him again."*

The engagement level seen here is high and seems similar to a deep engagement with an interactive in a science centre, but the descriptions of the activities and the learning behaviours in the Original VBLF Framework do not reflect this kind of engagement with an animal exhibit. For example, in the Original VBLF, the Breakthrough behaviour *Engaged and Involved* is described as "engaging in inquisitive behaviour, exploratory actions such as repeating the activity several times", "doing the activity as a means to an end, or meeting a challenge" or "experimenting, testing variables, looking for different outcomes" (see wording for Breakthrough Learning Behaviours in Table 2.1).

Figure 4.23 shows the average percentage of visitors engaged in each level of engagement for all three live animal exhibits. A more detailed analysis of each the Initiation engagement level for all exhibits shows how the framework's learning behaviours and activities do not reflect the types of behaviours that visitors engage in while visiting an animal exhibit. For example, Figures 4.24 shows that only the visitors at the Sharks and Fish exhibit were coded as *Doing the Activity*, which is the base level of a visitor interaction with an exhibit. Visitors were coded as *Doing the Activity* at the Sharks and Fish exhibit when they were observed interacting with the computer touch screens in front of the large aquarium. This provides evidence that the nature of the learning experience in an aquarium setting differs from that of science centres, where direct interaction and manipulation of exhibits is much more frequent and common. Clearly the learning behaviours framework needs to be modified to capture context-specific learning behaviours for aquaria, to better capture the learning experience that may be occurring and not detected by the activities and learning behaviour descriptions of the existing framework.
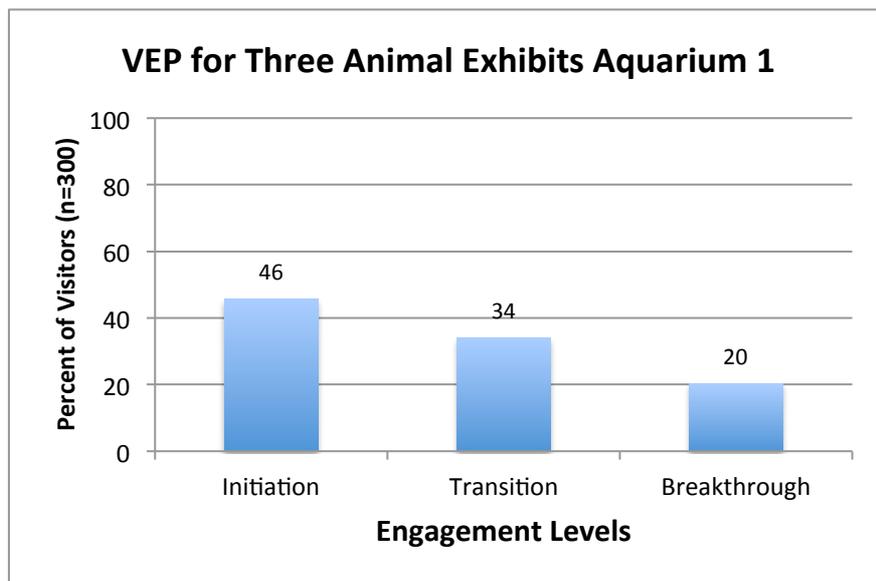
Figure 4.23 Highest level of engagement reached by visitors (%) for three live animal exhibits in Aquarium 1.
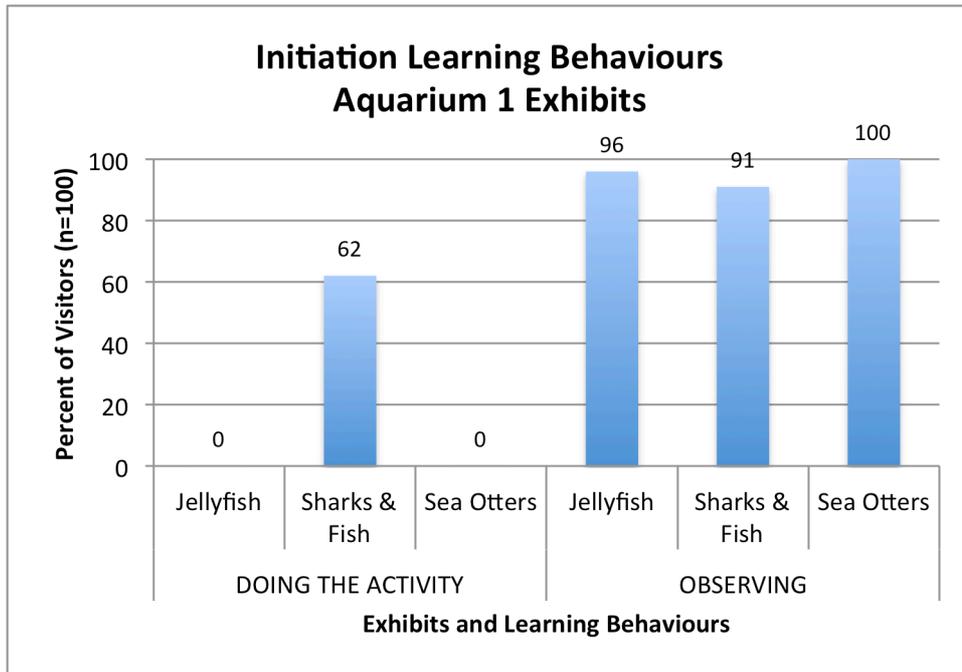
Figure 4.24 Percentage of visitors engaging in Doing the Activity and Observing Learning Behaviours at the Jellyfish, Sea Otters, and Sharks and Fish exhibits at Aquarium 1.

The results from the quantitative analysis of the Zoo 1 video data in the following section will add further information, contributing to the assessment of the framework through its application to the visitor experience with live animal exhibits in a zoo setting.

4.1.8 Zoo 1 Results

Figures 4.25 and 4.26 show the Visitor Engagement Profiles for the Gorilla exhibit and the Polar Bear exhibit respectively. As in the results for Aquarium 1, the framework was able to distinguish between the different visitor experiences at two different live animal exhibits. The differences captured are as follows;

- About a third (37%) of visitors at the Gorilla exhibit engaged in Breakthrough Level behaviours while only 11% of visitors at the Polar Bear exhibit reached that level of engagement.

- Most of the visitors (65%) at the Polar Bear exhibit engaged in Transition Level.

81
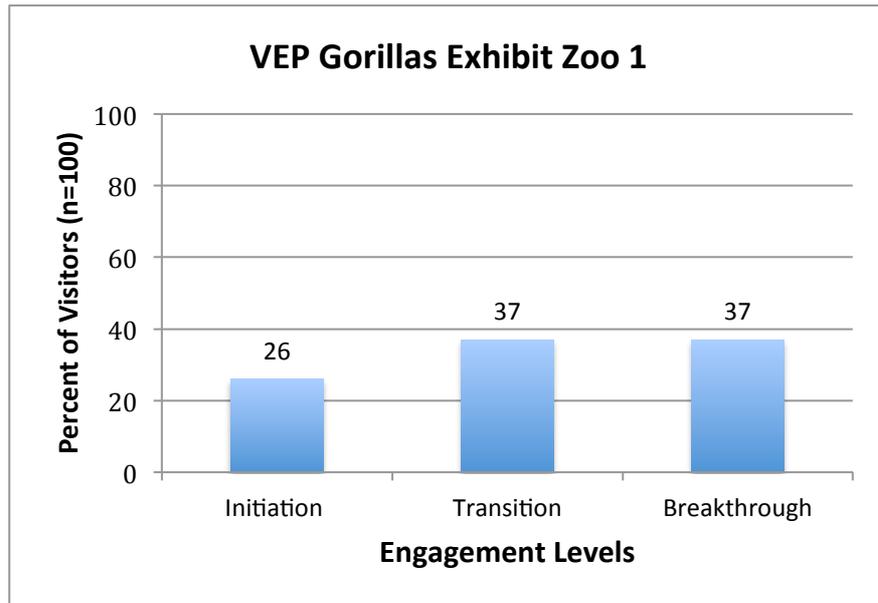
Figure 4.25 Highest level of engagement reached by visitors (%)
at the Gorillas exhibit in Zoo 1.
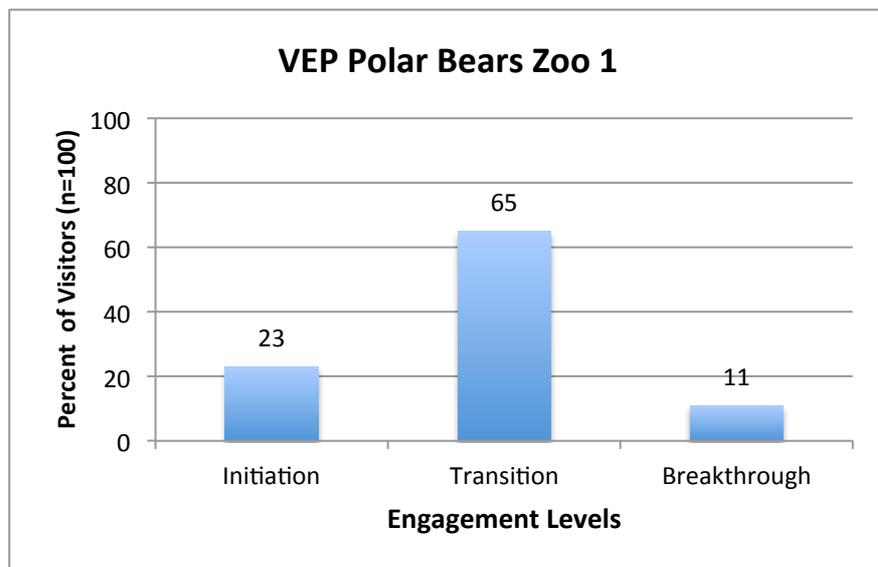
Figure 4.26 Highest level of engagement reached by visitors (%)
at the Polar Bears exhibit in Zoo 1.

4.1.9 Interpretation of Zoo 1 results

The quantitative analysis of the Gorilla exhibit and the Polar Bear exhibit
visitor experiences shows once again that the learning behaviours framework has the
potential to be an effective tool in assessing the learning impact of live animal
exhibits through its ability to distinguish between different exhibit experiences

attributable to the animal, its activity and interactive exhibit elements. Modifications to the descriptors are required however to best capture the nature of that experience. The results for the Gorilla exhibit are particularly worth noting because the framework captured 37% of visitors sampled engaging in Breakthrough Level learning behaviours. This is higher than other live animal exhibits evaluated for this phase of the study. Figure 4.27 shows that, in the Breakthrough learning behaviours, visitors engaged mostly in *Seeking and Sharing Information* and *Referring to Prior Knowledge and Experience*. Visitors can be coded as engaging in one or more learning behaviours within each engagement level.
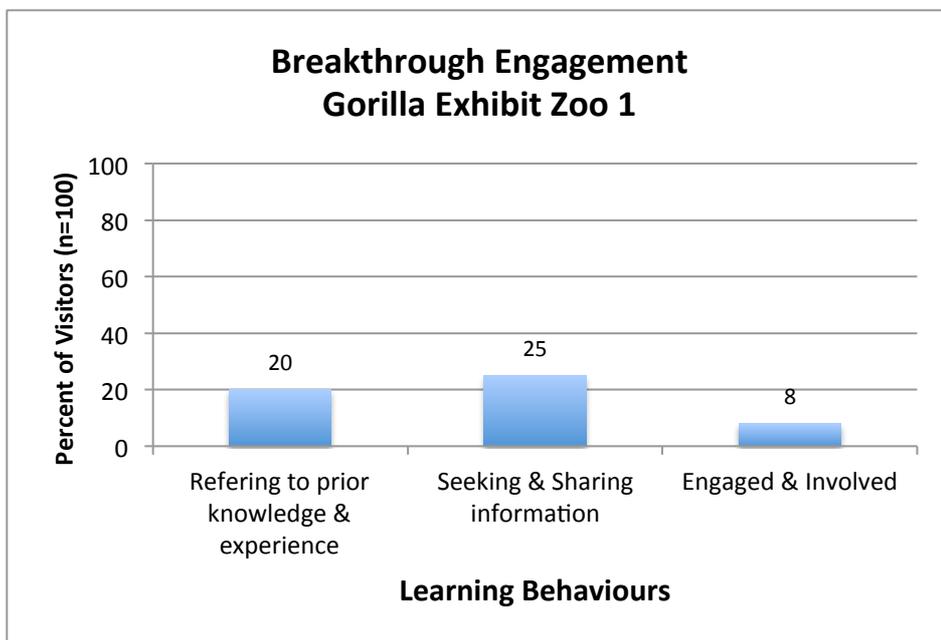
Figure 4.27 Percent of visitors engaged in Breakthrough learning behaviours at the Gorillas exhibit in Zoo 1.

The group of Gorillas in this exhibit included five young gorillas; a mother, her baby, two other adult females and a dominant male. The behaviour of the gorillas provided visitors with much to discuss among themselves about family structure and individual behaviours. Visitors made comparisons based on their own family or other family structures with which they were familiar. Furthermore, their comments reflected the fact that the gorilla behaviour was more human-like than the behaviour of other animals in exhibits and it was therefore more natural to make such comments. Studies have shown that this is what usually happens at primate exhibits (Myers et al.,

2004). It was clear from the visitor observation data that the animals and their activities played a significant role in engaging visitors in conversations that led to meaning making. Visitors in the Breakthrough Level of engagement also sought more information about the family of Gorillas on the labels and large display board adjacent to the habitat that listed the names of the Gorillas and their position in the group. Similarly, visitors in this sub-sample referred to prior knowledge they had about the Gorillas and primates in general to make meaning of what they were viewing in the exhibit as demonstrated by statements such as *"Their hands are just like ours, with nails and everything"* and *"Like Gorillas in the Mist. These are our closest relatives, like 90% of our DNA"*.

The Polar Bears exhibit produced similar results to those from the Sea Otters exhibit at Aquarium 1. The framework's descriptions of Learning Behaviours, in all Engagement Levels, did not effectively reflect the behaviours and dialogue observed as visitors engaged with the Polar Bear exhibit. For example, as was the case with the Sea Otters, visitors frequently expressed awe and wonder for the polar bears they were viewing with comments like *"Wow!", "Amazing!", "Beautiful!"* The amazement visitors experienced is also reflected in comments like *"He's huge!"* and *"Look at the size of this paws!"*. The strongly affective nature of this type of conversation is not captured in the framework and suggests again that, although effective at distinguishing between various types of exhibits, the framework should be revised if it is to be successfully used to assess the learning impact of animal exhibits.

Figure 4.28 shows the average engagement levels for both the Gorilla and the Polar Bear exhibits. Figure 4.29 shows the percentage of visitors engaging in Initiation Level learning behaviours and further demonstrates that the descriptions of these learning behaviours do not capture the context-specific nature of the activities visitors engage in while engaging with a live animal exhibit. As in Aquarium 1, observational notes were taken while coding the Zoo 1 video data, to better understand and describe the learning behaviours that are not currently found in the learning behaviours framework. This data collection and analysis is discussed further in Section 4.2.
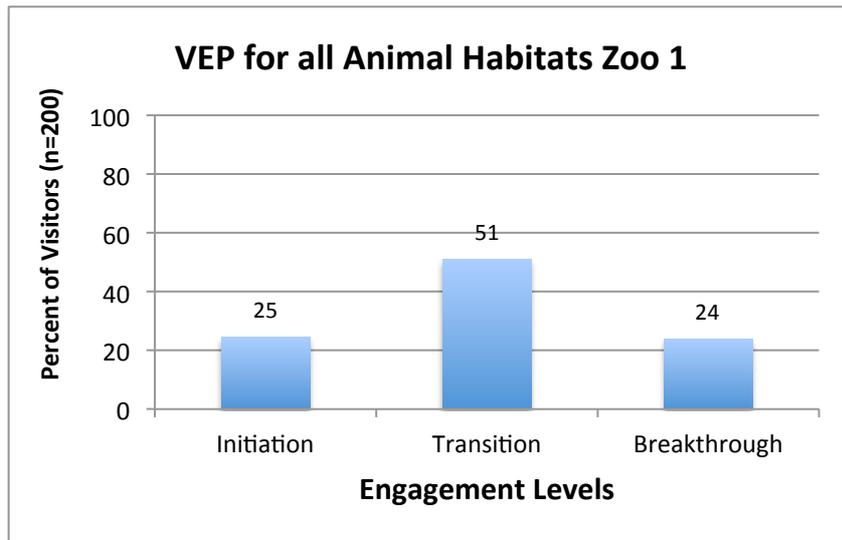
Figure 4.28 Percentage of visitors in each engagement level of learning behaviours for two animal exhibits at Zoo 1.
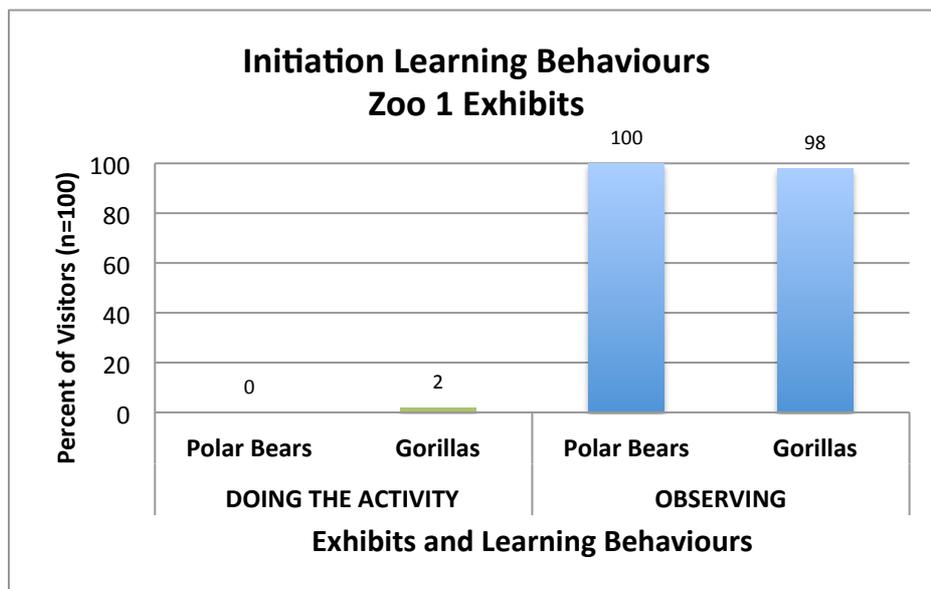
Figure 4.29 Percentage of visitors engaging in Doing the Activity and Observing learning behaviours at the Polar Bears and Gorillas exhibits at Zoo 1.

4.1.10 Conclusions from quantitative data analysis

The results from the quantitative analysis of the visitor experience with aquarium and zoo live animal exhibits showed that the VBLF can be a useful tool for evaluators to gain some information about the visitor engagement behaviours elicited by the exhibits, and about potential impact of exhibits on visitor learning. It was able to distinguish between different types of live animal exhibits, particularly between

those with interactive elements and those without. However, the analysis process provides sufficient evidence to conclude that the learning behaviours framework needs to be refined and modified to better capture the context-specific learning that occurs while visitors engage with a live animal exhibit. The nature of the learning experience is different than that described by the Original VBLF which was developed in a science centre context.

4.2 Qualitative Analysis of Behaviours and Dialogue

In addition to the quantitative analysis, observational notes were taken concurrently with coding the video data, to describe relevant visitor activities that seemed not to be captured by the learning behaviours identified in the Original Visitor-Based Learning Framework. This first pass of the video data was followed by repeated viewings to note details, describe visitor activities and to transcribe the dialogue. The quality of audio was sometimes quite poor due to the ambient noise in the aquarium setting. The cavernous space of the Sharks and Fish exhibit, along with the large number of visitors speaking simultaneously and excitedly, made hearing individual voices challenging. The following strategies were used to maximize the accuracy of reporting/noting of visitor conversations in the video data:

- Review the video repeatedly until sense is made of the conversation
- Use high quality headphones while listening the video
- Observe visitors' lips while listening carefully to their words

Although it was not possible to transcribe every word uttered by all the visitors observed in the video data, the strategies employed resulted in approximately three quarters of the conversations being captured and transcribed. The transcriptions of dialogue and detailed observational notes of visitor activities became the qualitative data that were then analysed for emergent patterns and themes. This analysis was guided by the qualitative analysis methods described by M. Miles and Huberman (1994) and Patton (2002). This iterative analysis process involved the following procedures:

1. Highlighting visitor activities and dialogue that are indicative of the visitor making meaning from his or her experience with the live animal exhibit, whether social, affective or cognitive in nature.

2. Ensuring that these activities and dialogue are not already captured by the examples of learning behaviours in the existing framework.

3. Grouping visitor activities and dialogue in themes that reflect similar intent or meaning in the visitor's experience.

4. Repeating the above steps with the video data from both Aquarium 1 and Zoo 1 until theoretical saturation is achieved, that is, until all relevant qualitative data fits into the themes identified by the analysis.

All observational notes and transcripts of dialogue were done using notebooks, a pencil and different coloured highlighters were used to reveal categories and themes within those notes. An example of observational notes taken while viewing the video data from the Gorillas exhibit has been scanned and can be found in Appendix 4A. Examples of observational notes from the Gorillas, Polar Bears and Sea Otters exhibits were typed to make them more easily legible for readers, and passages representing emergent themes are highlighted. These examples can be found Appendix 4B, 4C and 4D. The five context-specific behaviour themes are described in the next section.

4.2.1 Results of Qualitative Analysis for Aquarium 1 and Zoo 1

Although there are some obvious differences in the VEPs for each live animal exhibit, many similarities were found in what was not being captured by the Original VBLF. The qualitative analysis revealed themes of visitor behaviours and dialogue that are common to the visitor experience with a live animal exhibits, across all exhibits, in both Aquarium 1 and Zoo 1. In particular, there were five context-specific behaviours and examples of dialogue that were common across all five exhibits that are not accounted for in the existing learning behaviours framework.

1. Finding and identifying the animal(s). Visitors read the label, discussed among themselves, asked a question or guessed the name of the animal in the exhibit. Examples of dialogue representative of this theme include: *"Where is it?"; "I don't see it. Help me find it."; "Found him!"; "Look at him. This fish is called a rainbow runner"; "Can you see him?"; "Is that an otter? I think so."; "What are these? What does that sign say? They're Japanese Sea Nettles"*.

2. Describing the physical characteristics of the animal (colour, size,

distinguishing features). Visitors described what they saw and/or read the labels aloud, describing the physical traits of the animal in the exhibit. Visitors also discussed or read information about what the animal eats and where they live in their natural habitat. Comments that reflect this theme include: *"Look at all the tentacles"; "Look at the four little things underneath"; "This one has stripes"; "That one has gills on the bottom"; "That shark is huge!";"They have sharp teeth"; "Look how big their hand is".*

Also, visitors related the physical characteristics and animal behaviours to something they knew or could relate to, referring to prior knowledge to describe the characteristics by making statements such as: *"They look like umbrellas or parachutes"; "See where he goes? To the bottom like a mermaid"; "I guess it's just like swimming"; "Their hands are just like ours"; "That one's all matted up, looks like a hair ball".*

3. Describing every movement or behaviour the animal engages in. Children and adults alike spent much time describing or pointing out what the animals were doing. For example: *"He's coming up. He's scratching his chest"; "See how he brushes his whiskers?"; "He goes over there, sticks his head up, comes back over here."; "See how he is stretched all the way out?"; "They open and glide and float".*

4. Interpreting the animal's behaviour or traits. Visitors often further engaged with the live animal exhibit, beyond describing, and attempted to interpret the animal's behaviour or physical traits. For example, in reference to the Japanese Sea Nettle Jellyfish, one visitor commented: *"It's like a plant, maybe that's why they named it that".* Others examples included: *"See him grooming? That's what he's doing"; "Oh you tease. He knows what he's doing. He's like 'you guys are impressed'"; "What's that big bale of hay for? That's to play right?"; "I think the big one is cleaning the little one".*

5. Expressing affection for the animals. Visitors often expressed awe and amazement, or a desire to interact with the animals, whether the animal was a jellyfish or a sea otter. Expressions of awe and amazement like *"Wow!", "Awesome!" "Cool!"* were very common when visitors were viewing animals in the exhibits. Comments such as *"Can we touch him"; "I want to touch it!"* showed visitor desire to physically

interact with the animal, while others verbally or audibly tried to interact through affective responses such as *"Oh, you're so beautiful, yes you are!"* or *"Hi gorilla, how you doing? What's your name? My name is…"*. The type of affective response depended on the particular animal, however. For example, the Jellyfish were described as *"beautiful", "amazing", "spectacular"* while Sea Otters were *"cute", "adorable", and "funny"*.

Although not common across all live animal exhibits, an important finding in the Polar Bears and the Gorillas visitor experience was some expressions of concern. For example, at the Gorilla exhibit, a few visitors wondered aloud if the Gorillas were happy, or bored. Here are two examples: *"They must be bored. They don't mind though right? Because they were born here so they don't know any different?"* and *"I know, you don't belong in a cage, you belong in the wild in your real home. It's like he's listening… Have a nice day."*

The above themes describe visitor learning behaviours not captured by the Original VBLF. Modifications need to be made in order for the revised framework to reflect these context-specific learning behaviours within every engagement level, resulting in a responsive exhibit assessment tool for zoos and aquaria.

4.3 The Revised Framework

The results from both the quantitative and qualitative analysis of the aquarium and zoo video data led to modifications and revisions to the Original Visitor-Based Learning Framework and to the creation of a context-specific assessment tool that is responsive to the nature of the visitor learning experience in these informal science settings. The following sections outline the specific amendments made for each of the engagement levels of the framework along with the rationale and justification for those changes.

4.3.1 Revision of Initiation Engagement Level

Initiation learning behaviours represent the basic level of interaction a visitor has with an exhibit. In zoo and aquarium settings, watching and describing the animals and their activities are the equivalent of the Initiation interactions visitors have with interactive exhibits in a science centre. These types of activities represent the first attempt by visitors to engage with the live animal exhibit and were found to

be the most abundant of the learning behaviours. As in the Original VBLF, the length of time a visitor spends at an exhibit plays an important role in determining the level of engagement of the learning behaviours and activities. The Initiation Level of engagement describes activities that are not interpreted as involving a high cognitive effort and do not require a significant amount of time investment on the part of the visitor. For example, the average duration for Initiation Level engagement is approximately 20 seconds. The descriptions of these Initiation Level behaviours and activities need to be revised to be more reflective of this initial visitor interaction with a live animal exhibit in a zoo or aquarium setting.

In revising the Original VBLF, different types of Initiation Level activities were identified to capture the varying degree of involvement by visitors, even at this most basic level of interaction with a live animal exhibit. Table 4.3 shows the Learning Behaviours, Types of Activities and examples of observed behaviours and dialogue from the data that typify this engagement level. The categories that describe the behaviours and activities in the revised Initiation Level of the framework are *Finding and Identifying the Organism(s)* and *Observing the Habitat or the Organism(s)*. The sections below describe these categories in further detail and reflect the context-specific interactions observed in the zoo and aquarium settings.

Finding and Identifying the Organism(s)

When first arriving in front of a live animal exhibit, a visitor may search for the animal, find the animal, point it out to others, read a label to find the animal's name and make one or two simple statements about the animal's physical or behavioural traits. Visitors at this level of engagement make short, descriptive comments about their observations rather than engaging in lengthy deliberative discussions about the exhibit or the animal(s). Children and adults alike may make cultural references when viewing an animal, but at this level, these references are made without interpretation and do not appear to contribute to significant or deep meaning making. Some visitors may simply find the animal and move on, without any further interaction or engagement.

Observing the Habitat or the Organism(s)

A visitor's initial engagement with the live animal exhibit may involve observing the animal and taking a picture of it to record the event, without engaging in conversations or making statements about what they are observing. Visitors may

pause in front of the animal enclosure to watch the animal or animals for short periods of time, usually between 10 and 30 seconds. Not surprisingly, the presence and the activity or inactivity of the animal(s) in the exhibit appears to influence the amount of time a visitor spends observing the animal.

Table 4.3 Revised Framework for Initiation Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of activities in science centre	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Initiation 1. Doing the Activity Revised Title: 1. Finding and Identifying the Organism(s)	a. Doing activity in passing, not completely	a. Searching for the animal; not finding it, moving on; or finding it, acknowledging it and moving on	a. *"Where is it?" "I don't see it" "There it is"*
	b. Doing activity somewhat completely	b. Reading the label for animal's name; Pointing and/ or naming / identifying the animal	b. *"That's a Japanese Nettle Jelly" "This is the otter"*
	c. Doing activity completely, without further exploration	c. Makes one or two simple statements and/or questions about the animal's behaviour and / or physical traits	c. *"He's relaxing, just laying around" ; "He just lifted his head" "He's looking at me" "He's swimming"*
Initiation 2. Spending Time Watching Others Engaging in Activity Revised Title: 2. Observing the Habitat or the Organism(s)	a. Watching the exhibit work or someone doing activity	a. Observing the animal without verbal or facial expressions; not showing engagement (<30 seconds).	a. *Man pressed up against the glass to watch sharks, less than 30 secs and moves on; Family staring at the bear through the glass, not saying anything, then leave*
	b. Watching with expressed interest in activity (facial or verbal expressions)	b. Watching the animal with interest; facial and/ or verbal expressions	b. *"Watch him…here he comes" – smiles and watches for a bit*
	c. Interested in the outcome the activity	c. Taking picture of the animal; recording the event (but no indication of interpretation or doing something with the photo)	c. *Girl taking photos and showing others the photo she took.*

In summary, at this level of engagement, visitors are recognizing the animal, making one or two simple descriptive statements, expressing some enjoyment, observing the animal, taking a picture to remember the event and moving on. The length of time and level of inferred cognitive engagement at an exhibit determines

whether the behaviour is identified as Initiation or if it can be considered a higher level of engagement like Transition or Breakthrough.

4.3.2 Revision of Transition Engagement Level

At the Transition Level of engagement, visitors are beginning to show more interest in the exhibit and the animal(s) through their actions and their words. For example, visitors engaging at this level are having a visibly and audibly emotional reaction to the animal. They are spending more than 30 seconds observing the animal or the activity in the exhibit, search and point out more animals, and they may even express the desire to physically interact with the animal. The essence of this level of engagement is that the visitor wants more from the experience than the initial interaction allowed and is doing more than just giving a quick look to identify the animal, to describe what it is doing or to take a picture. The descriptions of behaviours found in the Original Framework category of *Repeating the Activity* are more reflective of the visitor experience with an interactive exhibit typically found in science centres. And, although the *Expressing Positive Emotional Responses* category in the Original Framework does refer to the affective aspect of learning, the examples did not accurately reflect the type of affective engagement of visitors observing animals in the zoo and aquarium setting. The types of behaviours and activities identified in the revised Transition Level of the framework reflect the context-specific interactions observed in the zoo and aquarium settings. The categories that describe visitor behaviours and activities in the revised Transition Level are *Exploring to Prolong Engagement* and *Demonstrating Affective Engagement.* These categories are described further in the following sections. Table 4.4 shows the learning behaviours, types of activities and examples of observed behaviours and dialogue from the data that typify the Transition Level of engagement.

4.3.3 Revision of Breakthrough Engagement Level

Visitors engaging in Breakthrough Level behaviours in a zoo or aquarium setting are investing time and cognitive energy to make meaning of what they are observing at the animal exhibit. As in the Original VBLF, interactions at this level reflect the psychomotor, affective and cognitive aspects of the learning experience. The length of the interaction, the number of questions and statements, and the meaning making nature of the dialogue are all key in identifying this level of activity

as Breakthrough Level engagement. For example, the duration of the interactions observed at the Breakthrough Level were typically longer than two minutes and could last up to 15 minutes or more, depending on factors like the activity level of the animal(s) or the presence of an interactive designed to aid interpretation. Also, visitors made usually four or five statements or asked four or five question about the animal, its behaviour, its habitat or its diet. In Breakthrough Level types of activities, visitors engaged in dialogue beyond simply naming the animal or stating what the animal was doing, thus making it clear that these visitors were interested and motivated to go beyond the experiences typically found in Initiation and Transition Levels of interactions.

The descriptions of Breakthrough Level activities and behaviours in the Original Framework needed to be revised to capture the higher level of cognitive engagement that can occur when visitors interact with an animal exhibit, reflecting the behaviours that show visitors attempting to gain more information about the animal, to make sense of the animal's behaviour or to discuss and reach conclusions about what they are observing at the exhibit.

In the Original VBLF, interactions at this level were described by three categories of Learning Behaviours: *Making References to Past Experiences or Knowledge*, *Sharing and Seeking More Information* and *Engaged and Involved*. The revised categories for Breakthrough Learning Behaviours are: *Making Links, Explaining* and *Extending the Experience.* Table 4.5 outlines these Learning Behaviours categories and shows the revised descriptions of activities that exemplify each of the Learning Behaviours in a zoo and aquarium setting. The sections below describe these categories in further detail.

Making Links

When making meaning of their experience with an animal exhibit, visitors are making links, whether to their prior experiences with similar animals, or to knowledge they already have about the animal, its physical traits, behaviours or habitat. Visitors in this category of Breakthrough behaviours may be making statements about their lived experiences that connect the animal or animals to a cultural reference such as a movie or a character they are familiar with. Visitors may also refer to a similar experience they had with the institution on a prior visit, to comparable experiences they had with

that animal species, or make comparisons and deductions based on this prior knowledge which is triggered by the interaction they have with the animal exhibit.

Table 4.4 Revised Framework for Transition Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Transition 3. Repeating the Activity	a. Repeat activity 2 or 3 times to attain desired outcome, to master exhibit function	a. Expressed desire to watch animal again, for a longer period of time with expressed interest in behaviour or physical traits	a. *"I could watch them all day"* *"Let's see if he does it again"* *"Let's just watch a little longer"* *"Just watch him one more time, he does this routine"*
Revised title: 3. Exploring to Prolong Engagement	b. Enjoyment of outcome	b. Expressed desire to find another similar animal	b. *"Let's go look at the other ones." "Let's go see the other bear on the other side"* *"How many are there? Are there more?*
	c. Changing variables once to see a difference in outcome	c. Make a few comparisons between individual animals within the same habitat, some attempt at interpretation	c. *"That one is the biggest of all of them".* *"Let's keep looking and find some bigger ones"* *"That's the mommy and that's the daddy"*
Transition 4. Expressing Emotional Response	a. Smiling, pleased with exhibit	a. Smiling and pointing at animal; pleased with finding it after searching	a. *"Look at them, they're up there"* points and smiles *"Ooh, there's the baby"* Search the habitat then *"There he is, back there!"* with smile and excitement as he points to animal
Revised title: 4. Demonstrating Affective Engagement	b. Stronger signs of enjoyment such as laughter, verbal references to enjoyment	b. Stronger signs of enjoyment / excitement such as laughter; verbal expressions of enjoyment ; Obvious signs of excitement when observing the animal; verbal outbursts of amazement and awe	b. *Pointing, laughing, look amused, say "Look he's grooming" "Did you see that mom? Did you see it?"* *As shark swims by "Wow, that's impressive" "Wow, that's awesome, that's really cool"* *Watching jellies "They are so beautiful. Ooo, I like that one"* *Watching polar bear "I love him"*

Table 4.4 (Cont'd) Revised Framework for Transition Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Transition 4. Expressing Emotional Response Revised title: 4. Demonstrating Affective Engagement	c. Obvious signs of eagerness to participate; excited disposition	c. Expressed desire to interact with the animal, physically and verbally (mimicking) or concern for the animal's well being	c. *"I'm touching the window so they can come see my hand"* want to see a reaction *from the animal* *Talking to the gorilla like talking to a baby or a dog "Hey, how're you doing?" "You're beautiful, yes you are!" "Oh my God, he's so cute. Oh look, there are two? Can we touch them?"* *"They look bored...but they don't mind, right?"*

Explaining

In this category of Breakthrough behaviours, visitors are demonstrating higher levels of cognitive engagement, motivation and interest by seeking further information through reading labels thoroughly, asking others for more information or sharing what they know or have learned about the animal in the exhibit. Visitors may read information aloud to others in their group, highlight interesting facts and discuss details about the animal's diet, physical traits, behaviours and diet with family, friends and staff. These behaviours seem to indicate that visitors are internalizing their new found knowledge by sharing and explaining its significance to others, all the while contributing to their own meaning making.

Extrapolating the Experience

At this level of interaction, the amount of time spent engaging with the live animal exhibit is significant, lasting upwards of three minutes, clearly distinguishing it from other Learning Behaviours. As visitors become more engaged and involved, their conversations and actions are inquisitive and exploratory in nature. They may speculate aloud about the reasons for the animal's behaviour or the purpose for things in the animal's habitat. Visitors show obvious signs of concentration and motivation to know more about the animal through longer periods of observation, in-depth conversations or by interacting with accompanying exhibits to deepen their learning experience. Visitors in this level of engagement may demonstrate, through statements, questions and conversations with others,

that they are cognisant of some broader messages of conservation or other environmental issues. These Learning Behaviours suggest that visitors are truly engaged in the learning process while observing and interacting with the live animal exhibit.

Table 4.5 Revised Framework for Breakthrough Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Breakthrough 5. Referring to Past Experiences While Engaging in Activity Revised title: 5. Making Links	a. Reference to past experience with exhibit	a. Reference to past experience with the animal or the institution	*a. "At the Biodome, there were 2 otters and they were huge like this"* *"The last time we were here, the baby was smaller. He's getting so big"* *"Remember when I showed you that … here it is"*
	b. Simple reference to comparable experience in visitor's life	b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; cultural references about animal that contribute to meaning making	*b. "Like Gorillas in the Mist… these are our closest relative, they share like 90% of our DNA"* *"Their hands are just like ours, with nails and everything"* *"They(zoo) are trying to stimulate them like in the wild"* *"Sometimes they use branches to catch insects"* *"He's yawning, same way you yawn"*
	c. Reference to comparable experience AND making comparisons, deductions based on observations of similarities and differences or prior knowledge	c. Reference to comparable experience in their life as well as making comparisons and deductions based on prior knowledge, or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat	*c. "I think that's the male because he's bigger. They wouldn't put 2 males in with the female because they would fight over her"* *"Look at their fingers, just like ours. They have opposable thumbs"*

Table 4.5 (Cont'd) Revised Framework for Breakthrough Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Breakthrough 6. Seeking and Sharing Information Revised title: 6. Explaining	a. Seeking. Calling someone over to look at exhibit, or to ask them to explain an exhibit; asking a question to staff or family member without lengthy discussion or exploration of topic	a. Calling on someone for information about the animal. Asking 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat	*a. Mom asks staff "What's he called?... Why do they call him a zebra shark? Does it have gills on the bottom like the other one?"* *Boy asks "I wonder how strong they are? Where do they come from?"*
	b. Seeking to consolidate. Reading signage thoroughly, having conversations about exhibit and related science with staff or family, friend	b. Reading signage thoroughly out loud to others; having conversations related to signage about the animal or exhibit related to physical traits, behaviours, diet, habitat	*b. Mom reads the signage about individual gorillas, out loud to family. "Says here that they can hang on to tree branches with both hands and feet", continues discussion… "it also says that…"*
	c. Sharing experience and information with others by explaining the exhibit to them, giving them details about gained information and observations; discussion and questions about exhibit with staff or family /friend	c. Sharing experience and information with others by explaining, describing the animal's traits/ behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family /friend	*c. Three brothers interacting with touch screen to identify fish and sharks. Br#2 to the other brothers: "Remember when I told you about the X, well there it is" while pointing to fish on bottom of tank "I told you". Br#1 "Oooh is this the black tailed shark?" to other brothers. They look it up on touch screen. Br#2 "Ok let's move onto to another fish" while leading brothers through other screens, reads to them. Br#3 chooses next fish to look for. Br#2 describes it to them. Continue like this for approx. 3 minutes*

Table 4.5 (Cont'd) Revised Framework for Breakthrough Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Breakthrough 7. Engaged and Involved Revised title: 7. Extending the Experience	a. Engaging in inquisitive behaviour, exploratory actions such as repeating the activity several times, reading signage, asking questions; remaining on task for 2-3 minutes	a. Engaging in inquisitive behaviour, exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits; reading signage, asking questions and remaining at exhibit/ habitat for 2-3 minutes	*a. Mom and children involved in discussion about every observed behaviour of gorillas, giving reasons for why the animals are doing what they're doing, remaining engaged with observation for at least 3 minutes* *Adults discussing "Very human, amazing…Maybe she's laying like that because she doesn't want to feed the baby right now. Look at the one upside down.. doing exercises and playing"*
	b. Concentration and motivation are obvious; doing the activity as a means to an end, or meeting a challenge; length of interaction significant, 3 to 5 minutes; outcome or result of activity important	b. Concentration and motivation to know more about the animal(s) are obvious. Engaging with animal habitat as a means to learn / understand more about the animal. Length of interaction significant, 3 to 5 minutes	*b. Mom and son using touch screen to identify fish in aquarium "That's it right there. Ok now let's find the rainbow one. I see him". Go back to touch screen. "Look for the white stripes" . Remain on this task for about 4 minutes*
	c. Experimenting, testing different variables, looking for different outcomes; engages in discussion with others (visitors or staff) about the various outcomes; experience - 'flow'; involved in activity for long period of time i.e. more than 5 minutes	c. Deep emotional or cognitive involvement with the experience of observing the animal, looking for different outcomes, engaging with accompanying exhibits, discussing many observations and deductions with others; may discuss wildlife conservation or environmental issues involved in observation activities for long period of time ie. more than 5 minutes	*c. Two children at touch screen engaged in activity of identifying fish and their traits. "That's the one I just saw. I want to check him out". Goes to touch screen to find that fish. "Look at this guy.. awesome!" "Let's pretend were studying fish" "Ok, What about this one?" They engage for approx. 10 minutes*

Table 4.5 (Cont'd) Revised Framework for Breakthrough Level Learning Behaviours

Engagement Level and Learning Behaviour	Types of Activities in Science Centres	Types of Activities in Zoos and Aquaria	Examples of Observed Behaviour in Zoos and Aquaria
Breakthrough 7. Engaged and Involved Revised title: 7. Extending the Experience			*Dad and son observing otters. Dad very involved in observing, describing, speculating about behaviour. Engages son in conversation about otter behaviour, remain for approx 15 minutes engaged in the activity of observing, describing and speculating. " They do the same thing over and over again. He goes over there, sticks his head up, comes back over here... see he just did it again. He does this routine, let's watch him again." Son asks "What do they do that for?"*

4.4 Summary

Although the Original Visitor-Based Learning Framework is a useful and practical tool for assessing visitor engagement in science centre settings, it is challenging and not highly effective to use it in the zoo and aquarium settings where exhibits are not typically interactive and the visitor experience is shaped by the observation of live animals in their exhibit habitat. To better capture the nature of the visitor learning experience in these settings, video data of visitors engaging with live animal exhibits at a zoo and at an aquarium were collected and analysed. The quantitative analysis of this data showed that, although the VBLF can distinguish between different types of live animal exhibits, many visitor behaviours are not captured by the Learning Behaviour categories and descriptions of the Original Framework and that revisions were needed for the assessment tool to be a valid and responsive instrument for zoo and aquarium settings. The qualitative analysis revealed context-specific visitor learning experiences and these were used to make the necessary modifications to the Original Framework. A Revised Visitor-Based Learning Framework, based in zoo and aquarium visitor behaviour data, was developed to better reflect the learning experience of visitors engaging with live animal exhibits. This Revised

Framework needs to be applied and tested with new visitor behaviour data to assess its ability to capture the visitor learning experience and its effectiveness at distinguish between various types of experiences in zoos and aquaria. In the following chapter, the Revised Framework will be applied to new data from a different zoo and aquarium and conclusions will be made about its potential as a learning assessment tool in these settings.

Chapter 5
Phase 3 Testing the Revised Visitor-Based Framework in Zoo and Aquarium Settings

Chapter 4 reported that the Original VBLF of learning behaviours showed potential for assessing the visitor learning experience with live animal exhibits in zoo and aquarium settings, but that some modifications were needed. Close observations and detailed qualitative analyses of the visitor experience revealed that the Original VBLF lacked behavioural categories and descriptions of activities that fully reflect the type of engagement that occurs with a live animal exhibit. The results of the qualitative data analyses of visitor activities and behaviours were used to revise and modify the behavioural categories and descriptions within each Engagement Level of the Original Framework and a Revised VBLF was developed. This Revised Framework is designed to be more representative of the visitor learning experience in zoos and aquaria. In Phase 3 of the research project, the Revised Framework was applied to new visitor behaviour data collected in Aquarium 2 and Zoo 2. In this chapter, the data collection methods for Aquarium 2 and Zoo 2 are briefly described, along with details of the data collected at each site. The data analysis methods and the results of this phase of the research project are outlined and lead to a discussion of the applicability and validity of the Revised VBLF for zoo and aquarium settings. In addition, both the Original Framework and the Revised Framework were used to analyse data for one Zoo 2 exhibit to further test the Revised Framework's validity when applied to live animal exhibits in informal science settings. The results of this comparison are also discussed in this chapter.

5.1 Applying the Revised VBLF in Aquarium 2 and Zoo 2

The following sections briefly describe the data collection methods used in Aquarium 2 and Zoo 2, the visitor samples, the research sites, the live animal exhibits chosen for this phase of the study and the data analyses performed. As in Phase 2 of the research, site visits took place before data collection in order to select the exhibits that would be part of the study and to choose the locations for the camera, microphone and tripod, in consultation with the contact person from each of the institutions. The exhibit selection was guided by the criteria outlined previously in Chapter 3, section 3.4. The exhibits chosen at Aquarium 2 were the Sharks and Fish exhibit and the Turtles exhibit.

They are described in section 5.1.1. At Zoo 2, the Grizzly Bears exhibit and the Giraffes exhibit were selected and are described in section 5.1.2.

5.1.1 Exhibits at Aquarium 2

Sharks and Fish Exhibit

The Sand Tiger Sharks live in a large 306 000 gallon (1158 cubic metres) aquarium exhibit along with other ocean species like eels and other fish. The main viewing window is 20 metres long with seating available a few feet away from the large glass wall of the aquarium. This is one of the main exhibits of the aquarium and is the first large habitat visitors encounter upon entering the facility, making it a hub where visitors gather to observe the ocean species. The large open space allowed for easy camera and microphone set up during data collection. Interpretive signage panels on both ends of this habitat list the various species of fish along with basic identification information. The main viewing window of this exhibit can be seen in Figure 5.1 while Figure 5.2 shows the interpretive signage that is adjacent to this sharks and fish habitat.

Turtles Exhibit

The turtles at Aquarium 2 are housed in a pond-like exhibit within a gallery showcasing many aquatic animals and freshwater pond life. The Turtles exhibit features a platform-like riverbank, plenty of plant life and a pool of water for the turtles to swim in. Figure 5.3 shows the viewing area for this exhibit where visitors can see above and below the water to observe turtles as they rest, dive and swim. The interpretative signage (Figure 5.4) that accompanies this exhibit includes identification information about the species of turtles found in the exhibit, as well as a panel informing visitors about the effects of pollution on turtles and their habitat. This exhibit is located directly across from a door that leads to an outdoor adventure trail and is a busy intersection in the aquarium, ensuring a high volume of visitors for data collection.

Figure 5.1 Fish and Sharks exhibit at Aquarium 2.
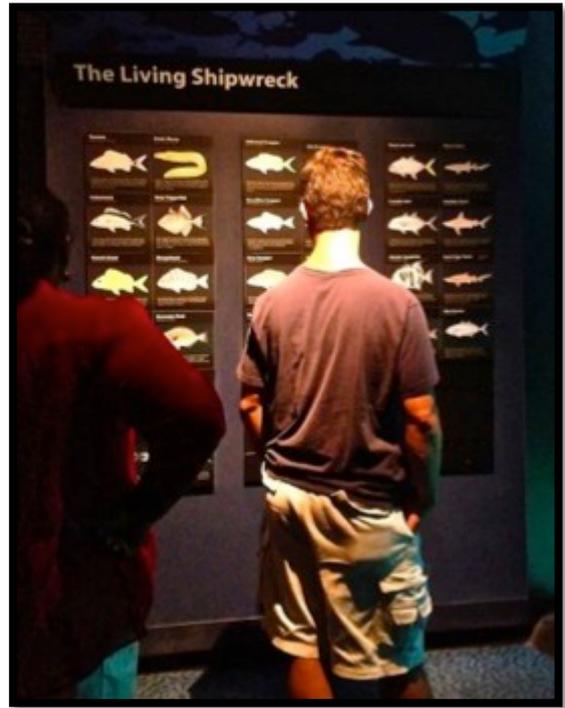
Figure 5.2 Signage found on the right and the left of the Sharks and Fish exhibit at Aquarium

Figure 5.3 The Turtles exhibit at Aquarium 2.
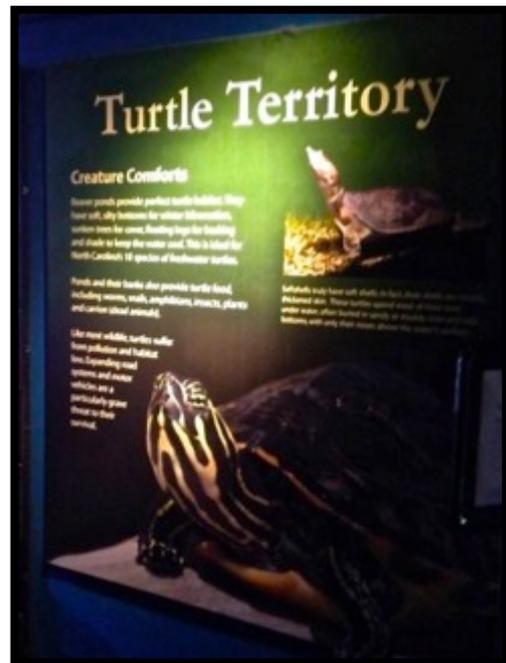
Figure 5.4 The signage found on the right of the Turtles exhibit at Aquarium 2.

5.1.2 Exhibits at Zoo 2

Grizzly Bears Exhibit

This large outdoor enclosure is home to two grizzly bears and is part of larger seven and a half acre wilderness exhibit that also houses grey wolves, bison and polar bears. Figure 5.5 shows the part of the habitat with a glass viewing area that allows visitors get up close to where the bears rest and Figure 5.6 shows the adjacent signage panel. The text on this panel describes concerns about the loss of grizzly bear habitat in the U.S. and the habitat range for these animals across the continent. This wilderness outdoor enclosure is a recent addition to the zoo and figures prominently on all their advertising, making it very popular with visitors and ensuring successful data collection.
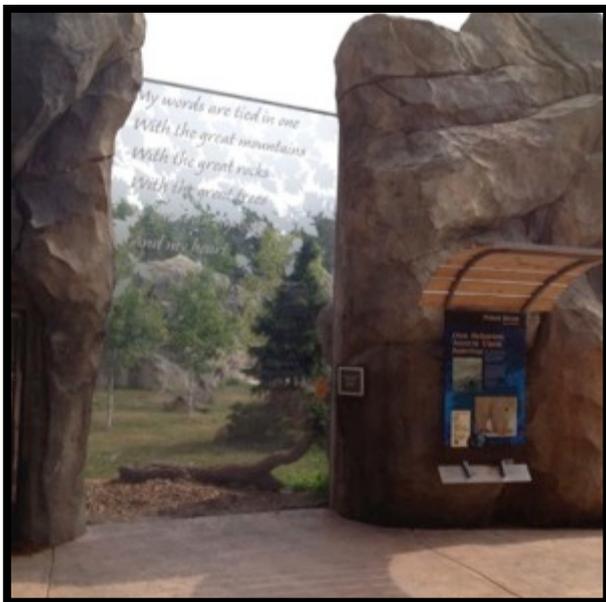
Figure 5.5 One of the viewing areas of the Grizzly Bears exhibit at Zoo 2.
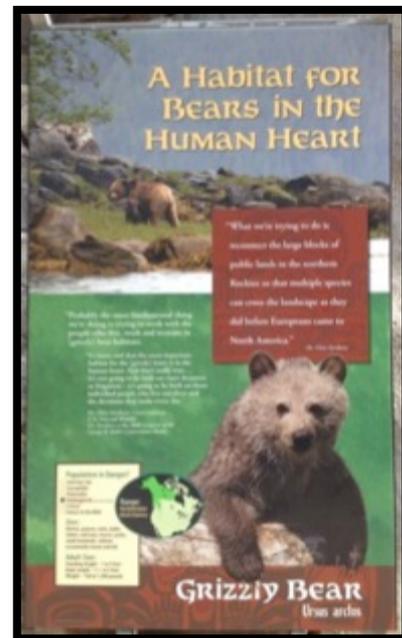
Figure 5.6 The signage found adjacent to the viewing area.

Giraffes Exhibit

The Giraffes exhibit at Zoo 2 is located within a large outdoor enclosed space as part of the African Savannah exhibit. One of the viewing areas for the giraffes is a covered, hut-like space and Figure 5.7 shows the open viewing area inside that hut. The signage is mounted at waist height on the short walls of the hut, and is in the form of a three-ring book. Each page can be turned and includes general information about giraffes and specific information about each of the giraffes in the habitat. An example of one of the pages in the book signage is shown in Figure 5.8. The area inside the hut is open, large and closest to

where the giraffes have access to their food, making it ideal for setting up a camera for data collection.

Figure 5.7 The Giraffes exhibit at Zoo 2.

Figure 5.8 The book-like signage at the Giraffes exhibit at Zoo 2.

5.1.3 Data collection procedures

Data collection at Zoo 2 took place on Saturday, June 16th 2012 at the beginning of the summer tourism period. Data were collected at Aquarium 2 on Thursday, July 26th 2012 at the height of the summer tourism season. As was done in the previous institutions and described in Chapter 3, video data were collected by placing a video camera and microphone near each exhibit to capture visitor behaviour and dialogue as they engaged with the live animal exhibit. Similarly, signs advising of the research activity were posted in strategic locations around the institutions, including at the entrance of the aquarium or the zoo, at the entrance to the exhibits themselves, and on or near the camera for the duration of the data collection. The wording on the research signs was decided in consultation with each institution's contact person. Aquarium 2 required that their logo be included on the research sign along with Curtin University's logo. Figures 5.9 through 5.15 show the placement of the camera and the research signs at Aquarium 2 and Zoo 2. Data collection took place at different times during the day. For example, data were collected at the Sharks and Fish exhibit at Aquarium 2 in the morning, and at the Turtles exhibit in the early afternoon. Similarly, data were collected at the Grizzly Bears exhibit in the morning, while visitor activities at the Giraffes exhibit were recorded in the late afternoon at Zoo 2.

At the request of the contact person at Zoo 2, a handout describing the research project was prepared prior to the data collection and available to distribute to visitors if any approached the researcher with questions about the study (see Appendix 5.1). The only visitors to approach the researcher were a man and a woman, a couple in their mid sixties, who read the research sign then asked about the research project. They were given the handout and a 20-minute conversation about the project ensued.

Figure 5.9 The camera and the research sign at the Sharks and Fish exhibit in Aquarium 2.

Figure 5.10 Research sign and camera at the Turtles exhibit in Zoo 2.

Figure 5.11 Research sign posted at the entrance to Aquarium 2.

Figure 5.12 Microphone and research sign at the Grizzly Bears exhibit in Zoo 2.

Figure 5.13 Research sign placed on the path to the Grizzly Bears exhibit entrance.

Figure 5.14 Camera placed inside the hut-like viewing area for the Giraffes exhibit at Zoo 2.

Figure 5.15 Research sign on the path to the Giraffes exhibit at Zoo 2.

5.1.4 Visitor Sample

As in Phase 1 and Phase 2, visitors who stopped, within the view of the video camera and the audio reach of the microphone, to observe the selected live animal exhibits during the data collection period, were included in the sample for Phase 3 of the research. Groups of children that were part of a camp or day care visit, or were not accompanied by their parents, were not included in the sample. In addition, very young children estimated to be under the age of three were not coded. One hundred visitors at each of the Sharks and Fish, Turtles, Grizzly Bears, and Giraffes exhibits made up the sample of visitors that were observed and coded for learning behaviours in the video recording.

The age of the visitors observed in the sample is based on an estimate made by the researcher. Similarly, the researcher coded a visitor as part of a family group, another group or alone, based on observations of interactions and conversations. Details of the visitor samples for each of the exhibits observed at Aquarium 2 and Zoo 2 are presented in Tables 5.1 and 5.2 respectively. Although it was not possible to find information about the visitor demographics from Aquarium 2, it can be argued that the visitor sample in this study is representative of a typical aquarium visitor population. However, the high percentage of children in this sample can be partly attributable to the fact that at the Sharks and Fish exhibit, many adults and parents stayed back from the aquarium window, either sitting or standing further back to observe the sharks and their children. Children were more likely to stand up against the glass of the sharks and fish habitat, making them also more likely to be captured on the video because of the camera's location.

It can be argued that the sample of visitors at Zoo 2 is representative of the visitors who typically attend that zoo. An internal report from 2012, made available to the researcher, shows that more females (68%) than males (32%) make up their visitor population. The report also stated that 77% of the visitors to Zoo 2 are accompanied by children under 11 years of age. In the sample used for this research, 81.5 % of visitors appeared to be in a family group. These data support the argument that this sample is representative of the zoo's visitors in that the majority of visitors are in a family group with young children.

Table 5.1 Sample of Visitors Observed at Each Exhibit at Aquarium 2

Exhibit	Males	Females	Children (3-17 yrs)	Adults (18+ yrs)	Part of family group
Sharks and Fish	44	56	43	57	87
Turtles	39	61	43	57	83
Total (n)	83	117	86	114	170
Percentage	41.5	58.5	43	57	83

Table 5.2 Sample of Visitors Observed at Each Exhibit at Zoo 2.

Exhibit	Males	Females	Children (3-17 yrs)	Adults (18+ yrs)	Part of family group
Grizzly Bears	43	57	38	61	94
Giraffes	48	52	24	76	69
Total (n)	91	109	62	137	163
Percentage	45.5	54.5	31	68.5	81.5

5.1.5 Quantitative Data Analysis

As was done in Phase 1 and 2 of the research project, all of the video data captured at Aquarium 2 and Zoo 2 in Phase 3 were downloaded onto a computer and the video files were imported directly into Studiocode software for analysis. The video data were analysed using the same procedures described in Chapter 3 and detailed in Phase 1, the Pilot Study. For this phase of the study however, the Revised VBLF was used to code visitor learning behaviours and dialogue. The coded behavioural data for each of the two exhibits at Aquarium 2 and Zoo 2 were then exported to a matrix for further analysis in Microsoft Excel. Again, using the same quantitative analysis procedures described in Phases 1 and 2, each sample of visitors was subdivided according to their highest level of interaction, that is, those who reached the Initiation level only, those who reached Transition only, and those who reached the Breakthrough Level of engagement. These data were then compiled to produce Visitor Engagement Profile (VEP) graphs for each exhibit. The resulting graphs show the percentage of visitors that engaged in the types of learning behaviours at the highest engagement level reached.

5.1.6 Aquarium 2 Results

Visitor Engagement Profiles

The Revised Framework was used to code visitor behaviours at the Sharks and Fish exhibit and the Turtles exhibit. The data analysis produced Visitor Engagement Profile graphs for each exhibit and they are found in Figure 5.16.

More visitors engaged only at the Initiation Level at the Turtles exhibit (31% of visitors) than at the Sharks and Fish exhibit (16%), while more visitors reached the Breakthrough Level at the Shark and Fish exhibit (31%) than at the Turtles exhibit (15%). This difference reflects the nature of each exhibit, the kinds of animals and their level of activity in the habitat, and the different engagement opportunities provided to visitors. The Sharks and Fish exhibit contained a variety of very active and large marine animals as well as panel displays with identification information for each kind of animal in the aquarium. Visitors spent time observing the variety of animals they could see, and engaged in discussions about the features and behaviours of these animals. The Turtles exhibit had only one type of animal, turtles, in the aquarium. Information panels on each side of the exhibit described their natural habitat and threats to these habitats and to the survival of their species. The turtles were somewhat active, periodically diving under water to swim about their aquarium. The smaller and homogenous nature of this exhibit seems to have offered fewer opportunities for visitors to engage in the types of activities reflected in Breakthrough levels of engagement.
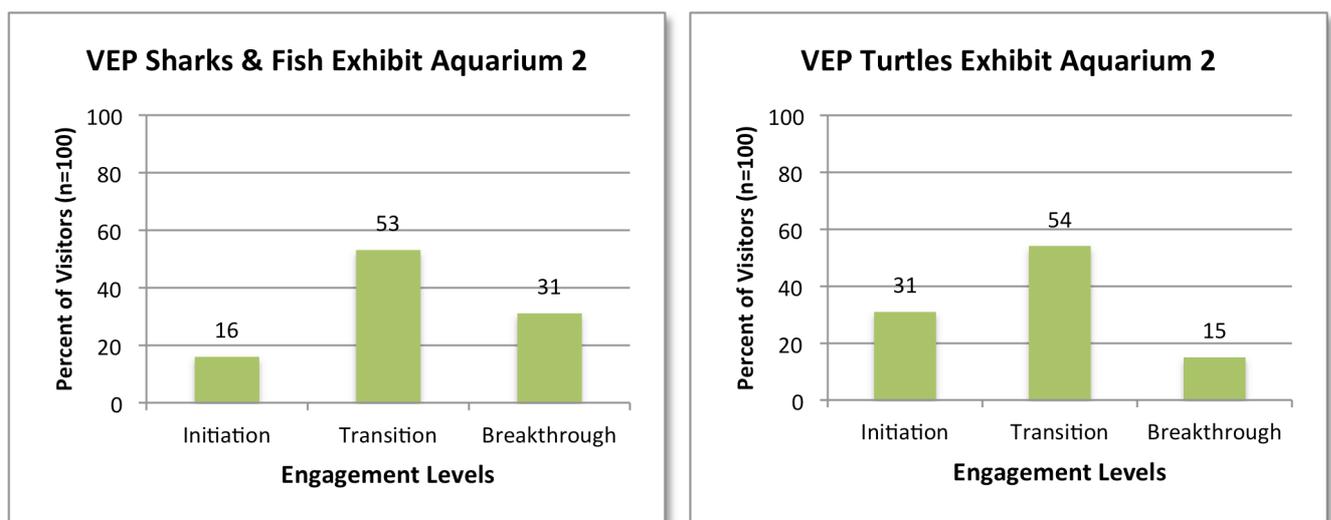
Figure 5.16 Highest engagement level reached by visitors (%) at the Sharks & Fish exhibit and the Turtles exhibit in Aquarium 2.

Learning Behaviours and Types of Activity

During coding with the Revised Framework, it was possible to account for all of the observed visitors' behaviours that were related to the learning experience at the live animal exhibits. For example, in the Initiation Level, the Learning Behaviours and the Types of Activities were reflective of what visitors did while at engaged at an animal exhibit. Figure 5.17 shows that the large majority of visitors at the Sharks and Fish and at the Turtles exhibits were coded as *Finding and Identifying* as well as *Observing the Habitat or the Organism*. It is important to note that visitors may have been coded as doing more than one Learning Behaviour and Type of Activity. Within each Learning Behaviour, the Revised Framework was also effective at capturing the Types of Activities engaged in by visitors. For example, Figure 5.18 shows that within the Learning Behaviour of *Finding and Identifying*, the Type of Activity that was coded most frequently was visitors making "one or two statements about the animal's behaviour or physical traits" at both the Turtles exhibit and the Sharks and Fish exhibits.
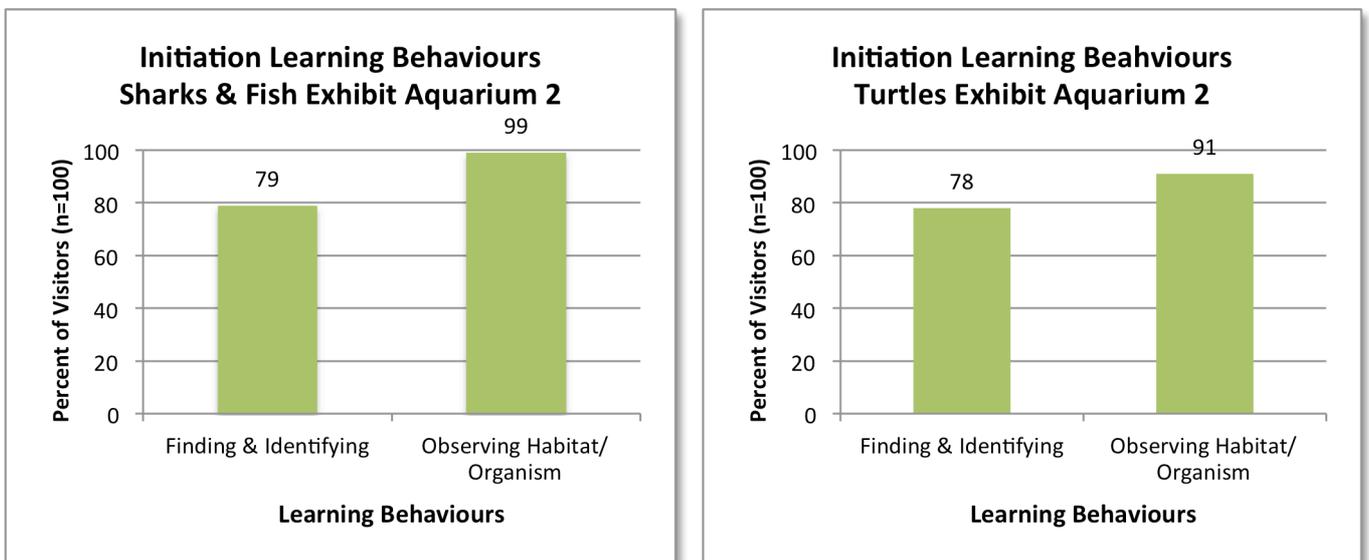
Figure 5.17 Percentage of visitors engaged in the Initiation Level learning behaviours of Finding & Identifying and Observing Habitat/Organism at the Sharks & Fish exhibit and at the Turtles in Aquarium 2.

The Learning Behaviours and Types of Activity in the Transition and Breakthrough Levels of engagement were similarly effective at capturing visitor behaviours and dialogue. Figure 5.19 shows the results for the Transition Level of engagement for both exhibits at

Aquarium 2, while Figure 5.20 shows the results for the Breakthrough Level of engagement for the same exhibits. All of the graphs for each of the Learning Behaviours and their Types of Activity can be found in Appendix 5B through 5H.
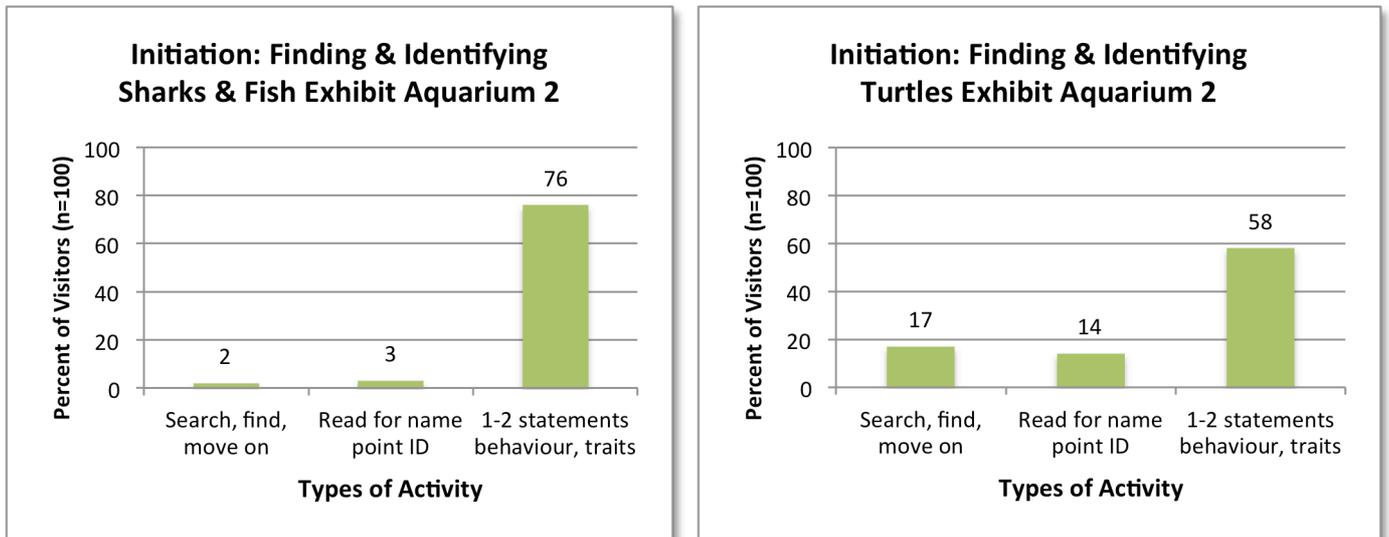
Figure 5.18 Percentage of visitors engaged in Types of Activity within the Finding & Identifying learning behaviour at the Sharks & Fish exhibit and at the Turtles exhibit in Aquarium 2.
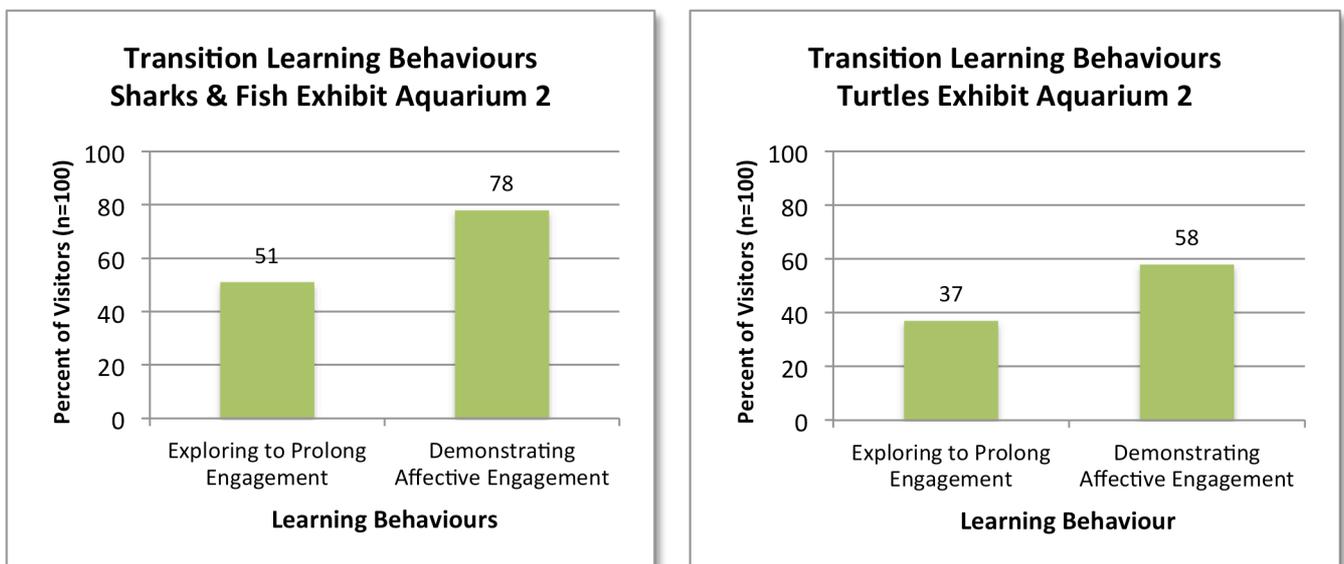
Figure 5.19 Percentage of visitors engaged in the Transition Level of engagement at the Sharks & Fish exhibit and at the Turtles exhibit in Aquarium 2.

Breakthrough Learning Behaviours
Sharks & Fish Exhibit Aquarium 2

Breakthrough Learning Behaviours
Turtles Exhibit Aquarium 2
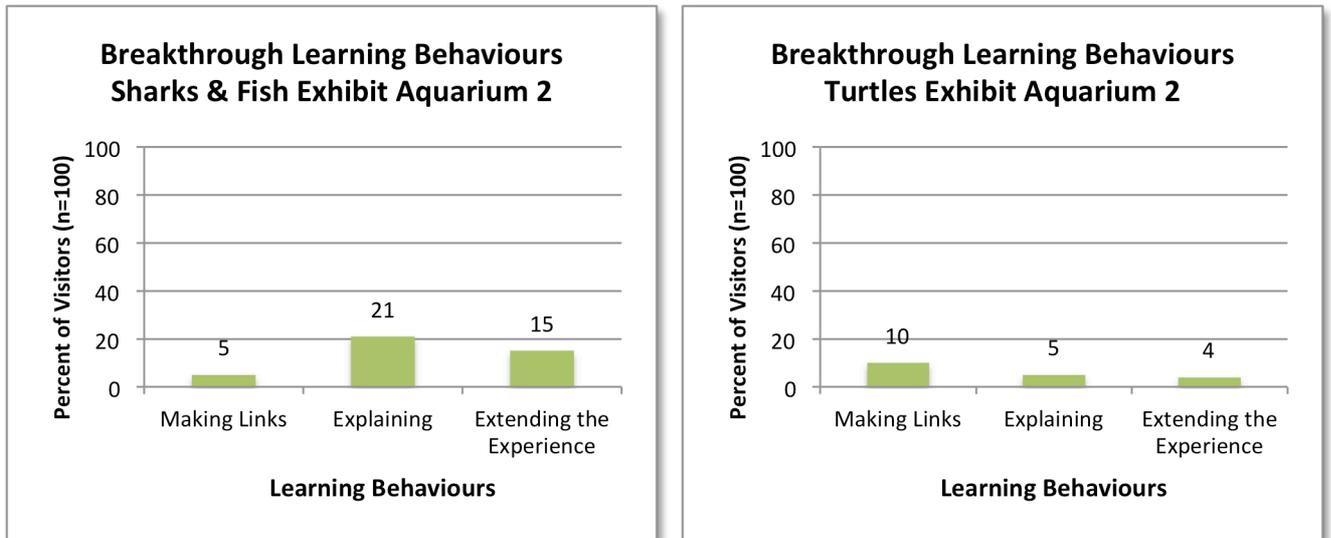
Figure 5.20 Percentage of visitors engaged in the Breakthrough Level of engagement at the Sharks & Fish exhibit.

The results of the data analysis using the Revised VBLF show that the revised Learning Behaviours, Types of Activity and the descriptions assigned to those categories were effective at capturing the nature of the visitor learning experience at Aquarium 2. This revised assessment tool and its categories allowed comprehensive coding of dialogue and behaviour as visitors interacted with the live animal exhibits. The categories of the Revised Framework differentiated between different kinds of exhibits by revealing different frequencies of learning behaviours depending on the characteristics of the exhibit. For example, it can be argued that sharks are an iconic species that elicit awe, wonder and amazement in people and this was captured by the *Demonstrating Affective Engagement* learning behaviour for the Sharks and Fish exhibit, where 78% of the visitors were coded in this category. The Turtles exhibit also engaged visitors emotionally, although less frequently (58% of visitors). The large aquarium of the Sharks and Fish exhibit, with its variety and active marine animals, engaged more visitors in Breakthrough learning behaviours than did the smaller Turtles exhibit, where relatively inactive turtles were on display. A closer look at the types of learning behaviours coded within the Breakthrough Level suggests that the Sharks and Fish exhibit provided more opportunities for visitors to discuss, share and wonder aloud about the animals and their behaviour than did the Turtles exhibit. Or, one could argue, visitors are drawn to large, iconic species like sharks and engage in more exploration about them than they do with less iconic species like turtles.

These exhibit variables and their impact on the visitor learning experience have implications for the use of the Revised VBLF and will be discussed further in Chapter 7, section 7.5.

5.1.7 Zoo 2 Results

Visitor Engagement Profiles

The Revised Framework was used to code visitor behaviours at the Grizzly Bears exhibit and the Giraffes exhibit at Zoo 2. The data analysis produced Visitor Engagement Profile graphs for each exhibit and they are found in Figure 5.21 below.
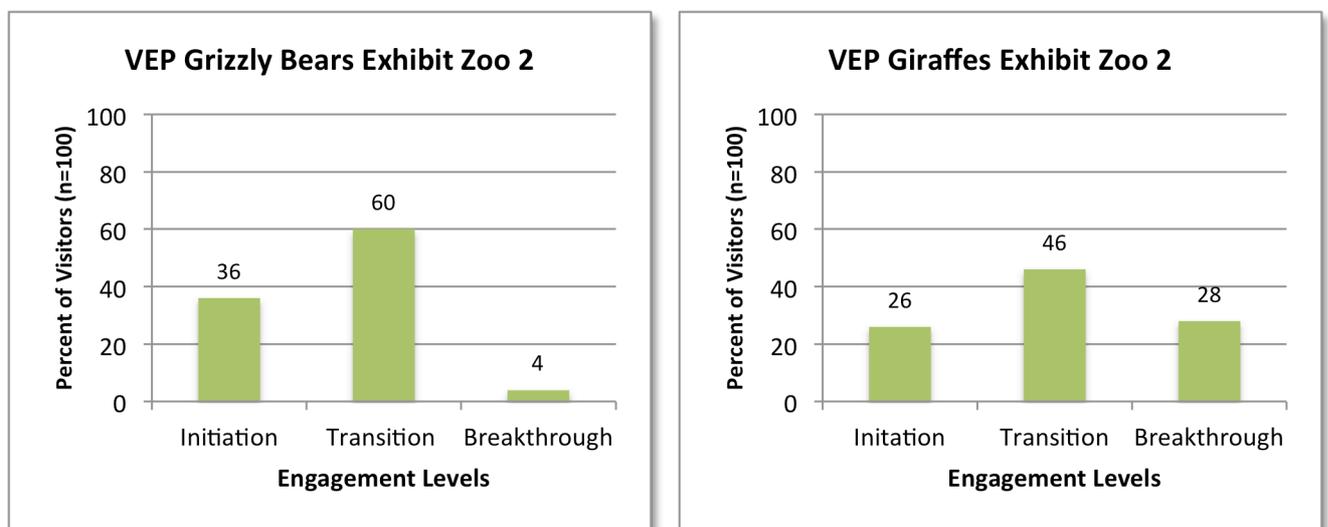
Figure 5.21 Highest level of engagement reached by visitors (%) at the Grizzly Bears exhibit and the Giraffes exhibit in Zoo 2.

The results for the Grizzly Bears and Giraffes exhibits show that more visitors reached only Initiation and Transition engagement levels at the Grizzly Bears exhibit (36% Initiation, 60% Transition) than at the Giraffes exhibit (26% Initiation, 46% Transition) while more visitors engaged in Breakthrough behaviours at the Giraffes exhibit (28%) than at the Grizzly Bears exhibit (4%). Similar to the findings for Aquarium 2 exhibits, this difference in visitor engagement reflects the nature of each exhibit, the level of activity of the animals in the habitat and the different engagement opportunities provided to visitors. The Giraffes exhibit had a very large viewing area, half-walls to lean against while viewing the animals, and book-like signage at waist height on this half wall. The giraffes were quite active, eating hay and leaves from the tall stands or trees and moving from one food stand to the next one quite frequently. The large, open viewing area provided visitors with space

to move about and follow the active giraffes while the book-like signage attracted and engaged visitors in reading and sharing the information with each other. The Grizzly Bears exhibit also has a large, open viewing area but during data collection, one grizzly bear was sleeping and huddled against the glass, in the small viewing area, while the other was not visible in the habitat. The video data collected were from this smaller viewing area as visitors stopped there to get close to the resting bear. The small space did not have signage within it but a large panel was situated adjacent to the glass viewing area. The smaller space, the low activity of the bear, and lack of signage within the small viewing space, seems to have offered visitors fewer opportunities engage in the higher level engagement activities found in the Breakthrough behaviours of the Revised VBLF.

Learning Behaviours and Types of Activity

As was the case with the exhibits in Aquarium 2, all of the learning-related visitor behaviours observed at the Giraffes and Grizzly Bears exhibits in Zoo 2 could be coded using the categories in the Revised Framework. The Learning Behaviours and Types of Activities found in all three levels of engagement reflected what visitors did as they engaged with the live animal exhibit. Figure 5.22 shows that most visitors engaged in *Finding and Identifying* or *Observing the Habitat Animal* or both, again demonstrating that Initiation Level learning behaviours in the Revised Framework effectively capture what can be considered to be the basic interaction visitors have with live animal exhibits. A further breakdown of the *Finding and Identifying* Learning Behaviour (Figure 5.23) shows that the Types of Activity in the Revised Framework capture the finer details of the learning behaviours observed. For example, at the Grizzly Bears exhibit, 49% of visitors engaging in *Finding and Identifying* behaviour "made one or two statements about the animal's behaviour or physical traits", while 67% of visitors at the Giraffes exhibit were coded as such. The frequency of each Type of Activity and Learning Behaviour captured in the Initiation Level at Zoo 2 exhibits are similar to those the results found for the exhibits at Aquarium 2. This helps validate and adds support to the conclusion that the Revised VBLF is an effective tool for assessing the visitor learning experience with live animal exhibits.
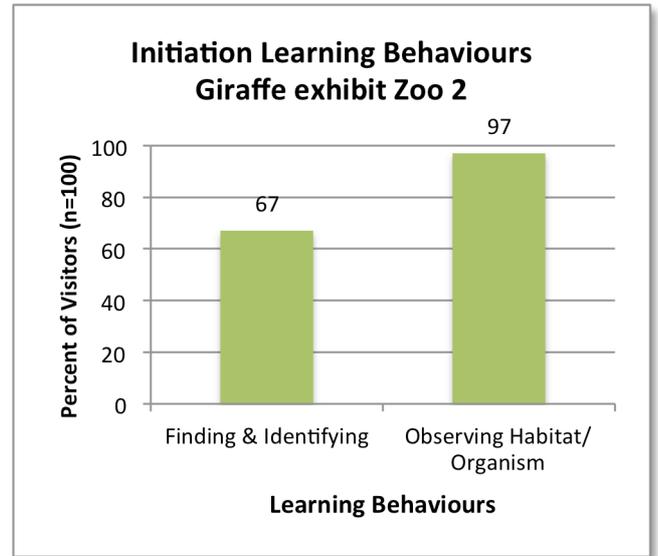
Figure 5.22 Percentage of visitors engaged in the Initiation Level learning behaviours of Finding & Identifying and Observing Habitat/Organism while visiting the Grizzly Bears and the Giraffes exhibits at Zoo 2.
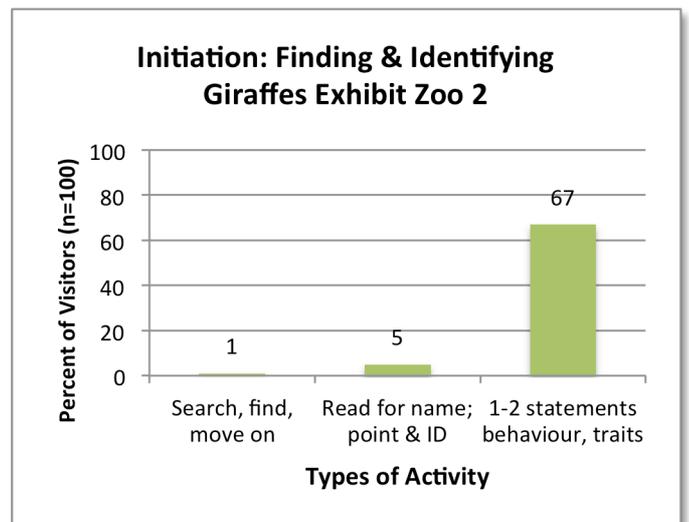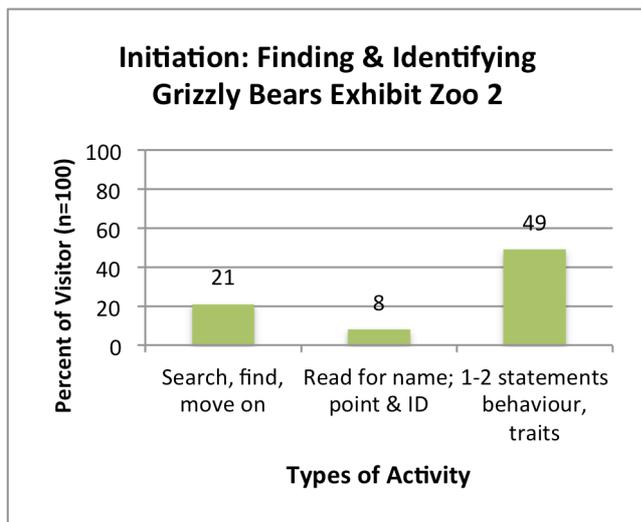
*Figure 5.23* Percentage of visitors engaged in Types of Activity within the Finding & Identifying Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

When visitors at these animal exhibits became more engaged in their learning experience, the Revised Framework was sufficiently robust to capture the more involved Learning Behaviours and Types of Activity described in the Transition and Breakthrough Levels of engagement. The findings for the Transition Level behaviours at both exhibits are in Figure 5.24 and show that the visitors at the Grizzly Bears exhibit were coded less frequently (30% of visitors) in *Exploring to Prolong Engagement* than those at the Giraffes

exhibit (50% of visitors). This finding again demonstrates that the Revised VBLF can reflect the different types of experiences offered by different exhibits, animals and different levels of animal activity. The percentage of visitors engaged in *Demonstrating Affective Engagement* is similar for both exhibits (57% of visitors at Grizzly Bears exhibit and 54% of visitors at the Giraffes exhibit).
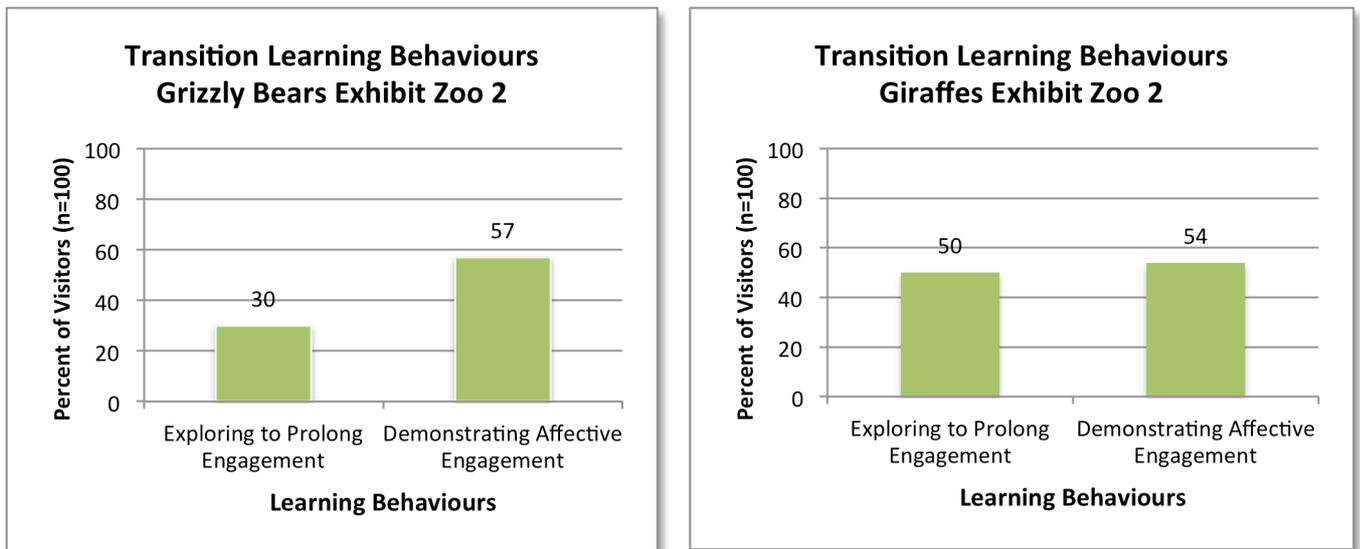
Figure 5.24 Percentage of visitors engaged in the Transition Level learning behaviours of Exploring to Prolong Engagement and Demonstrating Affective Engagement at the Grizzly Bears and Giraffes exhibits at Zoo 2.

The graphs showing the results for the Breakthrough Level of engagement for both the Grizzly Bears and the Giraffes exhibits are in Figure 5.25. These graphs reveal that more visitors engaged in Breakthrough learning behaviours at the Giraffes exhibit than at the Grizzly Bears exhibit and that of those visitors, 21% of them engaged in the Types of Activity found in the *Explaining* Learning Behaviour. All of the graphs for each of the Learning Behaviours and their Types of Activity can be found in Appendix 5B through 5H.
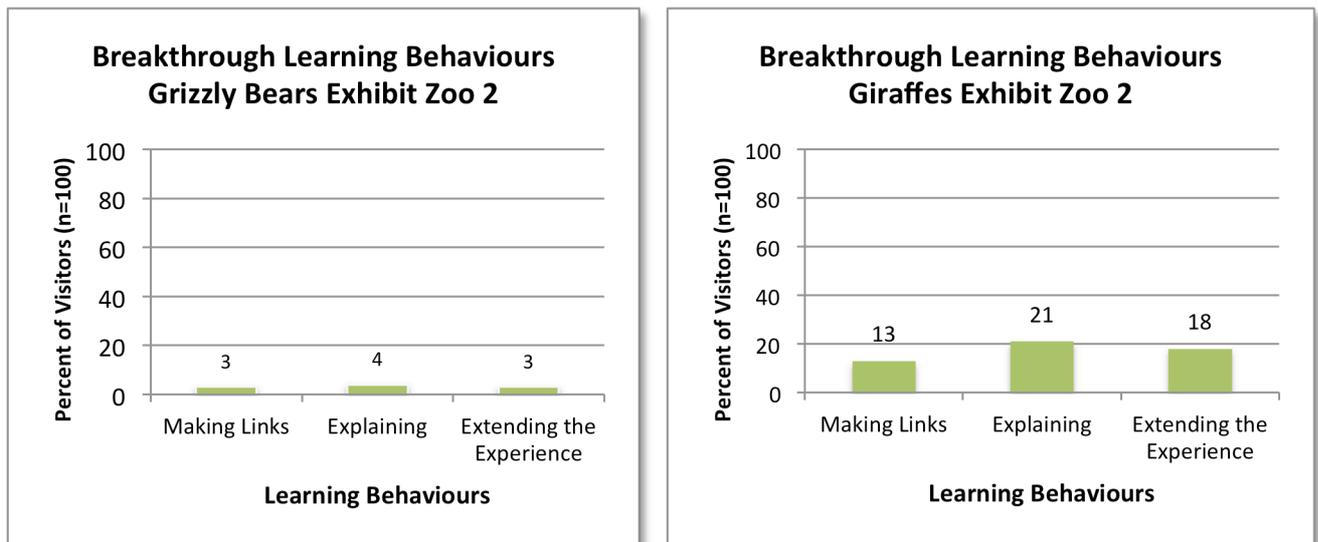
Figure 5.25 Percentage of visitors engaged in the Breakthrough learning behaviours of Making Links, Explaining and Extending the Experience at the Grizzly Bears and the Giraffes exhibits, Zoo 2.

The results of the assessment of visitor learning with zoo exhibits show that the revised Learning Behaviours, the Types of Activity and their detailed descriptions were effective at capturing the nature of the visitor experience with live animal exhibits. As with the aquarium exhibits, the Revised Framework allowed all the visitor dialogue and behaviours related to their interaction with the exhibit to be accounted for in the coding. In addition, as for the aquarium exhibits, the categories within the framework differentiated between different types of exhibits by revealing differences in the frequencies of Learning Behaviours depending on exhibit variables such as the level of activity of the animal or the presence and prominence of the signage and labels. For example, as stated earlier, the Giraffes exhibit had elements that encouraged visitor engagement, such as the book-like signage about the animals in the habitat, large open viewing spaces and active giraffes.

5.1.8 Summary of Phase 3 Results

The findings from Zoo 2 and Aquarium 2 were combined to produce an overall Visitor Engagement Profile and Learning Behaviours graphs for all four live animal exhibits. Four hundred visitors from two institutions make up the sample in these graphs. The results shown in Figure 5.26 represent the average percentage of visitors who reached a maximum of Initiation, Transition and Breakthrough Levels of engagement. Figures 5.27, 5.28 and 5.29 show the average percentage of visitors who engaged in the Learning

Behaviours in the Initiation, Transition and Breakthrough levels respectively, when the results of all four exhibits from both institutions are combined.
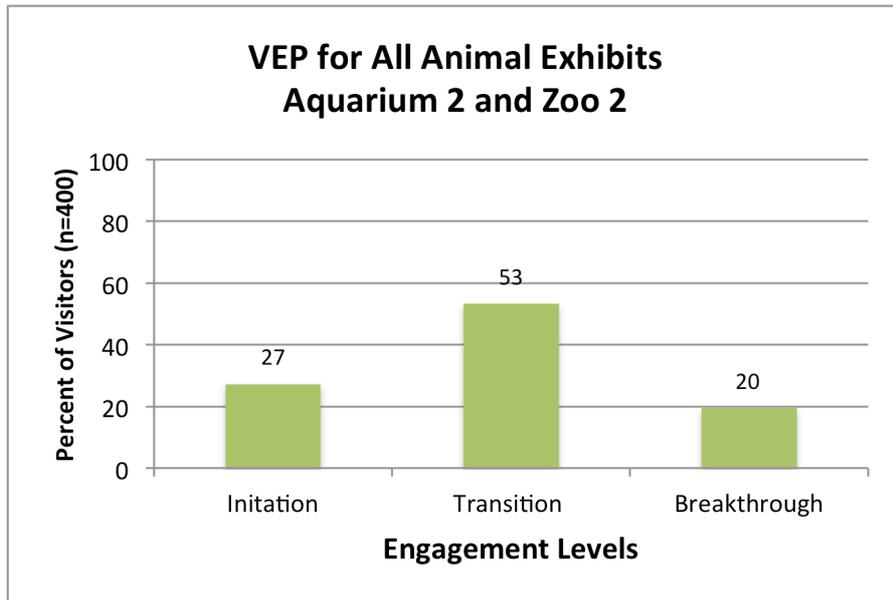
Figure 5.26 Highest level of engagement reached by visitors (%) for all animal exhibits in Phase 3 in Aquarium 2 and Zoo 2.
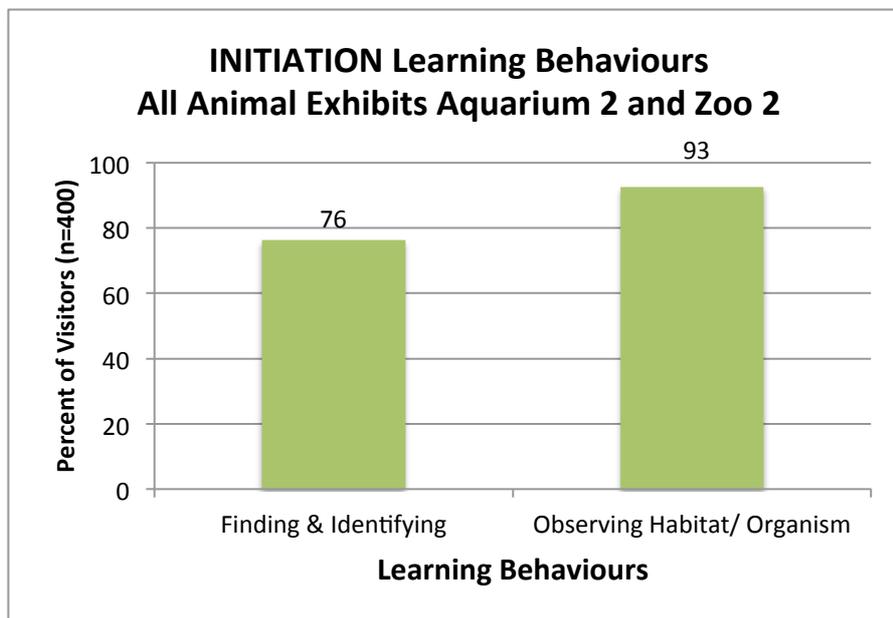
Figure 5.27 Percentage of visitors engaging in Finding & Identifying and Observing Animal/Habitat Learning Behaviours at four animal exhibits in Aquarium 2 and Zoo 2.
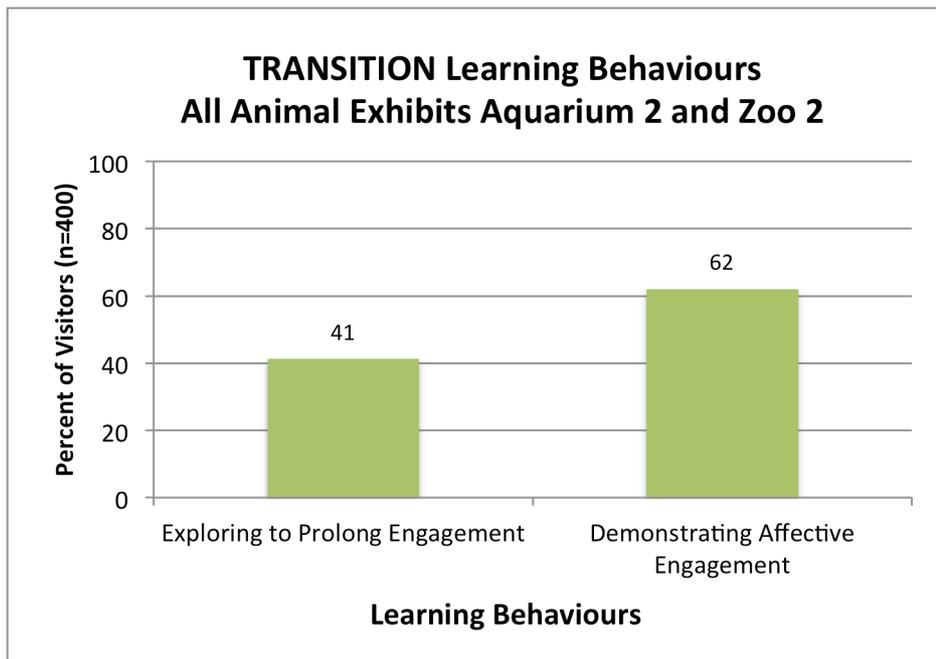
Figure 5.28 Percentage of visitors engaging in Exploring to Prolong Engagement and Demonstrating Affective Engagement at four animal exhibits in Aquarium 2 and Zoo 2.
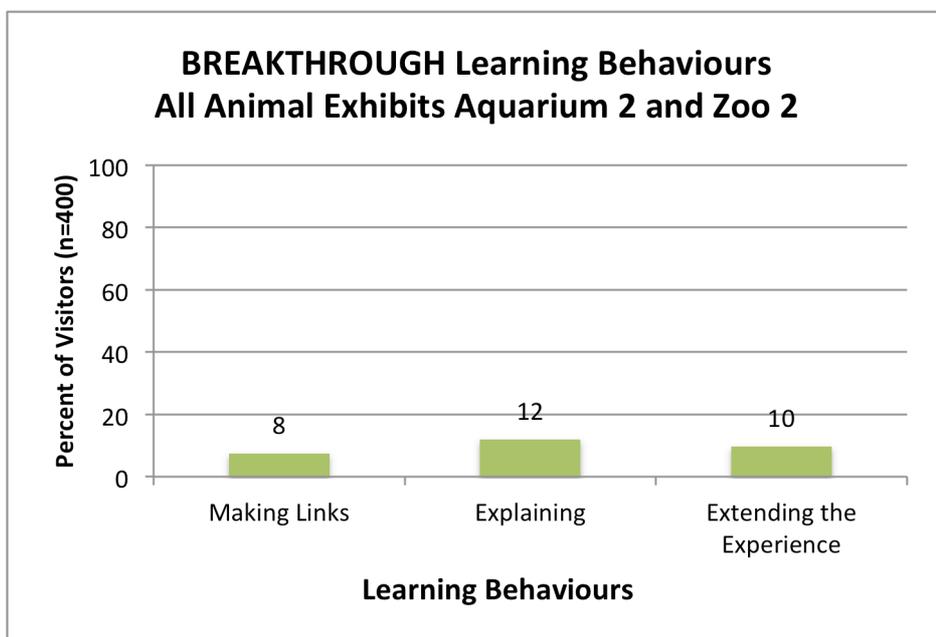
Figure 5.29 Percentage of visitors engaging in Making Links, Explaining and Extending the Experience at four animal exhibits in Aquarium 2 and Zoo 2.

5.1.9 Interpretation of Phase 3 Results

The Revised Framework proved to be effective at capturing the nature of the visitor experience in both the zoo and aquarium setting. All of the visitor behaviours and dialogue associated with engaging with the live animal exhibits could be coded with very few challenges, using the examples and the descriptions in Types of Activity and Learning Behaviours. This demonstrates that the Revised VBLF provides more precise coding and thus reflects the visitor learning experience in zoos and aquarium more effectively than did the Original VBLF.

Assessing the impact of live animal exhibits on visitor engagement using the Revised Framework also demonstrates that it can differentiate between different learning opportunities offered by live animal exhibits due to exhibit variables, such as the activity level of animals, display methods, signage type and placement and the presence of interactive elements. The differences and nuances of each exhibit that the Revised VBLF can capture strengthen the validity of the framework, showing that the visitor behaviours and dialogue being coded are actually what is occurring during the exhibit-visitor interaction.

5.2 Comparing the Effectiveness of the Revised with the Original Visitor-Based Learning Framework

The Revised VBLF is a modification and revision of the Original VBLF based on the results of the analysis reported in Chapter 4 that revealed gaps in the original framework's ability to capture the nature of the visitor learning experience in zoos and aquaria. Analysing the visitor experience with a live animal exhibit using the Original VBLF and comparing that assessment with the results of an analysis using the Revised VBLF, would offer additional support to the Revised Framework's validity as an effective assessment tool. The reliability of the Revised Framework as a practical assessment tool for zoo and aquarium practitioners also needs to be tested and established. This will be addressed in Chapter 6.

5.2.1 Results of Grizzly Bears Exhibit Assessment Using Both Frameworks

Using the same method for coding as described in Chapter 3, the video data from the Grizzly Bears exhibit at Zoo 2 were analysed with the Original VBLF (found in Chapter 2, Table 2.1). The results were compared to those from the analysis of the Grizzly Bear

exhibit using the Revised Framework. The entire sample of visitors for this assessment is 100 and the same visitors were coded using the Original Framework and the Revised Framework.

Figure 5.30 shows the two Visitor Engagement Profiles of the Grizzly Bears exhibit produced using each framework. As in all VEP graphs, the percentage of visitors in each of the Engagement Levels reflects the maximum engagement level reached by visitors in the sample. These VEPs are quite similar to each other. For example, more than half the visitors were coded as reaching Transition Level of Engagement when assessed using either the Original Framework (68%) or the Revised Framework (58%). However, the detailed graphs for individual engagement levels shown below, demonstrate that the Revised Framework is more precise for assessing specific Learning Behaviours and Types of Activity. For ease of reference, Tables 5.3, 5.4 and 5.5 display the Initiation, Transition and Breakthrough Learning Behaviours and Types of Activity for both the Original and Revised Frameworks.
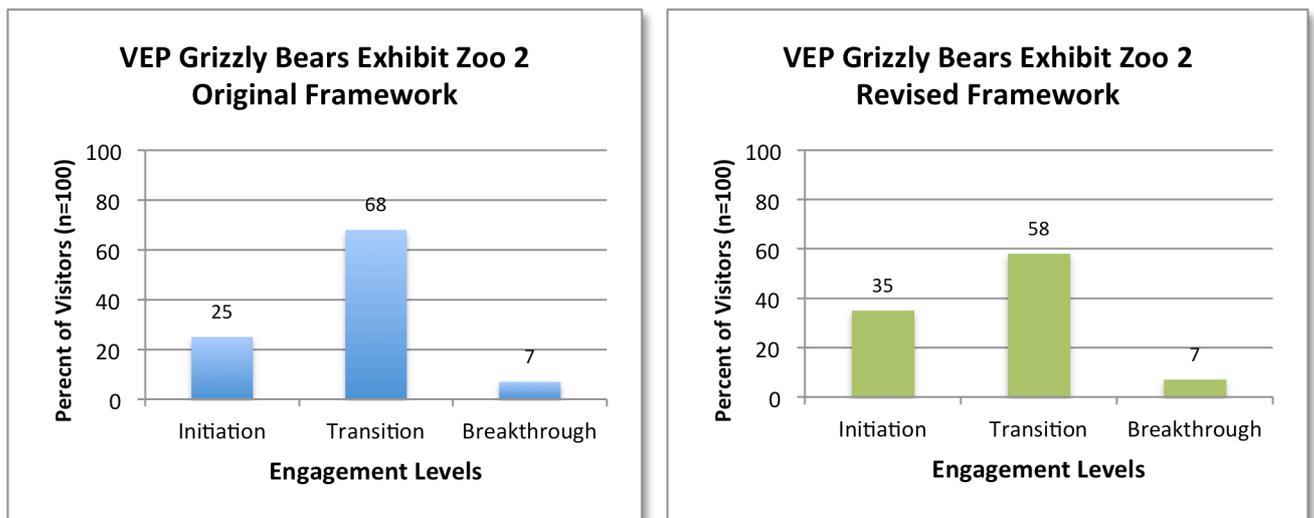
Figure 5.30 Highest level of engagement reached by visitors (%) for the Grizzly Bears exhibit at Zoo 2 as a result of applying the Original Framework and the Revised Framework to the same data.

Table 5.3 Original and Revised Frameworks for Initiation Learning Behaviours.

Engagement Level	Original Framework		Revised Framework	
Initiation	Learning Behaviour	Types of Activity	Learning Behaviour	Types of Activity
	1. Doing the Activity	a. Doing activity passing, not done completely	1. Finding and Identifying the Organism(s)	a. Searching for the animal; not finding it, moving on; or finding it, acknowledging it and moving on
		b. Doing activity somewhat completely		b. Reading the label for animal's name; pointing and/ or naming / identifying the animal
		c. Doing activity completely, without further exploration		c. Makes one or two simple statements and/or questions about the animal's behaviour and / or physical traits
	2. Spending Time Watching Others Engaging in Activity	a. Watching the exhibit work or someone doing activity	2. Observing the Habitat or the Organism(s)	a. Observing the animal without verbal or facial expressions; not showing engagement (<30 seconds)
		b. Watching with expressed interest in activity (facial or verbal expressions)		b. Watching the animal with interest; facial and/ or verbal expressions
		c. Interested in the outcome the activity		c. Taking picture of the animal; recording the event (but no indication of interpretation or doing something with the photo)

Figure 5.31 displays the results for the Initiation Level of engagement at the Grizzly Bears exhibit using the Original Framework and using the Revised Framework for the same sample of visitors. Although the entire sample in these graphs is 100, visitors can be coded as engaging in one or both Learning Behaviours and in one or more than one Type of Activity. Hence the percentages within each graph may not equal one hundred. Figure 5.31 shows that the Original Framework does not capture the nature of the of the visitor experience in the Initiation Level because *Doing the Activity* and the Types of Activity described in this Learning Behaviour do not describe the basic interaction with a live animal exhibit, resulting in that code never being assigned to a visitor. The Learning Behaviour *Doing the Activity* was revised in Chapter 4 to *Finding and Identifying* and the Types of Activity further describe the Learning Behaviour (Table 5.3). Figure 5.31 also

shows that the Revised Framework captures the Types of Activity at the Grizzly Bears exhibit for the *Finding and Identifying* Learning Behaviour, providing a more precise and refined assessment of the visitor learning experience.
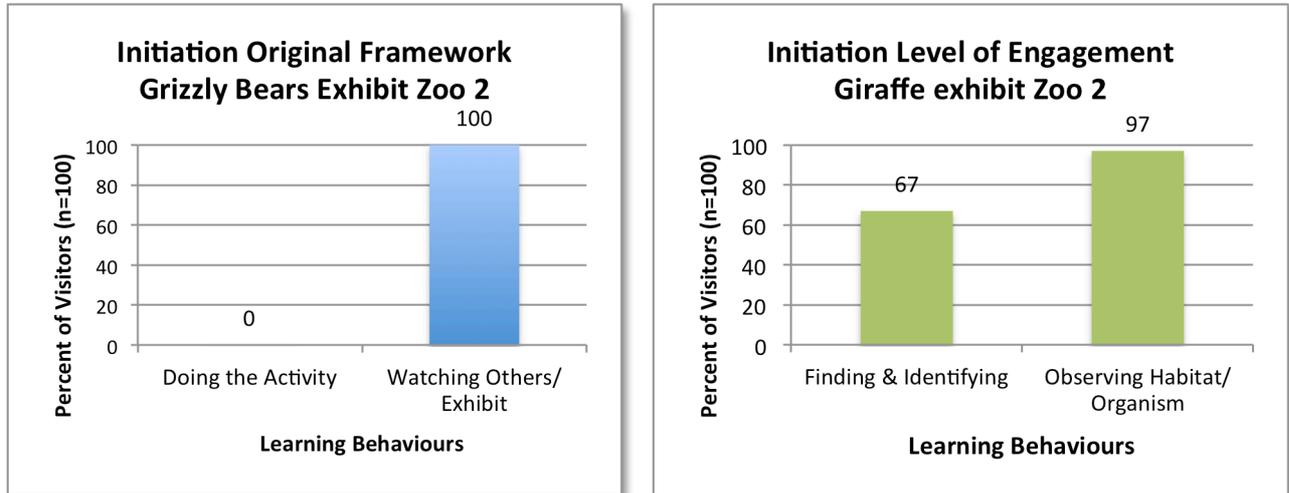
Figure 5.31 Percentage of visitors engaging in Initiation Level Learning Behaviours at the Grizzly Bears exhibit in Zoo 2 using the Original and Revised Frameworks.

The Learning Behaviours in the original Transition Level of engagement were revised from *Repeating the Activity* and *Expressing Emotional Response* to *Exploring to Prolong Engagement* and *Demonstrating Affective Engagement* respectively (see Table 5.4). The Types of Activity described in the Revised Framework further define these Learning Behaviours and, as seen in Figure 5.32, are more reflective of the visitor learning experience with a live animal exhibit. Figure 5.32 shows that, at the Transition Level of Engagement, the Revised Learning Behaviours reflect the experience of the visitors engaged in at the Grizzly Bears exhibit. For example, using the Original Framework, only five percent of visitors were coded as engaged in *Repeating the Activity* while 30% of visitors were coded as *Exploring to Prolong Engagement* with the Revised Framework. Although fewer visitors were coded as *Demonstrating Affective Engagement* (57%) then *Expressing Emotional Response* (74%), it can be argued that the refinement of the original Learning Behaviour of *Expressing Emotional Response* to *Demonstrating Affective Engagement* more accurately reflects the type of affective visitor engagement that results from interacting with a live animal exhibit. The Types of Activity describing the *Demonstrating Affective Engagement* Learning Behaviour refer to actions directly related to observing the live animal in the exhibit, like "obvious signs of excitement when

observing the animal" and "expressed desire to interact with the animal, or physically or verbally mimicking the animal". This characterization of affective engagement results in the coding of only those visitors engaged in expressing affection toward the animal or the experience with the animal exhibit, not those showing emotional responses not directed at that experience in particular.
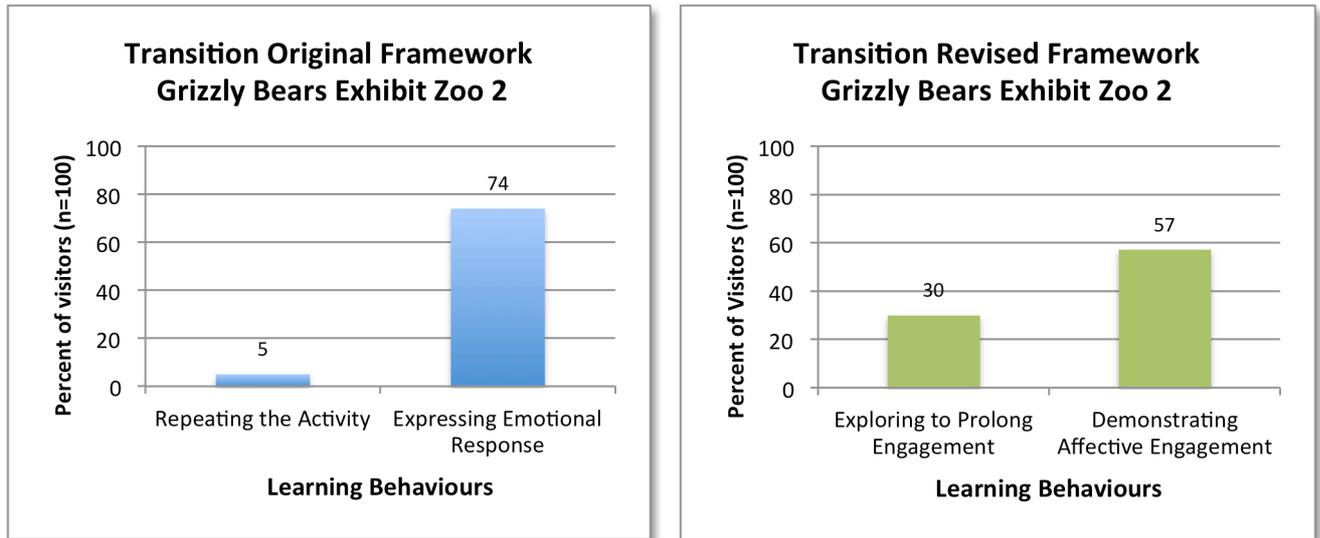
Figure 5.32 Percentage of visitors engaging in Transition Level Learning Behaviours at the Grizzly Bears exhibit in Zoo 2 using the Original and Revised Frameworks.

Table 5.4 Original and Revised Frameworks for Transition Learning Behaviours.

Engagement Level	Original Framework		Revised Framework	
	Learning Behaviour	Types of Activity	Learning Behaviour	Types of Activity
Transition	3. Repeating the Activity	a. Repeat activity 2 or 3 times to attain desired outcome, to master exhibit function	3. Exploring to Prolong Engagement	a. Expressed desire to watch animal again, for a longer period of time with expressed interest in behaviour or physical traits
		b. Enjoyment of outcome		b. Expressed desire to find another similar animal
		c. Changing variables once to see a difference in outcome		c. Changing variables once to see a difference in outcome

Table 5.4 (Cont'd) Original and Revised Frameworks for Transition Learning Behaviours.

Engagement Level	Original Framework		Revised Framework	
Transition	Learning Behaviour	Types of Activity	Learning Behaviour	Types of Activity
	4. Expressing Emotional Response	a. Smiling, pleased with exhibit	4. Demonstrating Affective Engagement	a. Smiling and pointing at animal; pleased with finding it after searching
		b. Stronger signs of enjoyment such as laughter, verbal reference to enjoyment		b. Stronger signs of enjoyment / excitement such as laughter; verbal expressions of enjoyment; obvious signs of excitement when observing the animal; verbal outbursts of amazement and awe
		c. Obvious signs of eagerness to participate; excited disposition		c. Expressed desire to interact with the animal, physically and verbally (mimicking) or concern for the animal's well being

At the Breakthrough Level of engagement (Table 5.5), the results of the analysis using the Original Framework were similar to those using the Revised Framework (Figure 5.33). Three percent of visitors were coded as *Referring to Past Experiences* (Original Framework) and as *Making Links* (Revised Framework) while four percent of visitors were coded as *Seeking and Sharing Information* (Original Framework) and as *Explaining* (Revised Framework). The Types of Activity for these Learning Behaviours are quite similar in both the Original and the Revised Framework and thus, not entirely surprisingly, led to similar coding of the visitor experience at the Grizzly Bears exhibit. In other words, both frameworks describe learning behaviours that clearly indicate the visitor is engaging in meaning making during his or her experience with the exhibit and both reflect the visitor's deeper cognitive engagement with the exhibit's content.

Table 5.5 Original and Revised Frameworks for Breakthrough Learning Behaviours.

Engagement Level	Original Framework		Revised Framework	
Breakthrough	Learning Behaviour	Types of Activity	Learning Behaviour	Types of Activity
	5. Referring to Past Experiences While Engaging in Activity	a. Reference to past experience with exhibit	5. Making Links	a. Reference to past experience with the animal or the institution
		b. Simple reference to comparable experience in visitor's life		b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; cultural references about animal that contribute to meaning making
		c. Reference to comparable experience AND making comparisons, deductions based on observations of similarities and differences or prior knowledge		c. Reference to comparable experience in their life as well as making comparisons and deductions based on prior knowledge, or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat
	6. Seeking and Sharing Information	a. Seeking. Calling someone over to look at exhibit, or to ask them to explain an exhibit; asking a question to staff or family member without lengthy discussion or exploration of topic	6. Explaining	a Calling on someone for information about the animal. Asking 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat
		b. Seeking to consolidate. Reading signage thoroughly, having conversations about exhibit and related science with staff or family, friend		b. Reading signage thoroughly out loud to others; having conversations related to signage about the animal or exhibit related to physical traits, behaviours, diet, habitat
		c. Sharing experience and information with others by explaining the exhibit to them, giving them details about gained information and observations; discussion and questions about exhibit with staff or family /friend		c. Sharing experience and information with others by explaining, describing the animal's traits/ behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family /friend

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Table 5.5 (Cont'd) Original and Revised Frameworks for Breakthrough Learning Behaviours.

Engagement Level	Original Framework		Revised Framework	
Breakthrough	Learning Behaviour	Types of Activity	Learning Behaviour	Types of Activity
	7. Engaged and Involved	a. Engaging in inquisitive behaviour, exploratory actions such as repeating the activity several times, reading signage, asking questions; remaining on task for 2-3 minutes. b. Concentration and motivation are obvious; doing the activity as a means to an end, or meeting a challenge; length of interaction significant, 3 to 5 minutes; outcome or result of activity important. c. Experimenting, testing different variables, looking for different outcomes; engages in discussion with others (visitors or staff) about the various outcomes; experience - 'flow'; involved in activity for long period of time i.e. more than 5 minutes.	7. Extending the Experience	a. Engaging in inquisitive behaviour, exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits; reading signage, asking questions and remaining at exhibit/ habitat for 2-3 minutes b. Concentration and motivation to know more about the animal(s) are obvious. Engaging with animal habitat as a means to learn / understand more about the animal. Length of interaction significant, 3 to 5 minutes. c. Deep emotional or cognitive involvement with the experience of observing the animal, looking for different outcomes, engaging with accompanying exhibits, discussing many observations and deductions with others; may discuss wildlife conservation or environmental issues; involved in observation activities for long period of time i.e. more than 5 minutes

In revising the Original Framework in Chapter 4, reference was made to a particular weakness in its ability to capture the most involved inquisitive learning behaviour in the Breakthrough category, where, with a typical interactive science centre exhibit, visitors can hypothesise, manipulate and test variables to produce different outcomes. The revised Learning Behaviour for that category is *Extending the Experience* and the Types of Activity describe what a deep cognitive experience can be with a live animal exhibit. In this case, four visitors were coded as *Extending the Experience* (Revised Framework) while only one visitor was coded as *Engaged and Involved* (Original Framework). Although the frequency of Breakthrough Level learning behaviours is low, these findings contribute to the validity

of the Revised Framework as a more effective and reflective tool to assess the learning impact of live animal exhibits found in zoos and aquaria.

5.3 Summary

In Phase 2 of this study, the Original VBLF was modified and revised to be more representative of the visitor learning experience in zoos and aquaria. Thus, as described in this chapter, Phase 3 of this research was designed and carried out to test the validity of the Revised VBLF as an effective assessment tool by applying it to new visitor behaviour data collected in Aquarium 2 and Zoo 2. The Revised Framework proved to be effective at capturing the nature of the visitor experience in both the aquarium and the zoo setting, enabling all visitor behaviours and dialogue associated with the engaging with the live animal exhibits to be coded. The results of this phase of the study demonstrated that the Revised VBLF provides more precise coding and thus reflects the visitor learning experience with live animal exhibits more effectively than did the Original Visitor-Based Learning Framework.

Furthermore, assessing visitor engagement using the Revised Framework demonstrated that it can differentiate between different learning opportunities offered by live animal exhibits due to various exhibit variables which strengthens the validity of the framework. In addition to applying the Revised Framework to new visitor data, the Original Framework and the Revised Framework were used to analyse data for the Grizzly Bears exhibit to further test the Revised Framework's validity. The results of this comparison confirmed that the tool provides more precise coding, especially in Initiation and Transition levels of engagement. This comparison also revealed a very low frequency of Breakthrough Level learning behaviours, even when the Revised Framework was applied to the visitor data. The implications of this finding will be discussed further in Chapter 7.

An important goal in developing the Revised VBLF is to provide zoo and aquarium practitioners with a reliable and practical assessment tool that can evaluate the potential impact of live animal exhibits on visitor learning. In the next chapter, the Revised VBLF is field tested with less experienced "test coders" to determine its usability and reliability.

Chapter 6
Field Testing the Revised Framework for Usability

6.1 Field Testing the Revised Visitor-Based Learning Framework

One of the goals of revising the VBLF is to provide a usable and practical assessment tool for zoo and aquarium practitioners who want to evaluate the potential impact of the live animal exhibits on visitor learning at their institutions. Therefore it is important not only to test the effectiveness of the Revised Framework in capturing visitor learning behaviours, but also to test it with respect to its usability, clarity and precision. Can others with less experience in research and learning behaviour observation use this tool with relative ease, resulting in a reliable assessment of the impact of live animal exhibits? Are the descriptions of the Learning Behaviours easily understood, precise and unambiguous so as to make coding visitor experiences practical for zoo and aquarium practitioners?

6.1.1 Method – Field Testing the Revised Framework

To answer these questions, it was necessary to have other people use the framework and use their coding patterns to test the usability and reliability of the Revised Framework. Observing visitors and describing their behaviour is a skilled task, so it was decided that the best test of the Revised Framework would be made by using "test-coders" who were experienced in visitor observation and familiar with the use of a framework to code behaviours. It would also be helpful if the test-coders had some familiarity with Studiocode so that its use was not a distraction to the coding process. Further, if another person was able to use the Revised Framework to code one of the animal video-recordings already coded, then a comparison could be made between their coding and the detailed coding already used to test the validity of the Revised Framework (as reported in Chapter 5). It was expected that the resulting match or mismatch would not only highlight code descriptors that were unclear or ambiguous, thus allowing the descriptors to be refined, but also highlight issues involved with learning how to use the Revised VBLF.

The first step was to recruit a graduate student, with some experience in coding learning behaviours, to use the Revised Framework and code visitor learning behaviours as they engaged with a live animal exhibit. This student was recruited because of her

availability and her familiarity with the coding software Studiocode. She had some experience with coding learning behaviours at exhibits in a science centre, but no experience coding the visitor experience with live animal exhibits. The Revised VBLF, the Learning Behaviours and the Types of Activity were introduced to the graduate student during a two-hour training session, using video data from the Grizzly Bear exhibit, throughout which the learning behaviours of ten visitors were coded. The graduate student was then asked to code the learning behaviours of 100 visitors at the Giraffes exhibit from Zoo 2. This exhibit was chosen for this testing phase of the research project because it provided the most clear audio and video data of all the video data collected in Aquarium 2 and Zoo 2. Although there were many segments of the video that were challenging to hear, it was the most suitable for this field test. The exhibit has a large viewing area outdoors, resulting in visitors being spread out and close enough to the microphone to pick up most conversations. There was no echo in the soundtrack, which was an issue with aquarium video data because it was recorded indoors in cavern-like spaces.

The second step was to determine how to make comparisons between the researcher's initial coding from Phase 3 and the new coding by the test-coder. It has been the researcher's experience at Science North, and that of other researchers in field (for example, Ash et al., 2007) that when coders are introduced to a new system, it takes some time to gain familiarity with the coding framework and also to "read" visitors' behaviour in a consistent way. For example, experience at Science North has shown that new coders tend to code fewer behaviours than more experienced coders, either because they have not yet learned the coding framework or are uncertain in their interpretation of observed behaviours, resulting in a cautious "under-coding". This is an issue particularly with live coding, because behaviours are fleeting and can be missed, especially if the conversation is difficult to hear. Coding video data has an advantage here because the coder is able to rewind and view repeatedly behaviours that are tricky to code, for example, when the audio quality makes it difficult to hear what people are saying, or it is not clear which visitor has spoken. In developing the Revised VBLF in Phase 2 and testing it for validity in Phase 3, many sections of the recorded video data were viewed repeatedly to understand what visitors were saying and to be certain whose voice was being heard, thus maximising the amount of behaviour coded and providing the most stringent test of the Revised Framework. It was likely that new coders would not have the same depth of knowledge of the coding framework and thus may code less of the behaviours.

Given these issues, it was essential to ensure that the comparisons to be made between the original coding and the field test coding were based on identical events. It is important to note that, when coding visitor behaviour, the coder researcher chooses the Type of Activity codes in the coding window (Figure 6.1). The Type of Activity code buttons are linked to a specific Learning Behaviour which, in turn, is linked to its Engagement Level. This means that when a code is entered at the Type of Activity level of the framework, the higher level details get populated automatically, based the corresponding category of Learning Behaviour and Engagement Level. As described in Chapter 3, the codes are tabulated using the Matrix function in Studiocode and exported to Excel to produce the spreadsheet of data. By comparing the graduate student's codes to the codes assigned by the researcher, it can be verified that codes were assigned to the same events. The graduate student's interpretation of the descriptors in the Revised Framework can also be assessed while noting any patterns of discrepancies that can inform a refinement of the framework's descriptors. If a refinement of descriptors is needed, it may be necessary to repeat the test coding in a second field test.
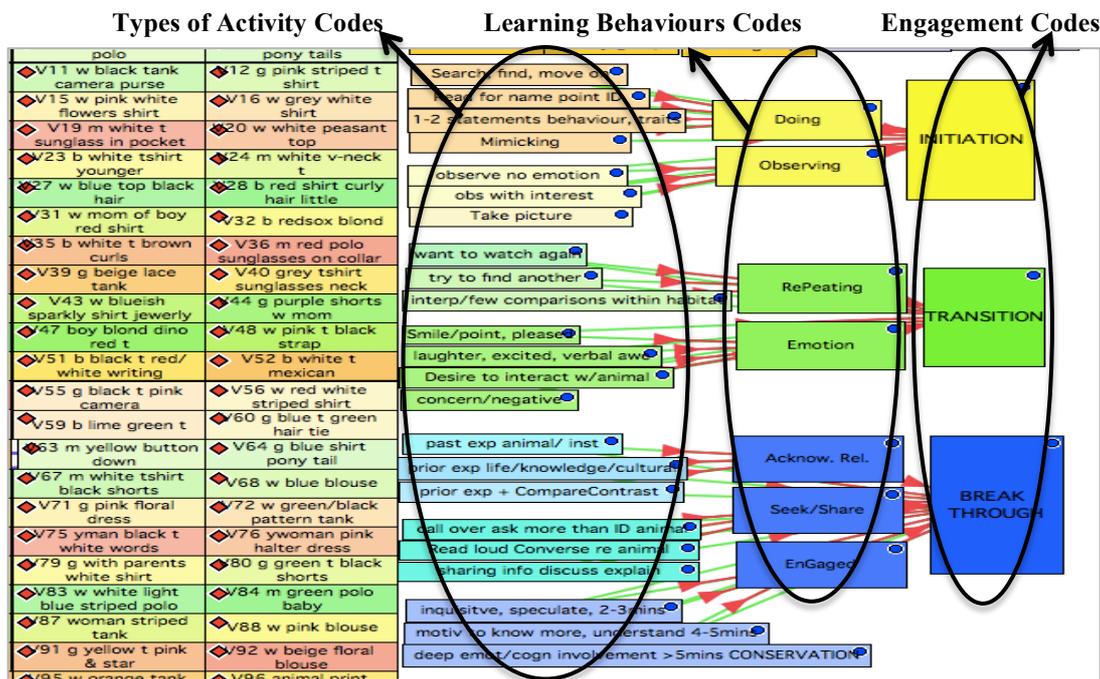
Figure 6.1 Types of Activity codes are linked to the Learning Behaviour codes and the Engagement Level codes in the coding window.

6.1.2 Results of the First Field Test

The graduate student coded 100 visitors at the Giraffes exhibit. The comparison of her coding results to the researcher's original coding results showed many discrepancies.

Further exploration of the discrepancies revealed a marked difference between the number of codes assigned by the researcher, and the number of codes assigned by the graduate student. The researcher assigned a greater number (395) of codes to 100 visitors than did the graduate student (318). This discrepancy suggests that there is a difference between the fine-grained coding done by the researcher and the more coarse-grained coding done by the graduate student. This is not entirely surprising given the level of experience, skill and knowledge the researcher has with respect to coding the learning behaviours described in the framework. It can be argued that the graduate student completed what one might call 'a first pass'[2] coding that doesn't involve as much reviewing, careful listening and repeat coding of events as does the precise and detailed coding one achieves through repeated viewing and analysis of video data. The graduate student's coding patterns were also reflective of what is seen at Science North when first training new student research assistants. Fewer codes are assigned and this can be attributed to their unfamiliarity with observing and coding visitor behaviours for learning. Although the graduate student assigned fewer, and often different, codes than the researcher, the graduate student did express her understanding and appreciation of the usefulness of the framework and its categories at capturing the learning experience of visitors engaging with live animal exhibits. She admitted that hearing and seeing visitors to code their behaviour is often very challenging and as a result, felt that she would have needed more time to review the video data to better code visitor behaviour. This certainly contributed to the assignment of fewer codes by the graduate student.

Further analysis of the results revealed patterns in the discrepancies that illuminated some ambiguities in the descriptions of the behaviours and also that some of the categories were not mutually exclusive. For example, two of the categories contained the action "pointing", once in the *Finding and Identifying* Learning Behaviour, and once in the *Demonstrating Affective Engagement* Learning Behaviour. An example of ambiguity was revealed in the Types of Activity "Read for name" and in "Reading signage out loud". The first is intended to describe an Initiation level behaviour where a visitor simply reads the name to identify the animal while the latter refers to a more engaged level of learning behaviour found in Breakthrough, and describes a visitor reading signage thoroughly to others, out loud, to spur conversation about what they are viewing. This further analysis

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[2] Research delegates at the Studiocode User Conference (March 2013) often referred to a "first pass" coding done by their graduate students at the preliminary stage of data analysis.

revealed that some the descriptions in the Types of Activity needed to be defined more precisely to remove the ambiguity and to improve the usability of the framework for practitioners.

6.1.3 Results – Refining the Revised Framework

The results of the graduate student's test coding revealed the need to refine the descriptors in the Revised Framework. The details of these refinements and the rationale for the changes are described in the following sections.

Refining Initiation level descriptors
1. Finding and Identifying

As seen in Table 6.1, the descriptors for *1. Finding and Identifying* included "b. Reading label for name or pointing/identifying". This descriptor is similar to *4. Demonstrating Affective Engagement* "a. Smiling and pointing at animal, pleased with finding it after searching", which means that these categories could be interpreted as not being mutually exclusive. The main behaviour that this category should be describing is a visitor engaged in identifying the animal in the exhibit, through "pointing and identifying" or "reading the label for the name" or "saying the name". This ambiguity was revealed through the graduate student use of this code for smiling and prolonged reading behaviours, both of which are meant to be captured in other categories (Transition and Breakthrough respectively). This category was thus refined to "b. Pointing and identifying or saying the name or reading the label for the name of the animal." This is more precise and places the emphasis on the *Identifying* behaviour.

2. Observing Animal / Habitat

Additional descriptors were added to "a. Observing the animal without verbal or facial expressions; not showing engagement" and "b. Observing animal with interest through facial or verbal expressions" in the Learning Behaviour *2. Observing Habitat or Animal.* Including an approximate duration to these descriptions removed an ambiguity in what was meant by "not showing engagement". The graduate student mentioned this ambiguity to the researcher and requested clarification while she was coding. The difference between these two behaviours can be challenging to perceive and by adding an approximate duration, the descriptors should be more easily interpreted and facilitate coding. Thus, the refined descriptions for these Types of Activity in the framework include "approximately 10 seconds" for "a. Observe animal without showing engagement" and "at

least 30 seconds, usually up to 60 seconds" for "b. Observing animal with interest through facial or verbal expressions".

Refining Transition level descriptors
3. Exploring to Prolong Engagement

The first Type of Activity for *3. Exploring to Prolong Engagement* is the descriptor "a. Expressed desire to watch animal again, for a longer period of time with expressed interest in behaviour or physical traits". This descriptor is meant to differentiate this level of engagement from simply searching and finding the animal in the exhibit which is an Initiation behaviour. The graduate student only coded this behaviour once for 100 visitors while the researcher assigned it 17 times. Including words such as "again" and phrases such as "with expressed interest", the descriptor may have been too narrowly focused and not capturing the essence of this learning behaviour for the user of the framework. By refining the description to "a. Expressed desire to watch animal for a longer period of time AND/OR expressed interest in behaviour or physical traits", the descriptor allows a coder to capture a visitor who either expresses they want to stay longer OR a visitor who expresses interest in the behaviour and physical traits of the animal. To distinguish this behaviour further, an approximate duration of one minute was also added to the description, meaning that this code should be assigned when a visitor is engaged for a longer period of time, at a level above *2. Observing Animal/Habitat.*

The descriptor for "b. Expressed desire to find another similar animal" was also refined to include visitors that are actively looking for more animals in the exhibits but not necessarily verbally expressing it. Again, this change was informed by the fact that the graduate student only assigned it five times, while the researcher assigned it 17 times to 100 visitors. The addition to the descriptor is "b. Expressed desire to find another similar animal; looking for more animals in the habitat".

The last Type of Activity descriptor is "c. Make a few comparisons between individual animals within the same habitat, some attempt at interpretation" and needed to be differentiated from the Initiation Level learning behaviour *Finding and Identifying* "a. Makes one or two simple statements and/or questions about the animal's behaviour and / or physical traits". The essence of this descriptor, given that it is a Transition Level learning behaviour, is that the visitor is doing more than stating one or two facts. He or she is comparing individual animals and making some attempt at interpreting what is being observed. Again, this refinement seemed necessary since the graduate student assigned this

code three times while the researcher coded it 35 times for 100 visitors. The graduate student commented that she found these two descriptors too similar to differentiate easily. To refine it, the word "comparisons" and the phrase "some attempt at interpretation" were bolded.

4. Demonstrating Affective Engagement

Refinements were made to the descriptors in *4. Demonstrating Affective Engagement*. As previously stated, the descriptor "a. Smiling and point at animal; pleased with finding it after searching" contains actions that are included in the Learning Behaviour *1. Finding and Identifying*, "b. Pointing and identifying". By removing the action of "pointing", the descriptor allows the coder to know with certainty that "pointing" belongs in Initiation. In addition, the phrase "finding after searching" implies that the code can only be assigned to a visitor that has spent time searching for the animal to find it. However, with many animal exhibits, searching is not necessary because the animal(s) is in plain view, as was the case with the Giraffe exhibit in Zoo 2. Thus, the descriptor for this Type of Activity was modified to be more precise "a. Smiling, looking pleased with finding or observing the animal(s)".

The descriptor "b. Stronger, obvious signs of enjoyment, excitement such as laughter; verbal expressions of enjoyment when observing the animal; verbal outbursts of amazement and awe", was also refined because, in the field test, the word "laughter" seemed too prominent, as the graduate student suggested that if she did not hear or see someone laughing, this code was not used. Further analysis of the graduate student's coding of this Type of Activity revealed that, although she assigned this code as often as the researcher, it was not assigned to the same visitors as the researcher. To refine this code, the phrases in the descriptor were ordered differently to emphasize that this code captures the visitor who is engaged in an affective response that involves a range of expressions of emotions. The refined code now reads "b. Verbal outbursts of affection, amazement and/or signs of awe; verbal expression of enjoyment when observing animal; stronger signs of excitement, such as laughter".

The last Type of Activity in *4. Demonstrating Affective Engagement* is "c. Expressed desire to interact with the animal, physically and verbally (mimicking); or concern for the animal's well being". In this case, the word "and" suggested to the graduate student that a visitor needed to be attempting to interact with the animal both physically and verbally, in a mimicking fashion. This descriptor was made more precise and refined to "b.

Expressed desire to interact with the animal, physically or verbally; including mimicking; OR concern for the animal's well being".

Refining Breakthrough level descriptors

The percentage of visitors who engaged in Breakthrough level behaviours is typically lower than those who reach Initiation and Transition Levels of engagement. Not surprisingly, the number of codes assigned at the Breakthrough Level in this field test was lower than those assigned at the Initiation and Transition Levels. Thus, the comparison and analysis of the researcher's codes with the graduate student's codes, were based on fewer events and fewer discrepancies occurred. However, it can be argued that due to the infrequency of these events, it is essential that the descriptors for these codes are precise and unambiguous to ensure that users can effectively capture the more engaged and involved learning behaviours.

5. Making Links

In the Learning Behaviour *5. Making Links,* the Revised Framework includes "a. Reference to past experience with the animal or the institution". The refined descriptor now reads "a. Reference to past experience with that type/species of animal or institution". Through this precision, the descriptor was broadened to include for example, a visitor referring to experiences with giraffes in general, not necessarily the giraffe at this zoo.

The following descriptor, "b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; cultural references about the animal that contribute to meaning making" lacked precision for a few reasons. Upon further analysis of the graduate student's codes, it seemed that "cultural references" and "contribute to meaning making" were too ambiguous to enable her to assign the code to visitors who, based on the researcher's observations, did meet the criteria for this code. In other words, this descriptor should capture the visitor who makes and expresses a personal connection that obviously contributes to their understanding. Thus, the refinement of the descriptor highlights this in "b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; stating a personal connection to their understanding".

A review of the descriptor "c. Reference to comparable experience in their life as well as making comparisons / deductions based on prior knowledge or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat", highlighted that the first phrase was not necessary and did not contribute to the precision of

this code. The refined code simply reads "c. Making comparisons / deductions based on prior knowledge or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat".

6. Explaining

The descriptor "a. Calling on someone for information about the animal. Asking 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat" was refined by bolding the word "Asking" to emphasize that this code is about asking questions, not making statements.

As was discussed earlier in the chapter, two descriptors referred to reading behaviour, contributing to the discrepancies in assigned codes between the graduate student and the researcher. Thus, the descriptor "b. Reading signage thoroughly out loud to others; having conversations related to signage about the animal or exhibit related to physical traits, behaviours, diet, habitat" needed to be refined and made more precise. A careful review of the words in this descriptor also revealed that, besides "reading", its definition was similar to the Type of Activity "c. Sharing experience and information with others by explaining, describing the animal's traits / behaviour to them, giving them details about their own observations; discussion and questions about animal with staff or family / friends". In making these descriptors more precise, it was important to differentiate between these two Types of Activity. The description in "b. Reading signage thoroughly" needed to emphasize that for this code to be assigned, the visitor is reading the signage out loud to initiate conversations and share that information. As for "c. Sharing experience and information with other", it is meant to capture the type of sharing that has progressed or evolved beyond reading signage to share information. The refined codes were crafted with this in mind and important distinguishing phrases were bolded for emphasis. These descriptors now read as "b. Reading through signage out loud to others **to initiate conversations about the animal or exhibit,** related to physical traits, behaviours, diet, habitat, conservation" and "c. Sharing experience and information with others **has evolved / progressed to** explaining, describing the animal's traits / behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family / friends".

7. Extending the Experience

At this level of engagement, codes are assigned to visitors who engage in many different learning behaviours that can be challenging to differentiate for less experienced observers. One of the defining characteristics of all descriptors in this category is the

duration of the interaction visitors have while at the live animal exhibit. To highlight this and to facilitate coding, the expected duration of the interaction has been bolded in each of the Types of Activity within the Learning Behaviour *Extending the Experience*.

The analysis of the graduate student's coding also revealed that the first Type of Activity, "a. Engaging in inquisitive behaviour, exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits, reading signage and asking many question"*,* was often not coded when in fact the visitor did engage in many or most of the actions listed in the descriptor. The various inquisitive behaviours listed in the descriptor are found individually in the descriptions of other Types of Activity which may lead a coder to assume that those actions were already coded and accounted for. To address this and to make the descriptor more precise, the word "many" was added to "exploratory actions" in the descriptor, with bold typeface for emphasis. The refined code is more precise and reads: "a. Engaging in inquisitive behaviour, **many** exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits, reading signage and asking many questions **and remaining at exhibit for 2-3 minutes".**

It becomes apparent that assigning a code for the Types of Activities in the framework needs to take into consideration the Learning Behaviour and, perhaps more importantly, the Level of Engagement to which that code belongs. In other words, ensuring that the type of activity observed be interpreted in accordance with the depth of engagement of that observed activity. Also, it is important to apply the entire description of the type of activity when interpreting an observed behaviour and assigning a code.

Table 6.1 The Revised VBLF Showing the Refined Descriptors for Types of Activity.

Engagement Level and Learning Behaviour	Types of Activity Revised Framework	Types of Activity Refined Descriptors
Initiation 1. Finding and Identifying the Organism(s)	a. Searching for the animal; not finding it, moving on; or finding it, acknowledging it and moving on	a. No change
	b. Reading the label for animal's name; pointing and/ or naming / identifying the animal	b. Pointing & identifying or saying the name or reading label for the name of the animal
	c. Makes one or two simple statements and/or questions about the animal's behaviour and /or physical traits	c. No change

Table 6.1 (Cont'd) The Revised VBLF Showing the Refined Descriptors for Types of Activity.

Engagement Level and Learning Behaviour	Types of Activity Revised Framework	Types of Activity Refined Descriptors
Initiation 2. Observing Habitat / Organism(s)	a. Observing the animal without verbal or facial expressions; not showing engagement	a. Observing the animal without verbal or facial expressions; not showing engagement; approximately 10 seconds.
	b. Observing the animal with interest through facial or verbal expressions	b. Observing the animal with interest through facial or verbal expressions, at least 30 seconds, usually up to 60 seconds. .
	c. Taking picture of the animal;, recording the event; no indication of interpretation or doing something with the photo	c. No change
Transition 3. Exploring to Prolong Engagement	a. Expressed desire to watch animal again, for a longer period of time with expressed interest in behaviour or physical traits	a. Expressed desire to watch animal for a longer period of time AND/OR expressed interest in behaviour or physical traits; remains at exhibit > 1 minute.
	b. Expressed desire to find another similar animal	b. Expressed desire to find another similar animal; looking for more animals in the habitat.
	c. Make a few comparisons between individual animals within the same habitat, some attempt at interpretation	c. Make a few **comparisons** between individual animals within the same habitat, **some attempt at interpretation**
4. Demonstrating Affective Engagement	a. Smiling and pointing at animal; pleased with finding it after searching	a. Smiling, looking pleased with finding or observing the animal(s).
	b. Stronger signs of enjoyment / excitement such as laughter; verbal expressions of enjoyment ; Obvious signs of excitement when observing the animal; verbal outbursts of amazement and awe	b. Verbal outbursts of affection, amazement and /or signs of awe; verbal expression of enjoyment when observing animal; stronger signs of excitement, such as laughter
	c. Expressed desire to interact with the animal, physically and verbally (mimicking) or concern for the animal's well being	c. Expressed desire to interact with the animal, physically or verbally, including mimicking; OR concern for the animal's well being

Table 6.1 (Cont'd) The Revised VBLF Showing the Refined Descriptors for Types of Activity.

Engagement Level and Learning Behaviour	Types of Activity Revised Framework	Types of Activity Refined Descriptors
Breakthrough 5. Making Links	a. Reference to past experience with the animal or the institution	a. Reference to past experience with that type/species of animal or institution
	b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; cultural references about animal that contribute to meaning making	b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; stating a personal connection to their understanding
	c. Reference to comparable experience in their life as well as making comparisons and deductions based on prior knowledge, or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat	c. Making comparisons / deductions based on prior knowledge or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat
6. Explaining	a. Calling on someone for information about the animal. Asking 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat	a. Calling on someone for information about the animal. **Asking** 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat
	b. Reading signage thoroughly out loud to others; having conversations related to signage about the animal or exhibit related to physical traits, behaviours, diet, habitat	b. Reading through signage out loud to others **to initiate conversations about the animal or exhibit** related to physical traits, behaviours, diet, habitat, conservation
	c. Sharing experience and information with others by explaining, describing the animal's traits/ behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family /friend	c. Sharing experience and information with others **has evolved / progressed to** explaining, describing the animal's traits / behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family / friends

Table 6.1 (Cont'd) The Revised VBLF Showing the Refined Descriptors for Types of Activity.

Engagement Level and Learning Behaviour	Types of Activity Revised Framework	Types of Activity Refined Descriptors
Breakthrough 7. Extending the Experience	a. Engaging in inquisitive behaviour, exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits; reading signage, asking questions and remaining at exhibit/ habitat for 2-3 minutes	a. Engaging in inquisitive behaviour, **many** exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits, reading signage and asking many questions and **remaining at exhibit for 2-3 minutes**
	b. Concentration and motivation to know more about the animal(s) are obvious. Engaging with animal habitat as a means to learn / understand more about the animal. Length of interaction significant, 3 to 5 minutes	b. Concentration and motivation to know more about the animal(s) are obvious. Engaging with animal habitat as a means to learn / understand more about the animal. **Length of interaction significant, 3 to 5 minutes**
	c. Deep emotional or cognitive involvement with the experience of observing the animal, looking for different outcomes, engaging with accompanying exhibits, discussing many observations and deductions with others; may discuss wildlife conservation or environmental issues; involved in observation activities for long period of time i.e. more than 5 minutes	c. Deep emotional or cognitive involvement with the experience of observing the animal, looking for different outcomes, engaging with accompanying exhibits, discussing many observations and deductions with others; may discuss wildlife conservation or environmental issues; involved in observation activities for long period of time i.e. **more than 5 minutes**

6.2 Second Field Test of the Revised Visitor-Based Learning Framework

It was important that these refinements to the framework be tested to see if the refined descriptors facilitated coding for a potential user, if any further refinements would be needed, and to reveal any other challenges associated with coding video data of visitor learning behaviours at live animal habitats.

6.2.1 Method – Second Field Test of the Revised Framework with Refinements

The next step in this process was to recruit a second test-coder with experience in using a learning behaviours framework, who was familiar with observing visitor learning behaviours and who could potentially provide feedback on the usability and the refined descriptors of the Revised Framework. This second test-coder was a research assistant

employed at Science North and had three years of learning behaviour coding experience using the Original VBLF and the Studiocode software in a science centre setting. Although she had little experience coding visitors interacting with live animal exhibits, her extensive experience with observing and interpreting learning behaviours in a science centre settings were valuable and gave her a level of familiarity needed to discuss the usability of the Revised VBLF with its refinements.

The researcher and the research assistant reviewed each of the refined descriptions within the Types of Activity of the framework. The research assistant was then asked to code the learning behaviours of 50 visitors at the Giraffe exhibit from Zoo 2. The researcher also performed a new data analysis, coding the same 50 visitors, using the refined Revised Framework. As described in section 6.1, this process enabled a comparison between the codes from each coder to reveal discrepancies in the events that were coded, and in the assigned codes for those events. It is important to note that at the end of her data analysis, the research assistant told the researcher she found it challenging to hear many of the conversations in the video data and to see the faces of the visitors to assess their facial expressions. As a result, she felt that she had "missed" many of the potential learning behaviours that, in her opinion, should have been coded.

Given that the research assistant perceived audio and visual challenges during coding, and given the results from the graduate student's test coding (fewer codes than the researcher), it was important to compare the number of codes assigned by the researcher and the research assistant, as well as to identify the similarities and differences in events coded. To fully understand the nature of the anticipated discrepancies between the researcher's codes and the research assistant's codes, a thorough discussion and review of a segment of the Giraffe exhibit video data took place between the researcher and the research assistant. This helped illuminate whether the discrepancies in the codes could be mostly resolved by reviewing and discussing the learning behaviour events with the research assistant.

6.2.2 Results, Analysis and Implications

As with the graduate student test-coder, the research assistant assigned fewer codes (178) to 50 visitors than did the researcher (248). This discrepancy in the number of codes assigned means that the researcher and the research assistant did not code the same event or instances of learning behaviour 70 times. In order to identify the root of these discrepancies, the researcher and the research assistant spent two hours reviewing and discussing each

learning behaviour (code) event for the first 18 visitors at the Giraffe exhibit (Zoo 2). This process revealed three important causes for the discrepancies:

1. **Differences in interpretation of descriptors**

   The research assistant and the researcher, despite the training and experience using another behavioural framework, assigned 3 of the 21 possible codes differently. For example:

   a. "Observing animal without showing engagement <10seconds" was coded by the research assistant as the first step in *Observing Animal/ Habitat*, no matter if the visitor went on to "observe animal with interest >30seconds" or not.

   b. "Taking picture of animal" was coded by the research assistant for visitors who were taking pictures AND for visitors who were "in" the picture that was being taken.

   c. For the researcher, "Expressed desire to watch animal for longer period of time and/or expressed interest in behaviour or physical traits" included coding visitors who changed physical locations when viewing the animal in the habitat to get a better view. This is not explicit in the refined descriptor and was not considered by the research assistant as a behaviour to be coded in this category.

   As a result of this analysis, the above descriptors were modified slightly to address the possible differences in interpretation. In addition, a review of the "Examples of observed behaviour in Zoos and Aquaria" column in the Revised Framework (see Tables 4.3 to 4.5) revealed that additional or different quotes and behaviours from the data could improve the usability of the framework for practitioners. The final Revised Framework can be found in Table 6.2.

2. **Missed events.** The research assistant had indeed missed many of the learning behaviours that the researcher had identified as events and coded accordingly. During the two hour discussion and review of the codes, the researcher addressed these "misses" by slowing and replaying the video for each code while the research assistant paid close attention to where a learning behaviour occurred. For every event that was examined closely, the research assistant agreed that a learning behaviour had occurred and assigned the same code as the researcher. A total of 93 codes was agreed for 18 visitors, of which 30 were added to the research assistant's original codes after the review and discussion.

3. **Human error** can occur when a researcher is clicking codes on the computer screen. In Studiocode, the coding window (Figure 6.1) for the Revised Framework is complex with a total of 21 codes that can be assigned for every behaviour. This potential error rate is multiplied by the number of visitors being coded. This can inevitably result in errors as the researcher is often simultaneously watching the video and clicking on the coding window, on the same screen. In fact, it was found that human error did account for several discrepancies between the codes of the researcher and those of the research assistant.

These three causes for discrepancy between the two sets of coding explained the differences in codes. The confusion caused by imprecise descriptors led to small refinements of the framework and the Final Revised VBLF is found in Table 6.2.

Table 6.2 Final Revised Visitor-Based Learning Framework for Zoos and Aquaria.

Engagement Level	Learning Behaviour	Types of Activity	Example of Observed Behaviour in Zoos and Aquaria
Initiation	1. Finding and Identifying the Organism(s)	a. Searching for animal	*a. "Where is it?" "I don't see it"; "There it is"*
		b. Pointing & identifying or Saying the name or reading for name	*b. "That's a Japanese Sea Nettle"; "That's the otter"*
		c. Making 1-2 simple observation statements (Stating a fact) re: behaviour / physical traits of animal	*c. "He's relaxing, just laying around" ; "He just lifted his head" "He's looking at me" "He's swimming"*
	2. Observing Habitat/ Organism(s)	a. Observing animal without showing engagement (<10 seconds)	*a. Man pressed up against the glass to watch sharks, less than 30 seconds and moves on; Family staring at the bear through the glass, not saying anything, then leave*
		b. Observing animal with interest through facial or verbal expressions (<30 seconds)	*b. "Watch him…here he comes" – smiles and watches for a bit longer*
		c. Taking picture of animal (no indication of interpretation)	*c. Girl taking photos and showing others the photo she took "Look"*
Transition	3. Exploring to Prolong Engagement	a. **Expressed** desire to watch animal for a longer period of time and/or expressed interest in behaviour or physical traits (30-60 seconds).	*a. "I could watch them all day"; "Let's see if he does it again"; "Let's just watch a little longer"; "Just watch him one more time, he does this routine"*

Table 6.2 (Cont'd) Final Revised Visitor-Based Learning Framework for Zoos and Aquaria.

Engagement Level	Learning Behaviour	Type of Activity	Example of observed behaviour in Zoo and Aquaria
Transition	3. Exploring to Prolong Engagement	b. **Expressed** desire to find another animal; looking for more animals in the habitat	b. *"Let's go look at the other ones." "Let's go see the other bear on the other side"; "How many are there? "Are there more?"*
		c. Make a few **comparisons** between individual animals within the same habitat, **some attempt at interpretation**	c. *"That one is the biggest of all of them" "Let's keep looking and find some bigger ones"; "That's the mommy and that's the daddy"*
	4. Demonstrating Affective Engagement	a. Smiling, looking pleased with finding animal(s)	a. *"Look at them, they're up there" points and smiles; "Ooh, there's the baby"; Search the habitat then "There he is, back there!" with smile and excitement as he points to animal.*
		b. Verbal outbursts of affection, amazement and/or awe; Verbal expressions of enjoyment when observing the animal; Stronger, obvious signs of excitement such as laughter	b. *Excitedly says "Did you see that mom? Did you see it?"; As shark swims by "Wow, that's impressive" "Wow, that's awesome, that's really cool"; Watching jellyfish "They are so beautiful. Oooh, I like that one"; Watching polar bear "I love him"*
		c. Expressed desire to interact with the animal, physically or verbally, including mimicking OR concern for the animal's well being	c. *"I'm touching the window so they can come see my hand" want to see a reaction from the animal; Talking to the gorilla like talking to a baby or a dog "Hey, how're you doing? You're beautiful, yes you are!";"Oh my God, he's so cute. Oh look, there are two? Can we touch them?" "They look bored...but they don't mind, right?"*

Table 6.2 (Cont'd). Final Revised Visitor-Based Learning Framework for Zoos and Aquaria.

Engagement Level	Learning Behaviour	Type of Activity	Example of observed behaviour in Zoo and Aquaria
Breakthrough	5. Making Links	a. Reference to past experience with that type/species of animal or the institution	a. *"At the Biodome, there were 2 otters and they were huge like this"; "The last time we were here, the baby was smaller. He's getting so big"; "Remember when I showed you that … here it is"*
		b. Simple reference to comparable experience in visitor's life or reference to their previous knowledge about the animal / habitat / exhibit; stating a personal connection to their understanding	b. *"Like Gorillas in the Mist… these are our closest relative, they share like 90% of our DNA"; "Their hands are just like ours, with nails and everything"; "They(zoo) are trying to stimulate them like in the wild"*
		c. Making comparisons/deductions based on prior knowledge, or observations of similarities and differences with respect to physical traits, behaviours, diet, habitat	c. *"I think that's the male because he's bigger. They wouldn't put 2 males in with the female because they would fight over her"; "Look at their fingers, just like ours. They even have opposable thumbs.*
	6. Explaining	a. Calling on someone for information about the animal. **Asking** 3-4 questions beyond the identity of the animal, related to the animal's physical traits, behaviour, diet, habitat.	a. *Mom asks staff "What's he called?... Why do they call him a zebra shark? Does it have gills on the bottom like the other one?"; Boy asks "I wonder how strong they are? Where do they come from?"*
		b. Reading through signage out loud to others to initiate conversations about the animal or exhibit related to physical traits, behaviours, diet, habitat, conservation.	b. *Mom reads the signage about individual gorillas, out loud to family.. "Says here that they can hang on to tree branches with both hands and feet", continues discussion… "it also says that…"*

Table 6.2 (Cont'd) Final Revised Visitor-Based Learning Framework for Zoos and Aquaria.

Engagement Level	Learning Behaviour	Type of Activity	Example of observed behaviour in Zoo and Aquaria
Breakthrough	6. Explaining	c. Sharing experience and information with others has evolved/ progressed to explaining, describing the animal's traits/ behaviour to them, giving them details about gained information and their own observations; discussion and questions about animal with staff or family /friend	c. *Boy demonstrates jellyfish's movement by putting his arms out and moves them in & out while saying "they open and close and glide and float"; Three brothers interacting with touch screen to identify fish and sharks. Br#2 to the other brothers: "Remember when I told you about the X, well there it is" while pointing to fish on bottom of tank "I told you". Br#1 "Oooh is this the black tailed shark?" to other brothers. They look it up on touch screen. Br#2 "Ok let's move onto to another fish" while leading brothers through other screens, reads to them. Br#3 chooses next fish to look for. Br#2 describes it to them. Continue like this for 3 minutes*
	7. Extending the Experience	a. Engaging in inquisitive behaviour, many exploratory actions such as speculating about reasons for animal's behaviour, habitat, physical traits and reading signage, and asking many questions and remaining at exhibit/ habitat for 2-3 minutes	a. *Mom and children involved in discussion about every observed behaviour of gorillas, giving reasons for why the animals are doing what they're doing, remaining engaged with observation for at least 3 minutes.; Adults discussing "Very human, amazing...Maybe she's laying like that because she doesn't want to feed the baby right now. Look at the one upside down, doing exercises and playing*
		b. Concentration /motivation to know more about the animal(s) are clearly visible. Engaging with animal habitat as a means to learn / understand more about the animal. Length of interaction significant, 3 to 5 minutes	b. *Mom and son using touch screen to identify fish in aquarium "That's it right there. Ok now let's find the rainbow one. I see him". Go back to touch screen. "Look for the white stripes" Remain on this task for about 4 minutes*
		c. Emotional or cognitive involvement with the experience of observing the animal demonstrated in comments. Looking for different outcomes, engaging with accompanying exhibits, discussing many observations and deductions with others; involved in observation activities for long period of time i.e. more than 5 minutes	c. *Two children at touch screen, very engaged in activity of identifying fish and their traits. Girl (sister) "That's the one I just saw. I want to check him out". Goes to touch screen to find that fish. Boy (brother) "Look at this guy.. awesome! Let's pretend were studying fish" Girl - "Ok, What about this one?" They engage in this experience for approx. 10 minutes*

6.3 Summary

Both field tests revealed that using the framework to its full potential requires considerable practice and constant reviewing of the video data on the part of the researcher who is coding. As expressed by the research assistant, effective coding requires practice and exposure to many examples of the behaviours in the framework. This allows the coder to become comfortable and confident with assigning codes. This has implications for the Revised Framework as a practical assessment tool for zoo and aquaria practitioners. These implications and suggestions for improving the outcomes when the framework is applied will be addressed in the final chapter.

Chapter 7
Summary, Conclusions and Implications

The aims of this study were to investigate the learning experiences of visitors in science centres, zoos and aquaria as they engage with exhibits, to determine the validity of the VBLF across informal science settings, and to encapsulate the visitor learning experience with live animal exhibits in a practical, effective and reliable assessment tool that can be used to evaluate the learning impact of exhibits in zoos and aquarium settings. More specifically, this study was conducted to answer the following research questions:

1. How can the Visitor-Based Learning Framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention?
and
2. What is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

This final chapter summarizes the study and its findings. The research design and methodologies used to answer the study's research questions are briefly reviewed and the conclusions relating to the research questions are given. Critical reflections on the study's research design and limitations are made and lead to a discussion of the significance of the study's findings. Finally, the implications of the findings for practitioners and researchers are discussed.

7.1 Summary of Research Design and Methods

7.1.1 Phase 1

A three-phase approach to data collection and analysis was used to answer this study's research questions. Phase 1 was designed to validate the Original VBLF as an exhibit learning impact assessment tool by applying it in a science centre setting other than Science North, where it had been developed and continues to be used successfully. Visitors interacting with selected exhibits in Science Centre 1 were video recorded and the video data were analysed using the Original VBLF to code learning behaviours. Coding of all video data was done using the Studiocode video analysis software. Phase 1 also served as a

trial of the methods and ethical protocols for the data collection procedures to be used throughout the entire study. The findings from Phase 1 of the research demonstrated that the VBLF is a valid assessment tool to evaluate the learning impact of exhibits in science centres.

7.1.2 Phase 2

In Phase 2 of the research, video data of visitors engaging with selected live animal exhibits at Aquarium 1 and Zoo 1 were collected and analysed by applying the Original VBLF, using Studiocode software. This analysis revealed that the Original Framework had the potential to be applied in zoo and aquarium settings and further analyses were performed to answer the research questions of this study. Observations of whether or not the Original Framework reflected the nature of the learning experience with live animal exhibits in zoo and aquarium setting were noted during the coding process. Transcriptions of visitor dialogue and observational notes of visitor behaviours were also taken during the coding process and these contributed additional information to the findings. Analysis of these qualitative data showed that the Learning Behaviours and Types of Activity categories in the Original Framework did not capture many of the observed visitor behaviours and that the nature of the learning experience with live animal exhibits was not effectively represented. Consequently, the Original VBLF was modified and revised based on the findings from the qualitative data analysis of video data in Aquarium 1 and Zoo 1. The revision process and the Revised VBLF that resulted from the work in Phase 2 are found in Figures 4.3, 4.4 and 4.5.

7.1.3 Phase 3

The work done in Phase 3 of the research was based on the results of Phase 2. In order to ascertain whether or not a modified VBLF could be effectively applied in aquaria and zoos, the Revised Framework was used to code new video data collected from two new environments, Aquarium 2 and Zoo 2. The results of this data analysis produced Visitor Engagement Profiles (VEP) for the live animal exhibits, quantifying the learning impact of each of the exhibits. To further investigate the learning processes that occur when a live animal exhibit elicits Initiation, Transition and Breakthrough levels of engagement, consideration was given to the characteristics of the exhibits themselves and the learning behaviours that may be associated with them. The work in Phase 3 also illuminated the nature of and the potential precursors to Breakthrough Level learning behaviours in zoo and

aquarium settings. The usability of the Revised VBLF was assessed by having test coders use the tool to compare coding results. Some of the descriptions for the Learning Behaviours and Type of Activity categories were further refined and the Revised Visitor-Based Learning Framework for Zoos and Aquaria was finalised and presented in Figure 6.2. The findings from Phases 2 and 3, the Revised Framework and implications for the field are discussed in the following sections, using the study's research questions to structure the discussion.

7.2 Summary of Findings

7.2.1 Applying and Modifying the Visitor-Based Learning Framework

RQ 1: How can the Visitor-Based Learning Framework be applied or modified so as to be effective in zoos and aquaria where visitor interaction with exhibits is less physical and involves more socially constructed meaning making, and where live animals and conservation messages are the focus of visitors' attention?

The Visitor-Based Learning Framework was successfully validated in a science centre setting in Phase 1 of the research. In Phase 2, the framework was applied to a zoo and aquarium setting and, although the Original VBLF showed potential as a tool for assessing the learning impact of exhibits in these settings, the context-specific nature of the visitor learning experience with live animal exhibits was not adequately represented by the descriptors within the framework. This finding suggested that the Original VBLF could be modified to better capture the learning impact of live animal exhibits. Through observations and analysis of the behaviour and dialogue of 500 visitors in Phase 2, the patterns of the visitor learning experience with live animal exhibits were revealed. Behavioural and conversational indicators of learning, identified through qualitative analysis, reflected the socially constructed, affective and cognitive dimensions of meaning-making in the informal science settings of zoos and aquaria. The patterns of the visitor learning experience and behavioural indicators informed the modifications made to the Original VBLF and resulted in a revised version of the framework that was intended to be more responsive to the visitor learning experience with live animal exhibits. Thus, the results of Phase 2 of the research:

a. showed that the Original Visitor-Based Learning Framework had the potential to be a useful assessment exhibit assessment tool for zoo and aquarium settings,

b. identified the modifications needed to effectively capture the visitor learning

experience with live animal exhibits,

c. culminated in the creation of a Revised Visitor-Based Learning Framework that could be applied in zoos and aquaria where live animals are the focus of the visitor's attention.

a. Potential assessment tool for zoos and aquaria

The results from Phase 2 showed that the Original VBLF had the potential to be a useful tool for evaluators in assessing the learning impact of a live animal exhibit because it was effective at distinguishing varying levels of engagement opportunities across animal exhibits. For instance, the Original VBLF revealed a higher percentage of visitors engaged at the Breakthrough Level for live animal exhibits where the animals were active, or there were interactive exhibit elements or other engaging features, than for exhibits with fewer engagement opportunities. The Visitor Engagement Profile for the Gorillas exhibit in Zoo 1, for example, showed that 37% of the visitors engaged in Breakthrough Level learning behaviours while only 11% of visitors at the Polar Bears exhibit engaged at that level (see Figure 4.25 and 4.26).

This difference in Breakthrough engagement was able to be attributed to the difference in learning opportunities presented by each exhibit. Although both animals are iconic, large mammal species, the Gorillas exhibit included a family group, composed of a mother, her baby, a dominant male and two other females. Most of the individuals in the group of gorillas were very active, and the viewing area enabled visitors to be quite close to the habitat. The human-like behaviours of the gorillas were frequently commented upon, and the large display board adjacent to the viewing area, showing the individual gorillas' names and position within the group, encouraged visitors to find and identify individuals within the habitat. Primates capture visitors' attention (Myers et al., 2004) and the combination of these features in the Gorillas exhibit presented visitors with engagement opportunities that were not present in the Polar Bears exhibit. For example, there were two large males in the Polar Bear habitat that were only moderately active, given the summer heat of over 35 degrees Celsius. The enclosure was large and open, which is conducive to the well-being of the bears, but may make the visibility of the animals more challenging for visitors. A smaller viewing window inside a cabin gave visitors an opportunity to get up close to a sleeping polar bear but there were no labels inviting visitors to engage in inquisitive behaviours.

These differences in engagement opportunities were revealed in the percentage of

visitors who engaged in Breakthrough learning behaviours as captured by the Original VBLF. Other research has shown that factors such as the activity level of the animal and the species of the animal have an impact on the staying time of visitors (Moss & Esson, 2010), which in turn suggests a higher level of engagement and a greater potential for learning. Further discussion of the impact of exhibit characteristics on visitor learning occurs in section 7.4 below.

b. Identification of modifications needed

Although the VBLF in its original form was able to distinguish varying engagement opportunities across exhibits in Phase 2, the descriptions of the learning behaviours within the framework, in all engagement levels, did not accurately reflect the behaviours and dialogue observed as visitors engaged with the live animal exhibits. In the Initiation Level of engagement for example, the basic learning behaviour of *Doing the Activity* was never coded at the Polar Bears exhibit, and only twice at the Grizzly Bears exhibit, because the descriptors found in the Types of Activity for this learning behaviour did not reflect the context-specific nature of the activities visitors engage in while observing a live animal in its habitat (see Figure 4.29). These findings, along with the results of the qualitative analysis of visitor behaviours and dialogue, supported the conclusion that the Original Framework needed to be revised or modified if it were to be used as an effective tool to assess the learning impact of live animal exhibits. The qualitative analyses of visitor behaviours and dialogue revealed that the nature of the learning experience appeared different than that described by the Original Framework, which was developed in a science centre context. Context-specific behaviours that were common across all five exhibits in Phase 2 of the study that were not accounted for in the Original Framework included:

1. Searching for and identifying the animal
2. Describing the physical characteristics of the animal
3. Describing animal movements and behaviours
4. Expressing affection for the animal
5. Interpreting the animal's behaviours or traits.

These context-specific learning behaviours correspond to findings by other researchers who have investigated the nature of the learning experience with live animals, and with preserved animals in natural history dioramas. Studies by Clayton et al. (2009), Tunnicliffe (1996a, 1996b; 1997), Tunnicliffe and Scheersoi (2010) and Ash et al. (2007) identified similar behaviours, such as naming or identifying the animal, describing the animal or its

body parts, emotional responses towards the animal, and interpreting the animal's behaviour as part of the meaning-making process while engaging with animal exhibits.

c. The creation of a Revised Visitor-Based Learning Framework

The results from both the quantitative and qualitative analyses of the zoo and aquarium video data in Phase 2 of the study led to the revision of the VBLF and the creation of a context-specific assessment tool that is responsive to the nature of the visitor learning experience in these informal science settings. Chapter 4 outlined the specific amendments made for each of the Engagement Levels, the Learning Behaviours and the Types of Activity together with the rationale and justification for those changes. Tables 4.3 to 4.5 show the modifications to the Original VBLF and the Revised VBLF.

The Initiation Level of engagement was revised to reflect the types of activities visitors first engage in when arriving at a live animal exhibit, and include behaviours such as searching for and identifying the animal, making simple statements and observing. Modifications to the Transition Level reflect a more involved visitor experience and include activities such expressing a desire to observe the animal for a longer period of time, to find another animal in the habitat, or strong signs of affective engagement as a result of the experience with the live animal exhibit. The Learning Behaviours in the Breakthrough Level of engagement were revised to be more responsive to higher levels of cognitive involvement as visitors engage with live animal exhibits. Indicators of higher-order learning with live animal exhibits include visitors making references to past experiences and prior knowledge, engaging in exploratory and inquisitive behaviour, and demonstrating motivation and interest to truly engage in meaning-making while observing and interacting with the live animal exhibit.

In summary, Phase 2 of the research answered Research Question 1 in showing that the Original VBLF could potentially be a useful assessment tool in zoos and aquaria, and that modifications reflecting the nature of the learning experience with live animal exhibits could be made. After the modifications were made, the next steps in answering Research Question 1 completely were to: 1. apply the Revised VBLF to new zoo and aquarium data to determine its effectiveness and validity at assessing the learning impact of live animal exhibits in those settings; and 2. ascertain the usability of the Revised Framework as a tool for zoo and aquarium practitioners.

7.2.2 Testing the Validity, Clarity and Usability of the Revised Visitor-Based Learning Framework

In Phase 3 of this study, the Revised VBLF was applied to new video data collected in Aquarium 2 and Zoo 2. The results of this phase demonstrated that the Revised VBLF is a responsive and effective assessment tool that captures the nature of the visitor learning experience with live animal exhibits. For example, the data analysis revealed that most visitors engaged in *Finding and Identifying* or *Observing the Animal/Habitat* or both, demonstrating that Initiation Level Learning Behaviours in the Revised Framework effectively capture what can be considered to be the basic interaction visitors have with live animal exhibits. Furthermore, the Revised Framework was found to be sufficiently robust to capture the more involved Learning Behaviours and Types of Activity described in the Transition and Breakthrough Levels of Engagement when visitors at these animal exhibits became more engaged in their learning experience. The Revised Framework was also able to distinguish between different types of exhibit and experiences, revealing potential exhibit characteristics that increase visitor engagement. The differences and nuances of each exhibit captured by the Revised VBLF strengthened the validity of the framework.

An analysis of the visitor experience with the Grizzly Bears exhibit from Zoo 2, using the Original VBLF and comparing that assessment with the results of an analysis using the Revised VLBF, offered additional support to the Revised Framework's validity as an effective assessment tool. The Learning Behaviours and Types of Activities in the Revised VBLF more effectively captured the visitor learning experience than those in the Original VBLF (see section 5.2). In addition, two field tests of the usability of the Revised Framework (Chapter 6) revealed that further refinements were needed to improve the precision and clarity of the Learning Behaviours and Types of Activity descriptions. These refinements were identified and implemented to produce the final Revised Visitor-Based Learning Framework for Zoos and Aquaria found in Table 6.2.

7.2.3 Initiation, Transition and Breakthrough with Live Animal Exhibits
RQ2. What is the nature of the learning processes that occur when Initiation, Transition and Breakthrough level learning behaviours are elicited by a live animal exhibit in an aquarium or zoo?

The purpose of revising the Original VBLF was to capture the visitor learning experience with live animal exhibits by gaining a better understanding of the nature of the learning processes that occur when visitors are observed in Initiation, Transition and

Breakthrough levels of engagement. In the following sections, the visitor learning experience with live animal exhibits in zoos and aquaria is discussed, structured by the seven levels of engagement of the Revised VBLF.

Initiation Level: 1. Finding & Identifying and 2.Observing the Organism/Habitat

The Learning Behaviours in the Initiation Level describe a visitor's engagement at a live animal exhibit at its most basic level and revisions to the Original Framework needed to reflect this. Visitors engaged at this level demonstrated that they were taking the initial steps towards a meaningful learning experience by *Finding and Identifying* the organisms in the habitat through naming, reading labels, or making simple statements about the animal's physical traits or behaviour. Visitors also engaged in these initial steps by simply *Observing the Organism or Habitat* or by taking pictures of the animals in the habitat. Watching and describing the animals and their activities are the equivalent of the Initiation interactions visitors have with interactive exhibits in a science centre and are activities that are interpreted as not involving a high cognitive effort or a significant amount of time investment on the part of the visitor.

These are consistent with what other researchers have identified as the first steps in making meaning while engaging with an animal exhibit. For example, in their study of zoos as free choice learning environments, Tofield et al. (2003) found that children spent most of their time seeking out animals. Seventy percent of the visitors observed by Clayton et al. (2009) named, described or made a comment about the animal in the exhibit, about its appearance or about its behaviour. Clayton et al. (2009) also found that 50% of the comments made by visitors were "purely descriptive statements that asserted facts about the exhibit or the animal" (p. 389). Similarly, Tunnicliffe and Scheersoi's (2010) analysis of visitor conversations at natural history dioramas revealed that visitors initially identify the specimens and comment on features or structures. These researchers concluded that a typical visitor interaction with a biological diorama occurs in a four-stage sequence: "Identify-Interest-Interpret-Investigate" (p. 196). The Engagement Levels and Learning Behaviours of the Revised VBLF share other commonalities with the Tunnicliffe and Scheersoi (2010) stages, and with Clayton et al.'s (2009) findings and are subsequently discussed further in this chapter.

Transition Level: 3. Exploring to Prolong Engagement and 4. Demonstrating Affective Engagement

The revisions made to the Transition Level learning behaviours capture a more involved visitor learning experience, as did the Transition Level in the Original Framework. However, the revised Learning Behaviours and Types of Activity are context-specific for the zoo and aquarium setting. Visitors engaged at this level were *Exploring to Prolong their Engagement* beyond a short observation time to name the animal and take its picture. They may have expressed a desire to observe longer, to find another animal, or they made comparisons between individuals within the habitat. This prolonged engagement is reflective of visitors showing more interest in what they are observing and resembles the "Interest" stage identified by Tunnicliffe and Scheersoi (2010). It can be argued that visitors who choose to engage for a little longer and express an interest in finding out more are showing signs of intrinsic motivation, perhaps encouraged by an emotional reaction to the live animal exhibit.

Visitors in the Transition level were also *Demonstrating Affective Engagement* towards the animals by showing strong signs of enjoyment, expressing amazement and awe, or a desire to interact with the animal. Although the Original VBLF included the learning behaviour *Expressing Positive Emotional Responses* (see Table 2.1), the examples and descriptions of the behaviour did not reflect the type of affective engagement of visitors observing live animals. Here, visitors frequently expressed more than simple pleasure about viewing the animal and stated their amazement, awe and wonder at the animal's beauty or certain features of the animal. Labelling affective engagement as a learning behaviour is consistent with research by Myers et al. (2004) that identified affective responses towards live animals as contributing to the visitor's meaning-making experience. Tunnicliffe and Scheersoi's (2010) "Interest" stage from diorama interactions also includes making affective comments about what is being observed. Expressing a desire to interact with the animal is a learning behaviour that Clayton et al. (2009) listed as an indicator of the visitor learning process. In Ash et al.'s (2007) study, it was found that the most common code applied to visitor's biological talk was "Aesthetic" described as "comments on the beauty of the subject, on how much they like or dislike" the animal". (p.1587)

The role of interest and affective engagement has been discussed extensively in the informal science literature (Briseno-Garzón et al., 2007; Falk & Dierking, 2013; Myers et al., 2004; NRC, 2009), which supports the inclusion of Transition Level learning behaviours in the assessment of the learning impact of live animal exhibits. The activities

and behaviours in the revised Transition Level indicate a more committed and engaged visitor, one who is exploring a little further in an attempt to make meaning of the experience, perhaps leading to Breakthrough Levels of engagement.

Breakthrough Level: 5. Making Links, 6. Explaining and 7. Extrapolating the Experience

The Breakthrough Learning Behaviours in the Revised VBLF are similar to those in the Original Framework, but like the Transition Level, modifications were made to incorporate context-specific examples that reflected the learning experience in zoo and aquarium settings. The revised Learning Behaviours capture the higher level of cognitive engagement that was sometimes observed when visitors engaged with live animal exhibits. Visitors at this level of engagement invested time and cognitive energy in making meaning of their experience and showed signs of motivation to learn more about the animals and the exhibit. They were *Making Links* to their prior knowledge and personal experiences, perhaps triggered by their observations of the live animal or an interaction with the live animal exhibit, its signage or interactive component. These references to previous experiences or knowledge sometimes led to visitors making comparisons or deductions about the animal's physical traits, behaviour or habitat. Similarly, Tunnicliffe and Scheersoi (2010) identified the "Interpret" stage, where visitors interpret what they are seeing based on what they know and understand, "at their level of biological knowledge" (p. 196). Clayton et al. (2009) suggested that "making inferences" about the animal's state of mind, intentions, or its family relationships is part of the learning process when visitors engage with live animal exhibits. In science centre settings, Stocklmayer and Gilbert (2002) referred to visitors' "remindings" as critical in learning from exhibits.

Visitors also demonstrated higher levels of cognitive involvement by seeking and sharing more information to build their understanding of what they were observing. The *Explaining* learning behaviour describes visitors who read information aloud to members of their group, asked questions, or shared what they had just discovered with others. Clayton et al. (2009) included a category called "seeking information" in their list of learning indicators when analysing visitor conversations at live animal exhibits (p. 387). Tunnicliffe and Scheersoi (2010) described how, in the "Investigate" phase, visitors raise questions about what they are observing in natural history dioramas with preserved animals. The social nature of learning is particularly evident in informal science settings where visitors typically make meaning and build understanding by sharing their experience with family members, friends or staff (Briseno-Garzón et al., 2007; Clayton et al., 2009).

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In the Revised Framework, *Extrapolating the Experience* describes visitors that showed obvious signs of concentration and motivation to know more about the animal, the habitat or other elements presented by the exhibit. Although very few visitors engaged in *Extrapolating the Experience* learning behaviours, those that did so demonstrated many inquisitive and exploratory behaviours during their interaction, and invested significant amounts of time in the learning experiences offered by the exhibit. These visitors showed significant cognitive or emotional involvement in observing the live animal(s) or interacting with components of the exhibit. Visitors at this level of engagement made comparisons and deductions, speculated about the animal's behaviour, physical traits or habitat, and had in-depth conversations about the live animal exhibit. It can be suggested that engaging in these learning behaviours may lead visitors to demonstrate that they are cognisant of the broader messages about conservation and wildlife issues and evidence of such learning would be coded as *Extrapolating the Experience.*

The work done in Phases 1, 2 and 3 involved complex methodologies, a substantial amount of data and comprehensive data analysis. In the following section, reflections on the research design, limitations and findings of this study are made.

7.3 Reflections on the Research Design, Limitations and Findings

The Visitor-Based Learning Framework, developed in and for science centre settings, is the assessment tool that was central to this entire study. To build on its strengths and make it useful in other informal science settings required a complex and multi-phased research approach for data collection and analysis. Although some challenges did occur, these phases were successfully implemented and they generated useable results that led to accomplishing the goals of this research.

First, the Original VBLF was applied and tested in a science centre other than Science North to strengthen confidence in its generalizability and validity. This first phase of the study (Chapter 3) was successful in two ways: It demonstrated that the Original VBLF reflects and captures the visitor learning experience in science centres; and it served as a trial for the data collection methods to be employed in the next phases of the study. Second, 500 visitors were video recorded and observed while they engaged with five live animal exhibits in Zoo 1 and Aquarium 1. This substantial data set was analysed quantitatively using the Original VBLF, and qualitatively to reveal patterns of visitor

learning behaviours not captured by the Original Framework. The mixed-method approach used in this second phase of the research was ideal to ensure that the nature of the learning experience with live animal exhibits was accurately reflected in the modifications made to the Learning Behaviours and to the descriptors found in the Types of Activity. Thus, the work in Phase 2 (Chapter 4) resulted in the creation of a Revised VBLF that is methodologically robust, and responsive to the learning behaviours in zoos and aquaria.

Third, this Revised VBLF was tested in two new zoo and aquarium settings to verify its validity at capturing the visitor learning experience. Four hundred visitors were video recorded and observed engaging with four live animal exhibits. This led to the successful assessment of the learning impact of those exhibits, demonstrating the tool's reliability. It also demonstrated the instrument's sensitivity in distinguishing highly engaging live animal exhibits from those that offer visitors fewer engagement opportunities.

At the end of Phase 3 (Chapter 5), it was recognized that the researcher's long experience in coding learning behaviours was perhaps a limitation in assessing the usability of the framework by others new to this method of data analysis. It was important to achieve the purpose of this research in developing a practical and readily usable exhibit assessment tool for practitioners in zoos and aquaria. Therefore, the Revised VBLF was "field tested" for usability (Chapter 6) with test-coders and refinements were made to identify, clarify and remove any ambiguities in the descriptions of the Learning Behaviours. As anticipated, this process also revealed that use of the Revised Framework by new coders will require some training and practice to recognize and consistently code the various behaviours observed. This will need to be taken into account for new users of the Revised Framework for either research into visitor behaviour, or for exhibit evaluation. These implications are further discussed in section 7.5.

The technology used to capture the video data of visitors engaging with exhibits also has its limitations. Despite the use of a supplementary microphone, visitors' conservations are sometimes inaudible, especially when large groups of people are in proximity of the video camera. In addition to audio challenges, video data collection is also limited by the stationary position of the camera. Visitors who move outside of the camera's viewer are not followed regardless of whether or not they continue to engage with the exhibit. These technological limitations require multiple reviews of the video data when coding visitor learning behaviours. The framework has yet to be tested for live coding, and these methodological implications are also discussed in section 7.5.

The multi-phased and rigorous methodologies used to develop and test the Revised VBLF have resulted in a tool that can assess the learning impact of live animal exhibits in zoos and aquaria that is ready for use beyond this research. Practitioners in zoo and aquarium settings can use this new instrument to evaluate the impact and assess the learning potential of live animal exhibits. Furthermore, this research found that visitors do not frequently engage in Breakthrough behaviours and this can stimulate further investigations into the visitor learning and engagement elicited by live animal exhibits. The significance of Breakthrough behaviours and the implications of finding low rates of Breakthrough engagement are discussed in the following section.

7.4 Discussion

The Revised VBLF was intended to provide zoos and aquaria with an instrument that can reliably assess the learning impact of live animal exhibits by observing the visitors who engage with them. The development and application of the Revised VBLF in Phases 2 and 3 revealed two important areas that need consideration in order to realize the full potential of the instrument as a practical evaluation tool for practitioners. The first is the significance of Breakthrough behaviours in the visitor learning experience and the second is the sensitivity of the Revised VBLF in distinguishing between different types of live animal exhibits by assessing visitor engagement.

Given that the mission of zoos and aquaria includes raising visitors' awareness and understanding of wildlife and conservation issues, it is important to recognize that Breakthrough levels of engagement are essential to achieving that goal. However, this study found that very few visitors reach these higher levels of cognitive and affective engagement. In the following sections, a brief overview of the findings from Phase 3 of the research is given to contextualize the discussion of the significance of Breakthrough learning behaviours, the relationship between Breakthrough engagement and conservation awareness, and the role of affective engagement in the learning experience with live animal exhibits. The importance of the requirement for the Revised VBLF to differentiate between different types of exhibits is also discussed.

7.4.1 The Significance of Breakthrough Learning Behaviours

The results of Phase 3 of this research (Chapter 5) revealed that few visitors engaged in Breakthrough types of learning behaviours. The Visitor Engagement Profile in

Figure 5.26 shows that the percentage of visitors who reached Breakthrough engagement averaged over all four live animal exhibits in Aquarium 2 and Zoo 2 was 20 percent. As was previously demonstrated, the Initiation Level learning behaviours of the Revised Framework characterise a basic interaction with a live animal habitat. Not surprisingly, this level of engagement occurred most frequently among Aquarium 2 and Zoo 2 visitors with 76% of visitors *Finding and Identifying* and 93% of visitors *Observing the Organism or Habitat* (Figure 5.27). Close to half of all visitors at Aquarium 2 and Zoo 2 engaged in Transition Level learning behaviours with 41% of visitors *Exploring to Prolong Engagement* and 62% of visitors *Demonstrating Affective Engagement* (Figure 5.28). Visitor engaged much less frequently in Breakthrough Learning Behaviours with only eight percent of visitors *Making Links,* 12% of visitors *Explaining* and 10% of visitors *Extending the Experience* (Figure 5.29).

Despite their apparent infrequency, it is important to include the Breakthrough Level learning behaviours in the Revised VBLF for zoos and aquaria. These learning behaviours represent a deep cognitive and emotional involvement and indicate that visitors are truly engaged in making meaning from their experience with a live animal exhibit. Similar to the "Interpret and Investigate" stages identified by Tunnicliffe and Scheersoi (2010), visitors who engage in these higher order cognitive activities have moved beyond naming, identifying and describing the animal and its behaviour to finding patterns, interpreting behaviour and making connections to larger ecological contexts. In her study examining family learning and exhibit characteristics, Sanford (2010) argued that the first form of talk is to list features as an initial way for visitors to understand what they are seeing but that this lower order thinking does not support robust learning. She goes on to state that analysis, synthesis and explanation are the most consistent indicators of learning (Sanford, 2010).

Enabling Breakthrough Level learning behaviours can be an important mechanism to engage visitors in higher order thinking which is comparable to the higher levels of cognitive learning identified by Bloom's taxonomy (Bloom & Krathwohl, 1956). The behaviours described in *Making Links, Explaining and Extrapolating the Experience* share similarities with Bloom's cognitive learning levels of analysis, synthesis and evaluation where learners draw on prior knowledge, experience and other sources of information to interpret, make sense of and place value on what they are seeing and experiencing. It can be argued that visitors need to engage in Breakthrough types of learning behaviours in order

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for them to become aware of the broader conservation messages while observing and interacting with live animal exhibits in zoos and aquaria.

7.4.2 Breakthrough and Conservation Awareness

It seems particularly relevant to include the learning behaviour *Extending the Experience* in the framework since one of the primary goals of zoos and aquaria is to help visitors gain a better understanding and appreciation of wildlife conservation issues, with aspirations of influencing people's behaviours and values (WAZA, 2005). Thus, it seems critical that the Revised Framework includes a way to assess whether or not a live animal exhibit engages visitors in thinking about, discussing, and making meaning of that experience as the pathway to acknowledging the broader ecological context it is meant to communicate. The inclusion of the phrase "may discuss wildlife conservation or environmental issues" in the description of *Extending the Experience* is meant to capture that level of engagement.

Even though many programs, shows and demonstrations add to the learning experience a visitor can have, live animal exhibits arguably make up the largest portion of the visitor experience in zoos and aquaria. Previous research has shown that a visit to a zoo or an aquarium can contribute to people's understanding and awareness of environmental and conservation issues (Briseno-Garzón et al., 2007; Kisiel et al., 2012; Wyles et al., 2013), as well as impact their knowledge about (Adelman et al., 2000) and attitudes towards wildlife and conservation (Clayton et al., 2009; Falk, Reinhard, et al., 2007). The longitudinal nature of learning cannot be overlooked and studies have shown that visitors' learning experiences in zoos and aquaria extend into their life once they have left the informal science setting (Adelman et al., 2000; Briseno-Garzón et al., 2007; Falk, Reinhard, et al., 2007). However, the findings in Phase 3 of this study (Chapter 5) and those from other studies (such as Clayton et al., 2009; Tofield, et al., 2003) suggest that live animal exhibits on their own may not provide sufficient opportunities for visitors to engage in Breakthrough behaviours overall, and in *Extending the Experience* in particular. The study by Clayton et al. (2009), for example, found little evidence of deeper cognitive and emotional involvement in visitor conversations. Their a priori comment analysis framework included the codes "expressing intent to advocate for animals or habitat protection in the wild" and "intent to change personal behaviour" to have an impact on wildlife in their study (p. 387), in anticipation of such engagement. However, these researchers did not find any evidence of these types of comments in the conversations they analysed. In their

investigation of adult learning in an aquarium setting, Briseno-Garzón et al. (2007) also found "little evidence of higher order thinking about the aquarium exhibits" and pointed out that this was similar to adult learning in science museums settings which is "characteristically low" on Bloom's levels of cognitive learning (p. 308).

It is perhaps not surprising that this deeper level of engagement and learning was found to be uncommon among the zoo and aquarium visitors in this study. Since visitors' agendas focus most often on entertainment and fun, with the potential for learning (Clayton et al., 2009; Linke & Winter, 2011; Tofield et al., 2003), their motivation to engage in deeply involved learning experiences is likely low. As Breakthrough levels of engagement represent high order thinking and meaning-making in the learning process, it is important to explore the ways to increase their frequency in zoo and aquarium settings. The Revised VBLF for Zoos and Aquaria can assist researchers and practitioners in understanding the relationship between live animal exhibits and visitor learning behaviours. This will be discussed further in Section 7.5.

7.4.3 Breakthrough and Affective Engagement

The affective domain of learning has relevance to the visitor learning experience provided by live animal exhibits. The taxonomy of affective learning domain identifies the way people react emotionally, respond and value objects, phenomenon or information as part of the learning process (Krathwohl & Masia, 1984). The *Extending the Experience* Learning Behaviour in the Revised VBLF includes, as its most engaged indicator of learning, "Deep emotional or cognitive involvement with the experience of intensely observing the animal and its behaviours" (Table 6.2) to capture this affective component of a deeply involved learning experience.

Phase 3 of this research showed that the visitor learning experience with live animal exhibits is highly affective in nature. Sixty two percent of visitors demonstrated affective learning behaviours in the Transition Level of the Revised VBLF such as smiling, laughing, and verbal outbursts of enjoyment, awe and wonder (Figure 5.28). Some researchers have argued that the affective experience of observing live animals in a zoo or an aquarium is critical because emotions lead visitors to caring about wildlife. For example Myers et al. (2004) argued that, although cognitive outcomes of zoo and aquarium visits have been better investigated, "cognitive research suggests that the emotional flavour of the learning may determine whether a visitor wants to remember, reflect on, repeat, share or avoid what was learned" (p. 300). In their study, Myers et al. (2004) used psychological constructs of

sentiment and emotion to develop a survey of categories of emotions, and their intensity, to assess the affective engagement of zoo visitors. The researchers found that the visitors most frequently reported feelings of respect, wonder, peacefulness, sense of beauty, special privilege, caring and attraction when viewing live animals in their zoo habitat. The researchers also found that wonder and respect were the emotions experienced most frequently by visitors and that these emotions were correlated with visitors' desire to save the animal concerned (Myers et al., 2004). Particularly relevant to this discussion is the suggestion by Myers et al. (2004) that these may represent "emotions motivating conservation" (p. 316).

The findings from the Myers et al. (2004) study and the results from Phase 3 of this research reveal that the visitor learning experience with live animal exhibits is firmly situated in the affective domain of learning. However, for most visitors, the learning experience appears to reach a ceiling in affective engagement, while engaging with broader conservation and wildlife messages as a result of a live animal exhibit experience seems rare. The high levels of affective engagement suggest that visitors are, at the very least, interested in the live animal exhibit and involved in a learning process. Having moved beyond naming, identifying and describing, it can be argued that a visitor's affective engagement is a precursor to Breakthrough Level learning, creating opportunities to build on Transition Level engagement to enable deeper involvement, into Breakthrough. Assessing the learning impact of a live animal exhibit with the Revised VBLF can help reveal these opportunities and will be further discussed in Section 7.5. Consequently, revealing opportunities to improve the learning impact of an exhibit requires a robust and sensitive assessment tool that distinguishes among different types of exhibit experiences.

7.4.4 The Sensitivity of the Revised Visitor-Based Learning Framework

The Revised Framework was able to distinguish between different types of live animal exhibits by revealing differences in the frequencies of Learning Behaviours depending on exhibit variables such as the activity level of the animals, the number of individual animals in the habitat, display methods, the presence and/or prominence of signage, and the presence of interactive exhibit elements. The Giraffes exhibit at Zoo 2, for example, had elements that encouraged visitor engagement, such as the book-like signage about the animals in the habitat, large open viewing spaces and active giraffes. In this case, 28% of the visitors observed engaged in Breakthrough behaviours (see Figure 5.21). In contrast, only four percent of visitors reached Breakthrough levels of engagement at the

Grizzly Bears exhibit at Zoo 2. The Grizzly Bears were not active during the time of video data collection, and one bear was huddled in the small space against the viewing glass that was between it and the visitors. The smaller viewing space, the low activity of the bears, and lack of signage within the viewing space, suggest that visitors had fewer opportunities to engage in higher levels of learning behaviours.

The impact of such variables on visitor's viewing time and subsequent engagement has been investigated in previous studies. Primates (Moss & Esson, 2010; Myers et al., 2004), naturalistic habitats (Ross et al., 2012), active animals (Bitgood et al., 1988; Margulis et al., 2003; Moss & Esson, 2010), and the presence of infant animals (Bitgood et al., 1988), have all been shown to increase the amount of time visitors spend at the exhibit, indicating increased interest and potential learning. The Revised VBLF can capture the different learning opportunities offered by live animal exhibits by determining the frequency of visitor learning behaviours and thus provides zoo and aquarium practitioners with a tool to assess the learning impact of individual exhibits. Suggestions, ideas and examples related to how the Revised VBLF can add to the evaluation tools available to zoo and aquarium practitioners and advance research in zoo and aquarium settings will be explored in the next section.

7.5 Implications for Practitioners and Researchers

The findings from this research and the resulting discussion have implications that can be grouped into three areas. First, there are implications for practitioners in informal science settings in general, and in zoos and aquaria in particular. These implications can be extended to exhibit designers and program developers. Second, there are the methodological implications for users of the Revised VBLF. And third, there are implications for researchers in the field of visitor studies in informal science settings.

7.5.1 Implications for Practitioners

A direct implication of this study is that its results have provided informal science institutions and practitioners with a practical yet robust methodological framework of behavioural and conversational indicators to assess the potential impact exhibits have on visitor learning. The science centre-based Original VBLF and the Revised Visitor-Based Learning Framework for Zoos and Aquaria are instruments that reveal how visitors are engaging with exhibits and can assist practitioners in improving learning opportunities

offered by those exhibits. Some researchers in this field have expressed the need for such assessment tools. Kisiel and Anderson (2010), for example, argued that educators or exhibit designers may be "overwhelmed by complexity, almost to the point of dismissing evaluation and returning to a more time-efficient approach—intuition or gut feelings" (p. 187). Kisiel and Anderson went on to suggest that researchers investigating learning in informal settings should be encouraged "to refine and develop observation protocols or similar tools that may allow easier access to outcome data" (p. 187). The findings from this research contribute to the toolbox of instruments available to practitioners in science centres, zoos and aquaria. This new instrument has implications for (a) exhibit evaluation, (b) exhibit design, and (c) the evaluation of the impact of interpreters.

a. Exhibit evaluation and increasing learning opportunities

Exhibits play a crucial role in fulfilling the educational goals of informal science institutions (Laherto, 2012). Assessing the learning impact of those exhibits can help practitioners identify potential gaps in the learning opportunities offered to visitors. As discussed in Chapter 2, the Visitor Engagement and Exhibit Assessment Model developed by Barriault and Pearson (2010) demonstrated this application of the VBLF. With the creation of the Revised VBLF in this study, zoo and aquarium practitioners can apply this relational model to live animal exhibits. In short, if an exhibit performs poorly, as revealed by a low percentage of visitors engaging in Breakthrough behaviours, practitioners are now equipped with the means to systematically assess the exhibit's learning opportunities and implement changes to the exhibit experience to improve those opportunities. The Revised VBLF can subsequently be applied to the same exhibit to assess the effectiveness of the modifications made as determined by the percentage of visitors engaged in Breakthrough behaviours. The possibilities for improvement can be demonstrated using the Grizzly Bears exhibit from Zoo 2 as an example.

Very few visitors demonstrated Breakthrough Level learning behaviours when engaging with the Grizzly Bears exhibit (Figure 5.21). Described another way, the exhibit did not provide sufficient opportunities for visitors to become more deeply engaged in meaning making. To increase the learning opportunities that engage visitors in these behaviours, practitioners will need to ask themselves questions based on the descriptors of Breakthrough behaviours in the Revised Framework. For example, can changes or additions be made to the exhibit to give visitors the opportunity to make links to their prior experiences and knowledge, to share insights with others to make meaning of their

experience, and to become more motivated to building new knowledge and understanding? Zoo practitioners could consider the following additions and changes:

- Place a label inside the small viewing area, encouraging visitors to make physical comparisons between their body parts and those of the bear. A phrase such as "Compare your hands to the bear's paws!" or "Notice the thickness of the bear's coat!" promotes connections to visitors' prior knowledge and experiences about their own bodies, and provides visitors with a launching point to engage in further conversations with people around them. These action phrases can be complemented by a few more lines of text that expand on these features.

Similarly, increasing opportunities for visitors to physically engage with elements of the live animal exhibit could lead visitors to analyse and evaluate features, share their discoveries with others and increase their interest and motivation to explore further. To encourage these Breakthrough behaviours, zoo practitioners may consider this:

- Add an interactive element to the viewing area such as securely mounted bear skulls that can be touched and examined closely by visitors. For example, three different species of skulls, from a Black Bear, a Polar Bear and a Grizzly Bear, would encourage visitors to make connections with their own knowledge about bears, discuss the similarities and differences of the skulls and teeth, and perhaps motivate them to seek out more information about those differences. Action labels such as "Compare the bear skulls" or "Notice the teeth" would likely stimulate conversations and discussion.

Once these changes have been implemented, a follow-up assessment of the learning impact of the exhibit can be done using the Revised VBLF. The resulting Visitor Engagement Profile of the Grizzly Bears exhibit would show the impact of those changes by revealing if there is an increase in the percentage of visitors reaching Breakthrough levels of engagement.

Findings from this study and previous research show that the visitor learning experience with live animal exhibits is typically more affective than cognitive. Therefore, amending the exhibit to give visitors opportunities to build on their affective reaction and engage in cognitive learning can increase their interest and motivation, encourage them to become more involved in the learning experience and help them reach the higher levels of learning behaviours found in Breakthrough. In addition, since the nature of learning in informal settings is socially driven, promoting conversation promotes learning. As

discussed in the literature review, conversations and the social dimension of learning are important drivers that enable visitors to investigate further and make meaning of the experience. By providing opportunities for social interactions through questions on signage or interactive exhibit elements, zoo and aquarium practitioners can promote Breakthrough levels of engagement. Researchers may want to investigate the precursors to Breakthrough learning behaviours and contribute to the exhibit design discussion. This has implications for researchers and is subsequently discussed in section 7.5.3.

b. Exhibit design

Incorporating signage and interactive elements in the visitor experience with live animal exhibits is similar to what is typically found in science centres. Exhibit characteristics that engage visitors in science centres have been investigated extensively (for example, Allen [2007] has provided a comprehensive list) and this literature could inform exhibit modifications in zoos and aquaria. Some studies have investigated the characteristics of live animal exhibits that increase visitor interest (as measured by the duration of a visitor's stay). However, characteristics such as the level of activity and visibility of the animal (Bitgood et al., 1988; Margulis et al., 2003), and the size and species of the animal (Moss & Esson, 2010) are inevitably out of the control of zoo and aquarium practitioners[3]. Naturalistic habitats have also been shown to increase visitor interest (Ross et al., 2012) and may be important factors in increasing learning opportunities. A number of zoos and aquaria do incorporate interactive elements into the live animal exhibit. The Sharks and Fish exhibit at Zoo 1 in this study includes touch screens to encourage visitors to identify and learn about the animals in the large aquarium. These touch screens are a type of signage, a way to communicate to visitors, and signage affects the learning impact of the exhibit (Gutwill & Humphrey, 2005; Hohenstein & Tran, 2007; McManus, 1987).

The findings in this study also suggest that the content and the placement of signage play an important role in encouraging Breakthrough learning behaviours. The Giraffes exhibit in Zoo 2 for example, has signage in the form of books or binders that are placed at waist height on the rails of the large viewing area. The content of the book-like signage

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[3] Understandably, live animals need to have areas in their habitats that allow them to be away from the noise and activity of visitors. Although beyond the scope of this study, striking a balance between an engaging visitor experience and the welfare of the animal is undoubtedly important. Fernandez, Tamborski, Pickens, and Timberlake (2009) reviewed a number of studies and provided recommendations on this issue.

includes specific information about each of the giraffes in the habitat, encouraging visitors to find the individuals based on this information. As previously reported, 28% of visitors to this exhibit engaged in Breakthrough behaviours. The Sharks and Fish habitat in Aquarium 1, with its interactive touch screen signage, engaged 30% of visitors in Breakthrough levels. One of the common science centre models of signage content applies the Exploratorium's format of "Try this" followed by "Notice" on exhibit labels to encourage visitors to do the activity then discuss the results. Although "doing" a physical activity with a live animal habitat is not usually possible, encouraging visitors to "notice" a feature and "compare" it to something they are familiar with may provide similar stimulation and encourage further engagement. Most studies investigating the impact of signage on the visitor learning experience is based in science centre settings (Gutwill [2007] provides a comprehensive review) suggesting that further research is needed to understand the use of signage in zoo and aquarium settings. Smith et al. (2011) also suggested that zoos try different methods of communication and compare their effectiveness to better understand how the zoo context can best achieve the zoo's stated desire to influence pro-wildlife thinking, attitudes and behaviours. The Revised VBLF can enable zoo and aquarium practitioners to conduct such investigations.

c. Assessing the impact of interpreters

The role of interpreters (staff, docents) in informal science settings is considered important in the visitor learning experience. Tunnicliffe and Scheersoi (2010) discussed the impact museum interpreters can have in enabling visitors to "Investigate" (as part of the four stages of learning, Identify – Interest – Interpret – Investigate) by increasing the opportunities for scaffolding visitors' thinking and therefore increasing their understanding. However, in their investigation of family learning at touch tanks, Kisiel et al. (2012) found that aquarium staff missed opportunities to stimulate visitors to think more deeply as they conversed about their experiences.

The Revised VBLF provides zoos and aquaria practitioners with an instrument for assessing the impact of interpreters in increasing the learning opportunities offered by live animal exhibits. Recent studies have shown that conservation educators, talks or presentations and guided experiences can increase visitor engagement and learning opportunities for visitors in zoos and aquaria (Jensen, 2014; Moss, Esson, & Bazley, 2010). By applying the Revised VBLF, practitioners can more directly assess the impact of these interventions on visitor engagement with live animal exhibits. In doing this however, zoo

and aquarium practitioners need to be aware of that there are some limitations to this methodology.

7.5.2 Implications for Methodology

Collecting data in informal science settings can be extremely challenging and finding innovative ways to capture the visitor learning experience has been addressed by others in this field (Sanford, 2010; Tunnicliffe, 2000). Osborne and Dillon (2007) observed that capturing data in the informal context "is fraught with problems" and list uncontrolled variables such as noise level and the unstructured nature of visits in these environments as contributing to those challenges (p. 1442). This study revealed some methodological challenges with both data collection and data analysis procedures that have implications for practitioners and other potential users of the Revised VBLF: (a) the video recording of visitors in informal settings and (b) the usability of the framework by novice users.

a. Video recording of visitors in informal settings

The decision to capture visitors on video as they engage with exhibits was made very thoughtfully in this study. For example, proper ethical protocols are imperative and each of the research sites required specific accommodations for their visitors. Consideration needs to be given to the physical location of the cameras and microphones so as to not interfere with the visitor experience while placing it close enough to capture clear audio and video of visitors engaging with the exhibits. Chapter 3 outlined the details of these important considerations in the data collection procedure.

Some of video data collected in this study was difficult to analyse for two reasons. First, despite the use of an external directional microphone (instead of the built-in camera microphone) the ambient noise in some of the exhibit spaces was recorded. This made it difficult to hear visitor dialogue and, subsequently, to assign a learning behaviour code. In these cases, reviewing the video several times was required to make sense of conversations. Second, some visitors captured in video data for an exhibit would physically move to a different location during their experience with an exhibit. For example, if an animal moved within its habitat, visitors might move with it to a different viewing area, out of the line of sight of the camera. The camera and microphone were stationary therefore, in these situations, it was often not possible to capture a visitor's entire learning experience with that exhibit. This may result in assigning insufficient codes of the learning impact of the exhibit, underestimating the engagement level of the visitor.

Live coding visitors may overcome some of these difficulties because the researcher can follow a visitor if he or she moves along the viewing area of the exhibit. Live coding can be less cumbersome than video recording and using coding software. However, there are also disadvantages to this method that can be anticipated. Visitor behaviours will likely be more influenced by the presence of a person rather than a camera. Also, the observer would have to be relatively close in order to clearly hear visitors' conversations, yet remain non-participatory during the observation. Furthermore, unlike with video data, the researcher cannot "replay" the behaviours to ensure sufficient codes have been assigned to account for the visitor's learning experience and level of engagement.

b. The usability of the Visitor-Based Learning Framework

Even with clear video and audio data, there were challenges associated with coding the visitor learning behaviours in the Revised VBLF for Zoos and Aquaria. Although refinements were made to clarify and remove ambiguity in the descriptions of the Learning Behaviours in the framework, findings from this research showed that, like with any assessment tool, familiarity with the framework improved its use. The "field test" of the Revised VBLF described in Chapter 6 revealed these implications for practitioners and demonstrated the importance of becoming familiar with the descriptors in the framework. Effective coding will require practice and exposure to many examples of the behaviours in the framework to allow the coder to become comfortable and confident with assigning codes. This caveat also applies to the use of coding software.

As discussed in Chapter 6, previous research experiences at Science North indicated that, when introduced to a new coding framework, new coders take time to gain familiarity with the coding framework and also to "read" visitors' behaviour in a consistent way. It is anticipated that familiarity with visitor behaviours in zoo and aquarium settings will be an advantage for practitioners when assigning codes using the Revised VBLF.

7.5.3 Implications for Researchers

There are important implications for researchers investigating the visitor learning experience in zoos and aquaria specifically and also for those examining learning in informal science institutions in general. Informal science researchers have identified the need for methodologies that assess the processes of learning across free-choice settings (Dierking et al., 2003; NRC, 2009; Rennie, 2007). The validation of the Original VBLF for science centres, and the creation of the Revised VBLF for Zoos and Aquaria, both contribute to the researcher's toolkit for assessing visitor learning across settings.

Some researchers have called specifically for more research into the effectiveness of exhibits at engaging visitors in learning in informal science settings (Sanford, 2010), and in zoos and aquaria in particular (Luebke & Matiasek, 2013; Moss & Esson, 2013; Reading & Miller, 2007). In discussing the results of their study on the impact of live animal exhibits, Luebke and Matiasek (2013) described the need for further research that can identify the "the actual relationship between visitors' subjective experiences and their overt behaviours in a zoo exhibit" (p. 414). The Revised VBLF provides researchers with a reliable instrument to capture these behaviours and the potential to explore that relationship. In their recent review of visitor learning research in zoos and aquaria, Moss and Esson (2013) criticized the narrow interpretation of visitor learning outcomes found in most studies. One of their suggestions for future research is for qualitative and mixed-method approaches to be used to investigate the nature of the zoo visitor experience. They argued that these approaches have the potential to "uncover a more meaningful range of outcomes to be validated by quantitative approaches" (p. 16). The methodology used in this research provides a means of filling the gap identified by Moss and Esson (2013). The qualitative approach to data analysis used in Chapter 4 resulted in descriptions of learning behaviours that are rooted in zoo and aquarium visitor experiences, allowing for a range of outcomes to be captured and identified in the Revised VBLF.

The findings of this research and the development of the Revised VBLF have answered this study's research questions but have also stimulated questions for future investigations. For example, can the affective attributes of live animal exhibit experiences contribute to the achievement of Breakthrough learning behaviours? Stated differently, does caring about animals lead visitors to seek and share more information, to make links with their prior experiences and knowledge, to become more aware of conservation issues, and perhaps to more pro-wildlife behaviours? Since the Revised VBLF can help reveal visitors' affective engagement at a live animal exhibit, zoo and aquarium researchers could use the results of an exhibit assessment to better understand the variables that influence this affective engagement. It would be important to investigate if affective engagement is a precursor to Breakthrough Level learning behaviours. The significance of Breakthrough levels of engagement has been discussed earlier in this chapter. However, one of the questions that remain unanswered is, how can Breakthrough behaviours in zoos and aquaria be encouraged to result in a higher awareness of the conservation goals and missions of these institutions? Can modifications to live animal exhibits provide more opportunities for visitors to engage at an emotional level with the live animal, leading to Breakthrough levels

of engagement that reflect an awareness of broader conservation messages? Gwynne (2007) has suggested that, in order to inspire people to adopt positive conservation attitudes, zoo exhibits need to "create relevance for visitors", "concentrate on cognitive information", "create an emotion-based experience" and "emphasize positive conservations solutions" (pp. 53-60). The implementation of such exhibit characteristics may increase the percentage of visitors who reach Breakthrough levels of engagement with live animal exhibits, and the Revised VBLF provides zoo and aquarium researchers with an instrument to investigate those possibilities.

The literature review in Chapter 2 discusses other research tools that have been developed and used to understand the visitor learning experience with live animal exhibits. It is important to understand the applicability and use of the assessment tools developed by Myers et al. (2004), by Ash et al. (2007) and Clayton et al. (2009), because these tools help situate the role and the value of the Revised VBLF in this field of research. For example, the investigation conducted by Myers et al. (2004) revealed the importance of capturing emotions as part of the visitor learning experience, and this emphasizes the value of the Revised VBLF as an assessment tool that can capture the affective, cognitive and socially constructed aspects of the learning process. The work of Ash et al. (2007) and their TOTBOT conversation assessment tool is very precisely focused on identifying and categorizing visitors' biological talk to understand visitor learning. The Revised VBLF will also enable researchers to assess learning by coding visitor dialogue but the inclusion of behavioural examples as indicators of learning adds to the framework's usefulness as a comprehensive exhibit evaluation tool. Similarly, the study by Clayton et al. (2009) used a pre-determined categorization system to analyse visitors' verbal responses to animals in zoo exhibits. Most of these categories are found in the Learning Behaviour and Types of Activity of the Revised VBLF, adding to the framework's validity and demonstrating how the Revised Framework can be used in a complementary way with other tools.

7.6 Final Comments

This study has developed an exhibit assessment tool that effectively captures the nature of the visitor learning experience with live animal exhibits. In answering its research questions, the study identified learning behaviours that are reflective of visitors' experiences with live animals in zoo or aquarium settings, behaviours that are notably different than those described in the Original VBLF designed for interactive exhibits in

science centres. Using the Revised Framework, the nature of the learning processes that occur in Initiation, Transition and Breakthrough levels of engagement can be described, enabling zoo and aquarium practitioners to assess the learning impact of live animal exhibits and subsequently modify or design new exhibits to optimize visitor learning opportunities. Additionally, researchers in this field can use the Revised VBLF to build understanding of the relationships between Breakthrough Level engagement, the affective nature of the live animal exhibit experience and conservation awareness in visitors. It is hoped that the Revised Visitor-Based Learning Framework for Zoos and Aquaria will be an important addition to the researcher's toolbox of assessment instruments and thus contribute to our understanding of visitor learning and the impact of exhibits across informal science settings.

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Appendix 3A
Generic Email Text to Contact Potential Research Sites

Dear Research Contact,

My name is Chantal Barriault and I am the Senior Scientist in Research and Evaluation at Science North in Sudbury, Canada. I came across your contact information through the members list of the Visitor Studies Association, of which I am also a member. I am also aware that Zoo / Aquarium / Science Centre conducts research and evaluation on the impact of their exhibits and I have read a number of those reports and articles.
I am writing to you because I have recently enrolled in the PhD program at Curtin University in Perth, Australia. My supervisor is Dr. Léonie Rennie and my topic is learning in science centres, zoos and aquaria. I have attached my proposal to this email for your information. I am writing to you in particular because I would very much like to conduct part of data collection at the Zoo/ Aquarium / Science Centre. The data collection would involve video recording visitors interacting with exhibits and informal.
The goal of the research is to refine the visitor learning behavior framework for science centres that I developed for my Master's degree. The April issue of Visitor Studies Journal published my article on this learning framework and I have attached it for your interest. I have also attached my PhD research proposal.

The data collection is still at least a year away but I wanted to contact you early to introduce myself and to ask if we could discuss the possibility of data collection at your facility. Naturally, the outcomes of my research will be shared with you, and I hope that it may prove useful and complementary to research that you may be carrying out.

I look forward to your response and would be happy to answer any questions you may have about my research proposal and methodology.

Best regards,

Chantal

Chantal Barriault
PhD Candidate
Science and Mathematics Education Centre
Curtin University
Perth, Australia

Appendix 3B
Research Application External Request Form Aquarium 1

GENERAL INFORMATION

Study Title

Visitor Engagement and Exhibit Assessment In Informal Science Learning Settings

All boxes included in this application will expand to accommodate additional text

Principal Investigator Name(s)
The Principal Investigator (PI) is the individual responsible for the project completion and work product. The PI must ensure that all aquarium guidelines, policies and procedures are followed.

1.   Chantal Barriault
2.
3.
4.

*A faxed faculty signature is required for any proposal submitted by a graduate student

Principal Investigator Contact Information (Include organization affiliation, address, telephone number, fax number and email address)

PI is a PhD student with Curtin University of Technology, Perth, Australia. Contact address is work office: Science North 100 Ramsey Lake Road Sudbury, ON P3E 5S9 CANADA Tel. 705.522.3701 xt. 245 Fax 705.523.4594 Email: barriaut@sciencenorth.ca

External Point of Contact Name and Contact Information (Include organization affiliation, address, telephone number, fax number and email address)

The External Point of Contact is the individual identified as the lead liaison between the PI and the aquarium for the duration of the project. Include typically PI This may or may not be the PI.

Chantal Barriault (PI) Contact address is work office: Science North 100 Ramsey Lake Road Sudbury, ON P3E 5S9 CANADA Tel. 705.522.3701 xt. 245

Fax 705.523.4594
Email: barriaut@sciencenorth.ca

PROJECT INFORMATION

Summary (Project summary for the lay person not to exceed 250 words)

This study will closely examine visitor behaviours and conversations in zoos, aquaria and science museums to better understand the learning impact of exhibits. Visitor behaviour and dialogue, as they interact with each other and with exhibits, will be video taped and analysed. The analysis will be based on a socio-cultural constructivist approach to learning where learning and development are social and collaborative activities. The research will focus on finding evidence for the precursors to meaning making and learning, so as to better understand the nature of learning behaviours in informal science learning settings and the particularities of these behaviours in zoos and aquaria where a visitor's interaction with exhibits is less physical and involves more social and reflective interaction. The study will build on the existing strengths of the "Visitor-Based Learning Framework" and will increase the framework's validity and applicability across settings.

The "Visitor-Based Learning Framework" (1998) has been used successfully to understand and assess the learning impact of exhibits in science centres. The "Visitor Engagement and Exhibit Assessment Model" (Barriault & Pearson, 2010) extends the framework into a relational model that describes and predicts relationships between exhibits, visitors and observable learning behaviours. In this model, *Breakthrough* behaviours describe an engagement level where the visitor is making meaning by using prior knowledge, prior experience and further inquiry. The framework and model have the potential to become practical visitor learning and exhibit impact assessment tools for practitioners across a range of informal science learning settings, including zoos and aquaria.

Background (Briefly describe the type of research to be conducted and the importance of such research. Also explain how research at XXX Aquarium advances your research goals.)

To gain a better understanding of the meaning visitors make from their experience with exhibits at the aquarium, I would like to videotape visitors during their normal interactions with 2 exhibits at the XXX Aquarium, the Oceanarium (Sea Otters) and the Caribbean Reef (sharks and fish habitat). Only one video taping session will be required and should take no longer than 2 hours. Video data will be collected at 2 other Chicago institutions, XXX and YYY. Upon completion of the data collection, I will analyse visitor behaviours and dialogue using the "Visitor-Based Framework" found in Table 1. I will pay particular attention to the nature of the *Breakthrough* behaviors to better understand and describe the visitor learning experience as it relates to messages of conservation, live animals and their habitats.

Table 1. The Visitor-Based Framework of Learning Behaviours

Learning Behaviours	Engagement Level
1. Doing the activity. 2. Observing the exhibit or other visitors engaging in the activity.	Initiation Behaviours
3. Repeating the activity. 4. Expressing emotional response in reaction to engaging in the activity.	Transition Behaviours
5. Referring to past experiences while engaging in activity. 6. Seeking and sharing information. 7. Being engaged and involved: testing variables, making comparisons, using information gained from activity.	Breakthrough Behaviours

Since the original framework was created from science centre data, and because zoos and aquaria have the additional goal of enhancing visitors' understanding of conservation and wildlife issues, I need to know more about what *Breakthrough* behaviours and conversations look and sound like, and how they are achieved in these settings.

The result of this research will make a significant contribution to the understanding of visitor behavior and learning in zoos and aquaria. Through this research, the framework used to assess the learning impact of exhibits will be modified and expanded to provide a practical yet robust tool for institutional staff who wish to collect their own data on visitor learning.

The XXX Aquarium has excellent live animal exhibits and provides visitors with compelling experiences that will enable me to collect valuable visitor behaviour data in a high quality research environment.

Methods

Subjects
General visitors at the XXX Aquarium will be the subjects for this study. Participants in the study will freely choose to interact with the exhibit where interactions are being recorded.

Data Collection
Video footage of visitors interacting with exhibits will be collected at the Oceanarium (Sea Otters) and at the Caribbean Reef (sharks and fish habitat). Audio of visitor conversations will also be recorded. This data collection is expected to take no more than 2 hours for each exhibit or habitat.

I intend to liaise with staff to ensure minimum inconvenience to both staff and visitors in making arrangements for the data collection. Only one videotaping session, probably no longer than two hours, is required, and I will provide all necessary equipment.

Ethical Issues

No names or other identifying information will be collected and pseudonyms will be used for institutions when reporting the research. This research project has received approval from Curtin University's Human Research Ethics Committee. A copy of this approval is attached to this application.

Implicit Consent

In order to ensure that visitors are informed about and can choose to participate in the video recording of their interactions at the exhibits, I will implement the protocols and procedures developed and published by Gutwill (2003) (see attached article). Further protocols can be implemented at the request of the XXX Aquarium. I propose that a sign indicating that research and video recording are occurring at the XXX Aquarium be posted at the main visitor entrance during the data collection period. The sign would include this statement: "You may be videotaped in certain areas of the aquarium today". Signs will also be posted in the exhibit areas that are being taped. The wording of the information and the inclusion of the institution's logo will be determined in consultation with staff at the aquarium. An example of an entrance sign is in Figure 2.

Figure 2. Sign posted at the entrance of a research site.

Cordons and an additional sign will be mounted around and beside the exhibit that is being videotaped. Figure 3 shows an example of the layout of a cordoned off exhibit area for research purposes. Note that the camera is in plain sight above the exhibit and has an additional sign on it telling visitors that it is recording. Similarly, the microphone will be placed near the exhibit in plain sight. The exact placement of the cordons, the camera and the sign at the exhibits will be discussed with the aquarium staff.

The sign at the entrance to the exhibit (**A** on Figure 3) will clearly state "Research in Progress" and that the videotaping is occurring at this moment with a red star note reading "NOW". Box 1. is an example of the type of information that would be displayed on the sign at the entrance to the exhibit. The actual wording of the information and the reason given for the research and videotaping will be discussed with the aquarium staff. Another similar, smaller sign will be placed directly beside or above the exhibit being filmed.

Box 1. Sample text on signs at the entrance to the exhibit being filmed

When? Between 1pm and 4pm today

Why? As part of the ongoing efforts to improve the visitor experience at the XXX Aquarium, we will be conducting research today in the aquarium today. We will be videotaping visitors interacting with our exhibits, taking notes and examining our exhibits more closely in order to better understand how effective they are.

Please proceed normally.

If you have any concerns about this research activity, please go to the main admission area to speak with a staff member and we will take the appropriate actions to ensure your comfort during your visit.
Thank you.

Project Outcomes (What is the expected outcome of the project? e.g. Data set, report, publication, presentation)

The research project will contribute to the completion of my PhD thesis and a peer-reviewed publication.

In addition, I will make a specific report to the XXX Aquarium and, if there is interest, I will present the findings of my study to the staff of the aquarium.

Timeline (How long is the work expected to take? Include a preferred start date and an end date. Are there phases?)

The work at the XXX Aquarium will involve videotaping visitors at 2 exhibits (the Oceanarium (Sea Otters) and at the Caribbean Reef (Sharks and fish habitat) for approximately 2 hours in July 2011. The specific date I am considering is July 28, 2011.

Data analysis will performed in the fall of 2011. A preliminary report of the findings relevant to the XXX Aquarium will be prepared and submitted in September 2012. The final doctoral thesis is scheduled for completion by the summer of 2014. The XXX Aquarium will receive a copy of the final thesis.

Budget (How is the project funded and by what organization? How long does the funding last?)

The project is not funded by any organization. I will receive some reimbursement from the university for the travel to XXX.

RESOURCES REQUIRED

Department, Aquarium and Staff Resources (What aquarium resources will be required? Be specific and detailed. How much of an aquarium employee's time? What data? What equipment? What samples?)

Approximately one hour of one staff person's time may be required.
Staff time will be required to advise on camera and microphone placement near the exhibits to ensure the study is not interfering with visitor flow through the aquarium. Also, advice will be sought for the wording on signs that inform visitors about the study and data collection.

Special Shipping and/or Handling Instructions (Be specific and detailed. For instance "Fill CPT tubes with whole blood to the blue line and chill immediately. Ship on ice but do not allow to freeze")

N/A

Necessary Permits (Are permits required to conduct this study? If so, please list the permits and agencies of responsibility. Copies of permits will be required to be on file at the aquarium prior to the commencement of the study)

Ethics approval is required by Curtin University to permit the collection and use of video footage of visitors interacting with exhibits. A copy of the ethic certificate has been attached to this application.

SIGNATURES

Any public presentation of a work product such as a report, publication or presentation identifying XXX Aquarium as an author, collaborator, or source requires at least one month lead time to secure necessary approvals. Acknowledgement of XXX Aquarium is required in any resulting work product(s) and a copy should be submitted to XXX's Conservation and Research Manager via email. XXX Aquarium staff who provide substantial contributions to the intellectual, theoretical, methodological, and/or analytical development of the research project, and/or who assist in writing or preparing the resulting work product should be listed as coauthors at the researcher's discretion. All coauthors must agree upon the final draft version

prior to publication. XXX Aquarium staff who provide guidance, assistance with husbandry or carrying out experimental protocols should be acknowledged.

Depending on the extent of research conducted, a Memorandum of Understanding (MOU) will be drafted and signed by both parties upon project approval. The MOU will outline roles and expectations of the researcher and of XXX Aquarium. Depending on the extent of XXX's involvement, an expectation on the resulting MOU may include coauthorship for XXX staff as stated above.

Researchers are strongly advised to consult guiding texts concerning the care and use of animals in research while developing methodology. We recommend the following:
- USDA's Animal Welfare Information Center (AWIC):
- http://awic.nal.usda.gov
- Guidelines for the Use of Fishes in research: http://www.fisheries.org/afs/docs/policy_16.pdf
- American Veterinary Medical Association (AVMA) policy statements and guidelines: http://www.nabranimallaw.org/Research_Animal_Protection/The_American_Veterinary_Medical_Association_(AVMA)/

See attached signature page.

Principal Investigator Signature

Print Name

Chantal Barriault

Date
March 21, 2011

Faculty Signature

Print Name

Dr. Léonie Rennie

Date

To submit, please email the application and the Principal Investigator's curriculum vitae. You may choose to scan and email the signature page, or fax the signature page to the number below:

NAME
Manager, Conservation and Research
XXX Aquarium
Email : XXXXXX   Telephone: 000000000   Fax: 000000000

Appendix 3C
Observational Notes for the Chemical Reaction Table
Science Centre 1

Chemical Periodic Table.   MSi   - long engagement

At the PT Table. Oo, just made x , that is pretty cool
~~telling someone over~~ explains what to do
looking for elements to drag over
happy & excited when succeed / create something
when others approach, watch for a bit but don't seem to engage
~~with~~ when someone is already there - wait
some disappointment when don't get a reaction
actual outburst of laughter when get a reaction
trying to remember combinations of elements or names of elements
from previous knowledge
Seems intuitive to use ; one reaction ; they're hooked
They look for more ~~often~~ elements they recognize , not much
talking, read the results ;
start to walk away but drawn back in
"there are elements in here" - take 2 of those & add them
H_2O)... ~~they~~ want to know about the things I know, I can
element ? Let's start with carbon, give it a
you can try anything you want really.   I just made medication
very cool. you just mix any 2 + it'll give you what you made
~~wanna try ?~~ (couple - woman leads). The photo ? looking for it
~~group of teens engaged together~~   Which one is so
Tell ~~acid sodium~~ ; tell me what happens .
See ~~monolide~~ - should be monoxide - it's wrong ; get a little
frustrated when doesn't do what expected
- add Cesium - cool as it blows up. laughs
some discuss the technology of the exhibit
H2 + H2 ?   look cool what is gave
let's just see what happens.
~~Did you see this~~, it's totally cool.
~~It gives you suggestion~~ I don't know , it doesn't do anything than
you know it's wrong

Learning Impact of the Chemical Reaction Table
An Evaluation of the Visitor Learning Experience
Science Centre 1

Chantal Barriault,
PhD Candidate, Centre for Science and Mathematics Education
Curtin University, Perth AU • barriault@sciencenorth.ca
December 2012
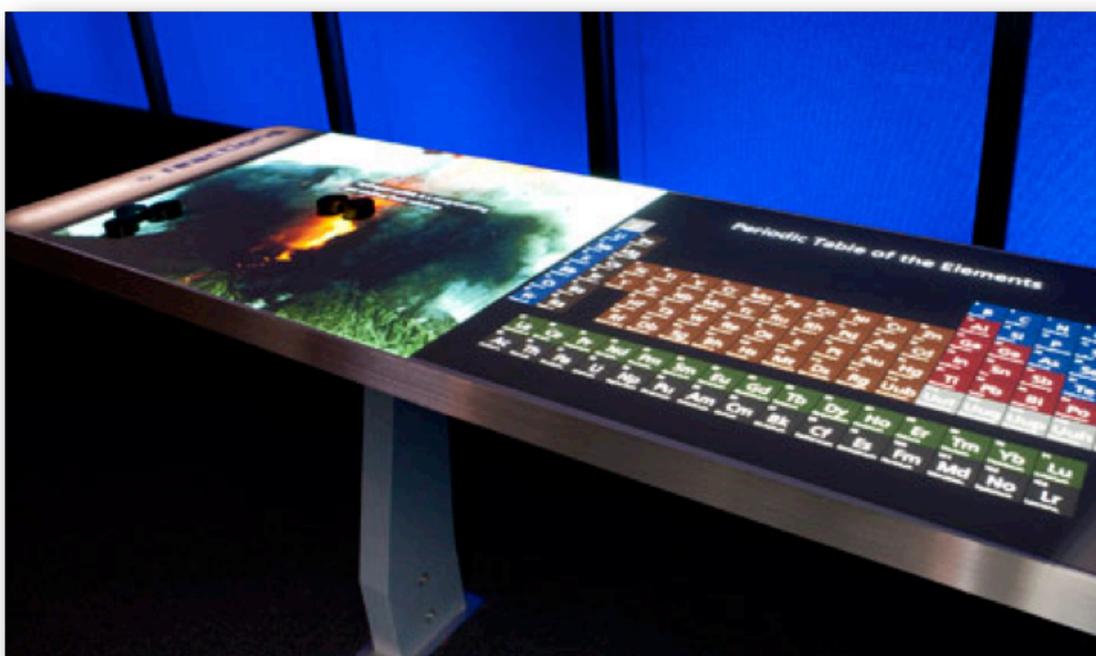
INTRODUCTION

Background

Visitor studies in settings of informal learning have grown exponentially over the past 20 years as stakeholders, funders and practitioners have sought ways to understand and assess the learning impact of exhibits and programs in their institutions. The "Visitor-Based Learning Framework" (Barriault, 1998) has been used successfully for this purpose at Science North in Sudbury, Ontario, and is now being used in several other places (Schliessmann & Ohding, 2009; Visscher & Morrissey, 2010). The learning framework was derived from observations of visitor interactions with exhibits in science centers. It consists of 7 learning behaviors that describe three engagement levels as visitors interact with science exhibits (see Table 1). The engagement levels are *Initiation, Transition, and Breakthrough.* Each of these engagement categories is based on types of behaviors and concrete examples of visitor – exhibit interactions that can be observed by trained science center practitioners.

The Visitor-Based Learning Framework (Barriault & Pearson, 2010; Barriault, 1998)

Initiation Behaviors involve *Doing the activity,* spending time *Observing* others engaging in the activity and, *Reading* labels to know how to use the exhibit. When visitors demonstrate these learning behaviors, they are taking the first steps towards a meaningful learning experience. Even though they are not yet completely involved in the experience, they are gaining some level of information through the interaction, which in turn, could lead to more learning. At this stage, visitors need to feel comfortable about committing themselves to engaging with an exhibit. Initiation behaviors enable them to test the waters with minimum personal risk and provide an entry point into further learning opportunities offered by the exhibit.

Transition Behaviors are described as *Repeating the activity* and *Expressing positive emotional responses* (in reaction to engaging in the activity). Smiles and outbursts of enjoyment, affective comments as well as repetition indicate that a level of comfort has been achieved and that visitors are willing, and even eager, to engage more thoroughly in the activity. Regardless of whether the activity is repeated in order to better understand it, to master the functions or to observe different outcomes, the net outcome is a more committed and motivated learning behavior.

Breakthrough behaviors are identified as *Referring to Past Experiences*, *Seeking and Sharing Information* and becoming *Engaged and Involved*. At this level of engagement, it becomes evident that the visitor is making meaning, building his or her own understanding of the concepts through recalling prior knowledge and prior experience, and by further inquiry, such as asking questions, hypothesising and testing variables. *Breakthrough* behaviors involve engagement that clearly moves beyond short-lived, purely physical interactions. Labelling these behaviors as part of the learning process is consistent with the constructivist literature on learning in informal settings (Hein, 1998; Leinhardt et al., 2002; Rennie, 2007) as well as with Falk and Dierking's (2000) Contextual Model of Learning.

Examples of types of activities that characterize each of the learning behaviors are outlined in Table 1. It is important to note that although the seven learning behaviors tend to occur sequentially, that is not always the case. In fact, the behaviors can occur in a variety of sequences. A rich learning experience means that many or most of these behaviors occur during an interaction with an exhibit.

Table 1. Types of Activities that characterize Learning Behaviors (Barriault Pearson, 2010)

Type of Activity and Exhibit Examples	Learning Behavior	Engagement Level
1. In passing, not done completely 2. Doing the activity somewhat completely 3. Doing the activity without further exploration or testing of variables	1. Doing the activity	Initiation Behaviors
1. Looking at the exhibit working, or someone doing the activity 2. Watching the exhibit or person using exhibit with expressed interest in the activity (facial expression or verbal) 3. Interested in learning outcome or in learning the activity; visitor does the activity after observing.	2 Spending time observing others engaging in activity or observing the exhibit	
1. Doing the activity two to three times to attain desired outcome, to master the exhibit's function. 2. Enjoyment of outcome 3. Changing the variables once looking for a difference in outcome; becoming involved / engaged	3. Repeating the activity	Transition Behaviors
1. Smiling, pleased with exhibit 2. Stronger signs of enjoyment such as laughter; verbal references to enjoyment 3. Obvious signs of eagerness to participate; excited disposition;	4. Expressing positive emotional response in reaction to engaging in activity	
1. Reference to past experience with exhibit or science center 2. Simple reference to comparable experience in visitor's life 3. Reference to comparable experience in their life as well as making comparisons and deductions based on observations of similarities and differences	5. Referring to past experiences while engaging in the activity	Breakthrough Behaviors
1. Calling someone over to look at exhibit, or to ask them to explain an exhibit; asking a question to staff or family member without lengthy discussion or exploration of topic. 2. Reading signage; having conversations about exhibit and related science with staff or family member 3. Sharing experiences and information with others by explaining the exhibit to them, giving them details about gained information and observations; discussions and questions about exhibit with staff or family member/friend	6. Seeking and sharing information	
1. Engaging in inquisitive behavior, exploratory actions such as repeating the activity several times, reading signage, asking questions; remaining on task for 2-3 minutes 2. Concentration and motivation are obvious; doing the activity as a means to an end, or meeting a challenge; length of interaction significant, 3 to 5 minutes; outcome or result of activity important 3. Experimenting, testing different variables, looking for different outcomes; engages in discussion with others (visitors or staff) about the various outcomes; experience - 'flow'; involved in activity for long period of time i.e. more than 5 minutes	7. Engaged and Involved: testing variables, making comparisons, using information gained from activity	

Plotting behaviors: Visitor Engagement Profiles (VEP)

The levels of engagement shown by visitors at a particular exhibit can be depicted in Visitor Engagement Profiles (VEPs) (Figure 1). Each of the three Engagement Level categories, Initiation, Transition and Breakthrough, is represented by a bar showing the percentage of visitors who show one or more of the behaviors characteristic of a category. The baseline for a VEP is the number of visitors who approach an exhibit and pay attention to it. Visitors who do not stop to interact with an exhibit are not included in a VEP. In other words, the attracting power of an exhibit is not assessed when using this tool. Instead, the VEP focuses our attention on the learning behaviors demonstrated by visitors once they have made the commitment to engage with the exhibit.

Figure 1. Visitor Engagement Profile Example
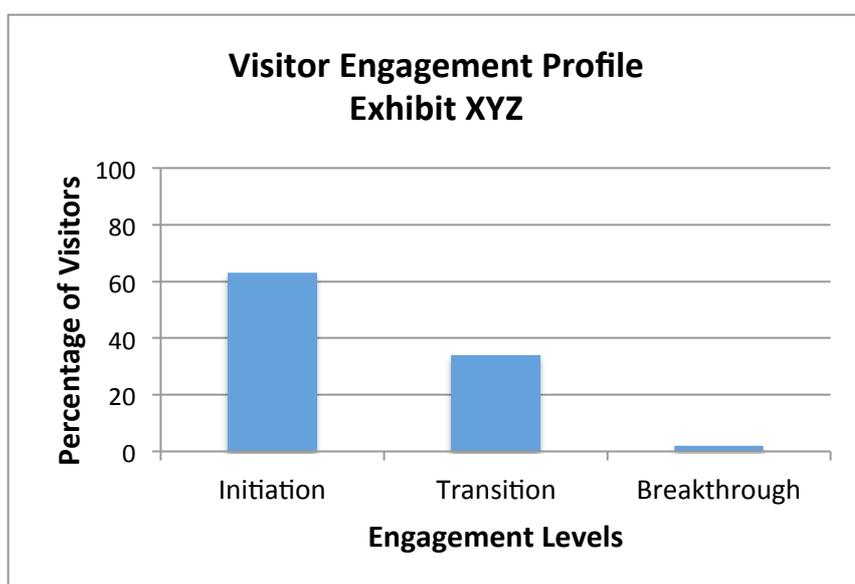
THE CHEMICAL REACTION TABLE

The ▮▮▮▮▮▮ has a host of highly engaging exhibits that explore the world of natural phenomena in their ▮▮▮▮▮▮▮▮ exhibition. As part of research conducted for my PhD, I video recorded 100 visitors as they interacted with the Chemical Reaction Table in July 2011. ▮▮▮ describes this exhibit on their website:

> "At the Create a Chemical Reaction table, you can take a drag-and-drop approach to the elements, mixing and matching them in a virtual chemical lab. Use pucks to choose elements from a projected periodic table, and pull them into a reaction lab to see what happens. You can bring in more molecules of the same element, throw new ones into the mix or just start over. The table can also suggest combinations you might want to try. It's a fun way to learn how a single molecule can be the difference between fire and fizzle."

METHODOLOGY

Visitors and Data Collection

One hundred visitors on general public visits to ███ were video recorded on July 24, 2011, as they interacted with the exhibit, and with each other. As is required by ethical research practices, communication about the research project was posted at both ends of the exhibit, explaining to visitors that they were being video recorded as part of a study. The researcher was present during the 80 minutes required to video record the 100 visitors engaging with the Chemical Reaction Table. Visitors were never approached or interviewed during the data collection unless they had specific questions about the study being conducted.

Data Analysis

The video was then analyzed using coding software and the Visitor-Based Learning Framework described in Table 1. The types of activities and learning behaviors that visitors engaged in while interacting with the Chemical Reaction Table were tabulated and plotted to reveal the Visitor Engagement Profile of the exhibit (Figure 4).

Further data analysis was performed on the data to reveal the percentage of visitors who **only** engaged in *Initiation* types of behaviors, those who moved on to engaging in *Transition* and finally those that engaged in meaning making activities as described in *Breakthrough Behaviors.* For example, if a visitor engaged in an *Initiation* type of activity, that activity was coded as either "Doing the Activity" or "Observing". However, if the visitor continued to be engaged and displayed *Transition* types of behaviors, that visitor was coded as having reached *Transition*, not *Initiation,* and the visitor was coded as either "Repeating" or "Expressing Positive Emotional Response". The same was done if the visitor engaged in *Breakthrough* type behaviors, ensuring that each visitor was counted in only one of the three Engagement Levels of the framework, while capturing the details of every learning behavior within each Engagement level (Figure 5). Whether the visitor was part of a group or alone while interacting with the exhibit was also coded and analyzed.

RESULTS

Visitors

Figure 2 summarizes the ages of the visitors observed, based on the interpretation of the researcher. Most of the visitors (61%) were coded as adults between the ages of 19 and 64. The second most common age group to interact with the exhibits were teens (19%) aged 14-18. Sixty one percent of visitors interacting with the exhibits did so as part of a family group, while 21% were part of a group that seemed social rather than family. Only 10% of the visitors interacted with the exhibit on their own, without interacting with others (Figure 3).

Figure 2. Age of Visitors interacting with the Chemical Reaction Table
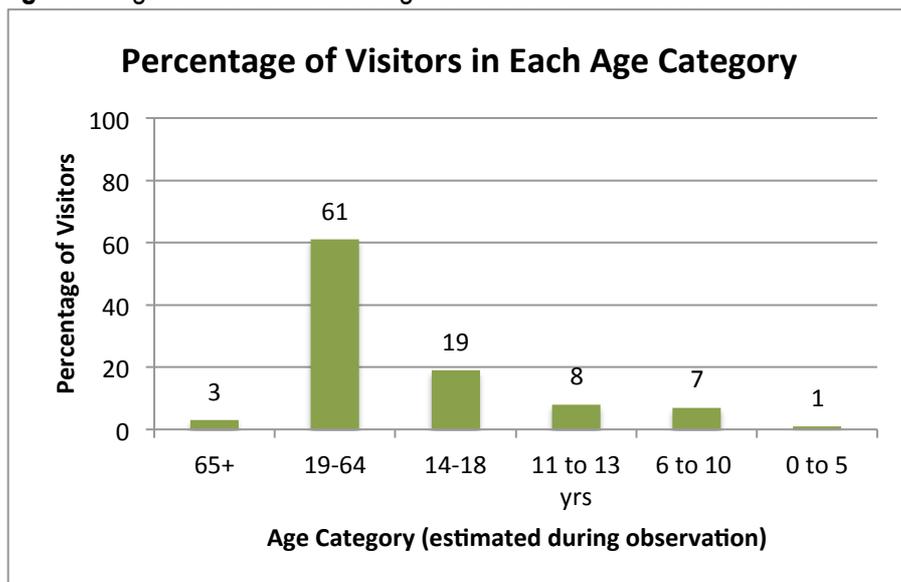
Figure 3. Type of Interaction: Alone, in a Family Group or Other Group
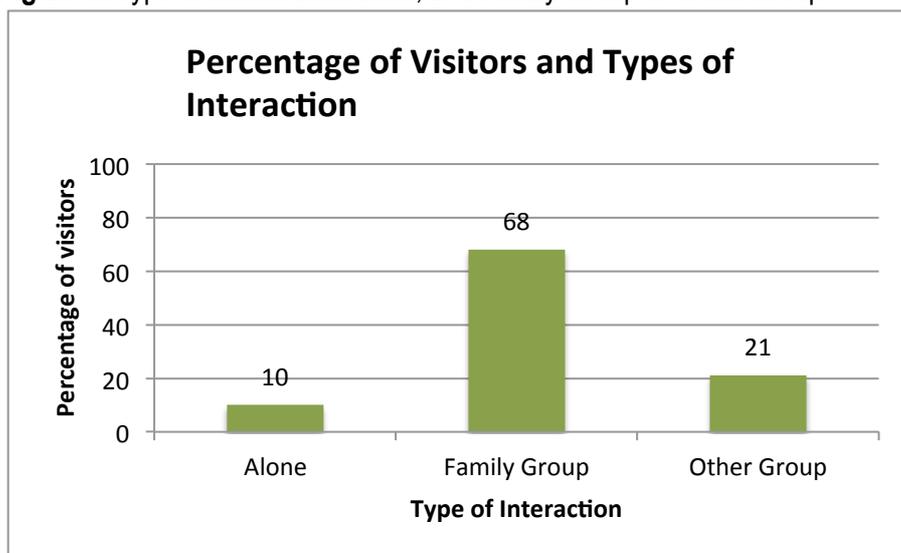
Average duration of interactions

In total, visitors interacted with the Chemical Reaction Table for an average of 3.02 minutes. Visitors who reached *Breakthrough* levels of engagement interacted with the exhibit for an average of 5.00 minutes. The cultural attractions industry average for length of time spent at an exhibit is between 30 and 60 seconds.

Visitor Engagement Profile

Figure 4 shows the VEP results for the Chemical Reaction Table and displays the cumulative percentage of visitors in each engagement level. Figure 5 shows the percentage of visitors in each of the engagement levels, but each visitor is only counted once, showing the percentage

of visitors who only engaged in *Initiation*, those who engaged in *Transition* and those who engaged in *Breakthrough* levels of learning behaviors.

Figure 4. Visitor Engagement Profile showing cumulative percentage of Engagement Levels

Visitor Engagement Pofile
Chemical Reaction Table
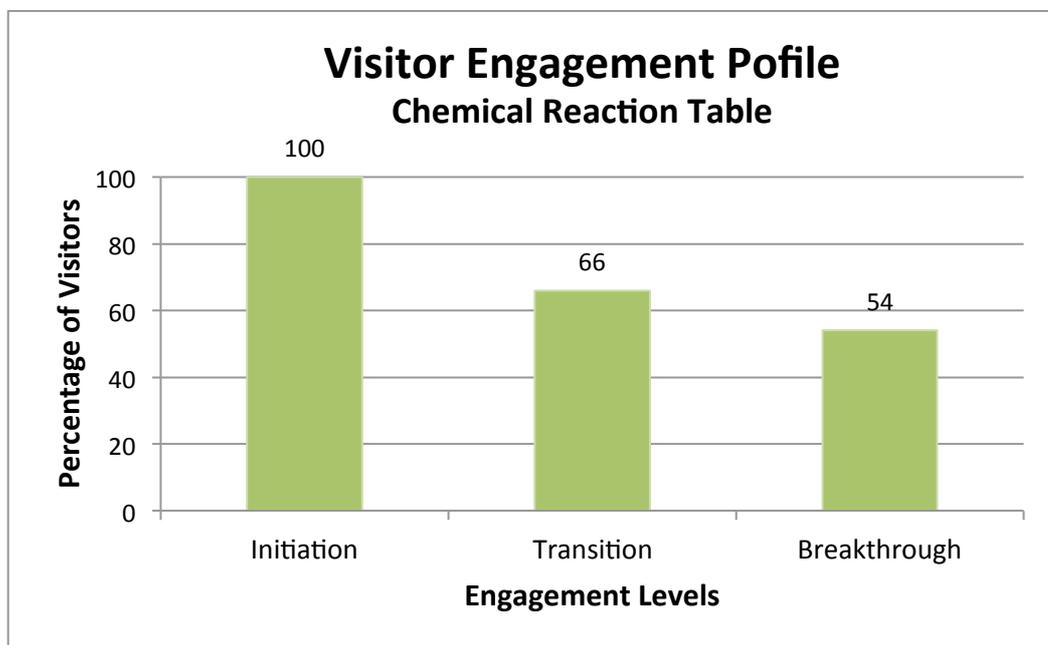
Figure 5. Percentage of visitors engaging in each Engagement Level

Visitor Enagement by Level
Chemical Reaction Exhibit
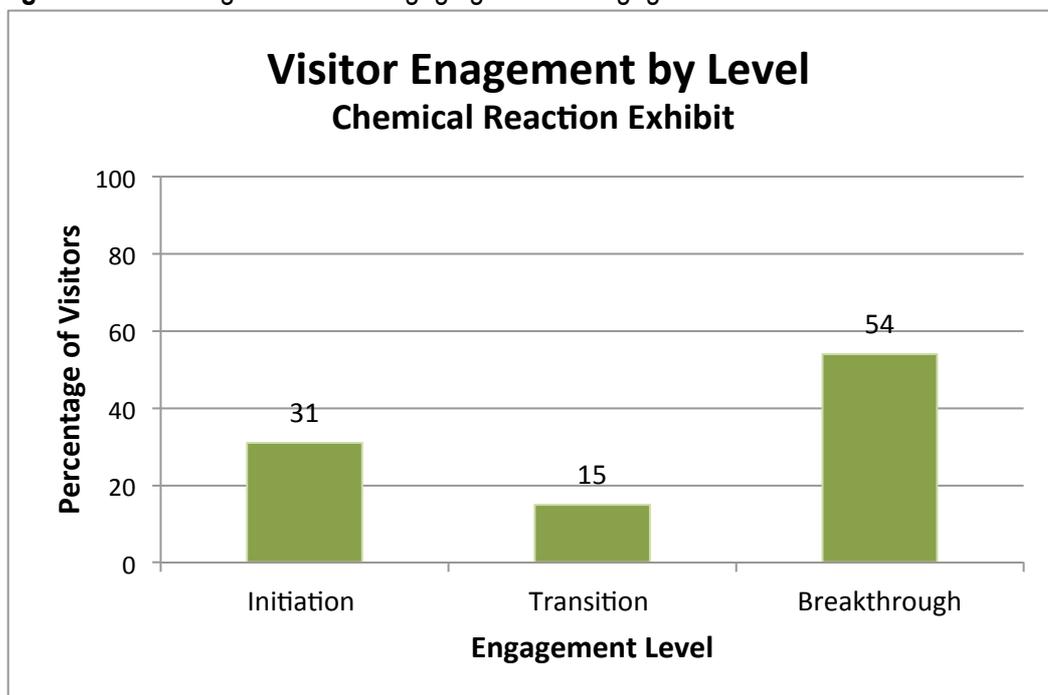
Described another way, over half of the visitors who interacted with the Chemical Reaction Table either made references to their previous experience or knowledge, sought for, or shared information with others, or tested variables, becoming involved in the activity for an extended period of time, or any combination of these.

It is relevant to this study to know how exhibits in science centers generally perform using this methodology, in order to situate the relative impact of the Chemical Reaction Table in engaging visitors in learning behaviors. Over 100 Visitor Engagement Profiles have been produced for exhibits at Science North and in 3 other science centers. On average, exhibits usually engage between 15 and 30 % of visitors in *Breakthrough* types of learning behaviors. Visitor engagement standards at Science North, and myself as the lead researcher using this method of assessment, suggest that a high impact exhibit should engage at least 40% of visitors in *Breakthrough* types of learning behaviors.

Visitor Engagement – Initiation and Transition Behaviors

Figure 6. Number of visitors engaging *Initiation* types of learning behaviors
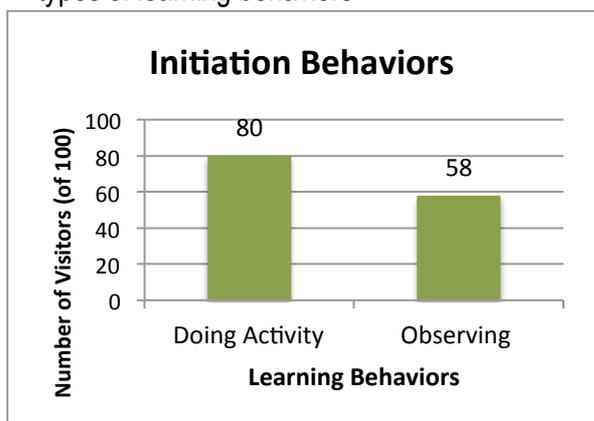
Most visitors (80 of 100) who approached the Chemical Reaction Table interacted with the exhibit in "Doing the Activity". Although some visitors simply observed the exhibit or watched others use it, most continued on to have an interaction with the table (Figure 6).

Figure 7. Number of visitors engaging *Transition* types of learning behaviors

Sixty six visitors engaged in *Transition* types of behaviors and most of them showed positive emotional responses and repeated the activity to either try to master it, or to try a different combination of elements (Figure 7).
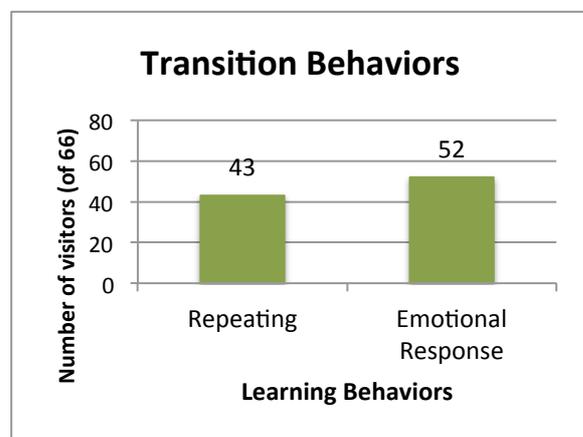
Visitor Engagement – Breakthrough Behaviors

Figure 8 shows the number of visitors who engaged in of each of the learning behaviors within the *Breakthrough* Engagement level. For example, the majority of visitors (44 of 54) engaging at the *Breakthrough* level spent time "Sharing and Seeking" information with others.

Figure 8. Number of visitors engaging in *Breakthrough* types of learning behaviors
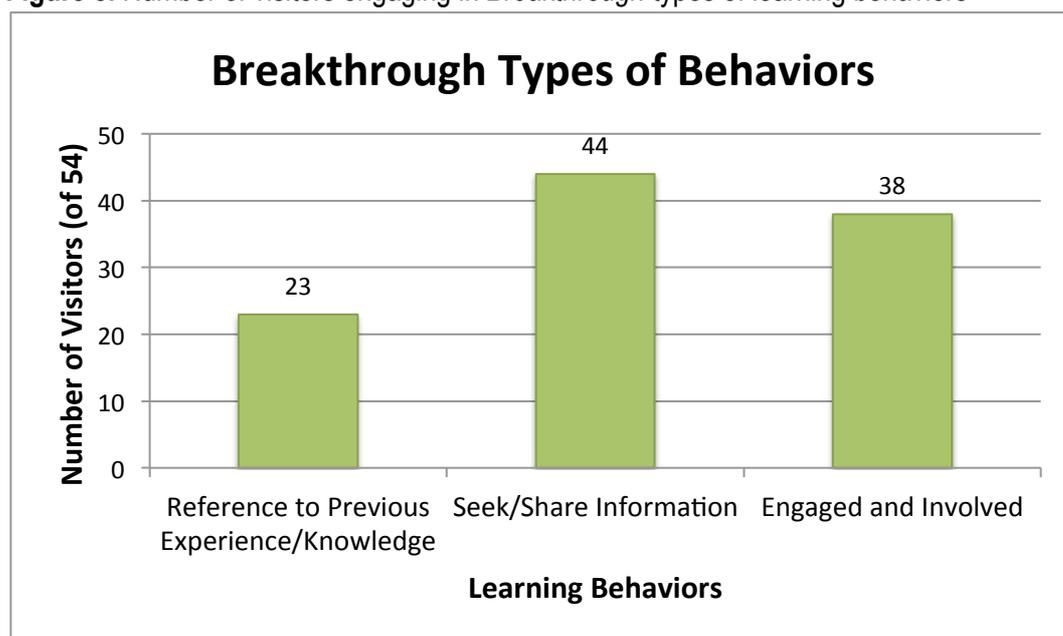
Although a complete analysis of visitors' conversations at the Chemical Reaction Table is beyond the scope of this study, broad themes emerged and highlighted how these *Breakthrough* types of Behaviors were encouraged by the opportunities presented by the exhibit. Many visitors referred to their high school chemistry classes, remembered some chemical formulas and tested these with their families and friends. Statements such as *"Try to make some salt…. I know that one. It's NaCl"*, *"Make water. That's easy. It's H2O"*, *"Let's start with Carbon, give me 2"*, demonstrate the immediate recognition that people experienced when first attempting to create a chemical reaction.

The design of the table encouraged social interaction that most visitors took full advantage of by doing the activity with others. Conversations demonstrating the sharing of information included comments like: *" Wanna know about the things I know… if I can remember…"*, *"You can try anything you want really. Here, just mix any 2 and it will give you what you made. Wanna try?"* , *" You add phosphate and tell me what happens".* The social nature of making meaning and learning means that visitors interacting around the exhibit engaged in conversations about the chemical reactions they were producing and the resulting products. The ability to manipulate variables, test them and succeed, complemented by the ability to use previous knowledge and the element of surprise when reactions occurred, all combined to engage 54% of the visitors in *Breakthrough* learning behaviors.

Other relevant observations

Early assured success is a concept proposed by Allen (2004) and describes the need for exhibits to provide relatively immediate success for visitors in order to engage them in a learning experience. Not surprisingly, this was found to be the case with the Chemical Reaction Table. Visitors were more likely to remain engaged in the exhibit and continue on to *Breakthrough* types of learning behaviors if they produced a reaction with their first attempt. They also seemed willing to work on the exhibit for about 60 seconds without the result of a chemical reaction before giving up and moving on to another exhibit. Visitors who could not

succeed at producing a chemical reaction within 30 to 60 seconds were more likely to walk away after engaging in only *Initiation* type learning behaviors.   As the results show however, more than half of the visitors did become motivated and interested enough to invest an average of 5 minutes in exploring the different possibilities presented by the exhibit.

CONCLUSION

The learning opportunities offered by the Chemical Reaction Table are numerous. The exhibit enables visitors to use their previous knowledge and experience about chemistry to succeed in exploring chemical reactions. The table's design, large surface area and multiple pucks encourage many visitors to interact with it at once, facilitating the social nature of learning and contributing to visitors' opportunities to share and seek understanding among themselves. Finally, the exhibit encourages the manipulation of many elements (variables) and ensures that visitors have the opportunity to become involved through testing combinations of elements and remaining engaged as every successful reaction motivates them to try again.

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Appendix 4B
Observational notes and transcripts of dialogue for Gorillas exhibit at Zoo 1

Legend:
- ■ (red) Finding Identifying
- ■ (yellow) Describing Physical traits
- ■ (green) Describing Behaviours
- ■ (blue) Interpretation
- ■ (purple) Expressing affection

Family group of visitors:
Mom: "Look at them up there, there's the baby."
Take turns describing what the gorillas are doing.
Dad: "He's just hanging"
Adults are putting voices to the gorillas.
Kids are relating to the family members.
Daughter: "There's the daddy, the mommy, the baby…"
Mom: "They're beautiful."
Son: "Monkey!"
Mom: "Very human, amazing."
"Maybe she's laying like that because she doesn't want to feed the baby right now."
Son: "Oh they're very stinky."
Mom: "She's doing her exercise. Look at this one upside down, doing his yoga. Magestic."
Kids and mom saying hello.
Mom: "See that one just grabbed the other one."
"She knows she's pretty. Look he's swinging. That's her baby. Here she comes."
"It's sad, I know".
Daughter "Look daddy, there's the baby one. Aaah, they're snugglish, playing. Hi Gorillas.", waves.

Young adult male with group of friends (early 20s)
"Their hands are just like ours, with nails and everything" and looks at his own hands.
"Like Gorillas in the Mist. These are our closest relatives, like 90% of our DNA."

Family of mother and 2 children:
Mom pointing to gorillas with her children says "I see his fingers. He's moving. He's looking at you. You are so cute. Adorable."
Makes kissing sound.
"I can watch you all day long… but kinda dumb, eating a stick. He can climb up there" pointing to top of structure.
More conversation and laughing, related to what animals are doing, pointing out everything.
Mom reading about each gorilla at the panel – Meet the Gorillas.

Other group:
Woman1: "See how close we are"
Woman 2: "Sharp teeth. Cute behind the cage"
Child: "Can the Gorilla get out?"
Woman1: No.
Child: "Why"
Woman 1: "Say hi to the gorilla"
Child: "Hi monkey. What's he doing?"

Woman 1: "It's not a monkey, it's a gorilla"
Together, they mostly point at animals, say what they are doing, compare them to family members.
Woman 2: "Oh neat. Did you see it? There's the baby. Oh my goodness how cute. How sweet. She's staring at us. Sleepy today? Or lazy. See, mommy's checking on him. There are 6 gorillas. Look how big he is. Look how big their hand is. I think the big one is cleaning the little one."
Woman 2 refers to sign and counts number of gorillas.
Emotional connection to baby and mom; outbursts of laughter and expressions of emotions toward them.

Group of adults:
Some talk to gorillas, especially the baby.
Woman: "Whatcha gonna do?" in a child-like voice to the baby
"Gorgeous fur. They look tired"
"Why are all those things in there?"
"Trying to make it stimulating like in the wild"
"Hey buddy, look at you, you're beautiful."
Woman calls to get the attention of the animals, whistles.
"Look at his neck, huge!. Oh that's a good diet. So primal. Look at the size of his feet! Look at them playing. Others just lying there, trying to find shade"

Mom and son:
Mom: "Look at their fingers, just like ours"
Boy: "They have opposable thumbs"
Mom waving. "Last year I was here and… he's peeing. Look at his bumbum. The little one is getting bigger and bigger."

Understanding the impact of Zoos and Aquariums

Thank you for your interest in my study about the impact of zoos and aquariums exhibits on visitors. I am a doctoral student at Curtin University in Perth, Australia and have been given permission by the XXX Zoo to complete part of my data collection here at the zoo.

The purpose of my study is to better understand the learning that occurs when visitors view and talk about animal exhibits in a setting like a zoo or an aquarium. To do this, I will need to closely examine visitor behaviors and conversations as they watch and talk about the animals and the exhibits. Filming visitors and recording their conversations about their experience will allow me to see and hear more details and to gain a better understanding of the impact that animal habitat exhibits have on people. No names or personal information about visitors will be gathered. My only interest for this research is visitor behaviour and response to their experience with the animal exhibits.

All the video and audio footage taken today will be stored on my password protected hard drive and stored in my home office. The only people who will view the video footage and listen to the recorded conversations are my research supervisor and I. The video and audio data will be destroyed, one year after the study's completion in 2016. The video and audio files will be destroyed using a digital shredder.

If you should have any further questions about this study, please feel free to email me, the researcher Chantal Barriault at **barriault@sciencenorth.ca** or my research supervisor, Dr. Léonie Rennie at **L.Rennie@curtin.edu.au**.

Curtin
University of Technology

*Figure 5B.1* Percentage of visitors engaged in Types of Activity within the *Finding & Identifying* learning behaviour at the Sharks & Fish exhibit and at the Turtles exhibit in Aquarium 2.
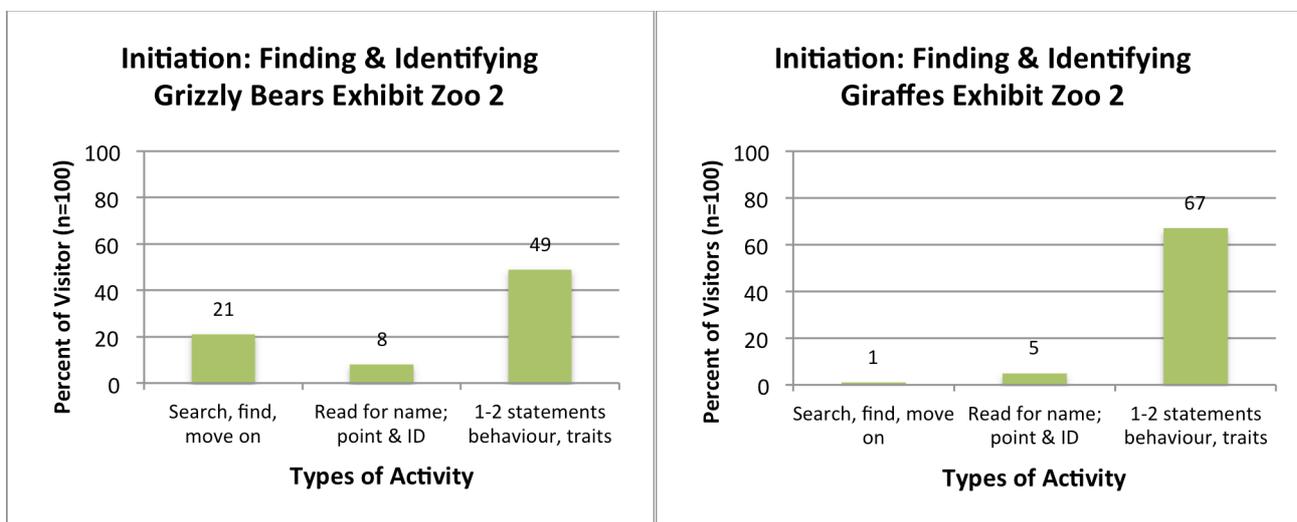

Figure 5B.2 Percentage of visitors engaged in Types of Activity within the *Finding & Identifying* learning behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

Appendix 5C
Results for Initiation Level Learning Behaviour *Observing the Habitat/ Organism(s)* and Types of Activity at Aquarium 2 and Zoo 2
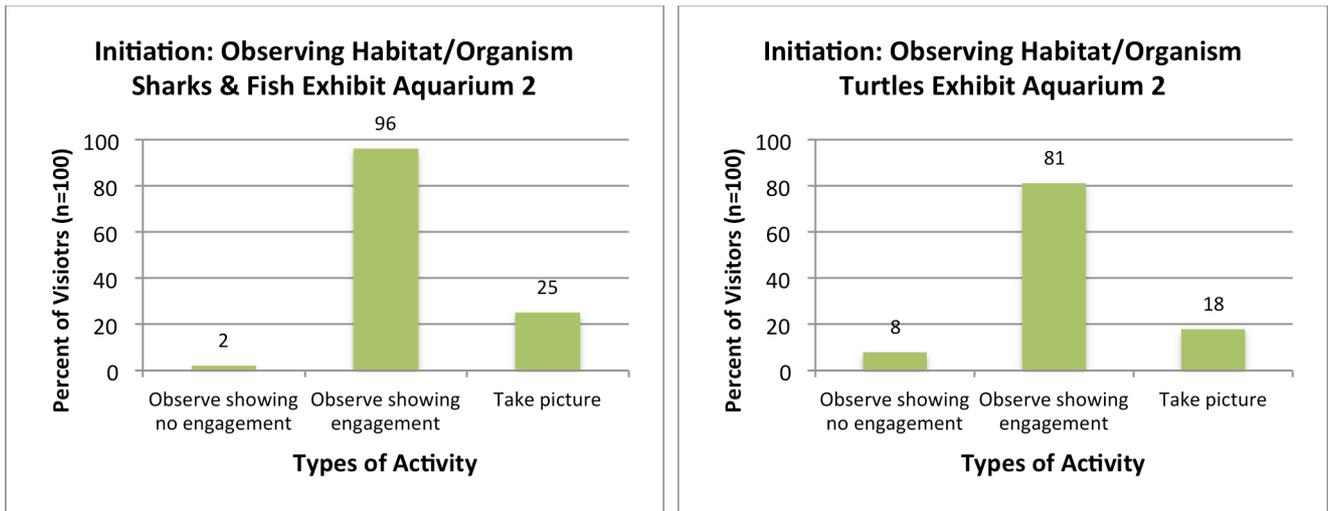

Figure 5C.1 Percentage of visitors engaged in Types of Activity within the *Observing the Habitat/Organism(s)* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.
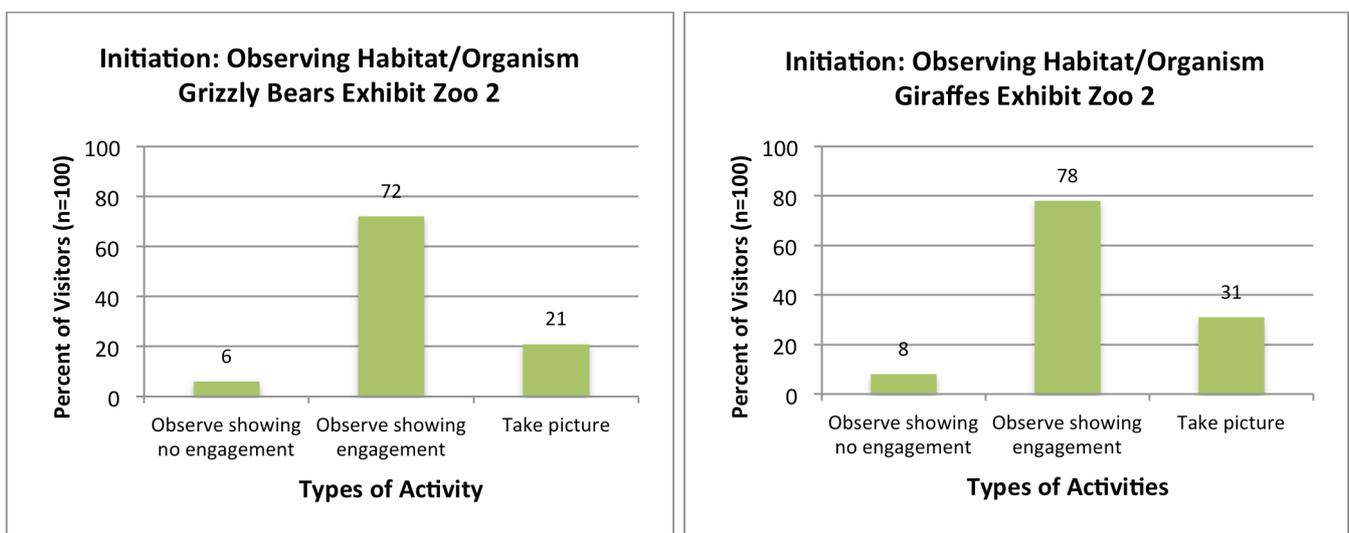
Figure 5C.2 Percentage of visitors engaged in Types of Activity within the *Observing the Habitat/Organism(s)* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

Appendix 5D
Results for Transition Level Learning Behaviour
Exploring to Prolong Engagement and Types of Activity at Aquarium 2 and Zoo 2
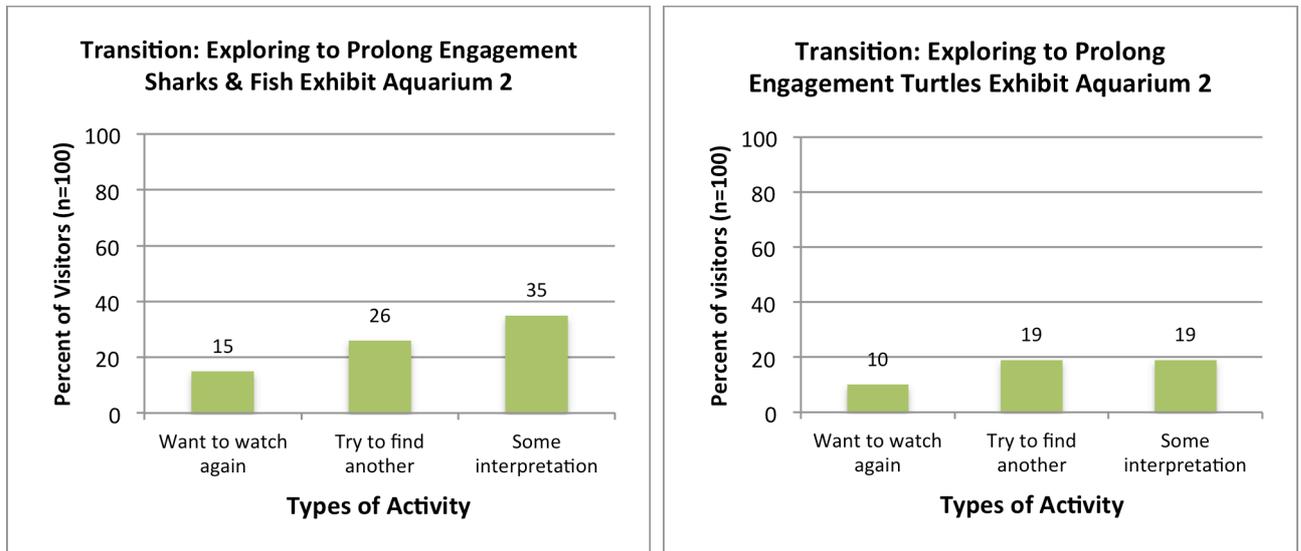
Figure 5D.1 Percentage of visitors engaged in Types of Activity within the *Exploring to Prolong Engagement* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.
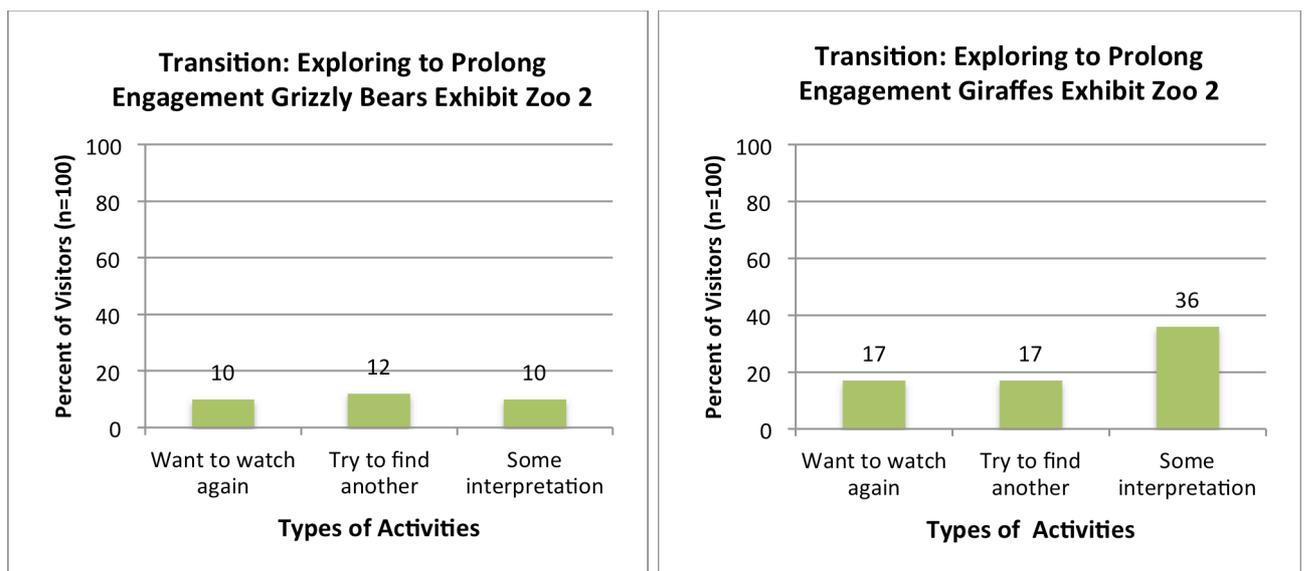

Figure 5D.2 Percentage of visitors engaged in Types of Activity within the *Exploring to Prolong Engagement* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

Appendix 5E
Results for Transition Level Learning Behaviour
Demonstrating Affective Engagement and Types of Activity
at Aquarium 2 and Zoo 2
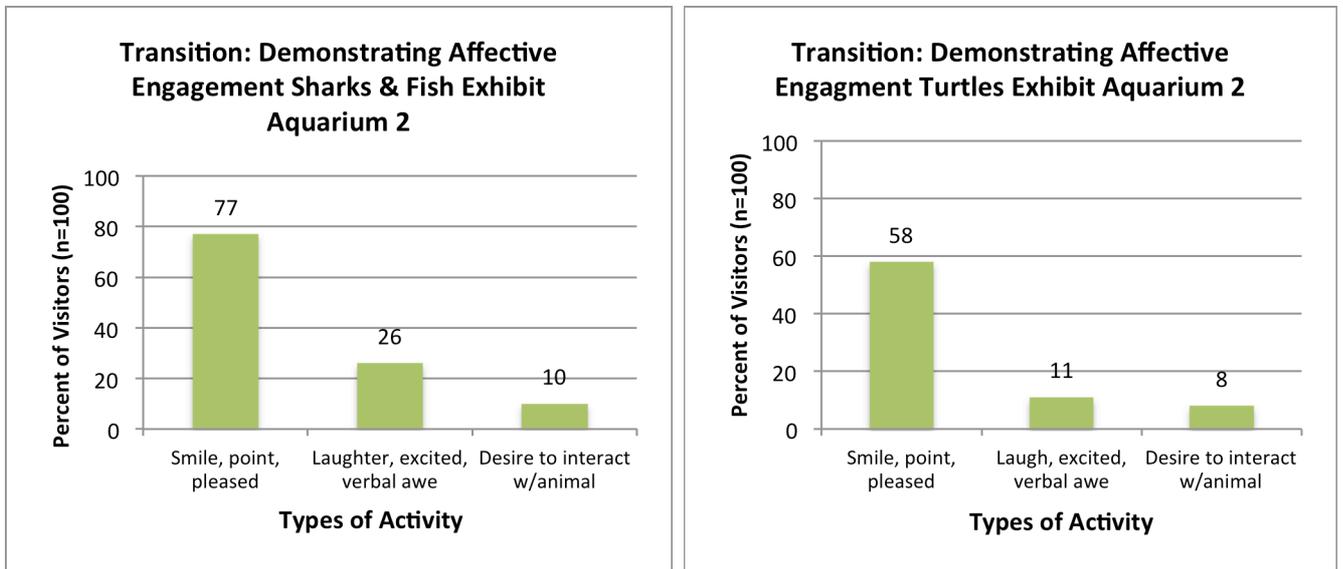
Figure 5E.1 Percentage of visitors engaged in Types of Activity within the *Demonstrating Affective Engagement* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.
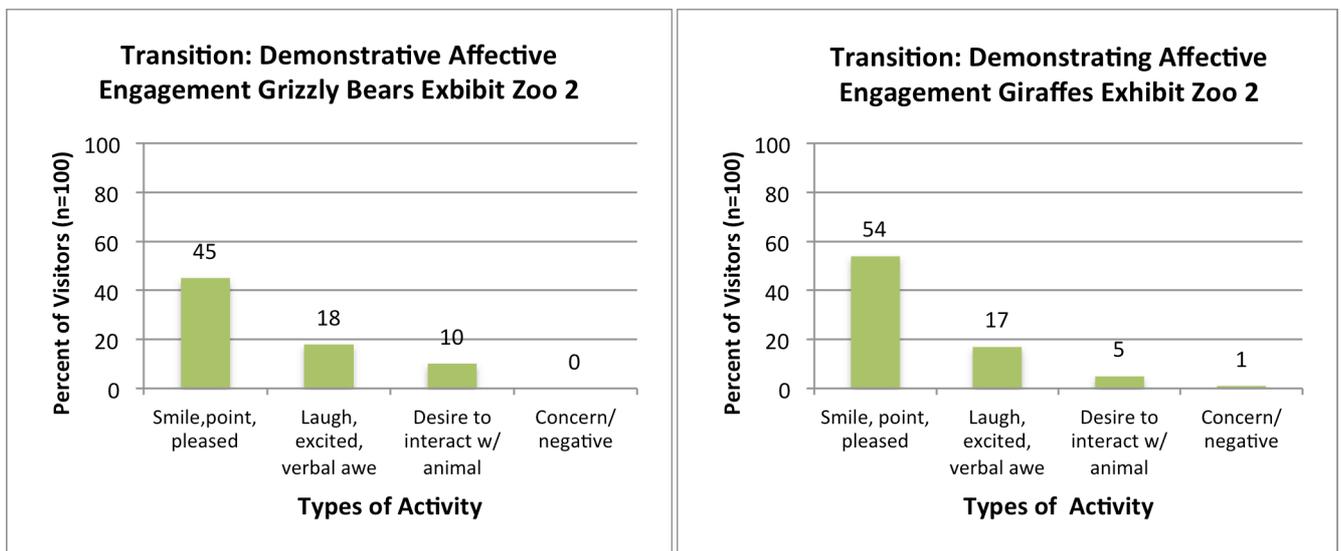
Figure 5E.2 Percentage of visitors engaged in Types of Activity within the *Demonstrating Affective Engagement* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

Appendix 5F
Results for Breakthrough Level Learning Behaviour
Making Links and Types of Activity at Aquarium 2 and Zoo 2
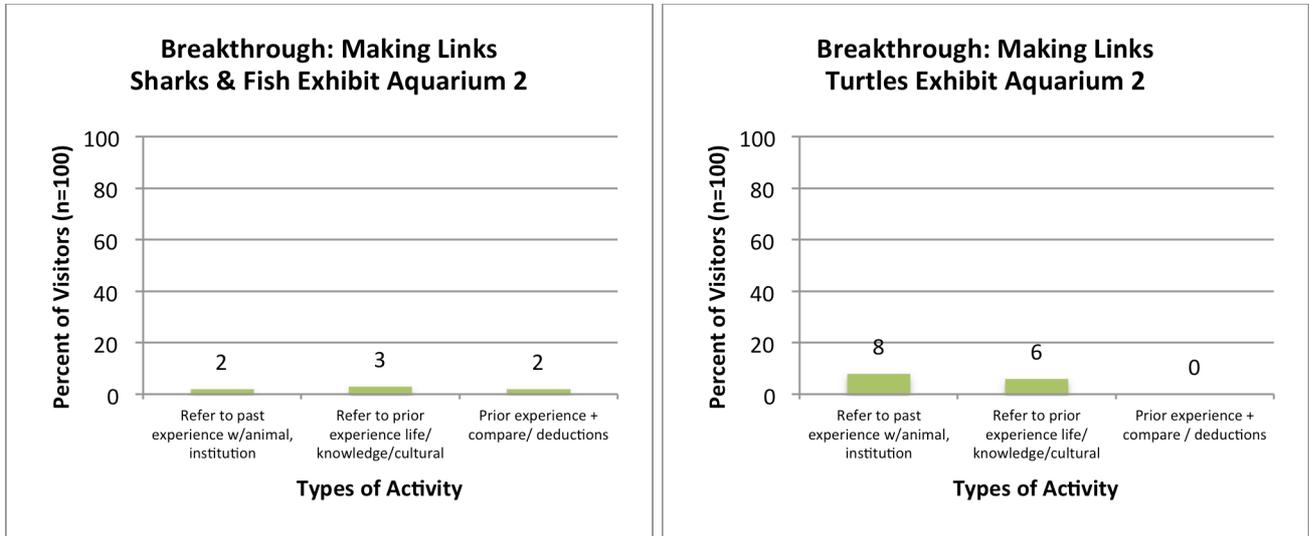

Figure 5F.1 Percentage of visitors engaged in Types of Activity within the *Making Links* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.
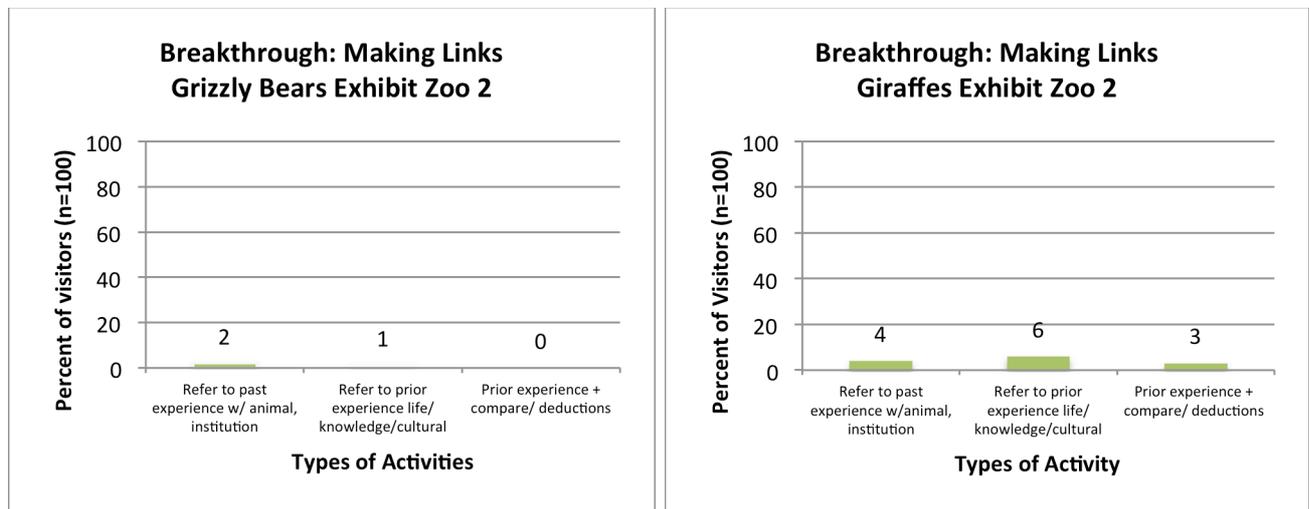
Figure 5F.2 Percentage of visitors engaged in Types of Activity within the *Making Links* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.
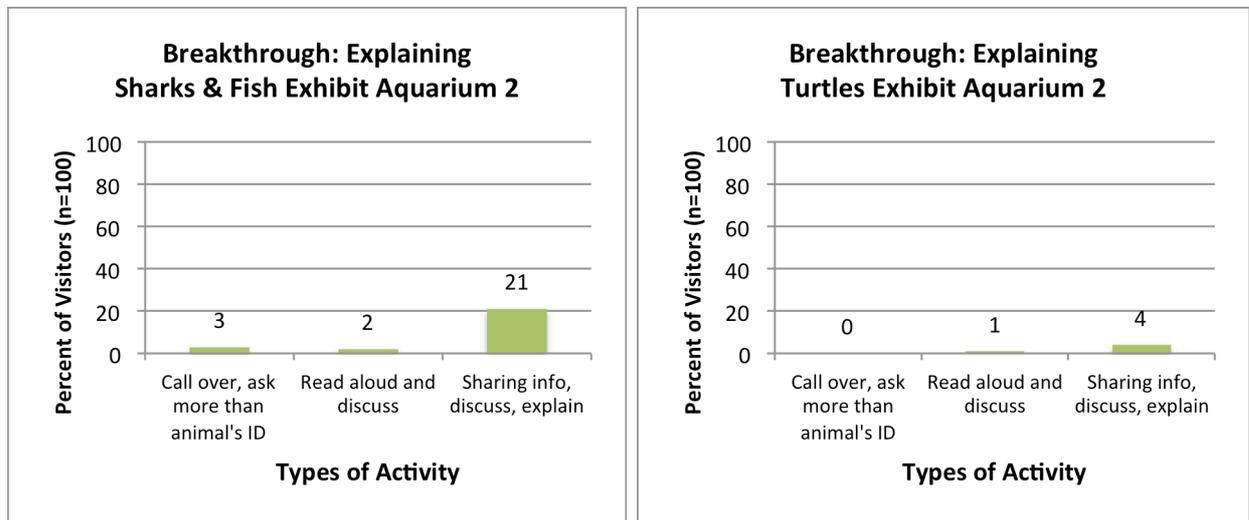
Figure 5G.1 Percentage of visitors engaged in Types of Activity within the *Explaining* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.
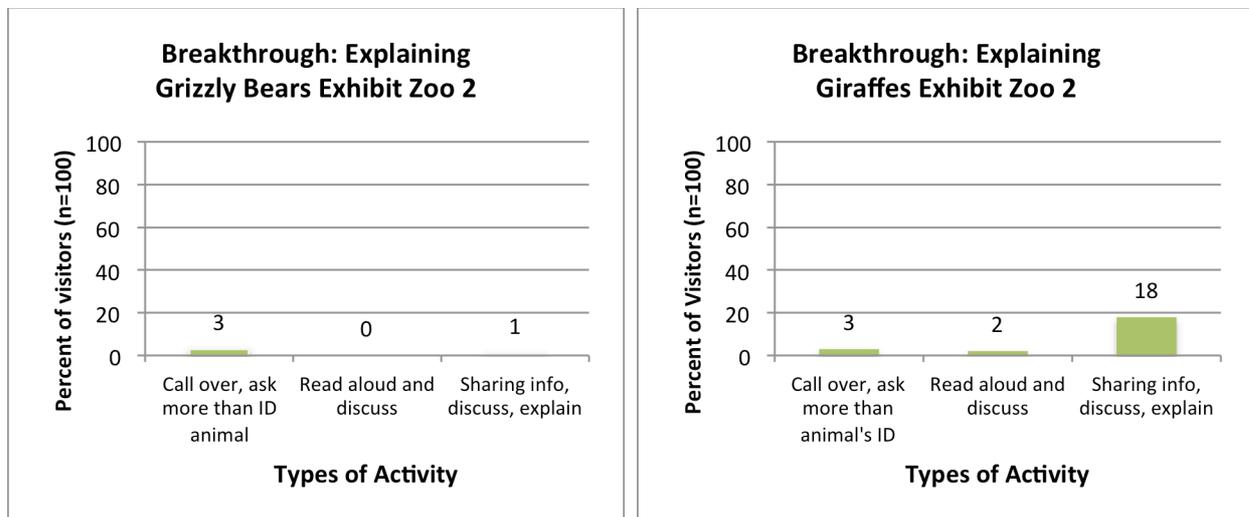

Figure 5G.2 Percentage of visitors engaged in Types of Activity within the *Explaining* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Zoo 2.

Appendix 5H
Results for Breakthrough Level Learning Behaviour *Extending the Experience* and Types of Activity at Aquarium 2 and Zoo 2
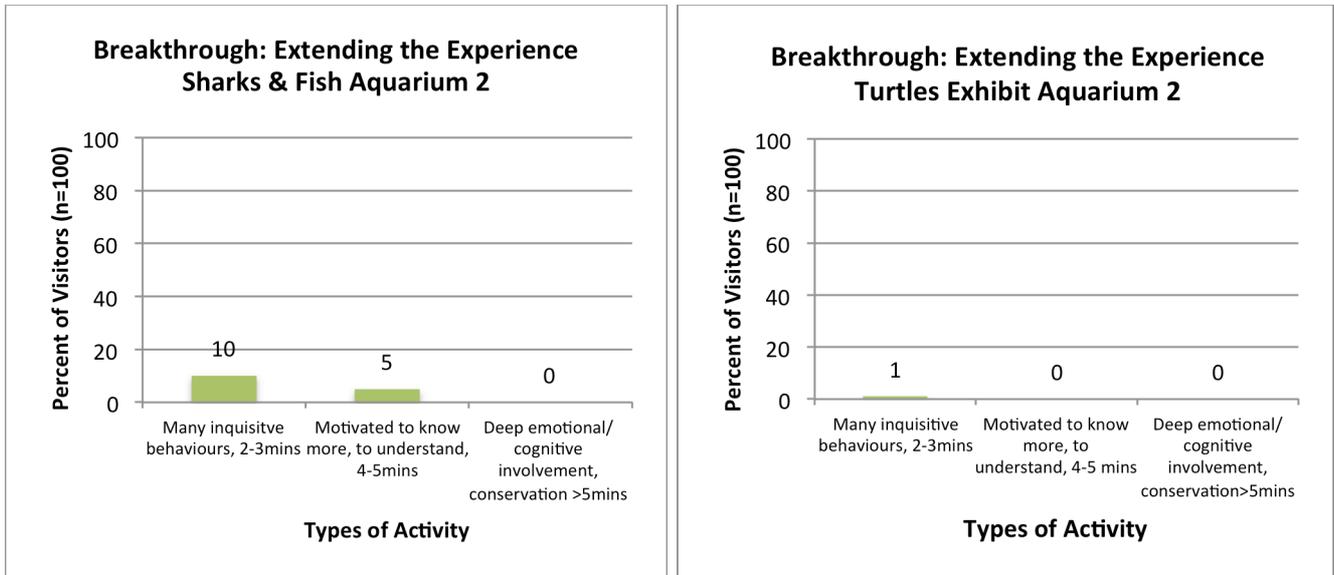

Figure 5H.1 Percentage of visitors engaged in Types of Activity within the *Extending the Experience* Learning Behaviour at the Sharks & Fish and at the Turtles exhibits at Aquarium 2.


Figure 5H.1 Percentage of visitors engaged in Types of Activity within the *Extending the Experience* Learning Behaviour at the Grizzly Bears and at the Giraffes exhibits at Aquarium 2.