ACHIEVING CONSERVATION:
NEW COGNITIVE BASED ZOO DESIGN GUIDELINES

by

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A THESIS

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Abstract

Typical aspects of a zoo's mission are conservation of wildlife and habitats. As part of conservation efforts zoos provide opportunities for visitors to learn about animals and their environments. Ultimately their goal is visitor understanding leading to conservation behavior. While documented zoo design methods such as landscape immersion, cultural resonance and interpretation elements provide opportunities to learn, current literature stops short of explaining how visitors learn. This research intends to bridge this gap through an innovative mixed methods approach under the hypothesis: if designers understand how visitors learn, their design approach will change to integrate learning and cognitive process theories, resulting in exhibit designs which engage visitor's cognitive processes increasing learning, thereby increasing the potential for conservation behavior.

A thorough literature review revealed cognitive psychology and learning theories vital to exhibit design. Cognitive processes are the mental processes visitors use to learn, think and act (Leonard, 2002). To design for visitor's cognitive processes designers need to be concerned with visitor's attention, perception, recall, understanding and memory (Koran, 1983). A personal design exercise testing novel approaches for incorporating cognitive processes into theoretical exhibits yielded potential new guidelines and typologies for exhibit design. To test these personal insights, integrated survey and participatory methods were envisioned to engage zoo design professionals. Professional zoo exhibit designers attended two workshops where they learned about cognitive processes and learning theories, discussed and sketched ideas for learning in zoos, and focused on how to integrate theories in design. The interactive charrette engaged zoo design professional's cognitive processes to uncover new approaches and typologies for zoo exhibit design. Participants completed pre and post-surveys to measure design approach changes. Chan's (Chan, 2001) five components of an individual's design style are used as a framework for the survey questions.

Results from the workshop suggest participants augmented their design approach by increasing the influence of cognitive processes in their design approach and concepts. Participants also showed an increased ability to create goals for learning and an increased ability to form constraints along with improvements in existing mental imagery. Additionally, participants demonstrated increases in their search pattern and order in typical design stages of research, site analysis and design development.

From the workshop analysis of the surveys, discussions, and sketches, new design strategies emerged to guide the design of exhibits in engaging and facilitating visitor's cognitive processes. A triangulation analysis methodology validated the design strategies creating 53 design guidelines for learning by comparing design strategies in the workshop, personal charrette and literature. The design guidelines are compiled into an interactive PDF for other zoo designers and professionals use. To assist the reader in employing the design guidelines most effectively learning principles explain the fundamental learning concepts grounding the guideline. Also, seven example projects illustrate the use of the guidelines. The guidelines, learning principles and example projects are hyperlinked to facilitate learning and application.

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To mom and dad

Preface

Sitting in an Olive Garden restaurant I ignored the unlimited salad and bread sticks and instead designed my first zoo exhibit as a young child after visiting the Kansas City Zoo. Since then I continued to sketch zoo exhibits exploring the savannas of Africa and rainforests of South America. As I grew older, I fulfilled my curiosity by searching the internet for information about zoo design from which I found landscape architecture. At Kansas State University my interest in the profession grew to encompass wide ranging issues from urban agriculture, stormwater management and landscape urbanism. During school I refrained from zoo design however through fortuitous events I received an internship for my fourth year at PGAV an architectural firm specializing in zoo design. On my internship I had the opportunity to work with many great people on zoo exhibit designs from large master planning projects to construction documentation and site design. From this experience, I rekindled my interest in zoo design. I began again to envision possible zoo exhibits and scenarios. Upon returning from the internship, I decided to capitalize on the opportunity of my fifth year by choosing to investigate zoo exhibit design.

In my prior research on zoo design, before starting this thesis, I had read Jon Coe's writing and was particularly intrigued by his idea of the Unzoo. It presented a radically different zoo experience for both the visitor and animal. I was also inspired by David Hancocks's book *A Different Nature: the paradoxical world of zoos and their uncertain future*. In his book, he describes many zoo exhibits which I found interesting in that the exhibits redefined my concept of a zoo, illuminating new potentials. Exhibits such as the Arizona-Sonora

Desert Museum and the Audubon Zoo illustrate the potential of native wildlife and their habitats. The Wildscreen and Noorder Dierenpark demonstrate the latent opportunities of zoos to function as more than a zoo but also a museum and science center, becoming a hybrid institution communicating ecological concepts through the multiple mediums of the different institutions. In reflection, I can now see my fascination with the exhibits through the connecting theme – engagement of cognitive processes. However, at the time I thought the connection was the future design of zoo exhibits.

In addition to Coe's and Hancocks's general writings about zoos, I investigated literature specifically describing zoo exhibit design techniques, guidelines and processes. I was continually frustrated with the limited number of resources I found about designing zoo exhibits. There were only a few sources such as Polakowski's book *Zoo Design: The Reality of Wild Illusions* and *The Long Range Physical Development Plan for the Woodland Park Zoo* which illustrated design strategies with diagrams, drawings and project examples. This frustration motivated and guided the end goal of this project, in that, the thesis needed to be useful for designers by specifically informing design decisions.

With Coe's and Hancocks's inspiration and a desire to influence design in mind, I set out to understand the future zoo. I began learning as much as a could about exhibit design from conservation, sustainability, entertainment, design techniques and education. While researching I began to feel tension between the information, discovering my own zoo paradox. In deep cogitation on my core values and interest I began to resolve some of the tension as a designer by improving visitor learning.

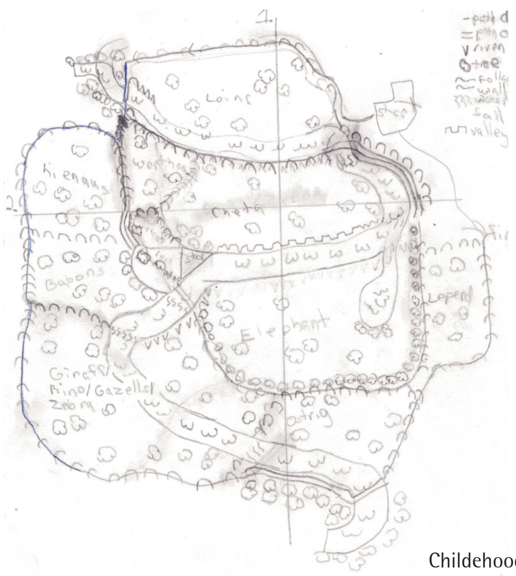


Figure 0.1
Childhood design concept

> “Many experts believe that the long-term success and sustainability of conservation efforts depends on how well we understand those we wish to engage”
>
> (Bell et al. 2009)

Background

Figure 1.0
Visitor engaging an exhibit

Zoo Design Theory

Annually one ninth of the global population visits zoos which is over 600 million people (WAZA 2005). Zoos have a unique position with such a large audience to provide visitors opportunities to learn about conservation and leveraging zoo's in-situ and ex-situ conservation programs. Zoos started education programs because they simply do not have the facilities, or capacity for conservation of the increasing number of threatened animals, and zoos are not sustainable long-term solutions in maintaining animal populations for the entire world's biodiversity (Soulé et al. 1986). It is through the cumulative effect of individual's small actions, in addition to large actions from institutions and governments, that together can begin to solve the environmental problems facing biodiversity (Ehrlich and Pringle 2008).

Visitors come to zoos in part to learn (Reading and Miller 2007; Clayton 2009) as cited in one study's findings where 87% of visitors indicating learning as a reason for visiting which ranked higher than fun (Gwynne 2007). Recently, a multi-institution extensive research study found zoos are contributing to visitor's attitudes and understanding about environmental and conservation issues (Falk and others 2007). Visitor's learning in zoos is generally attributed to personal encounters with animals, and the signs and interactive interpretive elements communicating conservation messages. However, zoo exhibits are not fully capturing their potential as learning environments because zoo exhibit designers are not designing specifically for visitor's learning processes. Typically during the design process of zoo exhibits multiple disciplines are involved. Zoo exhibit designers organize the program and develop the themes and design concepts for the exhibit while an interpretation designer or education staff at the zoo designs the educational elements such as signs, interactive kiosks, and visitor activities. This dichotomy of roles causes the exhibit to be simply a vessel into which educational elements are placed failing to capitalize on the potential of exhibits as designed learning environments. If the exhibit could complement the educational elements by facilitating and stimulating visitor's cognitive processes visitors would have more learning opportunities.

While recent trends show increased collaboration in zoo design (Oregon Coast Aquarium 2010), the problem will persist because zoo exhibit designers lack knowledge and understanding of human learning processes largely because they do not have a background in learning. One reason designers don't have an understanding of learning is a gap in the zoo exhibit design literature explaining how to design for cognitive processes. If zoo exhibit designers understand cognitive processes - how humans think, learn and act - then they could design for these processes. Once zoo exhibit designers understand these processes then they can augment their design approach to integrate learning theories resulting in exhibits designed for learning processes. The thesis then is, if designers understand how visitors learn, their design approach would change to integrate learning and cognitive process theories resulting in whole exhibit designs which engage cognitive processes increasing learning thereby increasing the potential for conservation behavior.

What is learning?

Learning in its most basic definition is a transformation of information into knowledge (Gagne 1985; Kolb 1984). More specifically, learning is the product of learning processes called cognitive processes. If one takes a general description of cognitive process as the "mental processes that individuals undergo as they think, learn, and perform problem-solving and decision-making activities" (Leonard 2002, 28) then designers can think of the zoo experience as a series of cognitive processes. The processes could be as simple as deciding which exhibit to visit or determining which sign to read. Or, the processes could be more complex such as knowing where giraffes live and understanding how their behavior effects their conservation in Africa. By focusing on cognitive processes, the zoo exhibit designer is concerned with how the visitor perceives, thinks and acts in exhibits (Koran Jr., Koran, and Foster 1989). For designers this means that they are not only concerned with the physical environment but also how the visitor thinks during the exhibit.

In exhibits, learning is the interaction of many different cognitive processes which influence how zoo exhibit designers make design decisions during the design process. For example, where visitors direct their attention and how they engage the exhibit is affected by the physical characteristics of exhibit elements. Also, the context surrounding the animals, educational elements and visitors themselves influence the cognitive processes visitors use to perceive and understand the information and situations they encounter by stimulating cognitive processes to recall prior knowledge. Humans use prior knowledge in learning by comparing new information to existing knowledge called contextualization. The process results in visitors building new knowledge with existing knowledge. These are two examples demonstrating how the design of exhibits influence the cognitive processes visitors engage in zoo exhibits. The examples illustrate how the process of learning is more than gaining knowledge but a result of cognitive processes.

Confusing learning and cognitive processes could result in a conceptual fault, especially for a zoo exhibit designer, who typically does not have a background in education. In literature, learning is often described as the result of an educational program because the educational researcher is concerned with the outcome of the program. Many of these studies focus on the end result instead of the process visitors took to come to new understanding. This is typically due to the research objective of determining the effectiveness of the educational programs causing changes in the visitor's knowledge or behavior. Also, the methods to measure learning processes occurring are difficult to employ in studies. If exhibit designers learned what they know about learning from these studies it could lead them to focus on the end results, not on the visitor's learning processes. This approach toward learning could result in exhibit designers designing exhibits for educational elements without considering how the placement and context engages, stimulates and facilitates visitor's cognitive processes.

How exhibits currently facilitate cognitive processes

Exhibit designers currently design exhibits to engage cognitive processes primarily by illustrating concepts visually. For example, exhibits can demonstrate predator prey relationships by removing the visual barriers between the animals. Also, exhibits can be organized following geographic, climatic, and taxonomic concepts such as ecological continuums, altitudinal gradients, and latitudinal gradients physically illustrating concepts for visitors to learn about ecological concepts (Polakowski 1987).

The current zoo exhibit design style, landscape immersion, primarily engages visitor's perceptual cognitive processes through the design of the context surrounding the animals which influences how visitors perceive animals. In modern zoo exhibits, animals live in a natural landscape instead of barred cages surrounded by concrete. When visitors see animals in a natural environment compared to a sterile concrete environment they perceive the animals to be wild and part of a larger system. The natural context also assists visitors in making associations between the animal and its natural habitat (Coe 1985). Similarly, cultural elements in exhibits help visitors conceptually link the animal to the native people living with the animal in the wild, called cultural resonance (Coe and Dykstra 2010). In addition to context, the spatial relationships between animals and visitors in exhibits affect visitor's perceptual cognitive processes. By positioning animals at or above visitor's eyelevel, they perceive the animal as an equal, whereas if the visitor is elevated they may perceive the animal as inferior (Coe 1985).

Modifying viewing angles are another way spatial relationships can engage perceptual cognitive processes. By eliminating cross exhibit views of other visitors, the animals appear to be in a more natural environment because elements not accurate to the native landscape are removed. Similarly, by concealing animal barriers from visitor's view they perceive the animal to be in a natural environment. The same strategy also generates a response in which visitors feel they are in the same space as the animal when views and the exhibit sequence are carefully constructed. Visitors may then perceive the animals as wild, instead of tame pets which is counter to zoo's conservation messages of animals being wild and autonomous creatures (Coe 1985).

The previous advancements of landscape immersion using natural landscapes, spatial relationships and viewing angles, made thirty years ago, were founded in psychology research. Since then, the design principles have changed little and new design strategies such as rotational exhibits, night safaris, the unzoo and sustainability (Coe and Dykstra 2010) have not targeted visitor's cognitive processes. However, the fields of cognitive psychology and education have made significant gains in understanding how people think during the last three decades. Some of the advancements have been mentioned in the zoo exhibit design literature such as Gardner's Multiple Intelligences (Coe and Dykstra 2010) but other theories remain absent.

Advances in learning theory

Around the time Coe was publishing his seminal work on landscape immersion in the 1980's. Koran was exploring the use of information-processing models in informal learning environments (Koran Jr. and Koran 1983); however, zoo exhibit designers have not described his ideas or applied them in the zoo exhibit design literature. Some themes in the theory were researched such as Bitgood's study on visitor attention (Bitgood 2010). Also at this time, Kolb was building on Lewin, Dewey and Piaget learning theories to develop his Experiential Learning theory describing how people learn from experiences (Kolb 1984). More recently, informal learning researchers have explored the factors influencing visitor learning and visitor's needs. Falk identified the factors influencing learning which lead to the identification of visitor Identities (Falk 2000).

New learning theories begin to explain the cognitive processes visitors engage during learning. For example, Gagne's Information-processing model, similar to Koran's theory, could provide insights into how to organize exhibits and the design of visitor activities. The instructional events describe the cognitive processes to facilitate and engage while the learner is processing environmental stimuli, using their prior knowledge and applying their knowledge during an activity (Gagne 1985).

Another theory, Kolb's Experiential Learning model, describes the cognitive processes a learner uses to understand concrete experiences and abstract concepts through interaction with the environment and internal reflection (Kolb 1984). Kolb's Experiential Learning model could be critical in understanding how to design interactive experiences to increase visitor's understanding of abstract scientific concepts.

Other theories specifically describe the zoo experience such as Falk's Contextual Model of learning which explains how personal, physical and sociocultural factors influence learning (Falk 2000). Building on the model, Falk identified the different needs of visitors when visiting informal learning environments (Falk 2009). The Visitor Identity theory provides insights into what motivates visitors and how to design exhibits to fulfill visitor's needs during learning.

Still other theories describe cognitive processes which could guide the design of visitor activities and the content in the activities. For example, Gardner's Multiple Intelligences describe different learning styles explaining how people prefer solving problems, the type of information people want to engage and the types of activities people desire (Gardner 1985). Another theory guiding the design of visitor activities is Bloom's Taxonomy. The theory describes different levels of cognitive processes, providing insights into designing activities to encourage deeper meaning and understanding (Bloom et al. 1984).

Knowledge to action

All of these theories show promising application in zoo exhibit design but their adaption and translation into the zoo context must be through a contemporary lens of learning in zoos. The current philosophy of learning is changing from 'knowing' to 'doing' and from 'awareness' to 'action' (Ogden and Heimlich 2009). Heimlich illustrates this philosophical shift in the context of evaluation of environmental education programs by posing the question, "is environmental education a means to an end (desired behaviors from thoughtful decisions), or is it an end unto itself (people who know how to think)?" (Heimlich 2010). Visitors need to be critical thinkers to understand the problems and how to solve them. This new philosophy expands the realm of cognitive processes occurring in exhibits to the full definition of cognitive processes – learning, thinking and doing. For visitors to be critical thinkers more complex cognitive processes need to be engaged (Bloom et al. 1984).

In addition to engaging more complex cognitive processes, the philosophical shift also adds cognitive processes to the content visitors can learn in exhibits. Visitors need to learn cognitive processes which they can employ outside the zoo which allows them to make informed decisions about conservation behavior. Learning leading to conservation "is ultimately about decision-making, critical thinking, and citizenship, including acting as an environmentally literate citizen which includes adopting actions that reduce environmental stressors affecting some conservation target." (Heimlich 2010). If exhibits are to facilitate visitor's cognitive processes, exhibits need to give them agency in achieving the goals of zoos by teaching them critical thinking skills needed to change their behavior, in addition to facilitating transformation of critical information into knowledge.

In the past, the approach to change visitor's behavior is to give them information assuming they will change their behavior. This philosophy is increasingly considered a myth (Ogden and Heimlich 2009) because behavior is complex. Behavior results from the interaction between many factors from affective, cognitive, values, skills and feedback mechanisms (Ardoin 2009). The process of making a decision about behavior is a cognitive activity. For example, the Theory of Planned Behavior describes humans as rational thinkers who cognitively weigh factors (Ajzen 1991). Since behavior change is a cognitive activity exhibits can provide opportunities for visitors to learn and practice the skills need to make behavioral decisions.

Not only do exhibits need to engage visitors in skills based information targeted at behavioral change, but also address the cognitive inputs of perception, social norms, attitudes, values and skills (Heimlich 2010). In a study of visitor's intent to change their behavior after visiting a zoo exhibit, Dierking found visitors are committed to changing their behavior. However, the information in many zoo exhibits is targeted at convincing people there is a problem rather than giving visitors the knowledge and tools to help them become more environmentally active and responsible citizens (Dierking, Adelman, and Ogden 2004). Therefore, visitors are ready to change to change their behavior but are lacking information and skills. Exhibits can then provide information which addresses visitor's cognitive skills in changing their behavior with not only facts and conceptual understanding but also physical skills and cognitive skills of critical thinking to address all the cognitive inputs of behavior.

Rethinking the role of zoo exhibits

Engaging visitor's cognitive processes is a starting point to achieve behavior change by improving the effectiveness of exhibits to facilitate visitor's learning processes. This is possible by redefining learning as a series of cognitive processes of thinking, learning and acting resulting in an expansion of the possible cognitive processes zoo exhibits intentionally engage. These learning processes add to the perceptual processes currently stimulated by landscape immersion techniques. To design for a new suite of cognitive processes, cognitive psychology and educational theory literature provides guidance in intentionally designing for new cognitive processes. However, the current design process presents challenges to designing for visitor's cognitive processes.

Zoo exhibit design process

The current zoo exhibit design process, as documented in literature, contains minimal discussion of visitor's cognitive processes and how exhibits can engage visitor's learning processes. In the literature designer's approach toward learning views the exhibit as a vessel for educational elements. This approach could be the result of a disconnect between zoo exhibit designers and educators, compounded by designers potential lack of knowledge about learning processes and the intuitive nature of design. If exhibits are to be designed to engage and facilitate cognitive processes then the design process needs to consider learning processes of how people learn.

The current process designers use to design a landscape immersion exhibit may follow the following processes as described by Coe (Coe 1996). All designers may not employ this process, since designers have different approaches to designing exhibits; however, this approach is the only design process documented in zoo exhibit design literature.

First, the goals and objectives are described which best communicate the conservation and education message, this step is important in any design process regardless of the design style. Then the exhibit designer and zoo staff establish the cognitive and affective objectives. Next, the exhibit designer identifies the theme or scenario for the exhibit, followed by the selection of the exhibit design style. In this discussion landscape immersion is the selected design style, but other design styles could include: the naturalistic style where animals are displayed in natural habitats but visitors are not surrounded by the same landscape, or the modernist style where animals are not displayed in surroundings mimicking natural environments (Coe 1996).

The first step in landscape immersion is to develop the context of the exhibit. The exhibit context consists of the natural elements from the geology to the vegetation, along with the cultural context created by the humans living in the native landscape. Next, the designer immerses the visitor in the landscape by concealing or disguising all the features which do not fit into the scenario. Then the designer presents the animals as respectfully as possible by influencing visitor's perceptual cognitive processes through the control of spatial relationships and viewing angles.

Lastly, animals and plants are added which accurately represent the replicated landscape (Coe 1996).

The process embeds meaning in the exhibit such as the relationships between the animals, plants and geology. However, this meaning is hidden unless the viewer can read the landscape. To assist visitors in reading the landscape, interpretive elements communicate the messages and the exhibit form conveys the implied messages to reveal the explicit meaning (Coe and Dykstra 2010; Polakowski 1987; Coe 1996). In this way, the exhibit becomes the vessel into which interpretive designers place the educational elements.

In creating the vessel, zoo exhibit designer's perspective of exhibit's role in learning is to create the context for the educational messages and elements which are designed by interpretive designers and zoo education staff. In addition to framing educational messages, the context also aims to motivate visitors to learn by inspiring them to care about animals leading to a desire to learn more about the animals. To do this, designers create a beautiful landscape and story along with opportunities for intimate animal encounters that "spark human curiosity which can then be directed into positive action on behalf of animals in real life situations (Polakowski 1987)." Inspiring visitors is but one emotion zoo exhibit designers can intentionally evoke in exhibits before appealing to their intellect. Polakowski describes design techniques for stimulating different emotional responses in exhibits to augment visitor learning (Polakowski 1987). In the literature, attention is given to designing exhibits for visitor's emotions but little is given to designing for cognitive processes. This is not to say designers do not care about learning, for zoo exhibit designers visitor learning in zoos is a high priority (Polakowski 1987; Coe 1996), but how exhibits are designed for cognitive aspects of learning in exhibits is missing from their design approach.

Disconnect between disciplines

One reason for zoo exhibit designers not addressing the missing gap of cognitive processes is a disconnect between the design of the educational elements and the design of zoo exhibits. During the design of zoo exhibits multiple disciplines are involved. Typically, the zoo exhibit designer organizes the program and assists in the development of themes and concepts for the exhibit. Then an interpretation designer or education staff at the zoo designs the education elements such as signs, interactive kiosks and visitor activities. This disconnect was found in a study of German zoos where only 30% of educators help make decisions during the planning process. Others have also identified this disconnect between zoo exhibit designers and educators (Coe 1996; Hancocks 2001; Coe and Beattie 1998). This disconnect could result in zoo exhibit designers relying on educators to design for learning resulting in exhibit designers overlooking how the exhibit affects visitor learning. With this approach, the exhibit could result in an exhibit form not optimal for the educational elements because the zoo exhibit designer may not understand how the exhibit design can respond to, engage and facilitate visitor's learning processes.

Even though recent literature suggests zoo educators have become more integrated into the design process

(Oregon Coast Aquarium 2010), the exhibits still may not be designed for visitor's cognitive processes since designers typically do not have a background in education or cognitive psychology. Designers may lack knowledge about cognitive process theories, similar to literature, leading to exhibits which miss the opportunity to be designed specifically for learning.

Designers intuition

If designers are missing knowledge about how people learn, they could be relying on their intuition as designers often do, rather than facts about how people learn. Designers in general use their intuition and experience to make design decisions. Coe supports this sentiment explaining "exhibit designers generally rely on their own inspiration, intuition, and unsophisticated evaluations to learn from their work and that of their colleagues. Reliable, valid, and integrated evaluations simply have not been available" (Coe and Dykstra 2010). Without evaluations of exhibit designs, designers may not have evidence to inform their design decisions.

If designers are using their intuition, which is based on their prior learning experiences, to guide design decisions then their intuition may be limiting the types of cognitive processes designed for in exhibits. Since learning is unique to the individual, the learning processes designers use are different from other's learning processes (Kolb 1984; Gardner 1985). Especially, since people pursue careers best suited to their cognitive style (Kolb 1984) possibly resulting in exhibits designed for design professional's cognitive processes. Designers could not be designing the best environment for other types of learners and visitors in exhibits because they do not have the personal experiences of other learning styles to inform their intuition.

In summary, designers may not have the theoretical foundation to understand learning without zoo exhibit design literature, a formal background in human learning or a comprehensive intuition. If designers do not understand the learning theory they may not be able to adequately designing exhibits which respond to human learning processes. Falk identified one example of designers not understanding theory which led to insufficient designs in his research on visitor Identities. He found that designers typically design exhibits without enough challenge for visitors with the Explorer Identity, even though designers are most like Explorers (Falk et al. 2007). If designers do not understanding the theoretical foundations of learning exhibits, how do designers know what cognitive processes to design for in exhibits?

History of zoo design for learning

Zoos began as demonstrations of the status and power of kings and wealthy individuals, representing man's ability to control nature (Routman, Ogden, and Winsten 2010; Coe 1996; Hancocks 2001). These facilities were primarily cages built to contain captive animals as curiosities; but, some of these institutions had an educational purpose. Nearly 3000 years ago, the Chou dynasty in China created a zoo called the Garden of Intelligence to store knowledge of the natural world. Other societies in India and Central America created the most extensive zoos in the world for study and to impart love and respect for animals. Outside of these grand zoos for sharing knowledge with all citizens, other menageries were used primarily by scholars, artists and scientists for study such as Leonardo di Vinci and Carl Linnaeus (Hancocks 2001).

With scientific enlightenment animal collections in Europe began to take the shape of zoos. The zoos began to reflect advancements in science in their organization resulting in the taxonomic design style. The style displayed animals of the same species next to each other for careful observation and comparison. Exhibits were designed for research and study; however, the average visitor probably had minimal learning (Hancocks 2001). Eventually, the design of zoos began to reflect informal parks used for recreation and respite from the living conditions caused by the Industrial Revolution.

In 1907, Hagenbeck revolutionized zoo exhibit design when he created the naturalistic style of zoo design. In his exhibits, animals are displayed in natural landscapes with carefully constructed sightlines, and dramatic scenes sometimes showing predator prey relationships. Many of the design strategies formed the foundations of the modern landscape immersion style. However, one distinction between landscape immersion exhibits is that Hagenbeck's landscapes were often romantic visions of the animals and their habitats and did not necessarily mimic the natural habitat of the animal. Secondly, the visitor is not in the same landscape of the animal as in landscape immersion; instead, they remained in the park-like landscape (Coe 1996). The purpose of the exhibits was not specifically education but the intent was to create an experience in which visitors gain an appreciation for animals (Routman, Ogden, and Winsten 2010).

Unfortunately, many of Hagenbeck's innovations were lost in the modernist movement which focused on functionality. Exhibit designers focused on creating sterile environments made of concrete, steel and tile intended to keep animals healthy. The exhibits became impressionistic concrete landscapes where animals were viewed within pieces of art. (Coe 1996; Hancocks 2001). During this period, zoos began to develop formal education programs but only reached a relatively small audience (Routman, Ogden, and Winsten 2010).

The influence of the environmental movement of the 1970's was a pivotal time in the zoo community. Zoos began to focus on conservation programs by breeding endangered species. By the 1980's it was apparent that conservation programs would not be enough to save all animals, so zoos began to focus on visitor learning of environmental and conservation issues (Routman, Ogden, and Winsten 2010). Also, during this time exhibit designers revived and advanced Hagenbeck's design ideas by surrounding visitors in an accurate landscape replicating the animal's habitat with the development of the landscape immersion style (Coe 1996). The innovations were intended to improve animal well-being and visitor learning.

As zoo educators began to focus on visitor learning in the 1990's, they looked to formal educators and psychologists to improve their teaching methods. They focused on increasing visitor's factual knowledge by focusing on the cognitive aspects of learning. Evaluation of the programs and interpretive elements found visitors learned from the exhibits but they did not change their behavior. Educators then began to focus on the affective domain, inspiring visitor's to care. Research found that attitudes are only marginally effective in modify visitors behavior. Most recently, educators have begun to look at behavior change theories for guidance in sharing educational messages (Routman, Ogden, and Winsten 2010). However, these advancements in designing for learning remain outside of the zoo exhibit design literature.

Throughout the modern history of zoos, designers have changed how they design exhibits in response to changing societal and environmental issues. Today, environmental factors threatening biodiversity pose an increased need for zoo exhibits to provide learning experiences resulting in behavior changes. As part of behavior change and learning, exhibits can design for learning by engaging visitor's cognitive processes. By redefining learning as a series of cognitive processes, which is how humans think, learn and act, zoo exhibit's role shifts from a static vessel containing educational elements to a dynamic vessel guiding visitor's cognitive processes during learning. However, for exhibits to be designed to engage and facilitate cognitive processes zoo exhibit designers lack an understanding of learning processes to provide a theoretical grounding for their design intuition. To understand how learning occurs, designers can look to cognitive psychology and educational theories for guidance.

Learning Theory

After reviewing learning theories I selected the following theories based on their applicability to inform zoo exhibit design. Falk's Contextual Model of Learning describes the personal, sociocultural and physical factors influencing learning during zoo visits. Also, Falk's Visitor Identities describe the different needs and motivations of visitors. Gardner's Multiple Intelligences also describe other individual preferences for learning processes. Bloom's Taxonomy describes different types of cognitive processes to achieve deeper meaning and understanding. Kolb's Experiential Learning and Gagne's information-processing model describe the processes of learning from how humans process their interactions with the environment and make-meaning from those interactions.

Contextual Model of Learning

In researching free-choice learning environments such as zoos and museums, Falk identified factors which influence our learning, and summarized them in the Contextual Model of Learning (Figure 1.1). He described three suites of factors: the personal, sociocultural and physical (Falk 2000; Falk 2006). The theory illustrates many factors generally associated with learning and specific considerations for free-choice learning environments.

The personal context includes prior knowledge and experience; motivation and interests; and choice and control. Prior knowledge provides a frame of reference for making meaning and how we approach and solve problems during the learning process. Our prior knowledge shapes our interests in turn influencing what we want to encounter during exhibits. We actively seek out what is familiar and cognitively comfortable because we desire information we can relate our experiences to. Since everyone's existing knowledge is different and unique, prior knowledge creates a challenge for designing exhibits for a great diversity of visitors. Also, during exhibits we want choice in what we attend to and want to control how we engage and make-meaning. When we are given the tools to use our choice productively to learn our learning increases (Falk 2000; Falk 2006).

The social-cultural context includes within-group mediation and mediation by others. Learning is a social activity and zoos are places of socialization. Interacting with other group members plays a key role in helping each other learn, especially between parents and children. Parents help their children interpret and make-meaning from the shared experience. As parents facilitate their children's learning, their knowledge is reinforced and supported as they interpret the experience to their

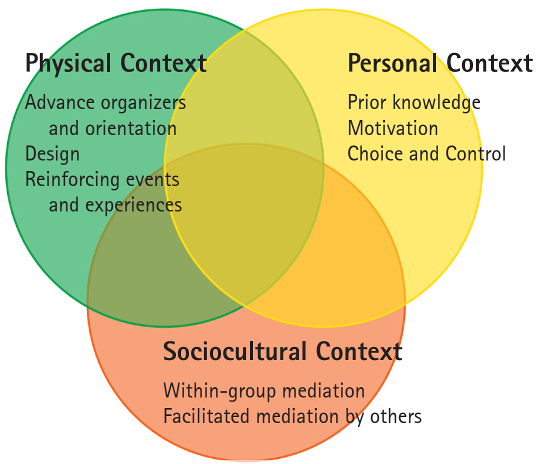


Figure 1.1
Contextual Model of Learning

children. Also, visitors interact with people outside their immediate group such as zoo staff and other visitors during learning (Falk 2000; Falk 2006).

The physical context includes advance organizers and orientation; design; and reinforcing events and experiences outside the zoo. When we know what to do during exhibits, our learning improves because we know how to engage which increases our comfort and reduces distractions. Distractions can occur when we are over stimulated causing disorientation which distracts us from learning. Exhibits can reduce distractions by providing us with conceptual and physical orientation and by explaining how to physically navigate space and how information conceptualal relates. Physical orientation increases our comfort when we know how to navigate spaces leading to increases in learning because we are not distracted with the task of navigating space. Conceptual orientation increases our understanding when we understand how information conceptually relates to each other (Falk 2000; Falk 2006).

As previously described by Coe, the exhibit design affects how we perceive animals. The spatial relationships and context in which the animals are viewed and encountered influences how we contextualize the animals (Coe 1985). Similarly, landscape, themeing and general context have emotional qualities which evoke emotions to augment cognitive aspects of the exhibits (Polakowski 1987; Coe 1985). The design of the exhibit elements, visitor circulation and views influence where we direct our attention and how we engage exhibits (Bitgood 2010). Also, the design of interpretation such as signs and interactive elements also influences learning through the design of the text, location of the elements and content (Bitgood 2002) among other many other factors.

The physical environment also extends outside the zoo since learning is a cumulative process occurring over time. Learning during zoos is not complete until the experiences are recalled outside the zoo for contextualization of information with new experiences. We encounter information related to our zoo experiences everyday through other institutions such as museums, school and media (Coe 1985; Falk 2000).

Visitor Identities

The Contextual Model of Learning is descriptive of visitor behavior but not predictive. Falk used the Contextual Model of Learning as a foundation for a new theory called Visitor Identities which predicts how visitors will behave during visits. Identities describe how we perceive the affordances the zoo provides resulting in our expected needs for the visit (Falk 2009). The theory describes the needs and motivations we come to the zoo expecting to fulfill during the visit. These motivations for visiting are multifaceted "being a complex sociological and psychological construct assembled from a myriad of sources, including a visitor's prior knowledge of and experience with the setting, perceived social relationships and expectations, the social and cultural meaning s/he attributes to the institution, and personal interests (Falk 2006)." From these factors we construct an Identity which is how we view ourselves and how we perceive others to view us (Falk 2009; Wagoner and Jensen 2010).

During visits we act in such a way to satisfy the needs of our Identities. As we move through exhibits we are seeking out opportunities to enact our Identity and behave accordingly. Our behavior acts as a feedback loop for our Identity by confirming our actions are satisfying the needs and goals of our Identity. The theory begins to predict how one will act during the visit based on our Identity. (Falk 2009; Wagoner and Jensen 2010).

Identities also explain how we make-meaning during exhibits and why zoo experiences are memorable. Identity is the filter through which we understand the zoo visit because Identity is a combination of prior knowledge, motivations, needs, and social relationships. We filter the experience through our Identity to determine what we attend to and how we engage, what prior knowledge and experiences to recall as we contextualize and make-meaning to determine what information is important and how it fits into our prior knowledge, experiences and interests (Falk 2009).

Falk's theory identifies five Identities explained in detail below: the Explorer, Facilitator, Professional, Experience Seeker and Recharger. For each visit, we enact one or a combination of Identities depending on the visiting scenario which is influenced by both who we are with and why we are visiting. Additionally, the Identity we enact changes with each visit as the factors influencing Identify change (Falk 2009).

Explorer

Visitors who come to fulfill their curiosity are Explorers. They are interested in general discovery of information; not a specific topic. Explorers focus on fulfilling their needs and are not concerned whether other group members enjoyed the visit (Falk 2006). They visit frequently therefore they have an understanding of how zoos are organized and what activities zoos have to offer (Falk 2009). Explorers have a general interest in learning, but not necessarily on a specific topic. In learning they rely on their prior knowledge to determine how they attend, frame and make meaning (Falk 2009).

Figure 1.2
Explorer Identity

Explorers rely heavily on their prior knowledge and experience to determine what is interesting and worth their time and effort in the exhibit (Falk 2009). Explorers push their intellectual boundaries and desire greater challenges than typically exists in exhibits (Falk et al. 2007). Even though learning is a high priority for Explores, studies indicate they show no significant changes in cognition or affective development (Falk et al. 2007).

Explorers need new and surprising opportunities such as temporary exhibits or in-depth programs (Falk et al. 2007). They want choice and flexibility to customize the visit to their interests and don't appreciate prescribed ways to experience the exhibit. Instead, they want to browse for interesting information and opportunities to exercise their minds through discovery. To increase their browsing ability, they need visual and intellectual clarity to determine if something is interesting and worth their time and effort (Falk 2009). This Identity is often common in designers, however research suggests designs may not be successful at fulfilling the needs of Explorers (Falk et al. 2007).

Figure 1.3
Facilitator Identity

Facilitator

Visitors who come to fulfill the needs of someone they care about are Facilitators. There are two types of Facilitators. Facilitating Parents who focus on satisfying the needs of their children by translating and interpreting the shared zoo experience. The experience is centered around their child's fun and learning, not themselves. The other type is Facilitating Socializers, who focus on fulfilling a friend or companion's needs and may not be interested in the content of the zoo. In facilitating the experience they take the Identity of their companion (Falk 2009).

Facilitators do not see the zoo as primarily a place for personal development and growth. Instead, they are seeking a fun experience for their companion where learning is part of the entertaining experience. When designing, it is the parent's prior knowledge, experience and interests to design for, not the child's knowledge because the parent is facilitating the experience (Falk 2009).

Facilitators need opportunities to socialize and the tools to help their companions learning (Falk et al. 2007). They need intergenerational interactions to share and engage each other in the same experience and to guide their children in learning, Facilitators need spatial orientation to easily navigate and intellectual orientation to interpret and help their children understand the situation (Falk 2009).

Figure 1.4
Experience Seeker Identity

Experience Seeker

Visitors who come to 'collect' an 'experience' are Experience Seekers (Falk 2006). They come for a new or famous exhibit which presents a unique experience. Experience Seekers are motivated by the idea of being there, not necessarily the content of the zoo (Falk et al. 2007). During the visit they may be interested in many different exhibits but center their visit around the primarily attractions (Falk 2009).

Experience Seekers show the least knowledge of the zoo content, however studies show the greatest cognitive and affect change (Falk and others 2007). Experience Seekers want an overview and not deep understanding of the zoo's content (Falk 2009).

Experience Seekers need good orientation to navigate unfamiliar exhibit spaces with the most important attractions highlighted. They want a unique experience different from other local attractions. Since they are there primarily to 'collect' an experience, they need opportunities to remember the visit (Falk 2009).

Figure 1.5
Professional Identity

Professional

Visitors who come with a strong knowledge, interest in the zoo and specific reason for the visit are Professionals. They are interested in advancing their own knowledge about their profession, hobby or job. Their visits are focused on accomplishing a task and are very conscious of the specific task (Falk 2006). In talking about their experience they can identify their reason for visiting and if the visit was successful (Falk 2009).

Professionals are highly focused and have a large body of knowledge. They are looking for in-depth information and references (Falk 2009). Additionally, they are the most in-tune Identity with the goals and activities of the zoo (Falk et al. 2007).

Professionals are interested in premium programs such as behind-the-scenes tours, interaction with experts, lectures and seminars (Falk eet al. 2007). In exhibits they do not follow the 'prescribed' visit experience instead they attend to what is important to them, which is typically different than other Identities. They prefer an experience with minimal distractions and small crowds (Falk 2009).

Figure 1.6
Recharger Identity

Recharger

Visitors who come "to reflect, rejuvenate, or generally just bask in the wonder of the place" are Rechargers (Falk 2006). They have a straight trajectory in that they are looking for a peaceful place to relax.

Rechargers likely understand the content of the zoo, however, it is not what motivates their behavior and visit (Falk 2009).

In exhibits Rechargers are looking for quieter programs. Exhibits need to create places for Rechargers to balance other noisier Identities such as Social Facilitators (Falk et at. 2007). They require little orientation because they are repeat visitors (Falk 2009).

Multiple Intelligences

The Identity we enact in exhibits is unique to each of us influenced by personal differences. Similarly, Gardner's theory of Multiple Intelligences describes the different ways we learn and solve problems. An Intelligence is the ability to solve problems and make products by solving problems, identifying problems, and providing valued services (Gardner 1999). Gardner developed eight Intelligences Linguistic, Musical, Logical, Spatial, Kinesthetic, Interpersonal, Intrapersonal and Naturalistic. We each have different preferences for learning and completing tasks using one or a combination of Intelligences. Most people possess all of the Intelligences in varying amounts and use them in personal ways (Campbell, Campbell, and Dickinson 2004).

Multiple Intelligences theory not only has promising application in zoo exhibits (Weiler and Smith 2009; Bell and others 2009) but also has been applied in exhibits. Landells used the Intelligences in the design of two zoo exhibits to engage visitors. She suggests using a strategy Gardner developed using an Intelligence as an entry point to spark interests and create avenues for further exploration. She also illustrated how the Intelligences do not work independently but occur simultaneously in different combinations and degrees of influence (Landells 2004). The following describes each of the eight Intelligences defined by Gardner.

The Linguistic Intelligence is the speaking, listening and writing of words and language. It is the sensitivity to sound, rhythm, and meaning of words and the ability to convince others of a course of action, to use words in remembering, to explain concepts and ability to use language to reflect on language (Campbell, Campbell, and Dickinson 2004). The Intelligence is concerned with the meaning of words; the order and context of words; the sounds, rhythms, inflection, and meter; and the different uses of words (Lazear 1986). People with this Intelligence express their skill in using language but also enjoy wordplay, jokes, and crosswords (Tirri and Nokelainen 2008). In zoos, visitors almost certainly use this Intelligence in some capacity during the exhibit to acquire, perceive, and communicate the environment around them while reading signs, listening to zoo staff, and talking with their companions.

In addition to using the Linguistic Intelligence for utilitarian purposes of communication, the zoo experience uses language to appeal to learners favoring this Intelligence. Humor such as puns has been used to communicate messages (Jackson-Gould et al. 1991). In addition to English, Robinson proposes an interpretive exhibit about teaching sign language to gorillas in which visitors could learn sign language (Robinson 1996).

The Musical Intelligence is the ability to recognize tonal patterns, environmental sounds and rhythms. It is the sensitivity to pitch, rhythm, timbre, and emotional qualities of sounds (Campbell, Campbell, and Dickinson 2004). People with this Intelligence can discern instruments, recognize melodies, and notice when sounds are out of tune (Tirri and Nokelainen 2008). In zoos, the visitor experience is full of many sounds from visitor conversations, animal vocalizations, flowing water, and mood setting music. Landells suggests an exhibit scenario with African drums and instruments in which visitors listen and participate in creating the music (Landells 2004).

The Logical Intelligence is often called 'scientific thinking' which deals with inductive and deductive thinking/reasoning, numbers and the recognition of abstract patterns (Lazear 1986). Additionally, it is the ability to solve problems, make rational decisions, and making connections between information. People with this Intelligence enjoy metaphors, discerning relationships, performing complex calculations, and scientific reasoning (Campbell, Campbell, and Dickinson 2004). They express their skill at solving mathematics and logical problem-solving but also look for consistency in models and logical series and they present information as logically possible with evidence (Tirri and Nokelainen 2008). In zoos, visitors possibly make sense of the complex experience using the Logical Intelligence to draw conclusions about animal behavior and presented information.

Much of the information presented in zoos is scientific information and concepts which could be communicated to appeal to the Logical Intelligence. Robinson proposed an exhibit comparing volumetrically different parts of animals' milk such as fats, carbohydrates, etc. (Robinson 1996). Landells describes an exhibit scenario where visitors identify animal species by analyzing the size and spacing of animal tracks (Landells 2004).

The Spatial Intelligence relies on the sense of sight and being able to visualize an object, create internal mental images and navigate space. It is the ability to recognizing relationships of objects in space, create graphic representations, manipulate images and an active imagination (Lazear 1986). People with this Intelligence enjoy diagrams, outlines, varying shapes, mapping, visual memory, board games, and art (Campbell, Campbell, and Dickinson 2004). They express clearly seeing images in the mind and skills at drawing and designing but also geometry, navigation and viewing landscapes from plan (Tirri and Nokelainen 2008). In zoos, visitors use their Spatial Intelligence extensively to understand interpretive graphics, observe animals and navigate zoo exhibits. One exhibit scenario engaging the Spatial Intelligence described by Landells is a grass maze visitors navigate (Landells 2004).

The Kinesthetic Intelligence relies on the brain's motor cortex which controls bodily motion. It is the ability to control voluntary movement, control of pre-programmed movements, awareness through the body, connection between the mind and body and mimetic abilities (Lazear 1986). People with this Intelligence enjoy role-playing, dancing, creative movements, and games (Campbell, Campbell, and Dickinson 2004). They express skills in concrete tasks with their hands and tasks requiring good coordination (Tirri and Nokelainen 2008). In addition to accomplishing physical tasks, people with this Intelligence use physical movement as a way to remember and learn information (Campbell, Campbell, and Dickinson 2004). The zoo visit is a physical activity and increasingly zoo exhibits and interpretation integrate interactive activities such as touch pools with animals and manipulative interpretation to increase learning. One exhibit proposed by Robinson is having visitors wear a jacket which causes visitors to move like a gorilla to understand how the physiology differs between humans and gorillas (Robinson 1996).

The Naturalistic Intelligence relies on our innate Biophilic qualities as humans and relates to our love for nature and the ability to observe patterns in nature. People with this Intelligence express big picture thinking, observation skill, perceiving relationships by classifying (Campbell, Campbell, and Dickinson 2004), protection for nature, and environmentally friendly behavior (Tirri and Nokelainen 2008). People come to zoos to observe, engage and be surrounded in nature during zoo exhibits. In addition to appreciating the animals in the zoo, exhibits are organized for people to use their classification skills by comparing and contrasting animal features. Zoos were originally designed to facilitate this Intelligence by taxonomically organizing similar species (Hancocks 2001).

The Intrapersonal Intelligence relates to inner states of being, self-reflection, metacognition, and awareness of spiritual realities (Lazear 1986). It is the ability to understand one's self by engaging their inner states of being, self-reflection and metacognition (Campbell, Campbell, and Dickinson 2004). People use this Intelligence to set goals, identify and express emotions, reflecting on the wonder and purpose of life, and understand their learning (Campbell, Campbell, and Dickinson 2004). They express these skills by reflecting on important issues in life and deep psychological and philosophical issues, analyzing themselves and having the courage to express their own (Tirri and Nokelainen 2008). In zoos, parents believe the setting provides an opportunity for their children to learn morals respecting nature and understand their place in the world (Heimlich 2010).

The Interpersonal Intelligence relies primarily on person-to-person communication and an understanding of personal relationships. It is the ability to take the view point of others; understanding others feelings, opinions, and beliefs; work cooperatively; be sensitive to others moods, motivations, feelings; and verbal and non-verbal communication (Lazear 1986). A person with this Intelligence enjoys collaborative learning, conflict management, learning through service, appreciates personal differences and multiple perspectives, and solving local and global problems (Campbell, Campbell, and Dickinson 2004). They express skills in social relations, making contacts with other people and working with different types of people (Tirri and Nokelainen 2008). In zoos much learning occurs through socialization both between parents and children, but also through interactions with zoo staff. In addition to using Interpersonal skills to interact with people, exhibits could encourage visitors to take the view point of other people or animals to increase learning (Koran Jr., Koran, and Foster 1989). In taking another view point, visitor's moral reasoning and balancing of issues increases (Myers Jr., Saunders, and Garrett 2004).

Bloom's Taxonomy

The previous theory described how cognitive processes are different for individuals. Bloom's Taxonomy also describes different types of cognitive processes but in respect to creating deeper meaning and understanding applicable to all individuals.

Bloom developed a classification system originally designed for evaluating the objectives of school curriculums. The tool measured the complexity of cognitive processes occurring during the exercises. It categorized objectives from simple to complex (Figure 1.7). Higher classifications are more difficult requiring a greater understanding of the information to complete the activities (Bloom et al. 1984). Krathwohl's revision of Bloom's original system has six categories:

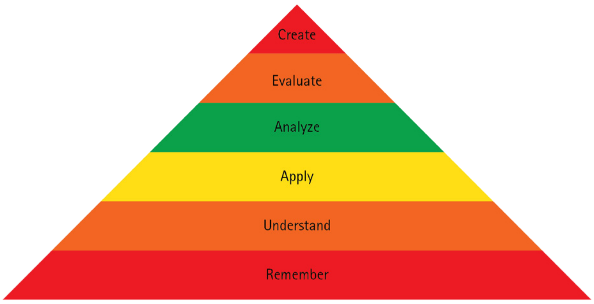


Figure 1.7
Bloom's Taxonomy

remember, understand, apply, analyze, evaluate and create (Krathwohl 2002).

Remember is the simplest process of recognizing and recalling simple concrete ideas such as terminology, facts, and patterns or more complex information such as classifications, methods, and theories (Bloom et al. 1984).

More complex is Understand, which is knowing the meaning of information. Comprehension is limited to demonstrating and applying the information in similar contexts as originally learned (Bloom et al. 1984). Processes such as interpreting, exemplifying, classifying, inferring, comparing, and explaining are examples of understanding.

Beyond understand is Apply which is the use of information in new situations and contexts. It is different from Understanding in that information can be used outside of the original context (Bloom et al. 1984). Processes such as executing and implementing are examples of Apply (Krathwohl 2002).

Analyze is the breaking of information it to parts and understanding the relationships between the parts, overall structure and purpose. Processes such as differentiating, organizing and attributing are examples (Krathwohl 2002).

Evaluate deals with making judgments based on criteria and standards. The criteria can be internal standards and external standards such as books. Evaluation can be confused with forming opinions but is different because opinions are typically not based on criteria but quick appraisals (Bloom et al. 1984). Processes such as checking and critiquing are examples (Krathwohl 2002).

The most complex process is Create which is the combining of elements to form a novel coherent whole or original product. An understanding of the pieces and relationships between information is needed (Bloom et al. 1984). Example processes are generating, planning and producing (Krathwohl 2002).

Experiential Learning

The previous theories of the Contextual Model of Learning, Visitor Identities, Multiple Intelligences and Bloom's Taxonomy illustrate factors influencing learning and individual differences in learning but do not describe the learning process. Kolb's Experiential Learning theory actually describes the process occurring during learning. The theory describes the cognitive processes a learner uses to understand concrete experiences and abstract concepts through interaction with the environment and internal reflection (Kolb 1984).

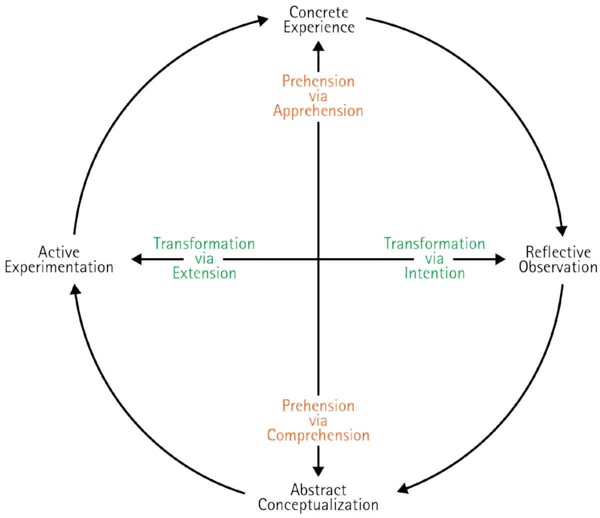


Figure 1.8
Experiential Learning model

Kolb describes a cyclical four stage process of concrete experiences, reflective observation, abstract conceptualization and active experimentation. The four stages are graphically represented on the ends of two crossing axis (Figure 1.8). The axes represent the two modes of prehension and transformation. At the ends of each mode are two stages which are opposing processes (Kolb 1984).

The first mode, Prehension, is how we perceive or grasp the physical environment or ideas. One process of Prehension is Apprehension which is the act of perceiving the physical environment. It is what we hear, see and feel during a concrete experience. Concrete experiences are immediate personal experiences – the here-and-now (Kolb 1984). Much of the zoo visit occurs through concrete experiences with animals and multi-sensory environments. For many people zoos are the only place where they can personally experience the animals and landscapes of distant environments.

Opposed to Apprehension is Comprehension. Comprehension is a process of internally grasping or perceiving an idea or concept abstractly. Abstract conceptualization allows people to remember concrete experiences and communicate the concepts by condensing the complex experience into a single idea (Kolb 1984). Without zoos many of the distant animals and landscapes discussed in school and seen in media are only abstract concepts understood through books and pictures. Additionally, many of the messages zoos communicate are abstract concepts such as ecological and biological functions.

The principles of landscape immersion are a design strategy to facilitate the prehension processes. By displaying animals in environments replicating their native landscape the abstraction of the animal's habitat is reduced and the experience is made more concrete (Coe 1985). Myers also provides design strategies for reducing abstraction to increase learning by using familiar concrete concepts and centering abstract concepts around specific animals (Myers Jr., Saunders, and Garrett 2004).

The second mode, Transformation, is how information is made meaningful with two opposing processes, Intention and Extension (Figure 1.8). Intention is the internal process of reflecting on Prehensions, our observations. By internally reflecting on observations, information is transformed into knowledge (Kolb 1984). In the zoo, learning requires Reflective Conceptualization because much of the learning content is passively perceived such as reading and observing animals.

Opposed is Extension which is how we physically interact and manipulate the environment to create knowledge by actively experimenting. Learning in zoos has the potential for many Extension processes because the zoo has many opportunities for interaction and engagement with the physical environment. Extension is becoming a more important part of zoo experiences as interactive interpretation becomes more popular. One study found that interactive interpretation has increased learning. In this study, an interactive table increased visitors understanding of the bearded vulture's behavior and ecology with long-term results. During the exhibit visitors touched bones, feathers, fur and food while also replicating vulture's behavior by dyeing the feathers with red soil. (Lindemann-Matthies and Kamer 2006). The activity allowed for apprehension processes and extension processes to test ideas.

Gagne's Information-Processing Model

Gagne's Information-Processing Model provides a different view of the learning processes compared to Kolb's Experiential Learning model. Gagne's Information-Processing Model explains how the learner receives a stimulus and creates meaning from the stimulus (Figure 1.9), similar to Koran's model developed for use in free-choice learning environments (Koran Jr. and Koran 1983). Gagne then developed for each step in the process instructions to facilitate the learning process.

The learning process begins with the learner receiving an environmental stimulus and directing their attention to the stimulus. Before visitors attend to a stimulus, they are unfocused and aware of a multitude of sensual stimuli surrounding them (Gagne 1985) from the physical environment, socializing visitors, and animals.

After we receive stimuli we focus our attention by filtering many stimuli using a process called selective perception (Gagne 1985). Once we focus our attention on an object, the stimulus is captured and stored temporarily in our short-term memory. If the information is meaningful it is moved to the long-term memory. If not, the information is forgotten (Gagne 1985).

Bitgood has studied part of this process, how we direct and focus our attention, in museums and other similar learning environments. He recently developed

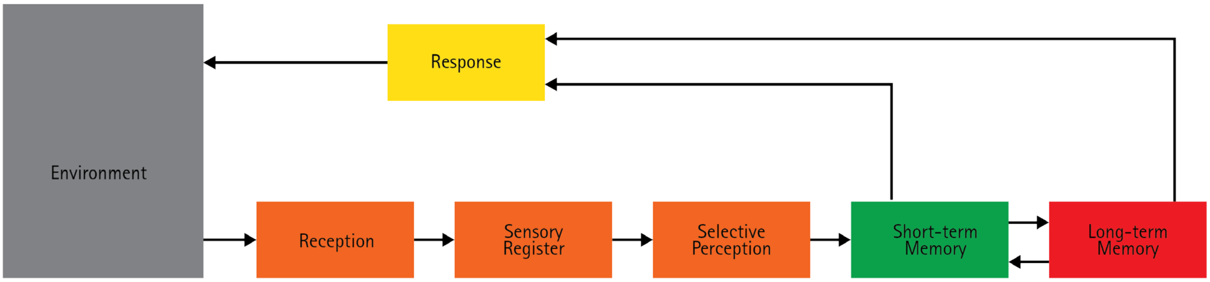


Figure 1.9
Information-processing Model

a model describing how we direct, focus and engage our attention (Bitgood 2010). We focus our attention in two ways orientating and searching. If a loud noise occurs we automatically respond to the powerful response using an orientating process. This response is an evolutionary feature of reacting to the environment. More consciously controlled processes are simultaneous and sequential scanning. During searching processes, we scan the environment looking for something of utility which meets some internal goal. In simultaneous scanning we scan the environment for something which 'pops out' drawing our attention, whereas sequential scanning is the process of evaluating one object for utility then moving to the next. (Bitgood 2010).

Once we direct our attention and receive a stimuli the information is stored in the short-term memory. For the information to move from the short-term memory to the long-term memory the information needs to be coded as meaningful. To creating meaning the short-term memory functions as the working memory where we combine and modify the information with prior knowledge. To recall prior knowledge from the long-term memory to the working memory, we use cues to link new information to existing knowledge. We can generate our own cues from other memories or we can receive cues from the environment (Gagne 1985).

To assess if learning occurred, we need to use our new learning by performing a task. Once we complete the task our learning is evaluated through feedback which indicates a correct or incorrect application of learning. The feedback on our performance is a new stimulus starting the whole processes over again. Feedback reinforces learning by demonstrating our learning which increases our confidence (Gagne 1985).

The entire process is regulated by two internal groups of processes, executive and expectancy, which we control during learning. Some of the processes naturally exist while others are learned and facilitated (Gagne 1985).

Executive processes are processes which we use in attending, learning, remembering, and thinking. The processes control what stimuli are entered into the short-term memory, what and how information is recalled, how meaning is created such as in large or small chunks, how to respond and how the information is generalized and used in problem solving (Gagne 1985). These processes differ from individual to individual.

The second set of control processes is Expectancy. Our expectancies are the reason or motivation to learn. These motivational processes determine and form learning goals needed in accomplishing the task. Outside sources can set expectancies or expectancies can be individually set (Gagne 1985). In free-choice learning situations, visitors typically set expectancies because they choose to be there and choose what exhibit elements to attend.

Gagne's Instructional Stages

For each of the previous steps in the learning process, Gagne developed instructional stages to facilitate the processes (Figure 1.10).

During the receiving stimuli stage we need to be alerted to coming learning opportunities so that we can

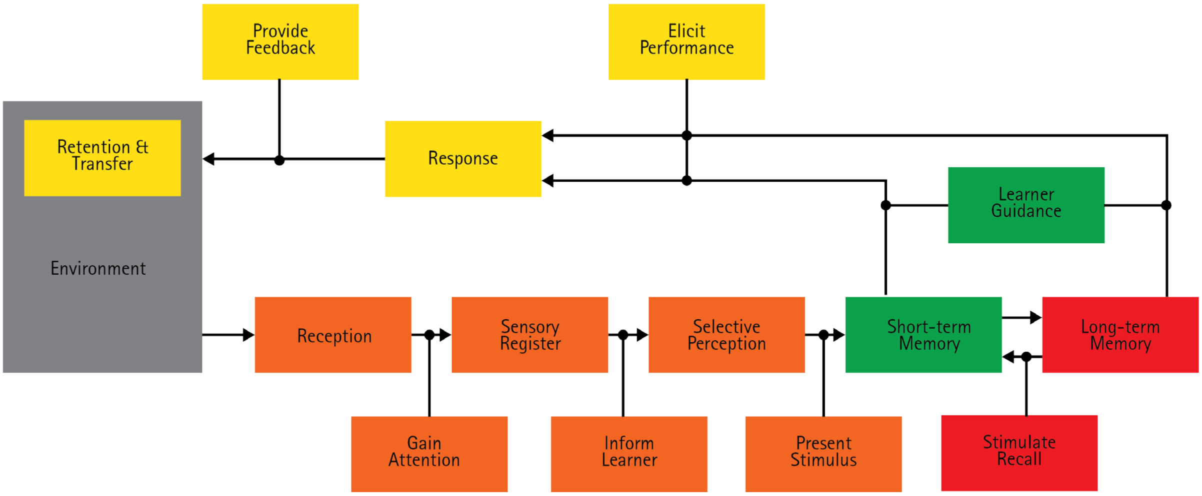


Figure 1.10
Instructional stages overlaid on the Information-processing model

direct our attention to the information (Gagne 1985). Bitgood's Attraction-value model provides guidance in gaining attention in informal learning environments. The design of the exhibit could focus visitor's attention using a powerful stimulus causing visitors to use an orientating response. This results in a quick direct response; however, once response occurs visitors rarely return their attention to prior exhibit elements (Bitgood 2010). A powerful stimulus could be useful in redirecting visitor's attention on a specific object but, if visitors are on a learning trajectory they many become distracted. Or, visitors could focus their attention using sequential scanning or simultaneous scanning processes. An exhibit which encourages a sequential process could increase engagement and understanding by limiting distractions and presenting information as intended by the designer (Bitgood 2010).

We need guidance in determining which stimulus is important because of the many stimuli in the zoo (Bitgood 2010). To assist us in directing our attention to the correct information exhibits can manage how we attend by: limiting competition between elements sequence, carefully design powerful stimuli to minimize distractions from learning, removing the need to sequentially shift attention between text and objects, and design circulation pathways which ensure we have an equal chance of engaging important elements. Additionally, the design of specific elements can capture our attention with distinctive factors such as high emotional-cognitive arousal, animal species and landmark qualities which contrast the physical and psychological background (Bitgood 2010).

To assist in the process of filtering stimuli, the instruction stage of informing the learner provides us with guidance in focusing attention on the learning content. When we understand why the information we are learning is important we are motivated to learn and we can direct our attention and effort on learning the intended information (Gagne 1985). Since we come to zoos expecting choice and control of the zoo experience (Falk 2000), zoos cannot force us to learn a specific topic. However, zoos can guide and suggest where to direct our attention and suggest how to use, learn and create meaning during an exhibit visit.

Exhibits can guide us by focusing our attention or by providing an example of how to learn (Gagne 1985). Questions help direct attention to a specific topic (Koran Jr., Koran, and Foster 1989; Bitgood 2002); however, zoos rarely ask questions (Robinson 1996). Handouts and games also help to focus our attention and cognitive processes (Koran Jr., Koran, and Foster 1989). Besides helping us direct our attention towards specific content, design can simplify communication of information such as using hierarchy of text and spatially grouping exhibits conceptually (Falk 2000).

After we focus our attention on a stimuli and store the information in the short-term memory we recall prior knowledge to contextualize the new information. To facilitate the process of using prior knowledge to contextualize new information, the instructional stage of stimulating recall prompts us to recall necessary prior knowledge (Gagne 1985). Learning about concepts or factual information requires recall of prerequisite information such as foundational concepts. If we are learning about behavior then we need to recall our prior or observed behaviors (Gagne 1985). In free-choice learning environments prior knowledge and experiences are used to contextualize and frame learning and new information (Falk 2000).

To stimulate the recall of information, questions can be used to encourage recall when placed at the beginning of exhibits (Koran Jr. and Koran 1983). Exhibit elements and the context of the exhibit also encourage recall of prior knowledge. Landscape immersion and cultural resonance encourages recall because we associate information with exhibit features. When using emotions to encourage recall of information designs should evoke emotions matching the emotional state of the intended material to be recalled because recalled information will have a similar emotional state of the visitor at the time (Chaffar and Frasson 2005).

Once a visitor recalls the necessary prior knowledge, designs can present the learning content by directing our attention to the information. We need guidance in focusing and attending to the critical learning information. This can be done by highlighting the content or by making it distinct and contrasting with the surrounding information (Gagne 1985).

For information to move from short-term memory to long-term memory, information needs to be meaningful. The instructional stage to facilitate this process is to provide learner guidance. Ways to facilitate meaning-making are by providing examples of how the information is used, demonstrating behavior, using concrete examples of abstract concepts, and relating the information to existing knowledge (Gagne 1985). By providing guidance, deeper cognitive processes can be encouraged to increase learning (Koran Jr., Koran, and Foster 1989). In the meaning making process the learner's emotional state is associated with memories (Chaffar and Frasson 2005).

After the information moves to long-term memory we need to apply our learning by eliciting performance (Gagne 1985). In zoos, we can apply information by manipulating interactive interpretation elements. Specific exhibit scenarios could include a presentation where actors portray a poacher and game warden. The warden accuses the poacher of poaching during which they enter into a heated argument. The audience is then asked to vote on the poacher's fate (Coe and Dykstra 2010). Another example is the Congo Exhibit at the Bronx zoo where visitors vote on which conservation activity their entrance fee will support (Gwynne 2007).

Once we perform an action applying our learning we need to know if our response was correct. The instructional stage of providing feedback provides a stimulus indicating the correctness of the performance (Gagne 1985). Feedback can be 'built-in' meaning we can evaluate our application by the action such as pushing a button turning on a light if the answer is correct. Or, feedback can be provided by an outside source such as zoo staff. Feedback can come in the form of intrinsic rewards which increase a person's pride, visibility, or joy whereas extrinsic rewards are material objects. Rewards can motivate us; however, they need to relate to the exhibits goals such as conservation. Intrinsic rewards are preferred over extrinsic rewards because the targeted behavior diminishes once the extrinsic reward is removed and may weaken intrinsic motivations (Price, Vining, and Saunders 2009). Feedback should also be supportive of learning and respect the nature of free-choice learning by not dictating a right or wrong answer (Irvine, Saunders, and Foster 1996). When we perform we should be in a positive emotional state because problem-solving and decision-making is more flexible and original (Chaffar and Frasson 2005).

Once learning has occurred the long-term retention and application of learning in new situations requires varied and spaced practice (Gagne 1985). One method is to connect the newly learned information to other existing knowledge. This strategy aligns with the WAZA calls for environmental issues to be made relevant to their own lives and experiences (WAZA 2005). Another method is the use of a question at the end of the exhibit to encourage divergent recall of information (Koran Jr. and Koran 1983). Additionally, the information can be repeated or referenced in other museums, schools, or institutions.

Learning Theory Summary

In summary, the learning theories provide zoo exhibit designers with knowledge about learning processes and how to engage and facilitate cognitive processes.

Falk's Contextual Model of Learning describes how the personal, sociocultural and physical context influences visitor learning in free-choice learning environments. The theory provides a basic understanding of the factors influencing learning in zoos. From which the theory paved the way for his Visitor Identity theory. The Visitor Identity identifies five Identities of Explorer, Facilitator, Experience Seeker, Professional and Recharger which visitors enact during the zoo visit. Each Identity describes visitor's affordances for the zoo and their needs, motivating their behavior during exhibits. The theory is useful in understanding a visitor's motivation for learning and how to design the exhibit experience to be the most satisfying.

In creating the experience Gardner's theory of Multiple Intelligences guides the design of visitor activities to engage individual's differences in learning. The theory describes how people approach and solve problems differently using an Intelligence. He identified eight Intelligences: Linguistic, Musical, Logical, Spatial, Kinesthetic, Interpersonal, Intrapersonal and Naturalistic. Another theory potentially guiding the cognitive processes engaged by visitor activities is Bloom's Taxonomy. Bloom identified six types of cognitive processes remember, understand, apply, analyze, evaluate and create. The processes build upon each other from simpler processes to more complex processes to achieve greater understanding.

The previous theories describe specific cognitive processes but not a learning process. Kolb's Experiential Learning model describes a four stage cyclical process of how we think, do, test and watch by grasping ideas and transforming information into knowledge. The theory potentially can inform how to use personal experiences and communicate abstract concepts in zoos most effectively. Another learning process Gagne's Information-processing model and associated Instructional stages describe how humans receive a stimulus and apply the stimulus as knowledge, as well as how to facilitate each step with Instructional stages. The theory provides guidance in how to coordinate the exhibit elements and experiences as a whole system.

The theories provide zoo exhibit designers with a foundation for understanding human learning to design exhibits which engage and facilitate visitor's cognitive processes.

Methods

Figure 2.0
Visitors in an exhibit

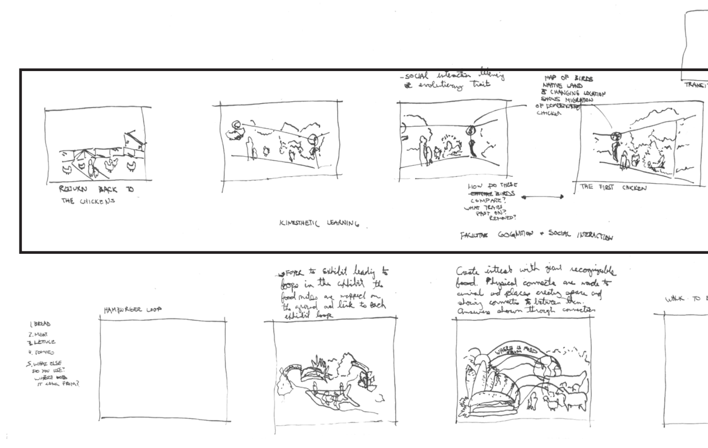
Personal Charrette

Introduction

Extensive review of zoo exhibit design literature found that the literature does not specifically describe how to design for learning processes. The learning theory literature provided a theoretical explanation for learning in zoo exhibits but did not explicitly describe how to design for learning. Whereas, the zoo exhibit design literature described different design techniques but did not provide strategies specifically addressing cognitive processes. As a designer, this missing information left me questioning what learning was and how learning was occurring in exhibits. To understand learning, I researched cognitive psychology and education theories and found a wealth of knowledge not discussed in zoo exhibit design literature. After learning about the theories presented in the previous section, I felt that exhibit designs could play a larger role in visitor learning by intentionally engage visitor's learning processes.

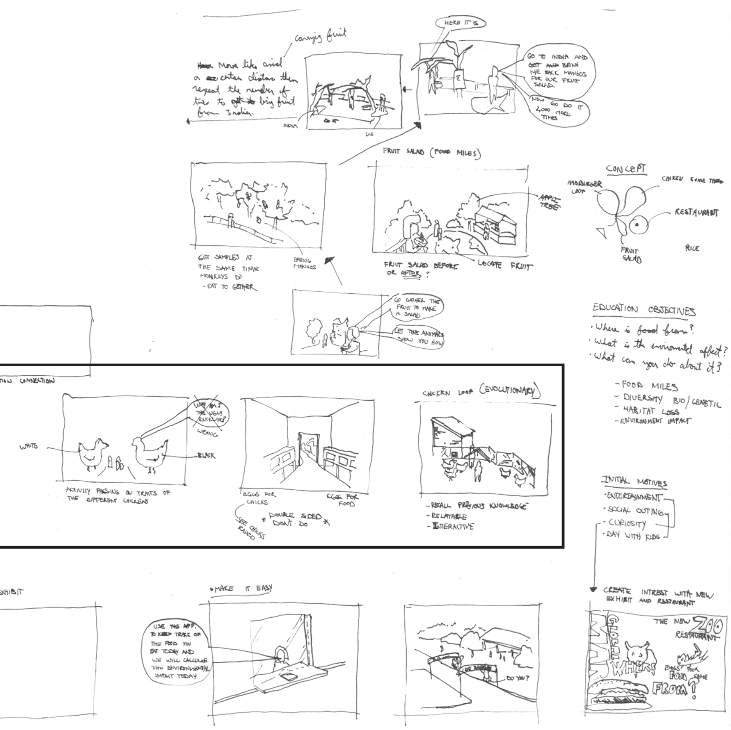
To personally understand the implications of the literature on zoo exhibit design, I conducted a personal charrette to interpret and translate the learning theory literature in the zoo context by synthesizing it with the zoo literature. The charrette was a rapid sketching activity where I quickly developed many design ideas. The ideas generated are not highly refined concepts, but rough design ideas which explored emerging design concepts. The objective of the charrette process was to understand how a zoo exhibit responds to visitor's learning by engaging and facilitating cognitive processes.

During the personal charrette, I spent a week quickly sketching five hypothetical zoo exhibits focused on how the visitor perceives, thinks and acts in exhibits. Each design was a hypothetical exhibit scenario which was not predetermined before beginning each charrette. To begin the process, I selected an arbitrary topic which was a subject I was interested in such as African ecosystems or Climate Change. From there, I developed an exhibit design which helped visitors learn about the subject with no predetermined program or goals prior to the design process. Since the exhibit was hypothetical, unbound by a physical location and associated site limitations and boundaries, the scale and scope of the project depended on achieving engagement of visitor's cognitive processes in learning the subject matter of the exhibit topic. After completing an exhibit design, the process began from scratch with a new hypothetical situation; therefore, the exhibits are unrelated in content and program, existing as separate designs.



Chicken Evolution

The first design, Chicken Evolution, explored how visitors can learn abstract concepts by concretely experiencing the abstract concepts, guided by Kolb's Experiential Learning model. Before experiencing any of the concepts visitors first recalled foundational knowledge needed to understand the abstract concept as explained by Gagne's information-processing model. To stimulate visitors to recall prior knowledge about chickens, they encountering domestic chickens and the reproductive cycle of chickens in a hen house with eggs. Then visitors sequential learn the abstract concept of evolution by concretely observing the evolutionary stages of the domestic chicken in different bird species (Figure 2.1).



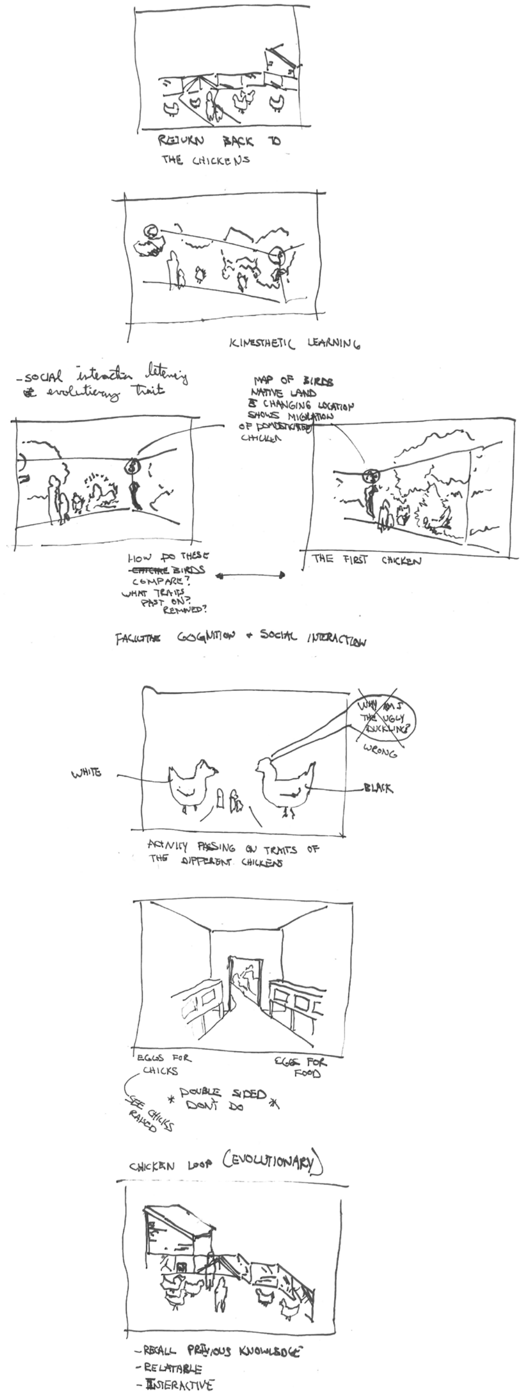


Figure 2.1
Chicken Adaption storyboard

Four Lives

The second design, Four Lives, was a significant advancement in my application and synthesis of learning theories as I explored specific aspects of learning resulting in new exhibit forms. The design investigated how an exhibit concept can begin by first developing a specific strategy to engage visitors in during exhibits, which I referred to as a cognitive strategy. The cognitive strategy explored how exhibits can require visitors to apply their learning and how exhibits can provide visitors feedback on learning. In the exhibit, visitors make a decision using their knowledge resulting in a new experience reflecting their use of learning. This strategy was informed by Gagne's theory. An additional layer was added to the strategy by exploring how an activity can engage different visitor Identities, as described by Falk, through socialization and increased opportunities for choice and control.

In the Four Lives exhibit, visitors learned about interconnected social and natural systems occurring between people and elephants in Africa. During the exhibit, visitors role-play either a farmer, poacher or ranger. Throughout the exhibit the pathways split where visitors use their knowledge to determine which path to take. At each junction, visitors encounter a situation such as a field destroyed by elephants and meet themed actors who present the situation. The actors facilitate the group in using their prior knowledge and information presented throughout the exhibit in choosing a pathway. Each pathway leads to a different situation which is a result of the decision they made. The visitor is free to interpret if they made the correct decision, based on the next situation they encounter (Figure 2.3). Situations could suggest a correct or incorrect application of learning such as arresting poachers. The exhibit circulation and organization responded to the design of the cognitive activity of making decisions resulting in a network of pathways (Figure 2.2).

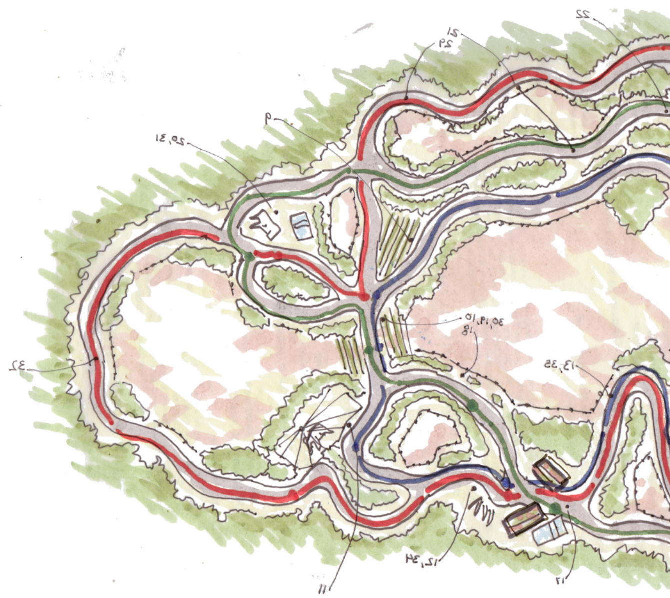
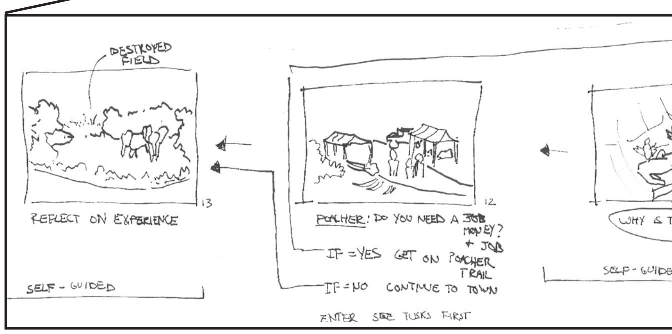


Figure 2.2
Four Lives exhibit plan



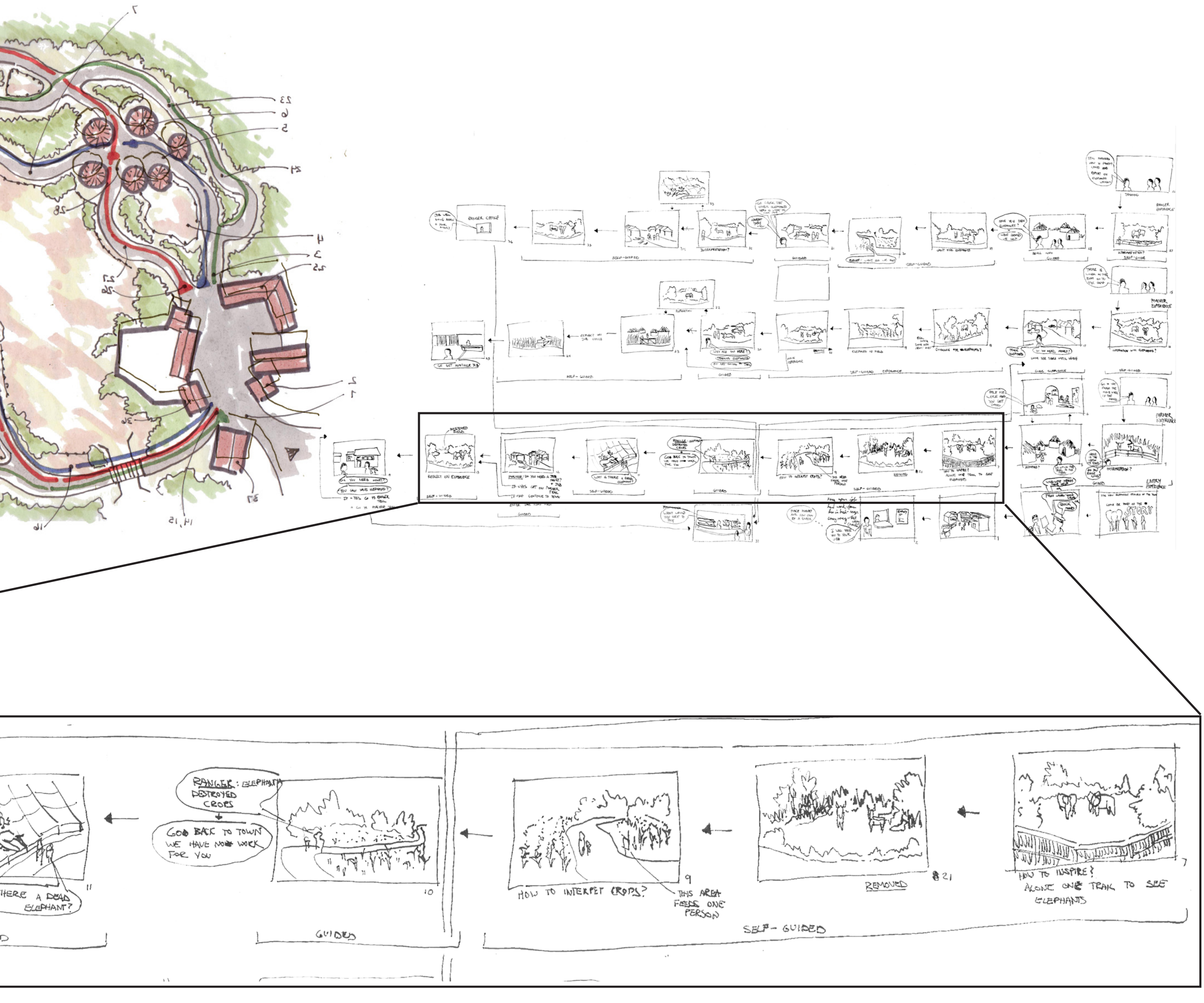


Figure 2.3
Four Lives exhibit storyboard

Climate Change

Visitor's learning processes also influenced the physical form of the next exhibit, Climate Change. The exhibit explored differences in visitor's prior knowledge, described in many learning theories, and how exhibits could be dynamic in responding to differences in visitor's abilities. The content and organization of the exhibit concepts is critical in understanding how the educational concepts fit into visitor's prior knowledge. This need to understand the relationships between concepts led me to develop the Concept Hierarchy Diagram (Figure 2.5). The diagram graphically represents the relationships between concepts, illustrating how the concepts build upon each other. In the exhibit, the concepts were physically demonstrated through the exhibit context of landscape, design features and selected animals (Figure 2.4). The context facilitated learning by demonstrating concepts, stimulating recall of prior knowledge, and encouraged visitors to think about the information in a specific way.

In the Climate Change exhibit visitors learn about concepts explaining climate change. Since visitors have varying degrees of understanding about climate change, the exhibit was designed as a series of loops describing different concepts related to climate change. Concepts were demonstrated in the design through the context of exhibits. For example, vehicles are included in the exhibit encouraging visitors to recall cars as sources of Co2 and stimulating visitors to recall prior knowledge about vehicles. Exhibits also encouraged visitors to contextualize exhibits in a specific such as by comparing two situations. When explaining concepts about habitat shifts, one side of an exhibit is a landscape replicating a before state and transitioning to the other side of the exhibit is a landscape replicating an after state.

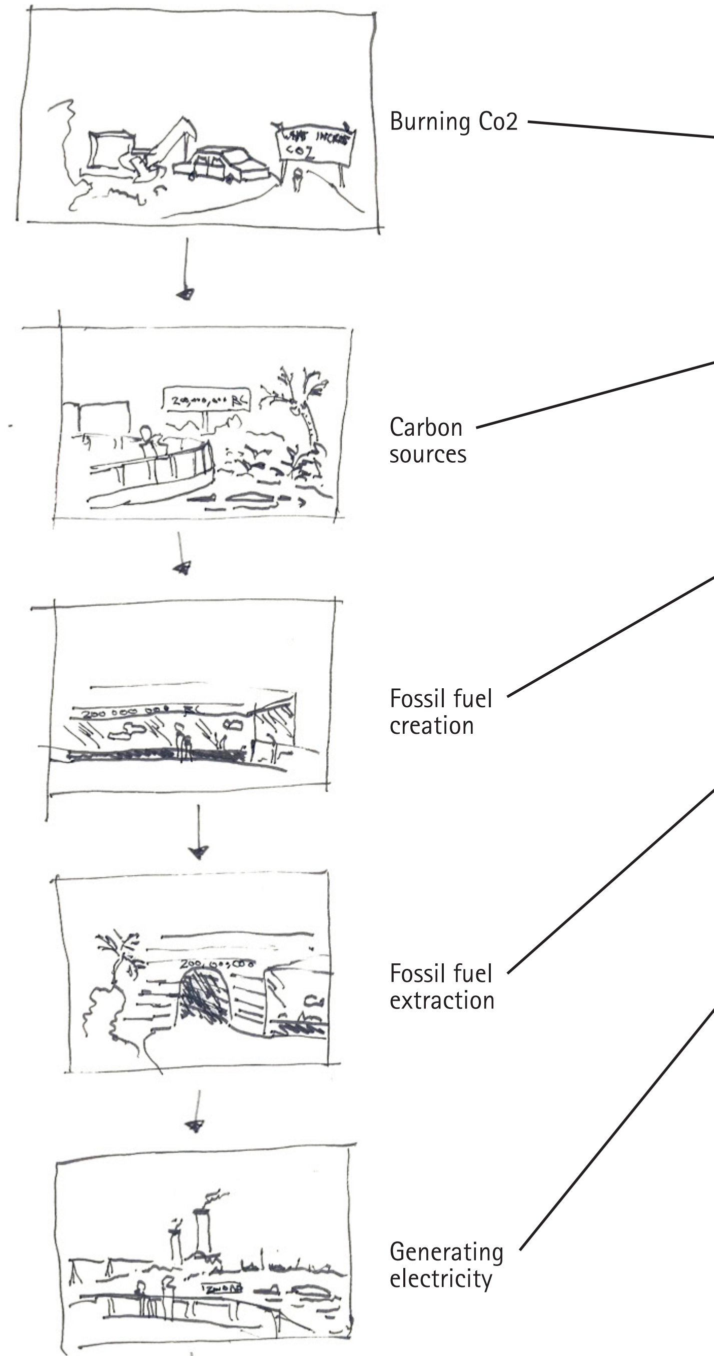


Figure 2.4
Segment of Climate Change exhibit storyboard

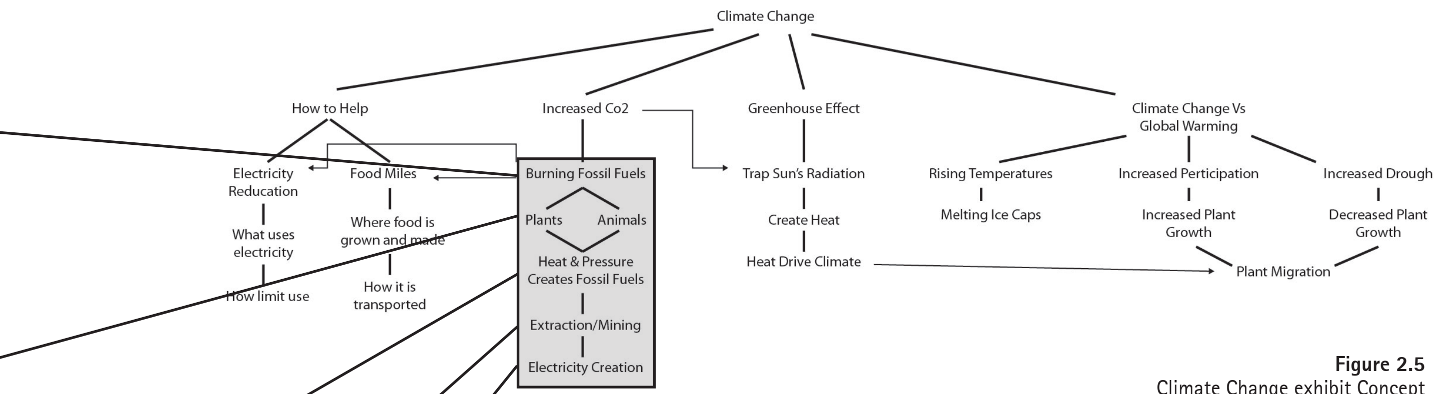
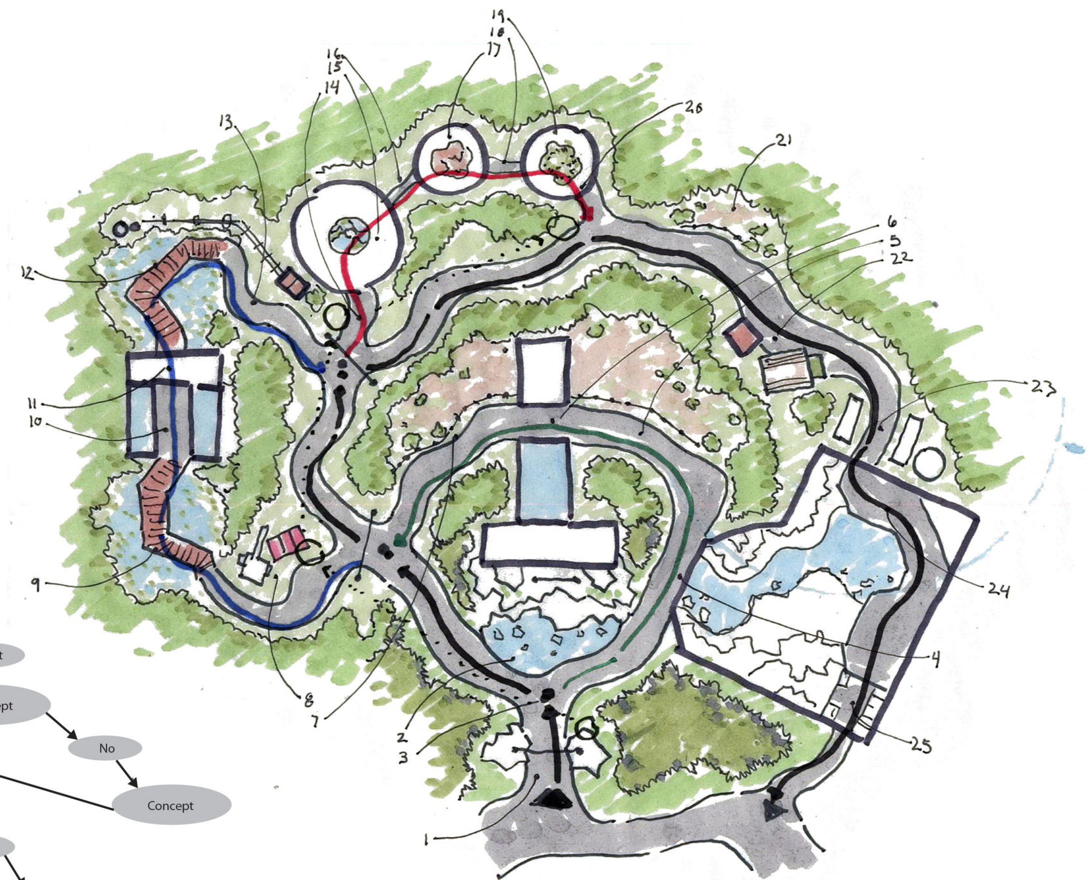


Figure 2.5
Climate Change exhibit Concept Hierarchy Diagram



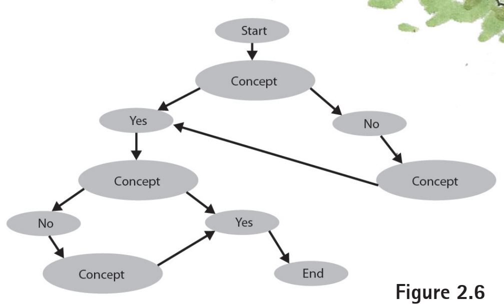


Figure 2.6
Visitor circulation loop diagram

Figure 2.7
Climate Change exhibit plan

Two Waterways

Two Waterways, the next exhibit was a break though in design process caused by thinking about how different exhibit organizational schemes could affect learning. The cognitive strategy initially developed was for visitors to compare two situations. However, the order in which visitors encountered the two situations influenced how they used the cognitive strategy. I created different diagrams exploring exhibit organization alternatives (Figure 2.10). This diagramming led to the full development of the Cognitive Process Diagram which shows the intended process visitors will engage and think about during the exhibit. In addition to the design process, the exhibit also explored how to relate information to visitor's prior knowledge and experiences outside the zoo, as described in the Contextual Model of Learning.

In the exhibit, visitors encounter two similar waterways where one is healthy and the other has poor water quality (Figure 2.4). During the exhibit, visitors learn about factors effecting water quality by observing good and bad examples of land management. Visitors first encounter one watershed, then the other culminating with an overall view of the two watersheds juxtaposed.

At this point, the two waterways join together where visitors identify the differences between the two landscapes using the information presented in the exhibit (Figure 2.8). The information presented throughout the exhibit uses the lessons learned in the previous exhibits about context and abstraction to relate to visitor's prior knowledge by making connections to their native landscape and activities in their daily lives.

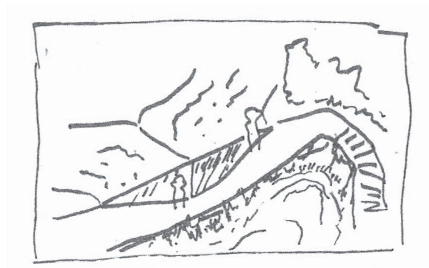


Figure 2.8
Joining of the two waterways

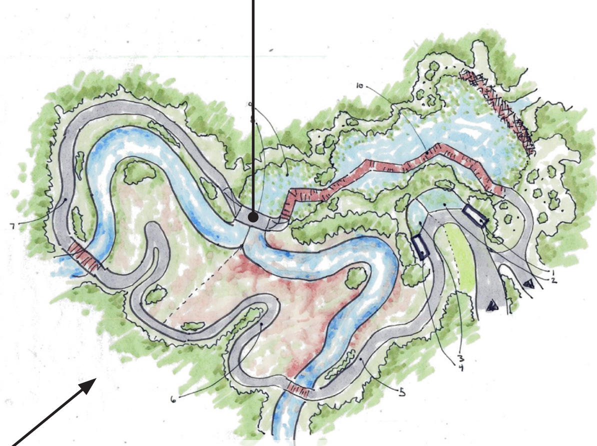
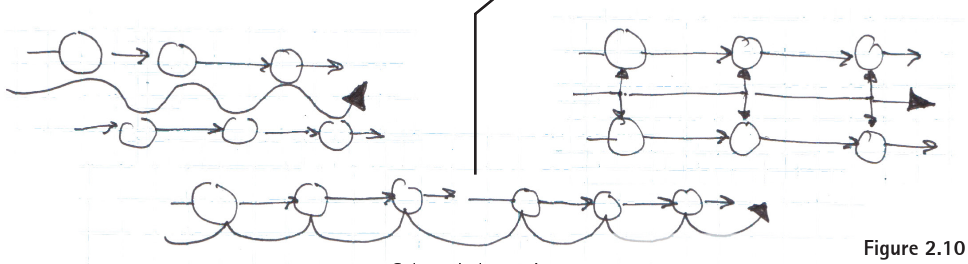


Figure 2.9
Two Waterways exhibit plan



Selected alternative

Figure 2.10
Exhibit organization alternatives

Tiger Range

The final exhibit, Tiger Range, began to take a different direction from the previous exhibits by starting to explore factors of behavior change theories such as perceived influence and social norms. To design for the factors the previous design strategies for engaging and facilitating learning processes were applied, furthering my understanding of those design strategies. In reflection, the integration of behavior change theories indicates I had gained a basic understanding of how exhibits could engage learning processes and I had progressed to more complex literature.

Even though the exhibit concept was tilted toward behavior change, it still required visitors to learn information in the exhibit. To design for visitor learning, the exhibit focused on reducing the abstraction of landscape ecology principles. During the exhibit, visitors learned about habitat fragmentation, wildlife corridors and the encroachment of humans. In the exhibit, visitors made a decision which, when combined as a group, affected the animal in the exhibit. During the exhibit, visitors decided where human development should occur in the tiger's exhibit. Their decisions influenced the connectivity between sections of the tiger's exhibit affecting the tiger's mobility (Figure 2.13).

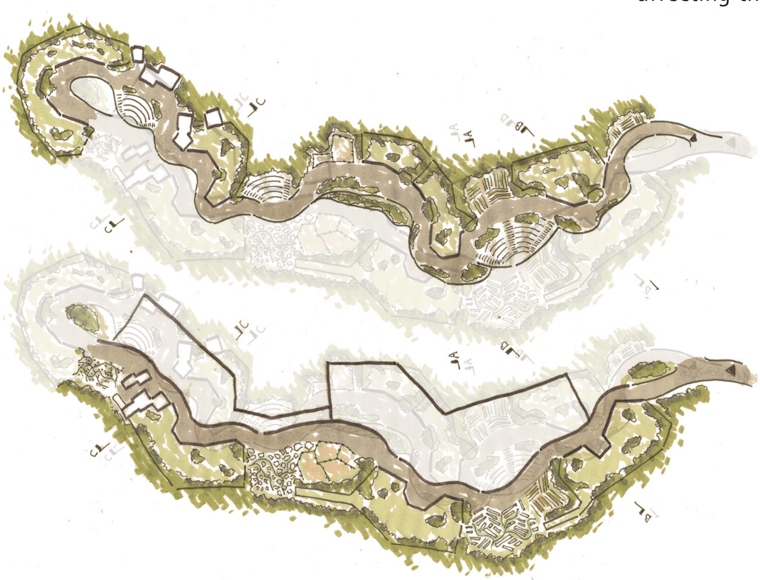


Figure 2.9
Two Waterways exhibit plan

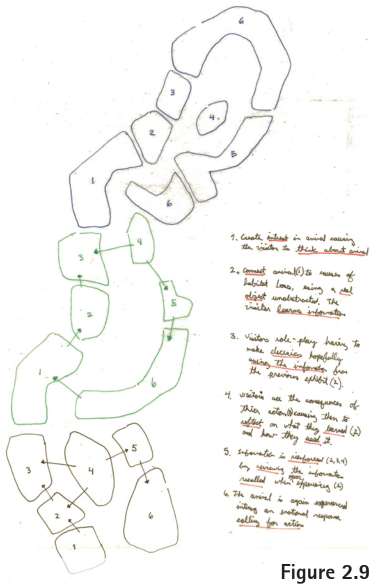


Figure 2.9
Two Waterways exhibit plan

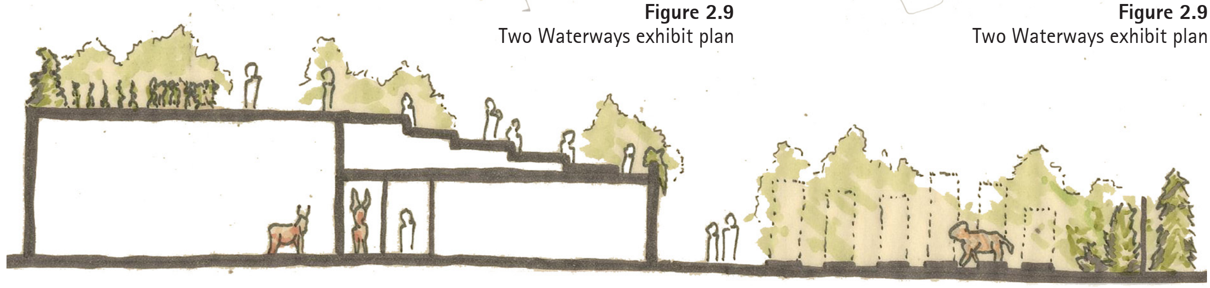


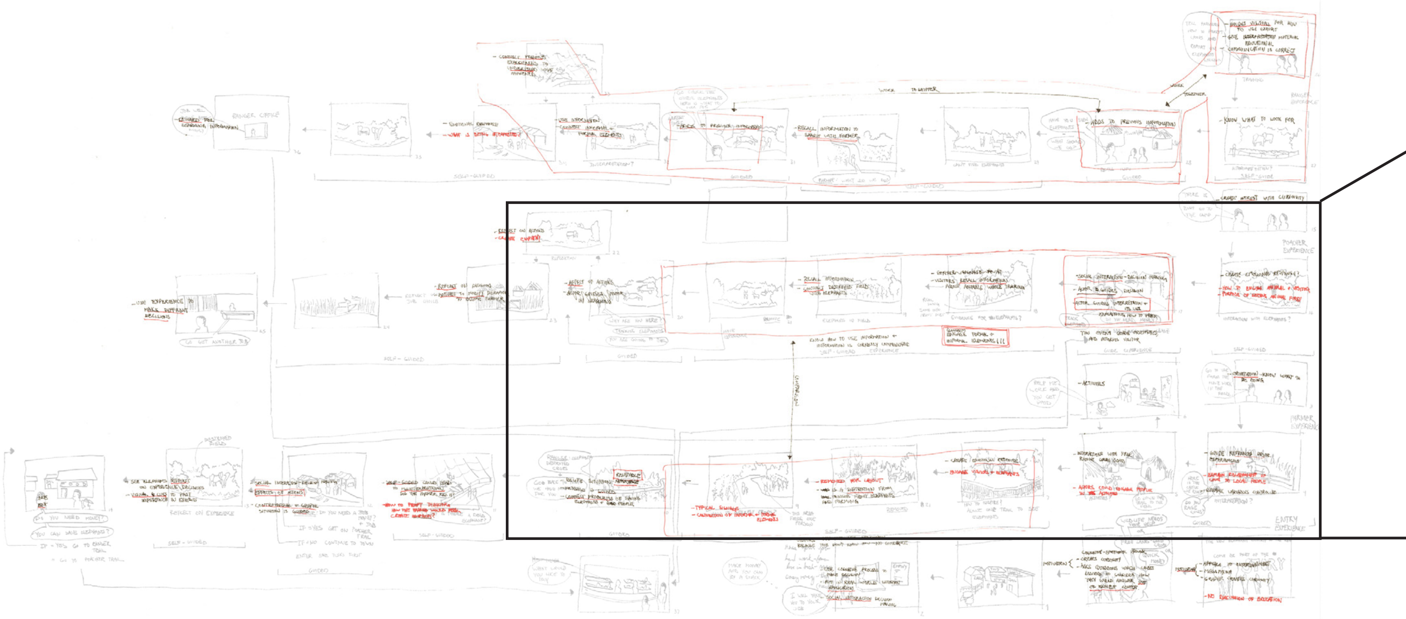
Figure 2.9
Two Waterways exhibit plan

Charrette analysis

After completing the personal charrette, I reflected on my application of learning theories. First I verified that I had applied learning theories by identifying where and how I translated learning theories into the exhibit designs (Figure 2.16). Some concepts from learning theories were consistently applied influencing the exhibit through context, visitor activities and animal selection. Not only were exhibit elements influenced in my design outcomes, but also the exhibit circulation, organization and visitor experience. Two new circulation typologies of networks and loops previously undocumented (Yanez, Collados, and Harrison 2005) were found in the Four Lives and Climate Change exhibit.

More interesting than the change in the physical form of exhibits was the change in the psychological landscape of exhibits. The visitor experiences in my designs shifted from a passive experience to an active experience where visitors participate in situations and engage activities which stimulate and facilitate their cognitive processes as a result of the physical landscape.

In addition to analyzing the actual designs, I also reflected on my design process. With each exhibit design a process began to unfold with some examples focusing on certain steps more than others. Overall, the process typically began by selecting a topic to provide a starting point for design. I then listed and organized the concepts needed to understand the overall exhibit message, creating a Concept Hierarchy Diagram (Figure 2.14), as described in literature (Miles 1982). Next, I developed design strategies for how a visitor in the exhibit would learn the exhibit message called a cognitive strategy. The strategies were then organized for the entire exhibit using a Cognitive Process Diagram (Figure 2.15). The diagrams then guided design decisions during the programming and design of the exhibit.



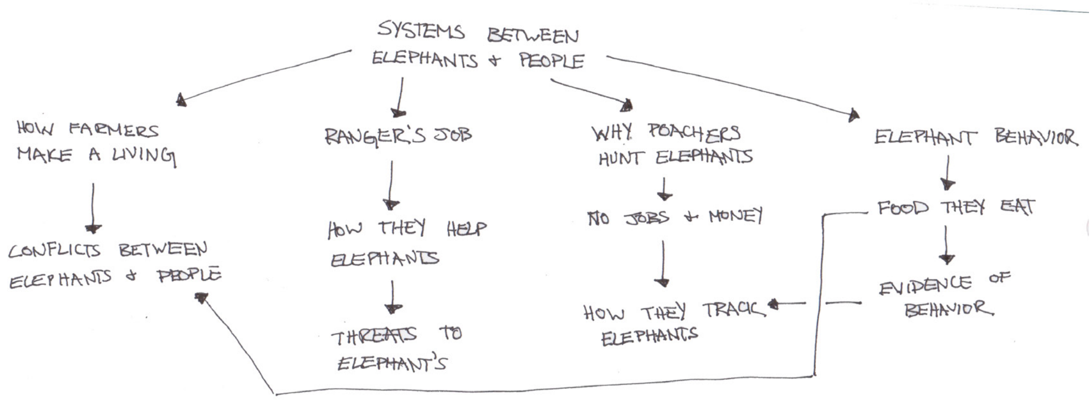


Figure 2.14
Example Concept Hierarchy Diagram

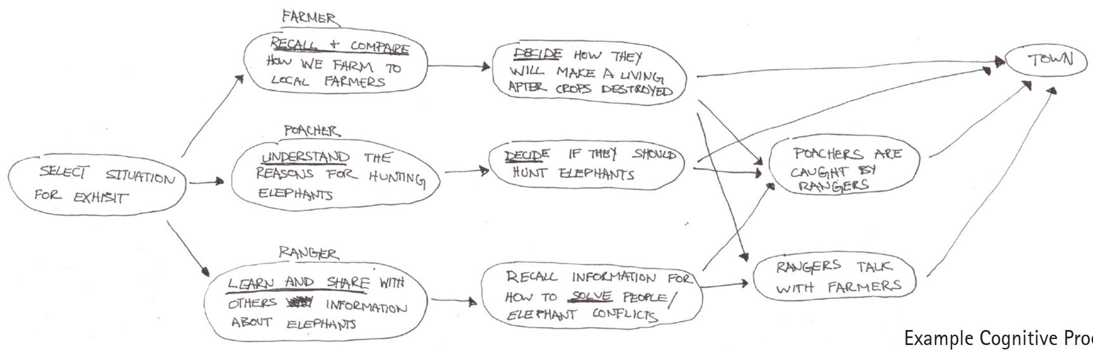


Figure 2.15
Example Cognitive Process Diagram

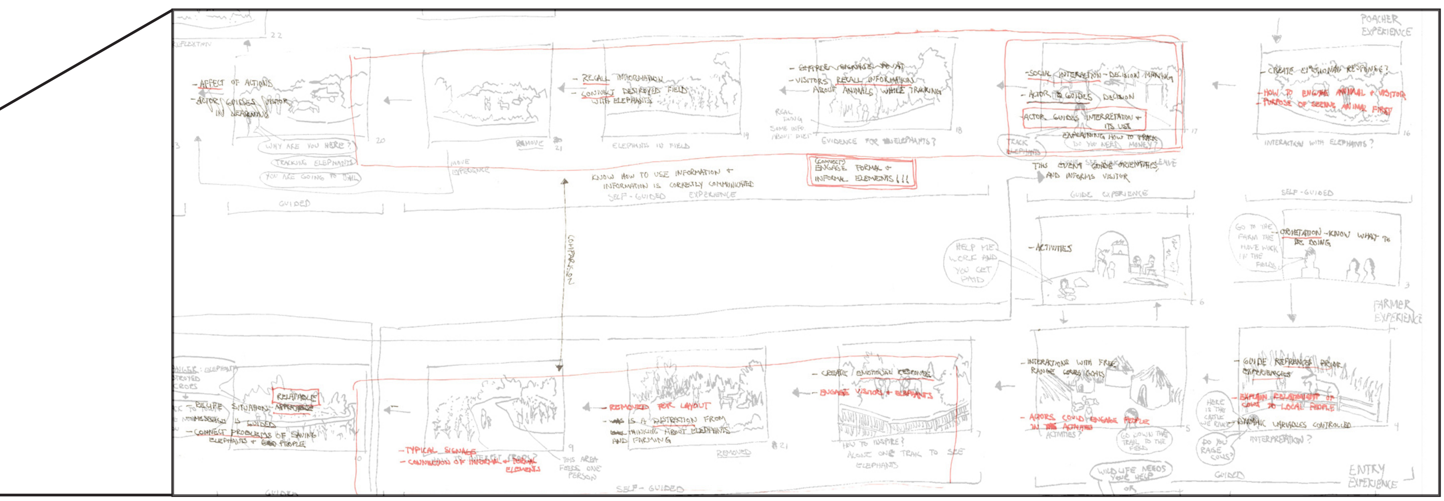


Figure 2.16
Example analysis for learning theories exhibit

While the design process began with learning in mind, learning became an influential force throughout the design process. The influence of learning generated the overall exhibit concept and organisational scheme to the design details of plant selection. I began to understand how exhibit form would influence visitor's cognitive processes allowing me to use learning as a variable in design decisions. I understood how different choices would result in engaging learning processes differently, changing the way I made design decisions. This overall change in approach led me to the thesis, if designers understand how visitors learn, their design approach would change to integrate learning and cognitive process theories resulting in exhibit designs which engage cognitive processes increasing learning there by increasing the potential for conservation behavior.

Survey Framework

From the personal charrette, I want to understand if zoo exhibit designers would similarly change their design approach after understanding learning theories and cognitive processes as I had during the personal charrette. By understanding how professionals change their design approach I could understand how important the theories were in the designing exhibits for visitor learning.

A mixed methods approach was required to determine if zoo exhibit designers change their design approach when they understand visitor's learning processes. The first important idea was to have zoo design professionals participate in a workshop learning about learning theories and to apply their learning in sketch problems and a charrette to design hypothetical exhibits. To evaluate a professional zoo designer's change in design approach during the workshop required a survey method where participants completed a survey before the workshop and after the workshop which are compared for differences. No study in the literature could be found using this mixed-methods approach. However, Walker used a pre and post-survey methodology combined with a charrette to evaluate college design student's learning and perceptions of the charrette as a learning experience (Walker and Seymour 2008).

A new survey question framework was developed using Chan's factors that generate an individual's design style to record the state of participant's design approach. Chan's factors include goals, constraints, mental imagery, personal preferences, and search pattern and order (Chan 2001). Chan's factors were chosen as the framework because Chan's theory addresses design approach on an individual level by removing the role of firm philosophy and project variables to how an individual makes design decisions. The theory was also chosen because it explains how design approach leads to design by linking designer's internal though processes and knowledge to the physical form of the design.

Chan's factors become the framework for the survey by establishing the purpose of each survey question. While the purpose of the survey questions follows Chan's factors, the content of the questions come from learning theory filtered through the lens of zoo exhibit design literature (Figure 2.17). In total the survey consisted of 30 four-point Likert questions and one open-ended question. The Likert scale survey question methodology was chosen to measure design

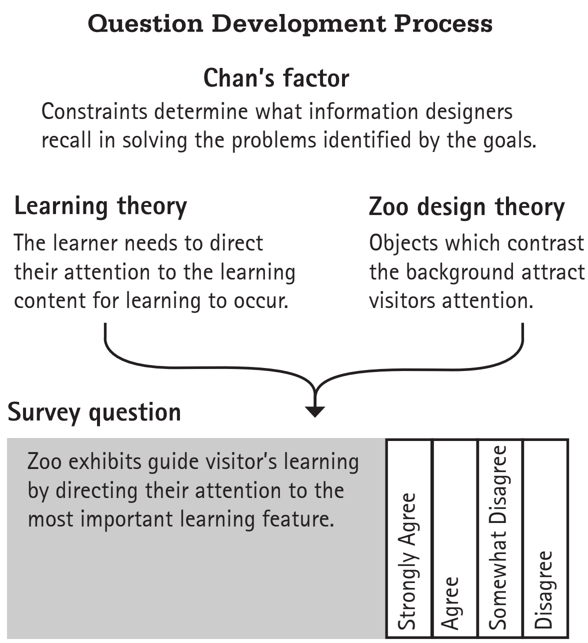


Figure 2.17
Example question development process

approach because the statistical comparison between the two studies is relatively easy compared to other survey methods requiring content analysis or other time consuming techniques.

The survey was administered using a two page paper handout. The handout was anonymously completed for both the pre-survey and post-survey because other variables such as age, employer or experience are not being studied, rather the survey focused on whether participants changed their approach. For a complete list of survey questions and the survey instrument see Appendix D.

Many factors influence a person's design approach. At the individual level, Chan described how a designer develops his or her approach referred to as a personal design style. A person's design style is composed of design processes and personal design strategies employed by the individual in making design decisions. In architecture the term style was developed by scholars "as a tool to differentiate works of art, they focus primarily on interpreting features in products to discover the period, group, regional, or vernacular style and how they develop and what their developments mean in a social, cultural, political, and psychological context (Chan 2001)."

Instead of using a classical definition of style, Chan examined the factors influencing a person's individual style. Every designer has their own internal processes and methods they prefer to use to make design decisions. As designers repeat the same processes, similar design solutions emerge. Chan described five 'mechanisms' that generate a personal style: goals, constraints, mental imagery, personal preferences, and search pattern and order (Chan 2001). In this study, the objective is to understand the role and influence of visitor learning on zoo exhibit designers in shaping their design approach.

Goals

As part of designer's design approach there are many internal factors influencing how designers make design decisions. Goals are the first factor in shaping an individual's design approach. Designers develop goals which prioritize design issues and define design problems. Once the issue is identified designers recall information needed to solve the design problem (Chan 2001). Understanding designer's internal goals are important because "how a designer identifies a problem determines the relative importance of each problem component related to the site, visitor, animal, and their management; and how the designer values social, economic, ecological, esthetic, and behavioral factors will influence the type and quality of the designed zoo form (Polakowski 1987, xi)." The mission and objectives of the zoo inform these internal goals by which are guiding the development and direction of the project (Coe 1996).

Since designer's internal goals are influenced by the larger goals of zoos the first question on the survey addresses the primary roles of zoos in society. The question measures the overall priorities influencing design decisions in goal development of education, entertainment, animal well-being and conservation. Comparison between different roles can allude to how important learning is in the design process which in turn affects individual's goals.

In addition to the overall role of zoos, the zoo's mission and specific project objectives highly influence designer's development of internal goals for learning. The influence of learning in the overall project goals are important considerations because mission statements poorly explain how visitors are to learn, especially related to cognitive processes based on Patrick's inventory of zoo mission statements (Patrick et al. 2007). The gap could similarly be present in the goals and objectives developed for zoo projects assuming the projects follow the mission of zoos. If designers base their goals and objectives off zoo mission statements and project goals, their internal goals may similarly reflect the minimal influence of learning processes. To measure the influence of learning on zoo mission, proposed exhibit objectives, proposed exhibit messages and personal goals Likert questions are used.

Once designers have identified the goals of the project they use their goals to identify the design problems. To solve problems designers recall information such as methods, design standards and techniques needed to solve the design problem. The required information is recalled from past experiences and knowledge to develop design solutions (Chan 2001). Therefore, a clearly articulated goal describing cognitive processes in learning would then require information to be recalled about cognitive processes. Information could come from two sources, personal experience or documented literature. A Likert question on the survey measures the later source of information by asking if existing literature and design processes are adequately helpful in design. The perceived literature resources available to designers reveals the information designers may recall in achieving the goals of the exhibit.

Constraints

After designers develop a set of goals and recall associated information they develop constraints using the recalled information. Constrains consist of information and criteria which limit design possibilities and identify design opportunities. Designers use the constraints in evaluating design alternatives in selecting the design solution which best achieves the design goal (Chan 2001). Examples of constraints could be set parameters such as spatial relationships, space requirements and material properties or dynamic parameters such as animal behavior or learning processes. Constraints could come from documented sources such as regulations or can be created by designers themselves. Designers develop their own constraints to inform design decisions from their cumulative knowledge and experience. If designers do not have knowledge about cognitive processes then they may not be able to adequately form constraints to make the best, or most informed design decisions for learning.

Since little literature exists explaining how to design zoo exhibits for engaging visitor's cognitive processes, designers are forced to develop their own constraints. To develop the constraints they use their knowledge of how people learn to create their own design strategies. If designers do not possess a strong understanding of learning then they may not be capable of creating the best constraints to guide design decisions. To measure if designers have the necessary knowledge about learning processes to form constraints, questions ask participants about their understanding of a series of learning concepts. The learning concepts selected were deemed important in the literature review and proved highly influential during my personal charrette. For each of the learning concepts a statement(s) was crafted as a Likert question.

The first learning concept designers need to understand is learning is the transformation of information into meaningful knowledge (Gagne 1985; Kolb 1984). This might seem obvious but without an understanding that learning is a dynamic process designers may not understand that the exhibit needs to facilitate and encourage processes, not only provide information.

Secondly, learning is a cumulative process. When people learn they are building and modifying existing knowledge from past experiences during the new situation. The process continues when learning is recalled for use in later situations, reinforcing learning (Gagne 1985; Kolb 1984; Falk 2009). Designers need to understand learning is a series of experiences through time - past, present and future. Therefore, zoo experiences need to connect current exhibit learning with past knowledge and apply zoo learning in future experiences.

Third, people learn in uniquely individual ways with different learning styles and personal preferences (Kolb 1984; Falk 2009; Gardner 1999). Designers need to understand this because they instinctively use their intuition and past experience to make design decisions. If designers do not understand how others unlike themselves think, then exhibits may not facilitate other learning styles limiting the audience engaged by the exhibit.

Fourth, learning increases when our learning processes are closed with a feedback loop (Gagne 1985). Visitors can evaluate and observe their learning by applying their new knowledge in the exhibit and receiving feedback during the exhibit experience.

Fifth, for learning to occur learners need to direct their attention on the learning material and then engage the information (Gagne 1985). Researchers have identified factors which attract and focus zoo visitor's attention (Bitgood 2002). Designers can use these techniques to guide visitors in directing their attention and engaging the exhibit.

Lastly, visitor's needs, expectations and motivations influence their behavior (Falk 2009). By understanding visitor's motivations, designers can integrate learning into the process of designing the exhibit to meet visitor's needs.

Mental Imagery

Once designers have identified constraints by recalling the information needed to solve the design problem as identified in the goal, designers recall prior designs they have experienced. The recalled solutions are internal representations referred to by Chan as mental images. Designers use the mental images to internally visualize the exhibit as they manipulate the spatial characteristic and configurations of the site. In their minds, designers represent the design as mental conceptual representations of physical objects previously encountered. These representations are stored in their memory and recalled during visualization of the project. Since designers have a specific set of images they have gained through experience, they repeatedly recall the same images, resulting in similar design decisions. Since designers can only visualize what they know, the images become another form of constraints (Chan 2001).

During the design of zoo exhibits designers recall their conceptualizations of interpretation, spatial configuration, landscape features etc., bringing to mind the physical and functional attributes of the elements along with past applications which inform design decisions. If designers do not have mental images of design elements which engage cognitive processes then they may not understand what and how an exhibit can engage cognitive processes.

To measure designer's mental imagery of zoo exhibits which respond to visitor's learning processes requires two series of questions which examine exhibits as a whole, and specific design elements in exhibits. The series of questions addressing exhibits overall asked if visitors learn in exhibits and if exhibits encourage visitor's learning processes. The second series of questions focuses on specific design elements such as context, spatial relationships and circulation organization. The selection of the exhibit design elements chosen for survey questions was influenced by the exhibit elements demonstrating the most change in form due to learning theories application during the personal charrette.

The two series of questions about mental imagery do not actually capture designer's mental imagery, but rather measure the general state of their mental imagery. To get a more accurate picture of designer's mental imagery an open-ended question asks participants to provide a specific exhibit example which engages a visitor's cognitive processes.

Personal Preferences

Similar to an individual's mental imagery is their personal preferences. Designer's personal preferences are their tendency to use the same aesthetic and functional forms to solve similar design problems. The solutions become presolution models which they repeatedly reuse for similar tasks and design problems (Chan 2001). If designers do not have presolution models which engage visitor's cognitive processes then the designer may not know how to design exhibits which facilitate learning.

To record a participant's personal preferences would require them to solve a design problem which is unfeasible with the survey instrument. Instead the comments and sketches from their workshop designs provide evidence of changes of participant's personal preferences. Also, some survey questions will give indications of personal preferences with the questions from mental imagery about design elements and the open-ended question, along with questions about the design stages discussed in the next section, search pattern and order.

Search Pattern and Order

The order in which designers employ different personal preferences, mental images, constraints and goals also influences their design approach. Designers repeatedly use similar processes in recalling and applying information resulting in a set of procedures. The first information recalled will influence the recall of the next procedure (Chan 2001). For example, a designer may first set a goal to design the visitor circulation before setting goals to design the visitor experience result in a consistent pattern influencing later design decisions.

Since an individual's search pattern and order is unique to specific situations it is difficult to measure using Likert scale questions. Instead of have a question about a specific situation with many variables, a general approach is taken to measure search pattern and order. For each stage in the typical process of design: research, site analysis, programming, concept development, construction documentation and post-occupancy evaluation the influence of learning during each design stage is measured. The assumption is that if designers place a relatively greater importance on learning in a design stage(s) then they integrate more procedures relating to learning into the design stage.

To get a more detailed description of the influence of learning in critical design stages additional questions evaluate specific events typically occurring in design stages. The questions focused on the concept development and design development stages because most design decisions resulting in the final form occur during these stages. The questions cover events such as concept development, generation of alternatives and selection of design concepts.

Survey analysis

In summary, the goals designers develop identify the design problem and the information to recall in solving the problem. From the recalled information designers form constraints which limit design possibilities and identify opportunities. Part of the recalled information includes designer's mental imagery of past encountered design solutions and presolution models from their personal preferences. The search pattern and order in which the designer employs the goals, constraints, mental images and personal preferences results in the design solution.

The survey questions measure designer's approach, but to understand how their approach changes during the workshop requires both a pre and post-survey for comparison. This means that workshop participants complete a survey before the workshop then complete the same survey at the conclusion of the workshop. The results of the two surveys are then compared using statistical analysis methods of mean and standard deviation. Questions are then relatively compared to other questions in the same question set.

Workshop Design

Zoo exhibit designers first need to gain new information about learning theories if they are to change their design approach by increasing the influence of learning. To provide professional zoo exhibit designers with this information, a day long interactive workshop was conceived where zoo design professionals would be presented information on learning theories and be asked to applied their learning in sketch sessions, dialog and a design charrette (Figure 2.18).

Why a workshop?

A workshop, also called a research charrette or focus group, was chosen as a method because it could provide participants with information about learning theories and is an efficient mechanism for capturing professional's interpretation and translation of the learning theories into the context of zoo exhibits using their experience. Workshops have been documented as being capable of collecting participants' expertise and experience quickly, connecting academia and practice, and are an effective learning tool in and of themselves.

The results from workshops can be immediately useful to professionals in practice because they assist in developing the findings. Since professionals are engaged in the development of the workshop findings the information and topics are relevant to their needs. To productively interact with professionals, communication is needed and Gibson found workshops are effective methods for creating a dialogue between professions and academics (Gibson Jr. and Whittington 2010). The interaction ultimately reduces the amount of time for the research to move from academia to practice because professionals have vested interests in the research.

A workshop was also selected because they are effective learning tools. Workshops provide participants with opportunities to engage the four stages in Kolb's Experiential Learning Theory, increasing conceptualization of the topics presented through action and reflection (Walker and Seymour 2008) resulting in increased understanding. A testament to the effectiveness of charrettes is their use in design schools for many years. In this workshop, it is important that participants understand the information to a level that they can synthesize it with their existing knowledge to augment their design approach with the presented information.

Workshops are not new to the design profession. Designers have used workshops to obtain stakeholder ideas and engage communities in developing alternatives and master plans. In other disciplines workshops have been used as a research tool to understand industry practices and develop plans and processes for use in professional practice (Gibson Jr. and Whittington 2010). Workshops have also been used by zoos to develop strategies and direction for their institution and profession (Wineman, Piper, and Maple 1996). However this research study is innovative in that other research methods are coupled with the workshop.

Development of the workshop

The survey framework of Chan's factors provided a theoretical foundation for understanding the variables

Charrette Organization

Pre-survey	
Introduction	Presentation describing learning and cognitive processes Participants discuss their motivation for designing zoo exhibits
Contextual Model of Learning	Presentation of physical, sociocultural and personal contexts Participants identify the context factors occurring in the video
Visitor Identities	Presentation of five visitor Identities Participants discuss their Identity and how to design for different Identities
Experiential Learning	Presentation of experiential learning model Participants discuss how the model explains a zoo learning experience
Multiple Intelligences	Presentation of eight Intelligences Participants sketch ideas for engaging each Intelligence
Information-processing Model	Presentation of information-processing model and instructional stages Participants described how the model explains a zoo learning experience
Bloom's Taxonomy	Presentation six levels of cognitive function Participants discussed the cognitive level during their learning experience
Structured Design Charrette	**Exhibit Topic** Participants select conservation or environmental issue **Goals** Participants identify learning objectives and learning strategy **Concept Hierarchy Diagram** Participants identity exhibit concepts and relationships between concepts **Cognitive Process Diagram** Participants diagram how visitors learn during the exhibit **Programming and Design** Participants develop exhibit content and communicate the design **Presentation** Participants share designs
Post-survey	

Figure 2.18
Charrette organization

contributing to an individual's design approach which influences the design of the workshop. Information presented was designed to assist participants in forming new constraints, and the structured design process provided examples of how to develop and integrate goals for learning. Also, the resulting designs could become new mental images and presolution models. In addition to Chan's factors, my personal charrette also shaped the content and organization of the workshop by identifying relevant learning theories and potential design processes to include in the workshop. The design processes developed in the personal charrette became the precedent for the structured design charrette in the workshop. Lastly, the learning theories themselves influenced the information presented and the design of workshop activities to engage participant's learning processes. From these sources, the workshop design assisted participants in learning about cognitive processes and providing opportunities for participants to augment their design approach with learning theories.

The workshop content and organization provided participants with information on learning theories and opportunities to reflect and synthesize the presented information through workshop activities (Figure 2.18). The activities conceived for the workshop, called Interactions, included watching videos, interactive discussions and creative sketching activities assisting participants in learning the learning theories. After learning the theories participants interpret and translate the information during the design of a hypothetical zoo exhibit following a structured design process developed during the personal charrette involving the Concept Hierarchy Diagram, Cognitive Process Diagram and cognitive strategies.

The learning theories in the workshop were designed to be presented both visually on presentation slides and verbally through description of the theories. The presentation slides and complete script of the workshop are found in Appendix B. Additionally, participants were given a workshop manual (Appendix C) which summarzes key concepts and allows participants to take notes if desired. Participants also used the workshop manual to complete some activities during the workshop. At the end of the workshop, the workshop manuals are scanned and emailed back to participants for their reference.

Workshops

The workshops were designed to begin with an introduction to the project explaining participant's consent to participate in the workshop and pre-survey. Participants could choose to participate and sign the consent form at the beginning or at any time during the workshop.

After participants completed the pre-survey, the presentation began by describing my motivation for designing zoo exhibits and how it has evolved over time to focus on visitor learning. Participants then explained why they design zoo exhibits, during Interaction 1.0. This activity is an icebreaker to help participants become comfortable with each other and the workshop situation. More importantly, this exercise encourages participants to recall and reflect on their design philosophy, providing a context for the day.

Next, a series of rhetorical questions prompt participants to think generally about learning in zoos, encouraging them to form their own conception of learning. These questions are followed by a description and definition of learning and cognitive processes in the context of the zoo. Examples and questions are integrated throughout this section of the workshop helping participants reflect and examine their understanding of learning and the zoo experience. As the introduction concludes, the goals and purpose of the workshop are described again, orienting them to the workshop activities.

The introduction is vitally important as it encourages participants to recall and reflect on their current design approach. It also provides participants with a basic understanding of learning and cognitive processes. The next segment of the workshop was designed to present the Contextual Model of Learning and build on the definition of learning by describing basic factors affecting learning in zoo exhibits.

Contextual Model of Learning

In this segment, participants first watch a short video of zoo visitors in a lion exhibit. The video shows active lions close to visitors, demonstrating an ideal situation for capturing visitor's attention with animals. This visual example leads to the detailed description of the Contextual Model of Learning and the three contexts: personal, sociocultural and physical (Falk 2000). The video is replayed for participants to contextualize the information with the video, during Interaction 1.1. Participants look for the factors in the Contextual Model affecting learning and then discuss in groups of two or three their observations, writing them on provided paper. Next, participants shared their observations in a led discussion with all groups. This activity allows participants to use the learning theories in the Contextual Model of Learning, providing them with a general background of free-choice learning in zoos.

Visitor Identity

After building a basic understanding of learning, more detailed information is presented describing the first step in learning, motivation, using Visitor Identity. The Visitor Identity theory is included in the workshop because of its discovered utility in framing visitor activities for learning.

First, a series of rhetorical questions were designed to cue participants to reflect on why they visit zoos and what they do during zoo visits. The questions help participants recall their past zoo experiences illuminating their Identity. This question exercise is followed by a description of the concept of an Identity and each type of visitor Identity (Falk 2009). For each Identity, an example is used describing a scene from a fictional family's visit to a zoo explaining the characteristics and needs of the Identity being presented. After the presentation of the Identities, participants share the Identity they generally enact when they go to exhibits during Interaction 1.2. Identification of participant's Identity is important for participants to readily recall their experiences, and to begin to understand their Identities influence on making design decisions. Their identity is also considered in later sketching activities to enhance learning and understanding regarding its influence on design decision making. After identifying their Identity, participants list how exhibits can stimulate and engage the different Identities in groups. This activity encourages participants to think about their prior experiences in zoos and synthesize the information to creatively develop design ideas. After developing ideas participants take a fifteen minute mid-morning break.

Experiential Learning

The second half of the morning builds on the basic factors influencing learning in zoos and focuses on specific learning processes described in the Experiential Learning model. The Experiential Learning model is presented in the workshop to provide guidance in explaining abstract concepts using concrete experiences of how to use the visitor activities most effectively for learning.

In the workshop, participants are asked how one learns what a snake's skin feels like for the first time. During Interaction 2.0, participants discuss the physical and mental steps used to gain knowledge about what a snake feels like. This activity encourages participants to critically analyze how learning occurs by first recalling prior learning experiences to develop an answer. The activity prepares them for learning about Kolb's Experiential Learning model by either illustrating holes in their knowledge if they cannot explain the process, or the activity encourages them to recall processes occurring during learning.

This interactive is followed by an explanation of how one learns how a snake feels according to the Experiential Learning model (Kolb 1984). A shared personal experience of feeding Lorikeets is used as an example of how the Experiential Learning model describes learning. After presenting the information, Interaction 2.1 asks participants to describe a personal learning experience in a zoo. Participants identify the four learning stages and the physical features of the exhibit they described through writing or sketching, facilitating their learning processes. This activity encourages participants to apply the learning theory as they analyze a personal learning experience.

Multiple Intelligences

After examining the learning processes all humans use during learning in the Experiential Learning model, the next workshop section Multiple Intelligences, describes how learning varies between individuals. I selected the Multiple Intelligences theory because it provided ideas for presenting information and visitor activities during the personal charrette.

In this section, Gardner's concept of an Intelligence and the different Intelligences are described (Gardner 1985). Each Intelligence presented demonstrates how one uses an Intelligence by illustrating a family's zoo visit followed by a description of the characteristics of the Intelligence. After presenting four Intelligences, participants in groups of two or three, sketch ideas for engaging each Intelligence during Interaction 3.0. On the presentation slide, questions guide participants thinking about generating concepts. For example, "How can exhibits engage the Linguistic Intelligence beyond utilitarian communication?" These questions are an important focusing mechanism for participant's creative ideas outside the obvious solutions of providing signs. The process is repeated for the remaining four Intelligences before breaking for lunch.

Information-processing model

After lunch Gagne's Information-processing model is explained as another theory on how learning generally occurs for all individuals. In addition to the Information-processing model, Gagne described how to engage the learning processes with Instructional stages. The stages are also presented with the model because together they provide guidance in how different cognitive processes are engaged in exhibits.

In this workshop segment, another personal learning experience is used to illustrate Gagne's Information-processing model. During the description, slides pose rhetorical questions to guide participant's thoughts about the narrative and slide images. After the description of the personal learning experience, the learning stages of Gagne's Information-processing model (Gagne 1985) are presented. Participants then refer back to their learning experience they analyzed for the Experiential Learning model during Interaction 2.0. This time, during Interaction 4.0, they analyze their experience for the different cognitive processes in the Information-processing model and how exhibit features facilitate the processes in the model. Participants then discuss their experience with the group.

After Interaction 4.0, the different Instructional stages for the cognitive process in the Information-processing model are presented (Gagne 1985). For each Instructional stage a hypothetical zoo experience illustrates how an exhibit can use the stage to guide design in facilitating learning processes. After the example, I describe the Instructional stage then participants generate ideas for how to design for each Instructional stage, during Interaction 4.1.

Bloom's Taxonomy

While describing the Performance and Feedback Instructional stages Bloom's Taxonomy is presented. The learning theory describes the different types of cognitive processes exhibits could engage during the Performance and Feedback stages with Bloom's Taxonomy extending the understanding and influence of the types of visitor activities in exhibits and the development of cognitive strategies.

The six levels of Bloom's Taxonomy (Bloom et al. 1984) are described using an example for each which illustrate and engage participants in the described cognitive process. For each level, an example is provided using information about Black and White Rhinos to demonstrate participant's level of thinking. Each example builds upon the previous one, encouraging participants to move to the next level of cognitive processes being presented. After each example, qualifications are described for cognitive processes to achieve each level.

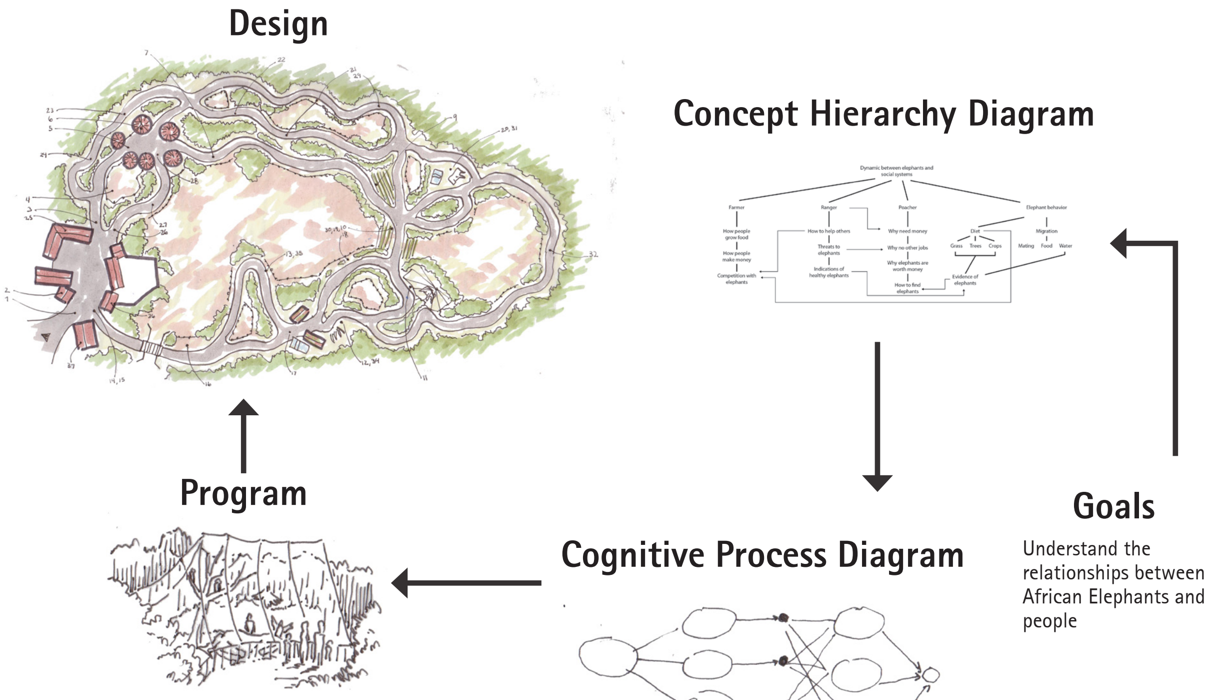


Figure 2.19
hop structured design charrette

Participants are asked to recall their prior learning experience from Interaction 2.0 which they also used in the Experiential Learning model section during Interaction 4.2. They analyze their learning experience for the cognitive level occurring during the experience followed by a discussion and idea generation session for achieving higher cognitive function. After Bloom's Taxonomy activities are complete participants take a fifteen minute break.

Structured Design Charrette

After the break, participants are asked to use what they learned throughout the day to design a hypothetical zoo exhibit in a structured design charrette. Participants follow the design process pioneered during the personal charrette employing the Concept Hierarchy Diagrams and Cognitive Process Diagrams. The activity of designing a complete zoo exhibit in a design charrette provides participants the opportunity to understand how to use their new knowledge about learning processes. Additionally, the new methods from the personal charrette provide examples of how to establish goals for learning and inform presolution models. The resulting designs provide participants with new mental images of exhibits and design process which together engage and facilitate thier learning processes.

The structured design charrette (Figure 2.19) begins with an overview of the entire charrette process to orient

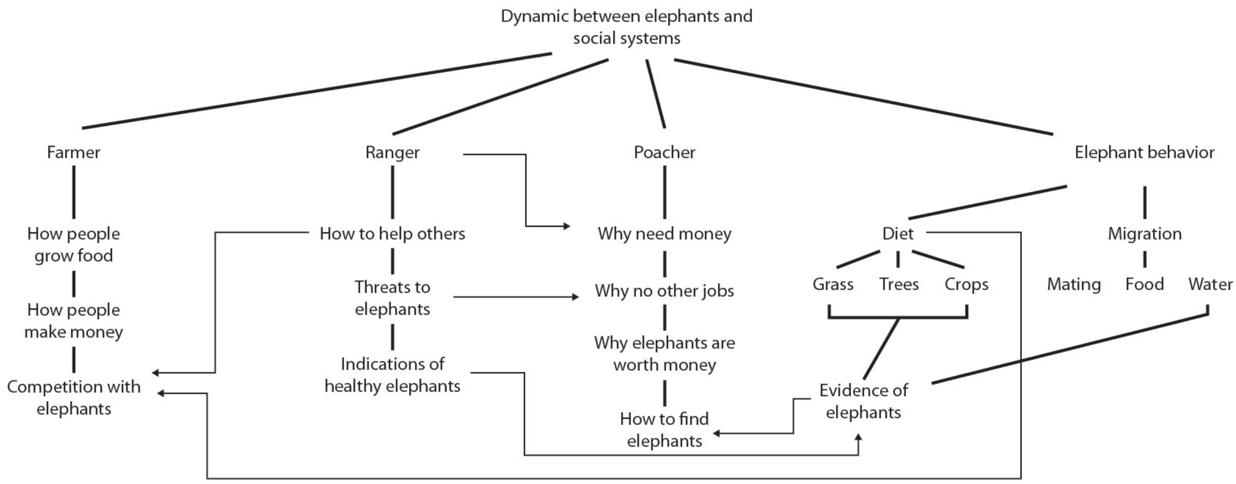


Figure 2.20
Concept Hierarchy Diagram

participants. For each step in the process, a project from my personal charrette is used as an example along with an explanation of the purpose of each step. Participants work individually during the first two steps then group in pairs or small groups for the remaining steps. As a group they select one, or a combination of the topics and goals to guide the collaborative design of the exhibit. When participants finish they share their design with the whole group.

The design process begins with participants selecting a conservation or environmental issue as the subject of the exhibit for Interaction 5.0. Participants select either a conservation or environmental issue for the topic of the exhibit, since the goal of zoos is conservation. The topic provides a context into which participants frame later steps in the structured charrette process, replicating the beginning of the design process in practice.

Next, participants developed goals and objectives for the exhibit, during Interaction 5.1. The goals give purpose to the design which guides design decisions by identifying what visitors will learn and the general strategy visitors will use to learn the information. During the facilitation of the charrette, rhetorical questions prompt participants to recall information from earlier in the workshop important to consider when developing goals, such as visitor Identities. After participants develop their goals they share them with the other participants in the workshop.

Participants then use the exhibit goals to inform the identification of the learning concepts included in the exhibit for Interaction 5.2. They sketch a Concept Hierarchy Diagram (Figure 2.20) as described by Miles (Miles 1982) to organize and understand the relationships between the concepts. By organizing

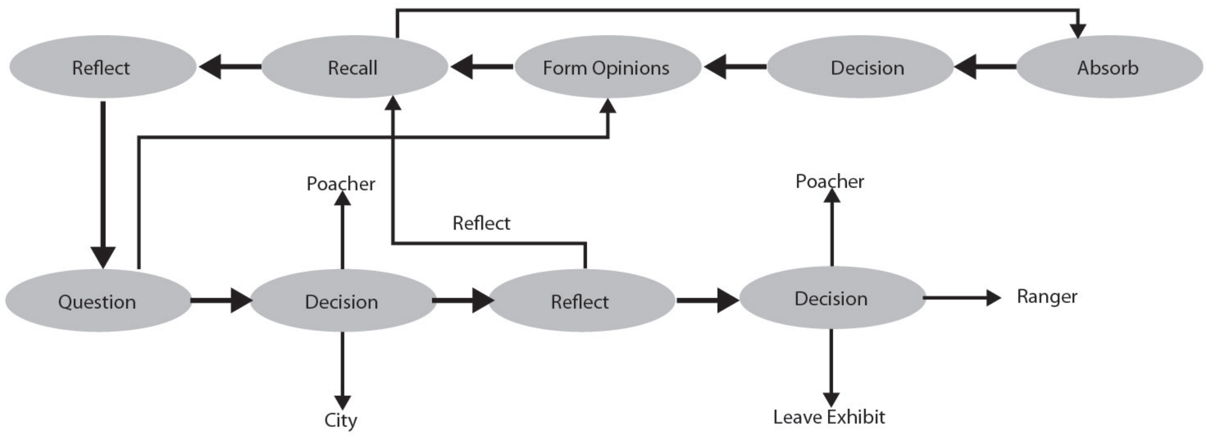


Figure 2.21
Cognitive Process Diagram

the concepts, participants increase their conceptual clarity because they understanding how concepts come together to form new concepts. The diagram identifies what concepts the exhibit needs to contain as well as the prior knowledge visitors need to recall during the exhibits to understand the content. After completing the diagram participants share them with the other participants.

Interaction 5.3 is designed to have participants combine the Concept Hierarchy Diagram with the goals they generated to create the Cognitive Process Diagram (Figure 2.21) . In the presentation explaining the Cognitive Process Diagram, rhetorical questions stimulate participant's recall of information presented earlier in the workshop in synthesizing key information. The diagram outlines the strategy the exhibit employs to engage visitor's thought processes. It describes the visitor activities and their intended thought processes during the exhibit. As the participants work on the Cognitive Process Diagram they discuss the function and design of the exhibit and slowly transition into Interaction 5.4, the design and program phase. In this step participants develop the content of the exhibit, spatial organization and the character of the spaces. They use traditional graphic methods such as plan, section and perspective to communicate the design. During the structured design charrette no distinct break is made in participant's design activities between the lasts steps of programming and design since the activities overlap.

After the exhibit designs are complete the workshop concludes with Interaction 5.5. Participants present their design to the entire group and explain their design concept. After presenting, participants provide comments on the exhibit designs and the workshop as a whole. I conclude the workshop by summarizing the day, thanking them for their time, and finishing with my thoughts on zoo's latent potential to leverage their conservation mission. Participants then complete the post-survey following the same procedure as the pre-survey.

Documentation

The documentation of the workshop for post-analysis uses multiple methods. To record participant's discussions and comments a video camera records participant conversations and a research assistant takes notes while managing the video camera. Participant's sketches are documented in the workshop manual, 11 x 17 and trace paper collected at the end of the workshop.

Contacting participants

Before inviting professional zoo exhibit designers, the locations of the workshops were identified. Multiple workshops were envisioned to be held in different cities throughout the United States to attract a diverse group of participants and allow more designers the opportunity to participate by reducing travel costs. In the selected cities the workshops were planned to be located at a zoo to remove distractions from the workplace helping to focus participants on the workshop. The zoos were viewed as a neutral site eliminating potential conflicts between competing participants, reducing potential favoritism to a firm and eliminating the possibility of seeing proprietary work at an office.

Once the workshop locations and dates were set invitations are sent to potential participants (Appendix A). The invitations described the workshop content, how participants could benefit, and the workshop timeline. E-mails were sent to principals leading architectural and landscape architecture firms who specialized in designing zoo exhibits. The principles then extended invitations to other members in the firm and other designers. Invitations are also sent to design and education staff at the zoo where the workshops are located. Two-weeks after sending invitations follow-up phone calls are made to answer questions and entice participation.

For each workshop, between five and ten participants were expected. The small group in the workshops is a manageable number to lead discussions and control the charrette. Gibson (Gibson Jr. and Whittington 2010) suggests between 6-10 participants for small group breakout activities during focus groups and Klatt (Klatt 1999) suggests between 2-7 for group activities with discussions and interactions in small groups. The small sample group is appropriate for the charrette; however, is not a large enough sample for statistical analysis of the survey results to be extrapolated outside the study. However, an investigation of the total number of zoo designers through informal phone calls to design firms about indicated about 150 total professionals nationally. The target audiences at two locations would then represent approximately 13 percent of the total zoo design population. This is acceptable because generalization of the survey results is not the intent of the research study, but rather to determine if a set of designers change their design approach.

Triangulation Analysis Method

During the workshop participants produced many comments and ideas for engaging visitor's cognitive processes. These products could result in design guidelines as the designs from the personal charrette had shown potential in the repeated application of learning theories. To analyze the workshop comments and ideas for patterns a technique was needed to analyze the workshop discussions and designs for design guidelines.

Even though previous studies were discovered using workshops as a methodology for dispensing information, gathering expert experience, and measuring increases in knowledge, no prior studies could be found using a workshop to develop design guidelines from comments and sketches. Gibson provided guidance in using a workshop for exploratory studies using multiple data collection methods to triangulate findings and conclusions. "Triangulation is the combination of multiple methodologies in a study of the same subject area such that the multiple sources indicate key parameters that can be ascertained by study of all results (Gibson Jr. and Whittington 2010)." From this general analysis strategy, a triangulation analysis method was developed using the products from the workshop, the personal charrette outcomes and literature to develop design guidelines to enhance learning by designing for cognitive processes in zoo exhibits.

Comparison analysis

The triangulation analysis methodology takes strategies and tactics found in the designs which are used to engage visitor's learning processes and compares them to other design strategies found in other sources. The sources include the comments and designs from the workshop, design ideas from the personal charrette, and literature on zoo exhibit design and zoo interpretation. When similar strategies are found in multiple sources the strategy is validated as a design guideline.

A preliminary step to the triangulation methodology was to first understand how the comments and ideas generated in the workshop engage visitor's learning processes (Figure 2.22). The review of the designs looked for the presence of learning theories by critically deconstructing the design strategy for how visitors

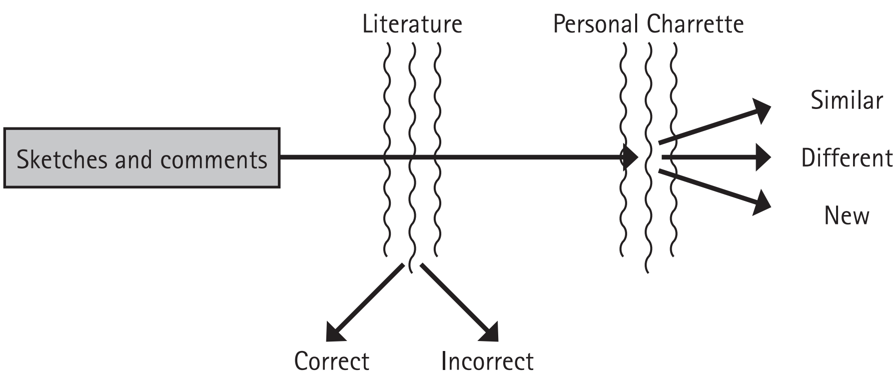


Figure 2.22
Comparison analysis

learning in the strategy and how the strategy follows the learning theories. Next, the strategies are compared to the strategies used in the personal charrette by looking for similarities, differences and new strategies to further understand the design strategies. These initial steps identify the tactics and strategies participants used to design for visitor's cognitive processes.

Triangulation analysis

The methodology used for this study is an innovative way to measure design approach and develop design guidelines. The triangulation analysis method is a new technique for developing design guidelines but is only possible through the innovative use of the workshop. The workshop is a unique way to provide professionals with new information and capture their experience in using their application of the information. For the workshop to be successful it pulled from both the personal charrette and Chan's five factors used to develop the survey. The content and organization of the survey is a new technique for measuring design approach. For all of the innovative methods used they would not be possible without the personal charrette which identified the research question leading to the methods.

The triangulation analysis methodology pioneers methods for developing design guidelines by engaging professionals and synthesizing literature resulting in design guidelines. The guidelines created using the triangulation analysis are supported by both professional experience and literature

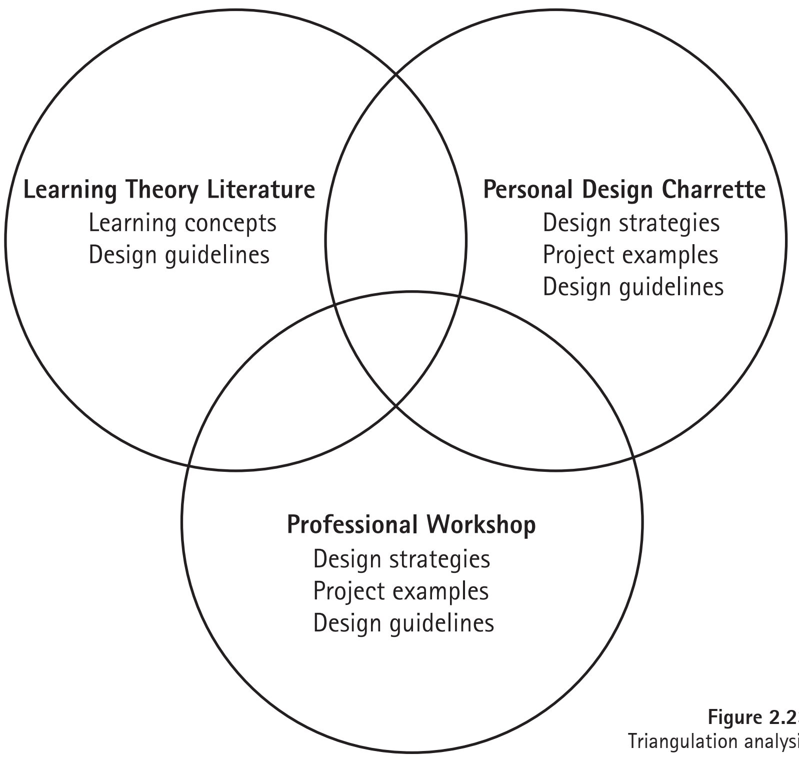


Figure 2.23
Triangulation analysis

indicating they have the greatest potential to engage visitor's cognitive processes increasing learning.

The selection and development of the methods required research outside of the original area of study, zoo exhibit design, resulting in a fruitful blending of other research to understand how zoo exhibit designers can design for visitor's cognitive processes. In the process, the methodology charted new territory for measuring design approach and developing design guidelines.

The methodology used for this study is an innovative way to measure design approach and develop design guidelines that are validated by professionals in the field. The triangulation analysis method is a new technique for developing design guidelines but is only possible through the innovative use of the workshop. The workshop is a unique way to provide professionals with new information and capture their expertise in their application of the information. For the workshop to be successful it pulled from both the personal charrette and Chan's five factors to develop the pre and post surveys. The content and organization of the survey is a new technique for measuring design approach. In this case, all of the innovative methods would not be possible without the personal charrette which identified the research question leading to these particular methods.

Discussion

Figure 3.0
What do you recall?

Workshop Products

The innovative methods using a workshop, survey and triangulation analysis proved successful in determining changes in participant's design approach and in developing design guidelines. The workshop provided professionals with information about learning theories and captured their experience through discussions and designs. During the workshop participants generated design ideas for engaging zoo visitor's learning processes through their comments and sketches. In conjunction with the workshop, the pre and post-surveys measured increases in design approach.

Not only did the workshop provide evidence of changes in design approach, but also valuable information in developing design guidelines for learning. The designs from the workshop were another input into the triangulation analysis with the personal charrette and literature to validate design strategies as guidelines.

Workshop participation

Before developing design guidelines or holding the workshops, the locations of the workshops were located and scheduled. Two locations were selected for the workshop one in St. Louis, Missouri and one in Seattle, Washington. Prior contacts in the St. Louis area with the architectural firm PGAV, from an internship were capitalized on per literature recommendation. Gibson suggests using previous contacts in workshops because they are more likely to participant (Gibson Jr. and Whittington 2010). The second workshop location was Seattle, Washington. Seattle was chosen as the location for the second workshop because Seattle has the greatest concentration of zoo exhibit design firms. The architectural firm Jones and Jones was selected as the contact to assist in coordinating the Seattle workshop. The two firms, PGAV and Jones and Jones, became the contact firms to assist in coordinating the set-up of the workshops.

Through correspondence with PGAV, contacts were made with the St. Louis zoo and the workshop was scheduled at the zoo for September 29, 2011. In talking with Jones and Jones to set up the Seattle workshop, they preferred the workshop to be located at their office instead of Seattle's Woodland Park Zoo, as originally planned. Following their recommendations the Seattle workshop was scheduled for October 6, 2011 at the Jones and Jones office.

After scheduling the firms and extending invites to participants a total of nine people participated in the workshops. For the St. Louis workshop at the zoo, six people participated with two additional zoo staff members joining for parts of the day. In Seattle, one person participated in the workshop at the Jones and Jones office.

The workshops provided participants with information about learning theories and opportunities to further their understanding of the learning theories through activities called Interactions. After providing participants with the learning theories, they applied the learning theories while designing hypothetical zoo exhibits during a structured design charrette following the design process developed in the personal charrette. The comments and sketches from both charrettes are discussed simultaneously as to not compare the two workshops. All sketches and designs created during the workshops are provided in Appendix E.

Introduction

The first section in the workshop was the introduction in which motivation is explained. During Interaction 1.0 participants described their motivation for designing zoo exhibits. Participants primarily described their motivation as a desire to create safe, healthy and stimulating environments for animals. This motivation could be due to some participants being inspired to become zoo exhibit designers after experiencing animals in poor living conditions. In comparison to a motivation to design exhibits, other participants began designing zoo exhibits as a result of fortuitous events such as being hired by a zoo design firm. Even though participants placed emphasis on animal well-being as an initial reason for designing exhibits, they did express education and inspiring people as a reason for designing zoos. However, participants did not explicitly discuss conservation as a driving factor. Not discussing conservation could be a reason for education not being a higher priority since conservation is the objective of education programs designed primarily by interpretive designers or zoo education staff. Since participants did not discuss visitor learning as a primary factor driving their motivation, their comments could reflect a minimal influence of learning in their personal design approach compared to other factors such as animal well-being. The survey demonstrated similar responses in questions about the roles of zoos (Figure 3.1).

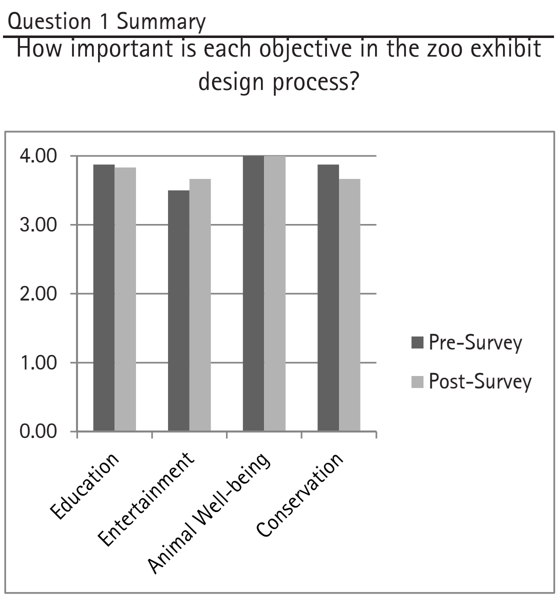


Figure 3.1
Roles of zoos in society

Contextual Model of Learning

After the introduction describing learning and cognitive processes the next section describes the Contextual Model of Learning. During the segment participants learn the factors influencing learning in zoos and watch a video of visitors in a zoo exhibit (Figure 3.2). After watching the video during Interaction 1.1,

Figure 3.2
Image from video clip during Interaction 1.1

participants identified most of the factors described in the Contextual model of Learning, while working in small groups. Participants focused the discussion on the Physical Context of the exhibit, specifically the location of an interpretive sign at the edge of the viewing area. Participants suggested the sign location limited visitor's learning by creating a disconnect between how the visitor engaged the information and the animal. They thought the sign needed to engage visitors with the lions. Participants felt that once visitors are interested in the animals they then desire information. Contradicting this belief, participants thought that since the sign did not distract visitors from viewing the lions the exhibit created opportunities for visitors to create their own meaning from the situation.

Participants spent significant time discussing the relationship between the animal and the visitors suggesting that an additional factor for the Physical Context in zoo environments is the animal in the exhibit. The animal was important in shaping the visitor's experience because the lions were very close to the glass and active. Visitors looked at the lions and the lions watched them, attracting workshop participant's attention. Participants discussed the interaction between guests and the exhibit, specifically the order in which they engaged the space, sign, animals and other guests.

Participants also discussed the sociocultural and personal contexts. The large viewing window encouraged socialization between guests as they viewed the same scene. Visitors shared much of the experience verbally by relating their prior knowledge of lions such as children calling the lions Simba and Nala from the Disney movie Lion King.

While participants were discussing the sociocultural, personal and physical context, they also referenced the workshop manual for the list of factors and identified the factors in real experiences outside the theoretical context of the model. This suggests participants understood the Contextual Model of Learning and the basic fundamentals underlying free-choice learning, contributing evidence that they have some knowledge to form learning constraints.

Visitor Identities

After learning about the Contextual Model of Learning participants explored visitor's motivation for learning through the needs of visitors, as described in the Visitor Identity theory. During the workshop activity Interaction 1.2 participants described their Identity and how to engage the different Identities.

All the Identities were expressed by at least one participant, however some Identities were described more than others. There was an emphasis on the Facilitator, Recharger, Explorer and Professional Identities. An interesting note about the Professional Identity is all participants expressed some degree of a Professional Identity by both analyzing and learning how to improve their designs. However, some participants described a conscious effort to depress their Professional Identity because it distracts them from enjoying exhibits.

During the discussion participants reiterated much of the information provided in the presentation when sharing detailed descriptions of their zoo experiences. Even though the descriptions repeated information, such as providing opportunities for Facilitators to demonstrate their knowledge to others, some ideas were useful to guide design. For example, Rechargers may like intimate interactions with animals during which they may make connections with animals by anthropomorphizing them. For Explorers, participants suggested creating interactive and sensual experiences to attract their attention. During these encounters Explorers may disregard authority so designers need to take extra precautions in some situations. For the Experience Seeker, participants suggested ways to later remember the experience such as photography, mobile media and visceral experiences.

Not many specific ideas were generated for how to design for the different Identities. However, the primary purpose of the activity was not to generate ideas, but rather increase participants understanding of the different Identities so that participants can use the information to inform later workshop activities.

Experiential learning model

After establishing a basic understanding of learning in the zoo using the Contextual Model of Learning and Visitor Identity theory, participants took a closer look at specific learning processes in the Experiential Learning model. The model describes how people learn from concrete experiences by making abstract conceptualizations.

To begin the session activity Interaction 2.0, participants discussed how someone would learn what a snake feels like for the first time. One participant was able to accurately describe the learning experience following the steps of the Experiential Learning model. She explained she has observed many people encountering snakes for the first time as how she understood the steps. Her description was interesting because before the workshop I had hypothesized participants would not be able to describe the steps. This hypothesis was true for all other participants as they could not provide an adequate description indicating participants did not have a complete grasp of learning, at least in the context of learning from personal experiences similar to the snake example.

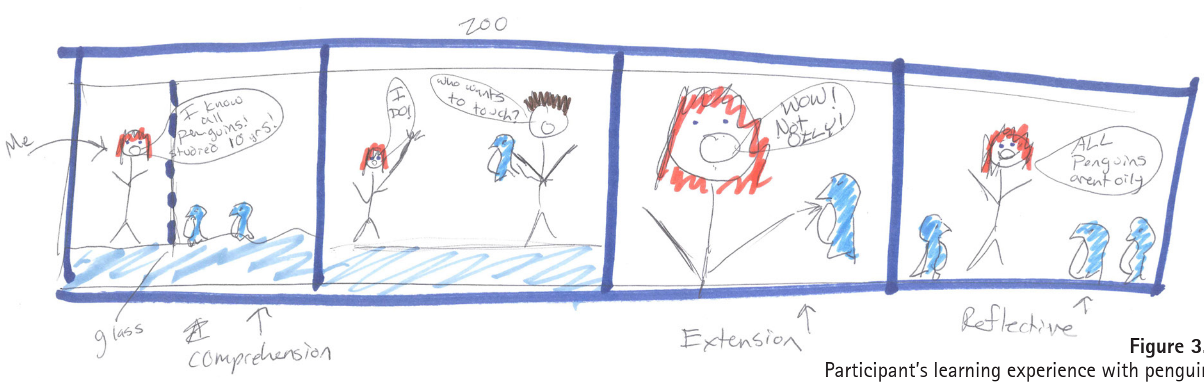


Figure 3.3
Participant's learning experience with penguins

After discussing the snake example, the Experiential Learning model was presented after which participants began Interaction 2.1. During this workshop activity participants described a personal learning experience in a zoo. Most of the experiences described were one-on-one experiences with animals. For example, one participant described petting penguins for the first time identifying how the interactive and sensually engaging situation allowed a change in their abstract conceptualizations of penguins' fur (Figure 3.3). Many of the experiences caused participants to redefine preexisting knowledge, or supported an abstract concept learned elsewhere. The descriptions mostly described their thoughts and actions with the animal while the physical design of the space relatively unaffected their experience.

The similarity between experiences of interactions with animals could be due to the snake and lorikeet examples provided during the presentation. Or, similarities could be due to participants not having a strong enough understanding of the theory to apply it in different contexts. This could be the case because participants requested additional clarification and explanation of the Experiential Learning model.

Multiple Intelligences

After learning about the overall learning process of the Experiential Learning model, participants learned about individual's different cognitive processes as described by Multiple Intelligences. During the workshop activity Interaction 3.0, participants worked in groups to develop ideas for how to engage each of the defined Intelligences. The ideas generated were primarily small scale ideas describing interpretative elements and visitor's interactions with the elements.

For example, one interpretive element idea generated during the workshop appealing to the Logical Intelligence is a large balance scale comparing the weight of a truck to the amount of food an elephant eats (Figure 3.4). Another interpretive element idea integrated into the

Figure 3.4
Comparison of elephant food to truck

exhibit form engaging visitors in a physical activity used the exhibit pathway as a noise making device. Visitors would step on different areas of the pathway to create noises imitating animal sounds (Figure 3.5). Another visitor activity described involved engaging visitors not with the exhibit form, but with the animals in the exhibit is the activity of communicating with

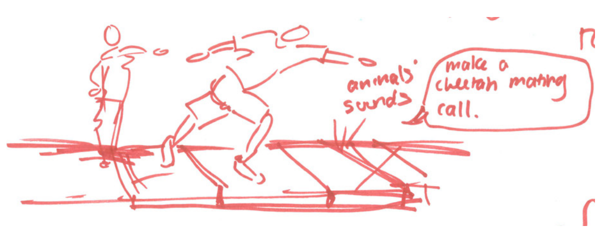


Figure 3.5
Noise making pathway

chimpanzees. Participants described visitors interacting with trained chimpanzees by communicating with them using a language of shapes and symbols. This activity not only appeals to the Linguistic Intelligence but the experience creates an intimate connection with animals appealing to Identities as described in the previous section.

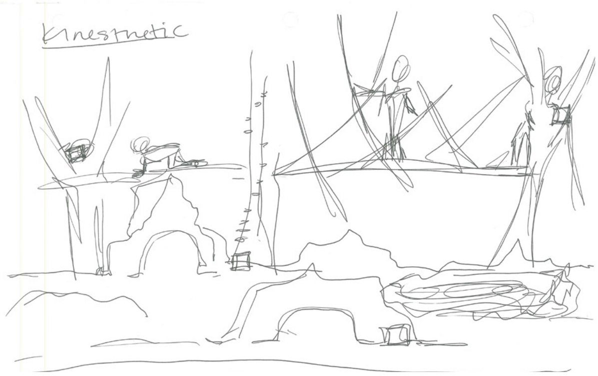


Figure 3.6
Using clues to locate animals

Other ideas explored not only interpretive elements, but also how the exhibit form itself can engage different Intelligences. For example, visitors could use clues in an exhibit to locate animals. The exhibit described contained many animals and multiple clues throughout the landscape which visitors would use to find animals (Figure 3.6). Another example had visitors working together in the exhibit to find their 'mate'. This exhibit idea required visitors to participate in the activity by navigating the exhibit space. One final visitor activity example workshops participants described encouraged visitors to mimick animal's behavior. The activity could become a theme throughout the exhibit because different animals and behaviors could be mimicked creating a diverse and varied visitor experience.

Gagne's Information-processing model

After developing ideas for engaging different Intelligences, participants learned about Gagne's Information-processing model and applied the model by analyzing their personal learning experience previously described during Interaction 2.0.

During the workshop activity Interaction 4.0, participants recalled their learning experience use earlier in the day to analyze the Information-processing model. Many of the participants identified the different stages, however the response stage was not necessarily present. The descriptions lacked specific details about the design of the exhibit which could be again due to the type of learning experience, one-on-one interactions with animals.

After analyzing their learning experience for use of the Information-processing model, participants generated ideas for the Instructional stages. Participants produced few specific examples during Interaction 4.1. Instead, they centered the discussion on general topics and design strategies associated with some instructional stages.

During the Gain Attention and Stimulate Recall stages, participants discussed the use of unexpected and controversial exhibit elements. Participant's conversations could have been triggered by presented images showing Steinbrener and Dempf's artwork in zoos. The images contained unexpected elements to spark visitors to think about environmental issues and problems (Steinbrener and Dempf 1996). Participants had mixed opinions about the use of unexpected and potential controversial elements in an exhibit design. For example, some participants interpreted the image with the penguins and the oil well (Figure 3.7) to be "artistically telling us we are ruining the environment," while others thought visitors would believe penguins live in harmony with oil wells.

Figure 3.7
Oil well juxtaposed with penguins

Participants discussed how unexpected elements could grab visitor's attention and create a memorable experience. However, the elements could potentially confuse visitors resulting in the embedded meaning not being understood. For the exhibit message to be communicated zoo staff or the exhibit itself would need to explain how the element relates to the exhibit message, so that the situation is not misinterpreted. Participants further explored the use of unexpected elements during the structured design charrette.

When visitors encounter unexpected elements they recall information about the element to create meaning. Similarly, participants discussed how to prompt visitors to recall specific prior knowledge by relating information back to the audience using an exhibit element familiar to most visitors. The exhibit element allows visitors to make an associate between the element and prior knowledge. Designers therefore need to make an assumption about the information visitors will associate with the element. This assumption is potentially counterproductive to learning because the recalled prior knowledge could result in misinterpretation of the exhibit. Visitors may recall information not intended by the design because they determine how to associate prior knowledge with elements, resulting in visitors using their prior knowledge to contextualize the exhibits incorrectly leading to misinterpretation.

Another strategy participants discussed is how to increase visitor's long-term understanding of information during the Retention and Transfer Instructional stage. Visitor's retention of information was perceived by workshop participants to increase with the number of times participants encounter information in an exhibit. Strategies include repeating messages throughout the exhibit using multiple methods of communication such as audio, written, video, etc. and distributing messages in different ways beyond obvious signs such as subtle carvings in trees.

Bloom's Taxonomy

While presenting the Instructional stages Bloom's Taxonomy was presented to guide participants in designing for the Performance and Feedback stages. After presenting Bloom's Taxonomy, participants completed Interaction 4.2 where they recalled their learning experience from Interaction 2.0 to analyze the use of Bloom's Taxonomy.

As a group, participants evaluated their learning experience higher in the taxonomy than expected, usually to a level of Analyze or Evaluate. Based on my understanding of their learning experience, I thought they generally overestimated their learning experiences. Typically the experience should have been at the Understanding level.

Participants then generated ideas for achieving higher levels of thinking in zoo exhibits. To reach higher cognitive processes, participants indicated visitors could be shown controversial images such as illustrating the good and bad things resulting from an oil spill causing them to analyze the two situations. Another example developed provided an envelope for visitors to write to politicians or businessmen reaching a creative level of thinking.

Structured Design Charrette

After learning about the different learning theories presented throughout the workshop participants applied the theories during the design of a zoo exhibit. To design the hypothetical exhibits participants followed the design process pioneered in the personal charrette during their structured design charrette. Participants created three exhibit designs.

The process began with Interaction 5.0 where participants selected the topic of the exhibit. All of the topics except one focused around one animal and an environmental problem facing the animal such as human impacts changing polar bear's habitat. The one project not centered on an animal focused around the resource conservation techniques of reduce, reuse and recycle.

Participants developed the goals and objectives for each of their exhibits during Interaction 5.1. The goals focused on the causes of the environmental problems associated with the selected topic. For many participants, the goals explaining how the exhibit would engage visitor's learning processes related to ways visitors could contribute to conservation in their daily activities. The goals were generally an understanding of something, for example "understanding clean water is vital to both otters and guests alike." Participants also augmented the basic strategy with emotional factors such as "make people care" or "inspire people to care." However, one goal targeted a specific cognitive process which began to describe a learning strategy such as using a series of questions, "Do you buy bottled water? Where do those bottles end up?"

Interaction 5.2 had participants use the goals they created to develop and identify the concepts for their exhibit by creating a Concept Hierarchy Diagram. The diagrams participants produced were very complex, typically arranging the concepts into a series of concepts forming a thread building to a central concept. One participant developed a color coding system to simplify communication of the diagram by highlighting

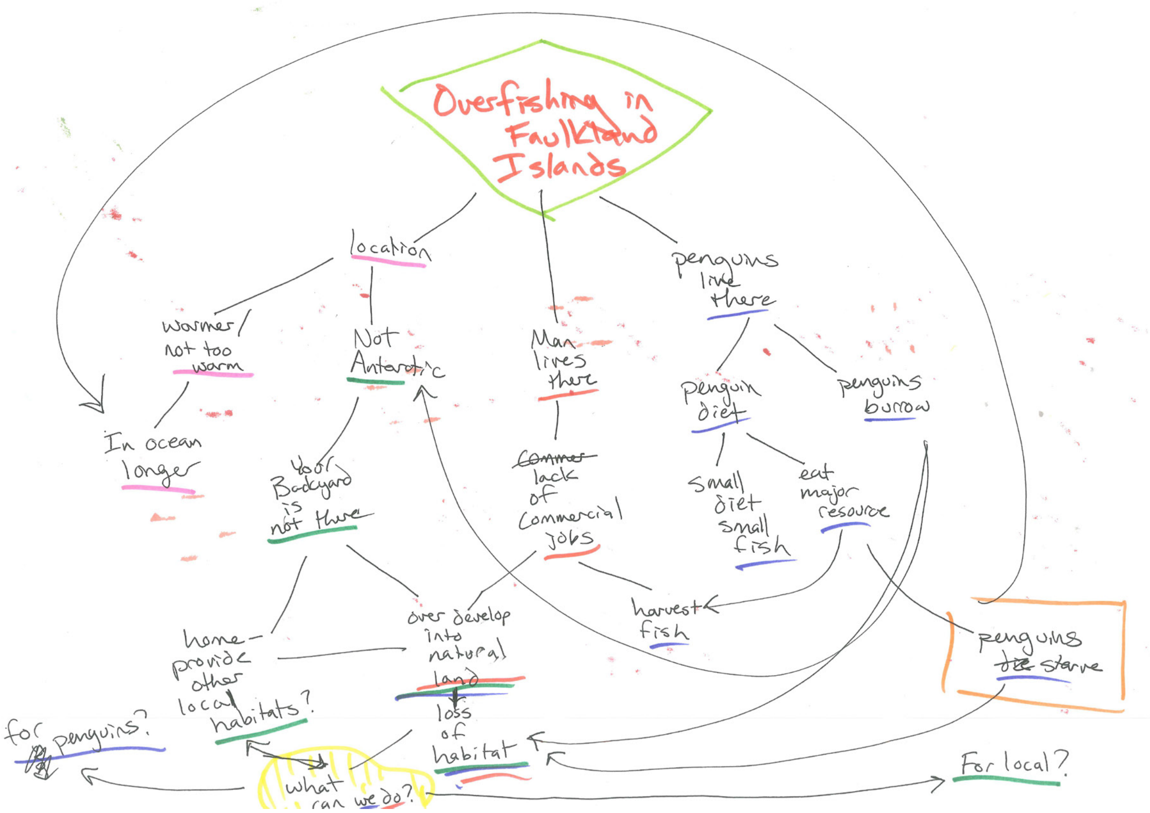


Figure 3.8
Color coded Concept Hierarchy Diagram

similar concepts and combining colors where concepts overlapped (Figure 3.8).

During the discussion of the Concept Hierarchy Diagrams, one participant described the integration of visitor's prior knowledge into the diagram. She integrated the strategy of encouraging visitors to recall common knowledge such as nationally recognizable companies and daily activities into the diagram.

Next, participants developed the cognitive strategies the exhibit would employ to intentionally engage specific cognitive processes. Participants organized the strategies into the Cognitive Process Diagram illustrating the intended cognitive processes the exhibit would engage during Interaction 5.3. The diagrams participants created followed primarily two tracks of strategically sequencing a set of cognitive strategies to work together (Figure 3.9) or using one cognitive strategy repeatedly (Figure 3.10).

Participants spent much of the design time on the Cognitive Process Diagram and developing strategies and program for engaging a visitor's cognitive processes. While participants were creating the diagram they referenced the information presented throughout

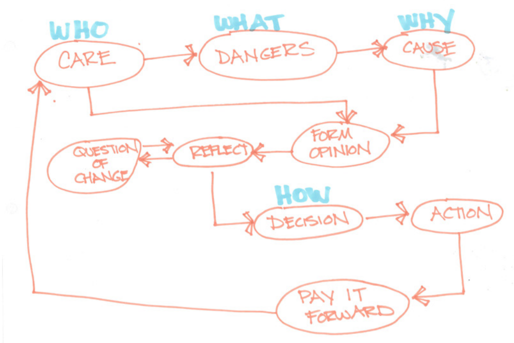


Figure 3.9
Cognitive Process Diagram using strategic sequencing

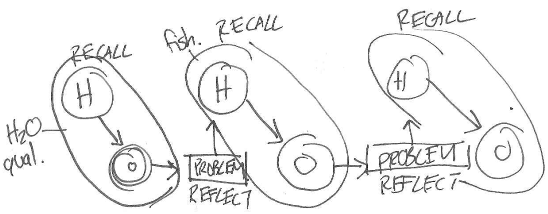


Figure 3.10
Cognitive Process Diagram using repetition

the day without prompting. For example, participants used Bloom's Taxonomy to evaluate their diagrams. As participants transitioned into the programming and design phase for Interaction 5.4 they referenced not only the Cognitive Process Diagram, but also the Concept Hierarchy Diagram to design the exhibit. In total participants designed three exhibits centering around otters, polar bears and wolves.

Otter exhibit outcomes

The Otter exhibit designed by workshop participants focused on explaining concepts about water quality and pollution and were communicated through what otters eat, drink and where they play. The cognitive strategy participants developed encouraged visitors to evaluate the water the animals are living in to the water they would want to use (Figure 3.11). Participants best

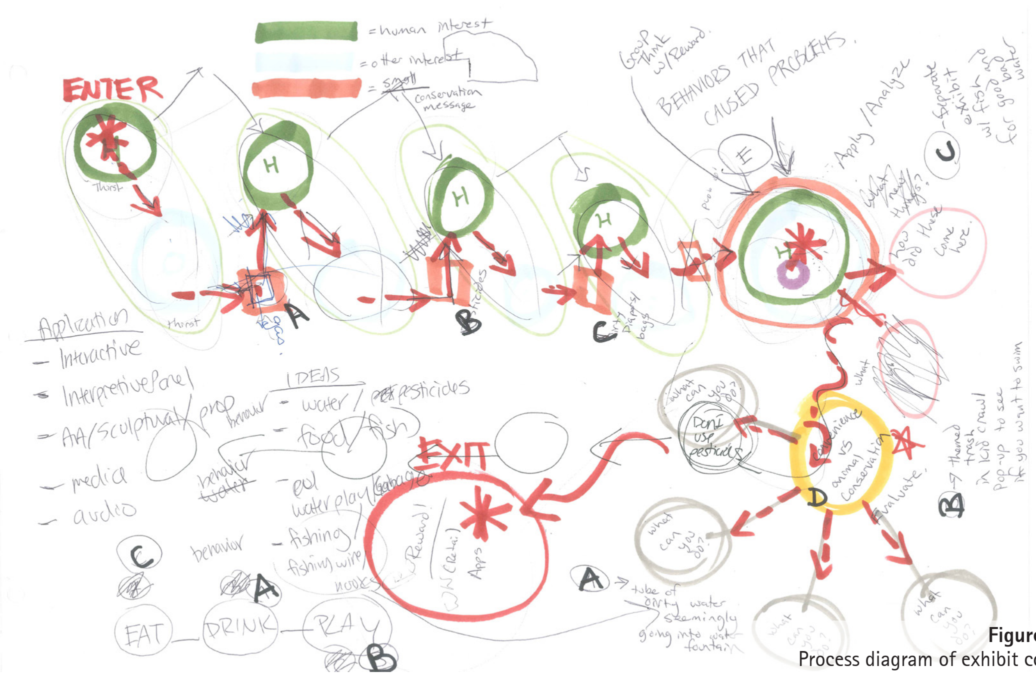


Figure 3.11
Process diagram of exhibit concept

described the cognitive strategy as, "You drink water. Otters drink water. Would you drink the water?" This cognitive activity was continually repeated, changing the subject, through the exhibit from drinking to eating and playing.

In the exhibit design concepts, visitors encountered situations with poor water quality such as polluted water and trash in the exhibits (Figure 3.13). While designing, the group discussed when visitors should encounter these negative elements during the exhibit sequence; first, last or in the middle? The group decided the elements should be at the beginning as the exhibit experience should end on a positive note.

When visitors encountered the unexpected situations in the designs, the design elements encouraged visitors to recall prior information such as what they use and what otters use to reflect on the situation. The exhibit culminated with visitors working together to complete a task to understand why the problems occurred. During this designed 'group think' activity, visitors were envisioned to receive an intrinsic reward when completing the activity by seeing the otters swimming above them (Figure 3.14).

Workshop participants originally conceived the exhibit would continue past the group think area, but participants ran out of time and did not complete the second half of their exhibit design. In the section which was not completed, visitors were asked about their behavior, specifically products they bought and how their choices affected otters' habitat. As the participants discussed this exhibit strategy they

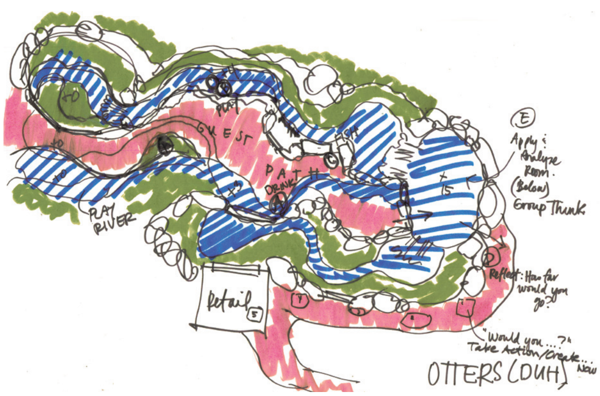


Figure 3.12
Otter exhibit plan

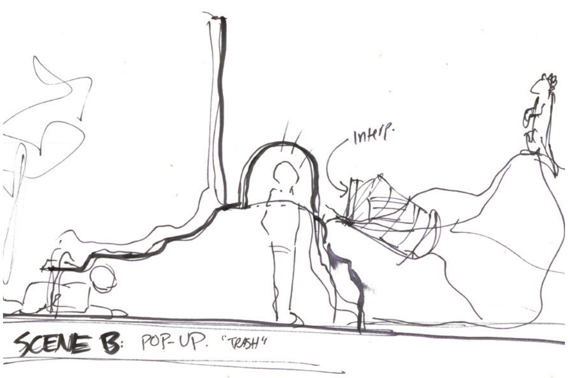


Figure 3.13
Oil drum in the otter exhibit

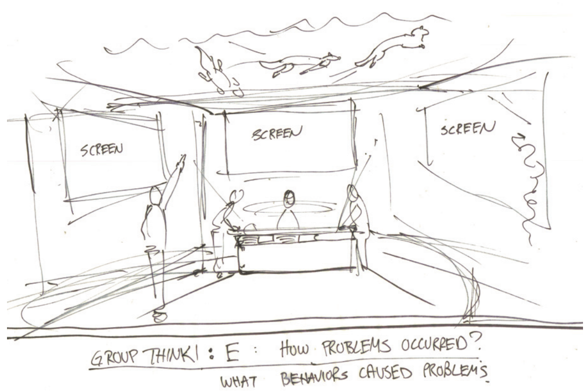


Figure 3.14
Group think area

brainstormed concepts such as having the exhibit end in a retail situation. When visitors chose the otter friendly items they would be rewarded with an extrinsic reward. The reward would go with visitors outside the zoo and remind them of conservation.

Polar Bear exhibit outcomes

Another exhibit designed during the structured design charrette was about polar bears and climate change (Figure 3.15). The participant's Cognitive Process Diagram was a series of different cognitive activities aimed at inducing a particular emotional state in visitors as they learned (Figure 3.16 and 3.17). Visitors would first have a close encounter with polar bears in a beautiful natural habitat to inspire visitors to care. Then visitors would encounter an unhealthy polar bear habitat created by climate change. In this exhibit design concept, educational elements were conceived to explain the causes of habitat degradation and the causes of the destruction.

The design concept then suggested visitors would recall their prior behavior as they encountered the next exhibit area where reflection is encouraged using small quiet spaces. After reflecting on their current behaviors visitors

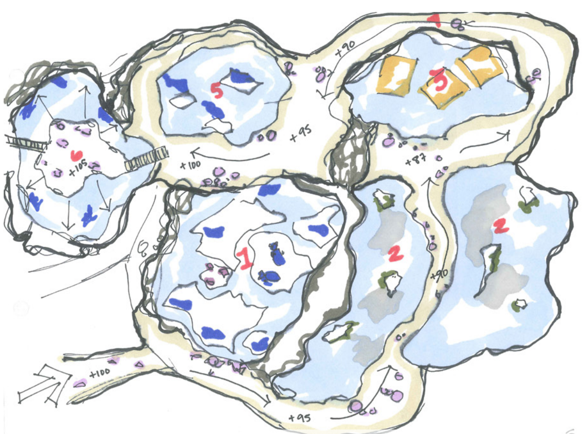


Figure 3.15
Polar bear exhibit plan

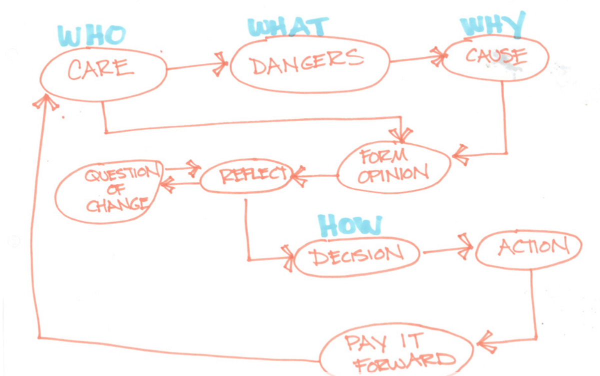


Figure 3.16
Cognitive Process Diagram

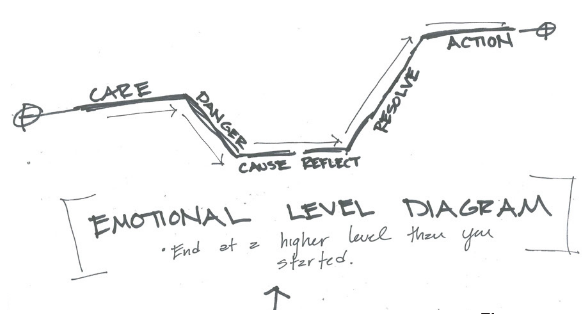


Figure 3.17
Group think area

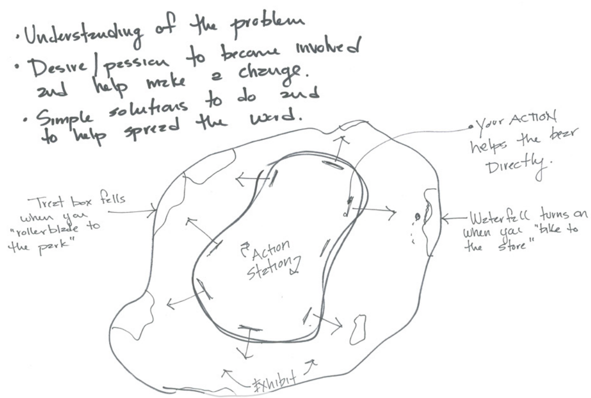


Figure 3.18
Activity area effecting the animal's area

would learn how they could improve polar bear habitat by reducing their own personal carbon footprint. Visitors would use the information about reducing carbon emission to help the polar bears in the next exhibit. This concept had visitors engage interpretive elements such as riding bikes which caused events to happen in the exhibit such as turning on waterfalls and feeding the polar bears (Figure 3.18). The exhibit ended on a positive note after seeing the effects of climate change on the polar bears by showing how habitats can improve through conservation actions.

Participants used emotions to augment the cognitive activities facilitated by the exhibit they designed. However, participants did not provide detailed descriptions of how the exhibit stimulated the emotional reactions except for an overall strategy of changing the topographic elevation following the intended emotional state of the visitor (Figure 3.17).

Wolves

The third exhibit design challenge asked participants to focus on wolves in the American northwest and change visitor's perception of wolves (Figure 3.19). In the exhibit, visitors first encounter cattle which are one reason for conflicts between humans and wolves. To communicate the wolf and cattle conflict the exhibit demonstrated the concepts by displaying cattle instead of using a sign to illustrate the concept. The participants discussed the benefits and problems of using a familiar animal like cattle instead of a more traditional exotic animal. Participants thought using cattle would not be possible in zoo exhibits because visitors do not desire to see these animals in a zoo, but to best communicate the concept were included in the exhibit anyway.

After encouraging visitors to recall their potential misconceptions about wolves eating cattle visitors then encounter the typical food of wolves, deer. In the design concept visitors encounter wolves eating a deer carcass.

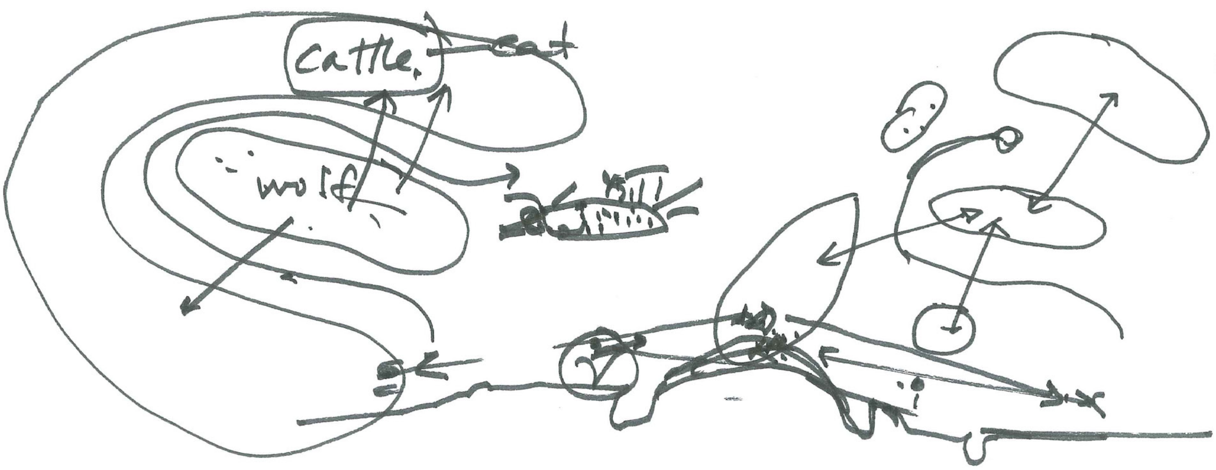


Figure 3.19
Wolves exhibit plan and section

Participants discussed the use of graphic elements such as the deer carcass and that such elements would probably not be included in zoo exhibits. At the end of the exhibit visitors would be asked to reassess their perception of wolves by deciding if wolves should be allowed to exist.

Conclusion

After completing the exhibit designs participants shared their designs with the other participants, during Interaction 5.5. Participants expressed they felt their designs were new exhibit types. One difference was the 'negative' tone of the exhibits such as the degraded polar bear habitat and the polluted otter habitat. The idea of using unexpected elements was new to participants, however the implementation techniques of propping and themeing were seen as not new. Participants implied that for the designs to communicate and engage visitors, unexpected elements are needed in an exhibit. They explained the challenge in using the elements was in not making the exhibit too depressing. The exhibits should try to strategically use the depressing situation and counter the negative emotions with positive emotions by inspiring visitors and making the exhibit 'fun and whimsy.'

In addition to the unexpected elements, participants thought the visitor activity in the polar bear exhibit was innovative. The activity area in the polar bear exhibit engaged visitors with an interpretive element requiring the use of their knowledge resulting in actions affecting the animal. The innovative component was the integration of direct interaction between animals while completing the activity.

In addition to the innovative design elements, participants also thought the design process itself was innovative. One participant suggested that the innovation in their otter exhibit design was in the 'group think' area. The participant explained they would have not developed the space for visitors to evaluate and analyze their behavior if it were not following the design process and applying the information presented during the workshop.

Participants demonstrated increases in learning and application of the presented learning theories during the workshop activities and structured design charrette. Evidence of their learning and application is in the three exhibit designs and many other ideas developed for engaging and facilitating cognitive processes (See Appendix E). However, if participant's new knowledge of learning theories results in changes in their design approach would require analysis of the pre and post-survey for changes in Chan's factors.

Survey Results

To understand how participants changed their design approach the pre-survey was compared to the post-survey. During the analysis surveys from both workshops were grouped together as to not compare the two workshops individually. The survey responses were analyzed primarily by investigating the mean and standard deviation between the pre and post-surveys. To understand the degree of change for each question the statistics were compared relative to other questions. The analysis of the surveys was separated into Chan's five factors (goals, constraints, mental imagery, search pattern and order and personal preferences). Chan's factors guided the analysis by identifying relationships between sets of questions. For all the survey responses see Appendix F.

Goals

The first set of survey questions addressed a participant's formation of goals. Designer's use goals to identify the design problems and to guide the recall of prior knowledge needed to develop solutions. The survey measured participant's design goals by evaluating the influence of learning in the zoo mission, design project and the individual designer. Additionally, participants were asked to recall prior knowledge used to solve design problems which the survey measured by understanding the literature available to and used by participants.

First, the overall influence of the roles of zoos to society - education, entertainment, animal well-being and conservation – in the design process was measured. The four roles were compared to determine their influences on participant's design decisions. Overall participants ranked all four roles very high with little variation between the pre and post-survey (Figure 3.20) indicating that visitor learning is not the first priority, but one of many priorities. The subtleties between responses are confirmed by participant's description of their motivation during the workshop introduction where they indicated animal well-being was the most important factor.

Question 1 Summary

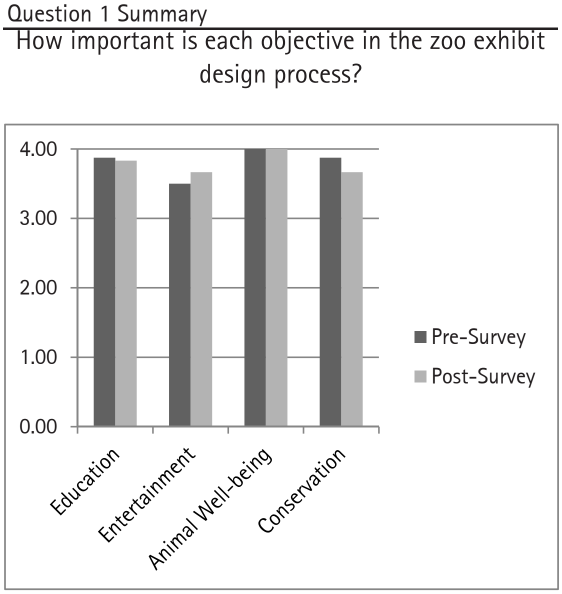


Figure 3.20
Influence of zoo's role in society

After understanding the zoo's role in influencing participant's goals, more specific but still overall goals of the zoo mission and exhibit objectives influence on learning was measured. The influence of objectives in projects from the zoo mission, proposed project objective and message were higher than participant's personal goals suggesting participants may feel they do not know how to develop goals for learning (Figure 3.21). However, the personal goals average increased by

Question 2 Summary

To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitors's thought processes?

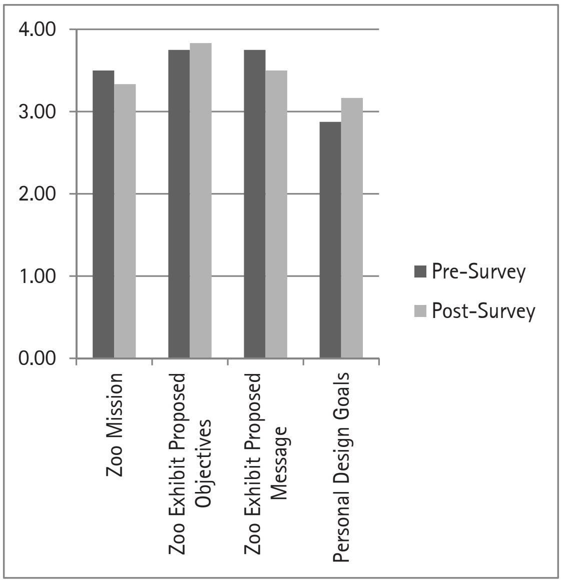


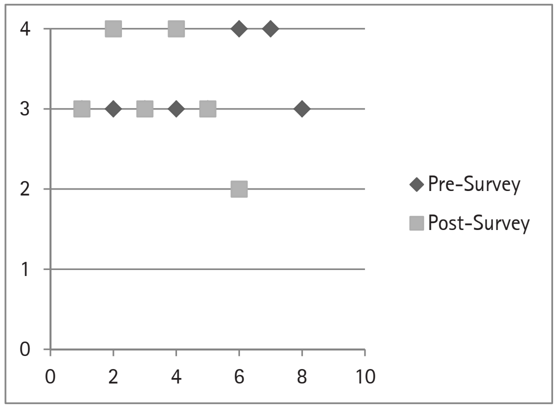
Figure 3.21
Influence of mission and project objectives

0.29 to 3.17; but, participants were not in agreement given the standard deviation increase from 0.83 to 1.17.

Even though the project objectives are more influential than the learning objectives, participants indicated zoo exhibit learning objectives weakly influenced design decisions with a post-survey average decrease of .08 to 3.17 (Figure 3.22). More defined project objectives would be important to improve because designer's personal goals for engaging visitor's cognitive processes showed a relatively low average decrease from 3.25 to 3.00. Also, participants were not in agreement with a significant standard deviation increase of 0.71 to 1.10 (Figure 3.23).

Question 20

Zoo exhibit learning objectives help guide design decisions.

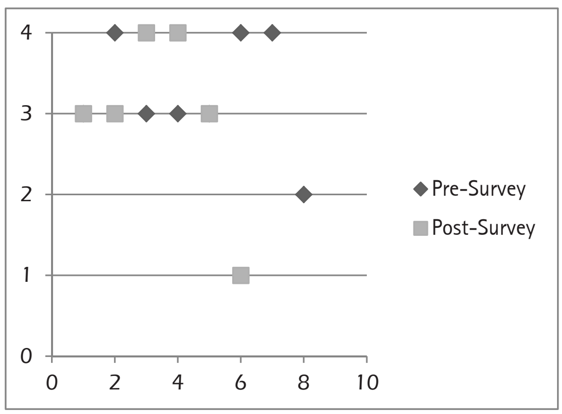


	Mean	SD
Pre-survey	3.25	0.46
Post-survey	3.17	0.75

Figure 3.22
Influence of zoo exhibit learning objectives

Question 19

Engaging visitor's thought processes is a personal goal when designing zoo exhibits.



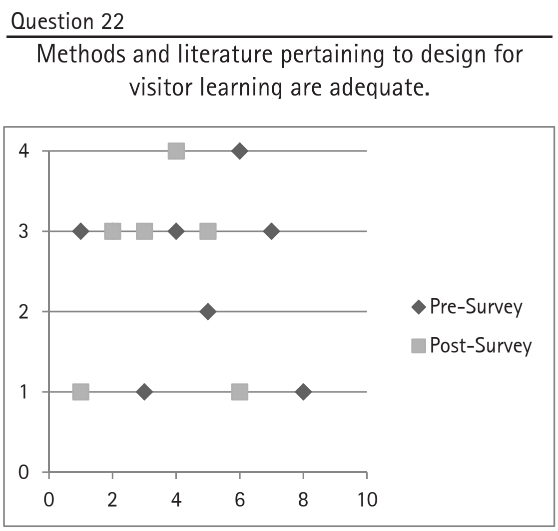
	Mean	SD
Pre-survey	3.25	0.71
Post-survey	3.00	1.10

Figure 3.23
Engaging visitor's thought process is a personal goal

One possible reason for personal design goals being relatively low is revealed in questions about literature on designing for learning. If participants do not have prior knowledge to use in designing for learning then they may not form goals to recall prior knowledge about learning. Participant's prior knowledge recalled is measured by understanding the existing literature and methods referenced during the design process.

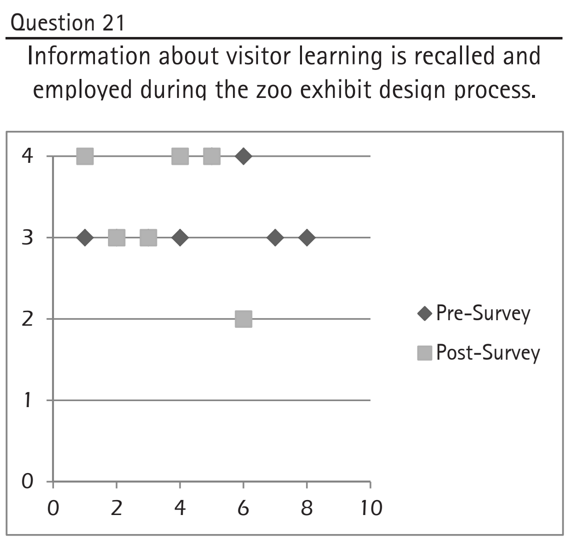
Participants identified a gap in the literature for designing for learning (Figure 3.24). The question had the lowest average out of all survey responses of 2.50 for both pre and post-survey. Suggesting participants do not know where to find information about learning to guide the formation of goals. However, a relatively high standard deviation increase from 1.07 to 1.22 indicated participants were not in agreement.

Also, the information participants recalled and employed during the design process had similar low responses (Figure 3.25). However, the response averages were higher, 3.25, and slightly increased to 3.33 in the post-survey. Similarities between the available literature and the application of information suggest participant's knowledge not only is weak but their use of knowledge during the design process is lacking. The increase does suggest the workshop provided participants with methods for how to employ their knowledge in the creation of goals.



	Mean	SD
Pre-survey	2.50	1.07
Post-survey	2.50	1.22

Figure 3.24
Existing literature about designing for learning



	Mean	SD
Pre-survey	3.25	0.46
Post-survey	3.33	0.82

Figure 3.25
Employment of literature about learning

From the survey participants slightly increased their formation of goals to include learning theories and cognitive processes. The overall goals for learning were high indicating learning is an important factor in designing. However, the personal goals of participants were relatively lower, but showed increases. One reason could be a lack of knowledge about learning and how to apply the information.

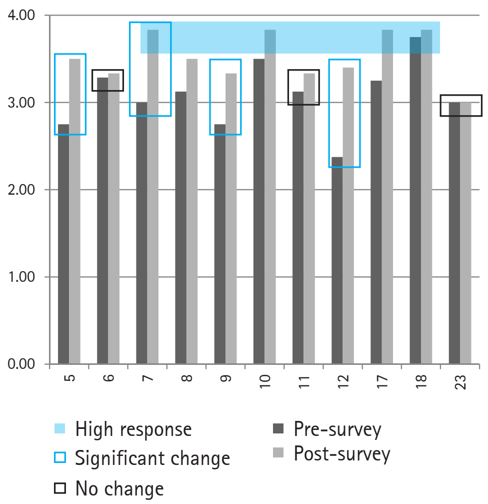
Constraints

After designers formed goals by identifying the design problems they referenced information and recalled prior knowledge. Designers then applied the information to form constraints which they used to identify design limitations and opportunities. In the survey, participant's constraints were measured using questions asking about basic learning concepts relating to zoo exhibit design.

Overall participant's responses to the constraint questions were relatively high suggesting participants already had an understanding of visitor learning. Many participant's responses also demonstrated increases in the creation of constraints during the workshop (Figure 3.26).

According to the survey results, participants already had an understanding of an important general learning concept that cognitive processes vary from person to person (Figure 3.26; Question 18). The average response was relatively high at 3.75 and showed minimal change on the post-survey of 0.08. Participants also showed a strong understanding of how to assist visitors in creating meaning (Figure 3.26; Question 10) with an average response of 3.50 increasing to 3.85.

Not only did participants come to the workshop with an understanding of some learning processes, they also increased their understanding of learning constraints. Participants increased their understanding of learning as a transformation process (Figure 3.26; Question 17)



5) Zoo exhibits facilitate visitor's learning by encouraging their thought processes.

6) Zoo exhibit designs facilitate visitor's motivation for learning.

7) Zoo exhibits guide visitor's learning by directing their attention to the most important learning features.

8) Zoo exhibits prompt visitors to recall prior knowledge.

9) Zoo exhibits engage visitors in the most important learning content.

10) Zoo exhibits assist visitors in creating meaning from the exhibit experience.

11) Zoo exhibits reinforce visitor learning by encouraging visitors to apply their knowledge.

12) Zoo exhibits provide visitors with feedback on their learning.

17) Learning is the transformation of information into knowledge.

18) People think about and learn the same information differently.

23) Visitors apply and recall information learned in zoo exhibits outside of zoos.

Figure 3.26
Summary of constraints questions

with an average response increase of 0.58 to 3.85 along with decreases in standard deviation. An even greater increase of 0.83 to 3.83 was observed in participant's ability to direct visitor's attention on the most important learning feature (Figure 3.27; Question 9). As a group, participants appeared to gain a strong grasp of directing visitor attention with a dramatic decrease in standard deviation of 0.66.

Other learning constraints also recorded increases, but the overall average was not as high as the previous questions. The constraint of exhibits providing visitors with feedback on their learning had the lowest average 2.38 on the pre-survey but received the greatest increase in the post-survey of 1.02 to 3.40 (Figure 3.26; Question 12). The increase could have been even greater but there was an outlier at 0.00 in the post-survey due to a participant not answering the question. Participants also showed significant increases in other concepts related specifically to exhibit design. The constraint of exhibits engaging visitors in the most important learning content showed an average increase of 0.58 to 3.33 on the post-survey with a consistently moderate standard deviation of 0.45 (Figure 3.26; Question 9). Other significant increases in participant's constraints were found in exhibits ability to facilitate learning processes with an average increase of 0.75 to 3.50 (Figure 3.26; Question 5). Participants strongly agreed in this increase demonstrated by a relatively very low standard deviation of 0.16. One final constraint showing a significant increase was on the question regarding exhibits prompting visitors to recall prior knowledge where the average increased 0.37 to 3.50 (Figure 3.26; Question 8).

Even though many constraints recorded increases some demonstrated minimal changes or no change. Responses about visitor's motivation for learning remained consistently low at 3.29 with an increase of 0.04 (Figure 3.26; Question 6). Participants also showed minimal change in exhibits ability to reinforce visitor's learning through application of knowledge with a low average of 3.30 increasing to 3.33 (Figure 3.26; Question 11). One constraint of exhibits encouraging participants to apply their knowledge outside zoos (Figure 3.26; Question 23) did not show any change and remained at a low average of 3.00. Not only did these responses not show significant changes but were generally lower relative to other constraints.

Participants demonstrated a strong knowledge of some learning constraints such as individual differences in learning and how to encourage visitors to create meaning. However, some of the most important aspects of learning such as applying knowledge and receiving feedback on their learning were lower before the workshop suggesting designers were not facilitating all cognitive processes.

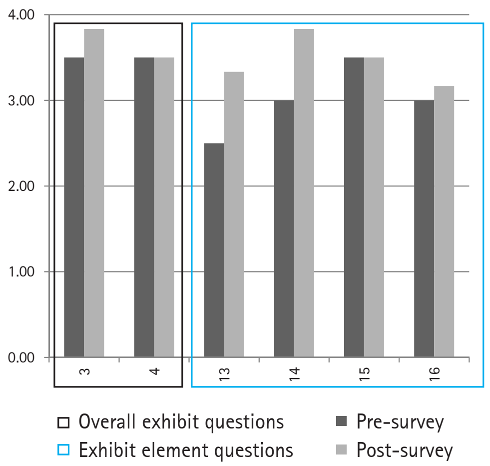
After the workshop, participants showed significant increases in their learning knowledge indicating participants felt they could more strategically design the visitor experience to encourage visitor's thought processes, directing their attention to learning content, and assisting visitors in creating meaning. This shows that participants gained knowledge needed to change their design approach.

Mental Imagery

In addition to designers recalling prior knowledge about learning to form constraints, they also recalled mental imagery of prior exhibits they had encountered as examples of previous solutions to solving similar design problems. The survey measured participant's mental imagery by using two sets of questions examining exhibits as a whole, and as specific design elements. Additionally, an open-ended question measured participant's mental images for learning.

The first set of Likert questions asked general questions about visitor learning in exhibits. Participants believed visitors learn from zoo exhibits with the average response increasing by 0.33 to 3.83 (Figure 3.27; Question 3). The increase indicates participant's mental imagery of exhibits designed for learning increased overall because participants could evaluate their mental images for learning. If they would not have modified their mental images the responses would have stayed the same. However, the second question asking if zoo exhibits encouraged visitor learning suggests otherwise (Figure 3.28; Question 4). Participants showed no improvement from 3.50 in the post-survey with a significant standard deviation of 0.55. This suggests that participants overall mental imagery of exhibits may not have significantly changed for visitor's cognitive processes.

The second set of questions was intended to measure participant's mental imagery of specific design elements from context, organization, circulation organization and spatial relationships. Participant's responses showed they felt they could encourage specific visitor's cognitive processes during the exhibit experience with the average post-survey response increasing by 0.83 to 3.83 (Figure 3.27; Question 13). However, participants disagreed with a standard deviation of 0.82. Participants felt the specific cognitive processes could be encouraged and stimulated by the context of the experience from the exhibit elements and landscape with the average post-survey response increasing by 0.83 to 3.83 (Figure 3.27; Question 14). However, increases were not observed in how participants



3) Visitors learn from zoo exhibit designs.

4) Zoo exhibits encourage visitor learning.

13) The visitor experience in a zoo exhibit is designed to engage a sequence of thought processes.

14) The zoo exhibit landscape, design elements and theming are designed to create an environment which encourages specific cognitive processes.

15) The spatial relationships between a visitor and animal are designed to encourage visitor's to think about the zoo exhibit in a specific way.

16) Zoo exhibit circulation organization is designed for visitor learning.

Figure 3.27
Summary of mental imagery questions

viewed the circulation organization of exhibits. This survey question showed a minimal average gain 0.17 in the post-survey and was relatively low at 3.00 with a 0.75 standard deviation (Figure 3.27; Question 16). This response is supported during the workshop with participants not developing new circulation typologies and spatial relationships. Participants felt similarly about exhibit spatial relationships with no change in the average 3.50 and disagreement expressed with a 0.55 standard deviation.

To understand a specific mental image of participants an open-ended question asked participants to provide an example of an exhibit they believe engages a visitor's learning processes. On the pre-survey most participants did not provide a specific exhibit example, but rather provided generalized responses such as 'any interactive exhibit' or exhibits with close animal encounters and an emotional storyline. These reponses suggest participants did not have mental images of exhibits supported with evidence. However, some responses did give indications of mental images through the general descriptions using examples with specific animals such as bears or jellyfish. The examples allude to specific exhibits participants have previously encountered. The pre-survey descriptions did not provide specific examples or detailed descriptions explaining how the exhibit engages learning processes.

For the post-survey participants again gave general descriptions, but contained information about how exhibits engage visitor's cognitive processes. For example, exhibits need to include multiple learning styles and exhibits with "an intentional message from the beginning of the design process." This change in description to include descriptions of cognitive processes demonstrates modifications in participant's existing mental imagery. Since participants did not provide specific examples no new mental images were identified.

Participant's mental imagery showed a minimal change between the pre and post-survey. The open-ended question showed indirect changes, but participants did not appear to have an in-depth understanding. Participant's mental imagery as a whole was unable to be determined, but the participant's mental imagery of some design elements was changed during the workshop. The exhibit context of landscaping and themeing along with the exhibit sequence demonstrated changes while visitor circulation and spatial relationships showed no changes.

Personal Preferences

In addition to the mental imagery, designers recall presolution models as their personal preferences. Since the presolution models are not evaluated on the survey evidence for changes in participant's personal preferences come from the workshop and indirect survey questions of the design elements in the mental imagery section and design stages in the search pattern and order. The synthesis of the workshop and survey questions is explained in the conclusions section.

Search pattern and order

The sequence in which designers employ their personal preferences, mental imagery, constraints and goals influences the designs through their search pattern and order. For the survey, participant's search pattern and order is measured using a general strategy evaluating the influence in learning during typical design stages. A refined evaluation of the design development stage examines events occurring during the stage.

The design stages which changed the most are research and site analysis. Both stages increased by 0.62 and 0.57 respectively (Figure 3.28). The changes could be attributed to participants understanding how important prior knowledge is in the learning process and how visitor's prior knowledge informs design decision. During the research and site analysis stages participants would most likely investigate visitor's prior knowledge. However, a question measuring the influence of visitor's prior knowledge in the design process found the average responses relatively low at 3.00 with a minimally increase of 0.17 on the post-survey (Figure 3.29; Question 26). The accuracy of the average response is weak with a

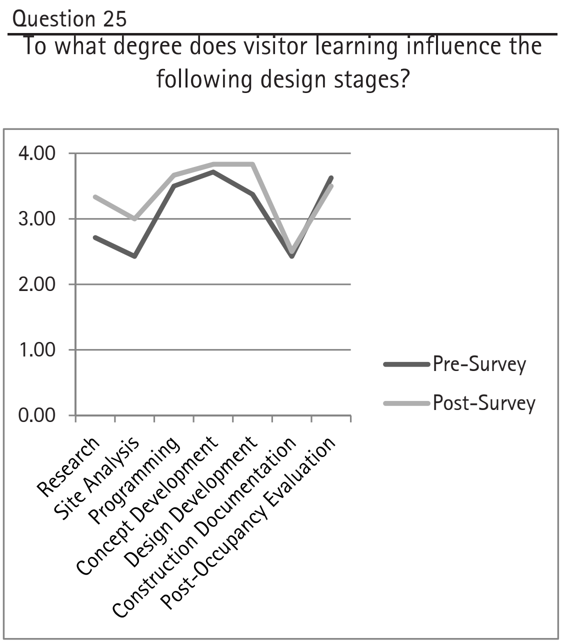


Figure 3.28
Influence of learning changes in typical design stages

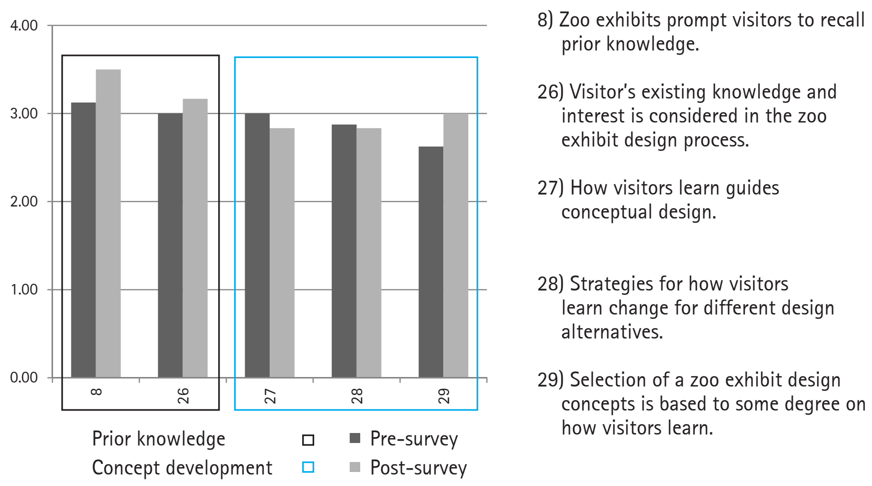


Figure 3.29
Influence of learning changes in typical design stages

high standard deviation around 0.95 for both surveys. Especially when compared to another question which shows exhibits prompt visitors to recall prior knowledge increased by 0.38 to 3.50 (Figure 3.29; Question 8).

In addition to the influence of learning increasing during the research and site analysis stage, the design development phase also increased by 0.46 to 3.83 on the post-survey. However, the quality of this improvement is uncertain due to other survey questions examining events during the design development phase. As part of the design development phase designers generate multiple design alternatives then select one option for the design. On the survey, participants responded that the influence of learning in the design concepts remained consistently low at 2.83 and decreased by 0.05 for the post-survey (Figure 3.29; Question 28). Similarly, the influence of learning in the development of concept design also showed minimal decreases of 0.17 to 2.83 but again the standard deviation was considerable at 0.75 (Figure 3.29; Question 27). Even though learning was not a significant factor in the design concepts the selection of the design concepts showed some increase in influence of learning 0.37 but remained relatively low at 3.00 (Figure 3.29; Question 29).

The indirect evaluation of participant's search pattern and order using the typical design stages provided insights into participant's changes observed in the initial stages of research and site analysis. The increases in the influence of learning may be due to the influence of visitor's prior knowledge during design. Also, the design development stage showed increased influence of learning but is uncertain due to a lower influence of learning in generating design concepts and selecting concepts. The minimal influence of learning could be interpreted as participants not knowing how to form goals for learning when developing concepts. Also, participants may not understand how to use constraints for learning outside of making detailed design decisions. Additionally, their presolution models and mental imagery of design concepts may not contain learning theories.

Summary

The change in participant's design approach between the pre and post-survey indicates a slight increase in learning during the workshop even though learning was already a significant influence in the overall zoo and project goals. However, the personal goals of participants were lower but showed increases in the influence of learning in the creation of goals. The high influence of learning in goals allows participants to utilize constraints to evaluate design decisions. Participant's constraints showed increases in critical cognitive processes and gained the knowledge to inform the creation of goals. In addition to recalling constraints, participants recalled mental images which had minimal increases for learning. Participant's mental imagery showed modifications to their existing mental imagery but no new mental images. Search pattern and order also showed increased influence of learning, while exhibit concept design showed a lower influence of learning. Overall, the survey did find minimal increases in participants design approach. However, when combined with the workshop results participant's design approach shows greater changes. The synthesis of the workshop and survey is discussed in the conclusions chapter.

Design Strategies

After analyzing the pre and post-survey for changes in design approach, the design guidelines for learning are developed using the triangulation analysis methodology. The triangulation analysis method developes design guidelines by identifying patterns in design strategies between the personal charrette designs, workshop ideas and sketches, and zoo design literature. When the same design strategy occurs in multiple sources the strategy becomes a design guideline.

Preliminary Comparison

Before beginning the triangulation analysis the design strategies participants developed to engage visitor's learning processes are identified in their comments and ideas. First, the discussions and sketches were analyzed to understand how participants used the learning theories as design strategies. Once the strategies are identified in the workshop the strategies are compared to the design strategies I developed during the personal charrette for similarities, differences and new strategies.

Similarities

The most obvious similarity between the personal charrette and the workshop designs was the controversial nature and distressing tone of some exhibit situations. For example, in the workshop participates developed design strategies of polluted drinking fountains in the Otter Exhibit, and in the personal charrette I used a poaching camp in the Four Lives exhibit (Figure 3.31). Both strategies used unexpected elements to encourage visitors to recall prior knowledge and stimulate cognitive-emotional arousal. To reduce possible negative emotions, additional design strategies were developed in both charrettes such as focus on the causes, how visitors can make a difference, and end the exhibit on a positive note.

A variation on the design strategy of controversial exhibits is in the Polar Bear exhibit from the workshop and the Two Waterways exhibit from the personal charrette is to engage visitors in the cognitive activity of comparison. Visitors compare a healthy habitat to an unhealthy habitat in both exhibits by observing and understanding differences between the two landscapes.

Another cognitive activity occurring in both the workshop and personal charrette is group interaction which encouraged visitors to solve a problem together.

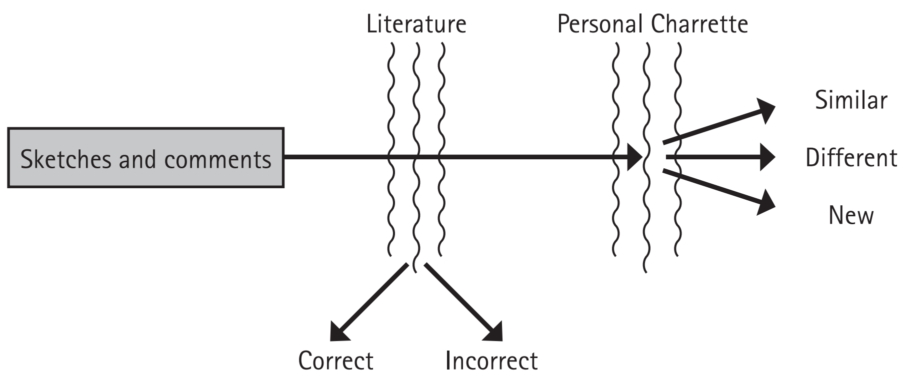


Figure 3.30
Comparison analysis

Poaching camp developed in personal charrette

Polluted drinking fountain develop in workshop

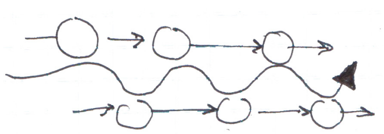
Figure 3.31
Similar distressing situations

In the Otter exhibit from the workshop, visitors work together to complete an activity whereas in the Four Lives exhibit from the personal charrette visitors work together to made a group decision. The design strategies are designed to increase the complexity of visitor's cognitive processes and engage their Interpersonal Intelligences while appealing to Facilitators.

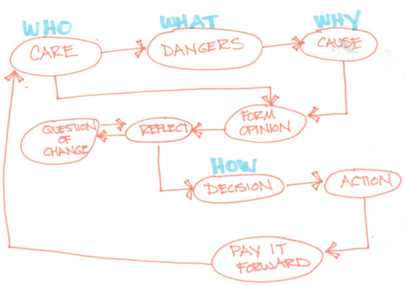
Another major similarity is the design strategy used to employ the cognitive activities. During the personal charrette I developed two general design strategies repeating the same cognitive activity and using a sequence of different cognitive activities (Figure 3.32). Participants also employed the same design strategies in the Cognitive Process Diagrams.

Similar use of strategic sequencing

Personal charrette

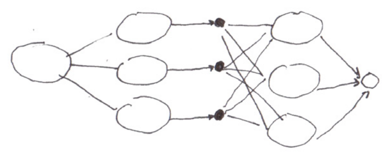


Workshop



Similar use of repetition

Personal charrette



Workshop

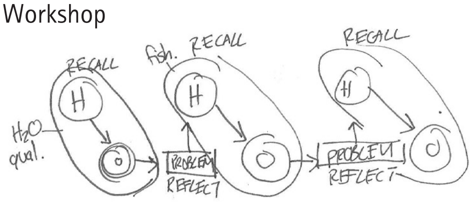


Figure 3.32
Similar Cognitive Process Diagram strategies

Differences

Not only were similarities found in the personal charrette and the workshops but also differences. The major difference between the workshops design strategies and my personal charrette was the exhibit circulation and organizational strategies. During the personal charrette new circulation strategies were pioneered consisting of networks and loops but in the workshops participants did not create any new circulation and organization strategies (Figure 3.33). One participant briefly described a potential idea where visitors created their own adventure by selecting different pathways following their own experience. But, she did not advance the concept because the exhibit was "unrealistic and probably not possible."

New

Other differences between the personal charrette and workshop are new design strategies developed in the workshop. A design strategy found in multiple charrette examples, but not in the personal charrette, is starting the exhibit experience with an intimate encounter with the 'star' animal of the exhibit. The intimate encounter at the beginning of the exhibit creates a visceral response in visitors which motivates visitors to want to care for and learn about the animal through a concrete experience. The design strategy also focuses visitors by reducing possible distractions from their excitement to see the animal. Once visitors see the animal they can "get the excitement out of their system" and focus on the exhibit.

In addition to the visceral strategy participants also created new cognitive activities. One cognitive activity developed is mimicking animals. Multiple participants identify the strategy of replicating animal's behavior as an activity which engages several Intelligences such as Kinesthetic, Interpersonal and Naturalistic. Another seminal cognitive activity is the visitor activity of locating animals using clues in an exhibit. In the exhibit, visitors navigate a tree house and other environments using their Kinesthetic, Spatial and Logical Intelligences to find animals. Another cognitive activity was having

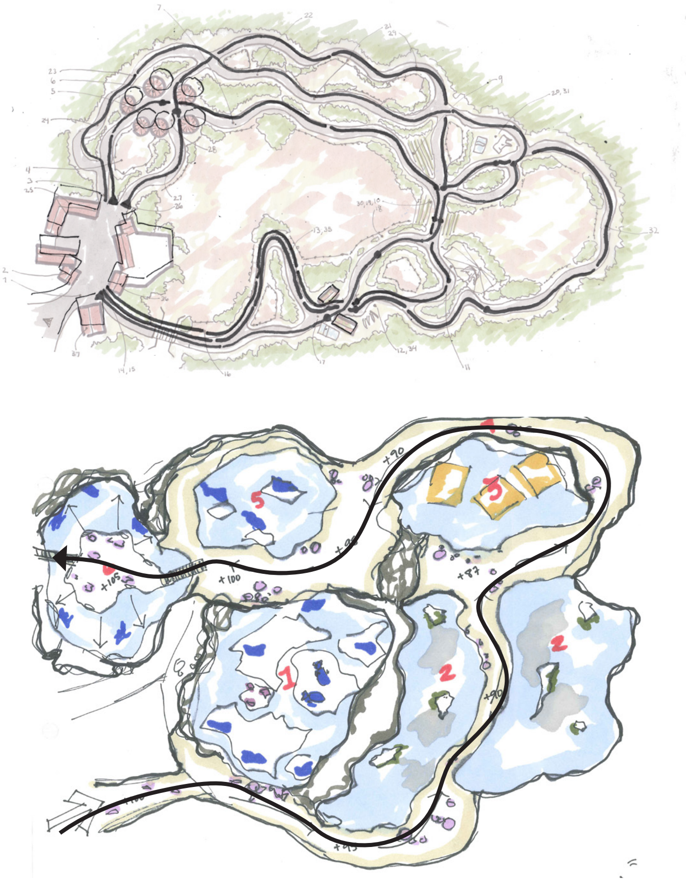


Figure 3.33
Different circulation strategies

visitors evaluate a situation for example in the Wolf exhibit from the workshops. The activity encouraged visitors to reach higher levels of cognitive processes. Lastly, participants particularly found the cognitive activity of helping an animal such as in the Polar Bear exhibit. The activity had visitors apply and practice the information presented in the exhibit. More importantly, the activity directly engaged visitors with the animal through interaction.

Triangulation technique

After identifying the design strategies used in the workshop by comparing for similarities, differences and new strategies, the design strategies from both the workshop and personal charrette along with the literature were analyzed for design guidelines using the triangulation analysis method. The design strategies are considered a design guideline when the strategies occur in more than one source. When the design strategy is supported by multiple sources of information such as professional experience and literature enough evidence exists to validate the guideline (Figure 3.34).

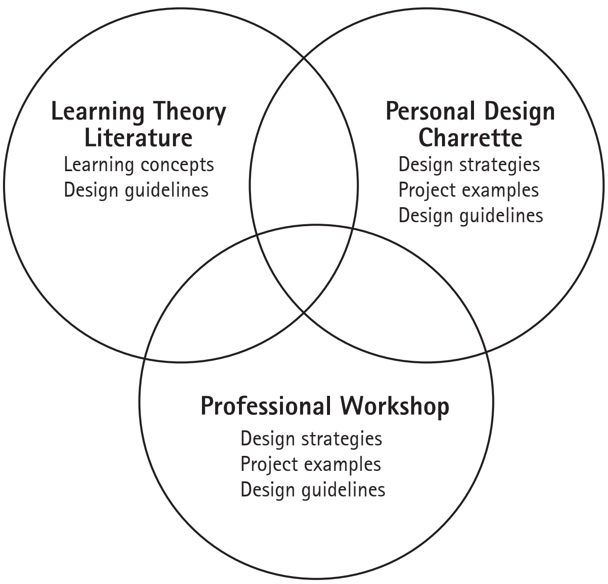


Figure 3.34
Triangulation analysis technique

Design strategies can become design guidelines in three ways. First, if the design strategy is found in all three sources of the workshop, personal charrette and literature the design strategy demonstrates the greatest evidence for validation as a guideline. The second option is when a design strategy is found in two sources the design strategy is validated if significant evidence exists in the literature or it is critical to design. And third, when the design strategy is found in only one source it is not considered a guideline unless it is found in literature and the design strategy is relevant to issues zoo exhibit designers addressed during the workshop.

Three sources

The design strategies found in all three sources of workshop, personal charrette and literature include the use of unexpected features to encourage visitors to recall prior knowledge and frame understanding. The Otter exhibit from the workshop and the Four Lives exhibit from the personal charrette are examples of the design strategy. The design strategy using unexpected features is not explicitly found in literature but related examples such as graphic images on signs are discussed (Stoinski et al. 2002). The images were not used strategically in the context of the entire exhibit as in the designs from the workshop. Literature also provides guidelines for managing potential negative emotions in managing visitor's cognitive-emotional level (Bitgood

2002). The design strategy of unexpected elements led to the creation of design guidelines 2.8, 2.9, 4.3, 4.4 and 4.5 relating to directing visitor's attention and stimulating their recall of prior knowledge.

Another strategy found is the use of questions in the learning process. The Otter and Two Waterways exhibits used questions extensively to engage visitors in learning processes. In literature, questions are important techniques for engaging visitors. This is an important guideline because Robinson suggests zoos need to ask more questions (Robinson 1996) to increase understanding. The guidelines 3.1, 4.2 and 6.5 resulted from the analysis.

Another common overarching design strategy concerning a fundamental learning process found in all three sources is the importance of using prior knowledge in learning. Multiple design strategies led to a series of guidelines explaining how to stimulate visitors to recall knowledge and how to assist visitors in using the knowledge during learning processes. Guidelines came from design strategies using unexpected elements, questions and creating an exhibit context. An entire section of design guidelines 4.0-4.7 is dedicated to stimulating visitors to recall prior knowledge along with guidelines 8.2, 8.3 and 10.4.

Two sources

Design strategies found in two sources from the workshop and literature also resulted in design guidelines. One design strategy which led to the development of guidelines is a visceral experience. The design strategy of using a visceral experience by creating a close encounter with the animal was developed during the workshop sketches and comments along with literature. Creating a visceral experience is not directly discussed in literature but the learning theory supports the design strategy because intimate encounters provide visitors with a concrete experience which assists the learning process of abstract concepts (Kolb 1984). The guideline 4.5 Visceral Experience creates a close encounter with animals at the beginning of the experience, increasing visitor's attention and motivation.

Not only were guidelines developed from the workshop and literature but also the personal charrette and literature. A design strategy developed in the Chicken Evolution and Climate Change exhibits explored learning processes of abstract concepts. Literature about communicating abstract concepts in zoos (Myers Jr., Saunders, and Garrett 2004) and learning theories (Kolb 1984) advanced these design strategies. The design ideas and theory formed the guidelines 6.2-6.5 about abstract concepts.

One source

Design guidelines were also created from a single source of literature. Guidelines were selected because they were relevant to participant's comments and design ideas.

Design strategies were synthesized into guidelines from literature for example, the Identity guidelines from Falk's work in free-choice learning environments (Falk et al. 2007; Falk 2009; Falk 2006). After studying multiple sources about Identities, the fundamental need of each Identity was distilled and generalized into a guideline. The guideline provided enough information to inform design but not enough to not limit designer's creativity and ability to interpretation the guideline. For example in guideline 1.1 Explorer Discovery, the principle need of Explorers is freedom and choice, therefore the guideline instructs designers to create experiences with choice and more opportunities for exploration.

Similarly, design strategies from literature were framed to provide direction in designing. Guideline 3.1 Manage Attention was adopted directly from the literature (Bitgood 2010). However, the design strategy did not directly inform designing a zoo exhibit so the design strategy was revised to provide direct instruction for how to direct visitor's attention in zoo exhibits.

Design strategies were also adopted from literature which would be important for designers to know were added to the guidelines. Guideline 5.8 Match Emotions with Recall was not discussed or appeared to be consciously applied during the workshop. However, participants did discuss the use of emotions in designs often during the workshop. Additionally, it is important because participants created exhibits to stimulate visitors to recall prior knowledge in conjunction with emotions. The guideline was directly adopted from literature building on Gagne's Information-processing model (Gagne 1985).

Some design strategies developed during the personal charrette did not appear in other sources. For example in the personal charrette the circulation typologies of networks and loops found in the Four Lives and Climate Change exhibits were not developed in the workshop or present in zoo design literature (Yanez, Collados, and Harrison 2005; Kraak 2008). Even though the design strategies were influenced by my interpretation of literature during my personal charrette, not enough evidence was found from other sources to validate the design strategies.

In total 53 guidelines were created using the triangulation analysis method. The method was useful in validating design strategies found in the workshop, personal charrette and literature. To create the design strategies, the comparison between the workshop and personal charrette was useful in understanding how the design strategies engage visitor's learning processes.

Summary

The mixed-methods of workshop, charrette and triangulation analysis were successful in engaging and capturing participant's experience, measuring design approach and developing design guidelines.

The triangulation analysis methodology identified patterns in design strategies found in the personal charrette, workshop and literature. The design strategies found in multiple sources were validated as design guidelines rooted in professional's experience captured with the workshop and zoo design and learning theory literature.

During the workshop, participant's generated many ideas and sketches in the workshop discussions and design activities. The process engaged participants with the learning theories facilitating their learning and understanding of the presented information. Participants applied the information in the structured design charrette producing three exhibit designs. In the final exhibits designs, participant's exhibits were designed to engage visitor's cognitive processes suggesting participant's changed their design approach.

On the survey, the change in participant's design approach showed slight increases in the influence of learning. The goals participants created indicate learning is a significant force in the overall design process; however, their personal goals for learning were relatively lower. After the workshop, participant's personal goals for learning showed slight increases in the influence of learning. Participants also showed increases in their ability to form learning constraints with increases in understanding of concepts about learning. Even though participant's knowledge about learning increased their mental imagery demonstrated no new mental images, but instead showed modifications of existing mental images. Participant's search pattern and order showed an increase in learning but the increase is uncertain due to the relatively low influence of learning in developing concepts, alternatives and selection of the concepts. Overall, participants showed slight increases in influence of learning in their design approach.

Conclusions

Figure 4.0
A zoo exhibit

Design Approach

The survey demonstrated slight increases in participant's design approach; however, when contextualized with the workshop comments and designs, the survey shows greater influence of learning in participant's design approach. The workshop comments and sketches provided additional evidence for supporting the survey responses. From the analysis, some recommendations are made to assist designers in designing for learning.

More useful to designers is the design guideline document for engaging and facilitating visitor's learning processes. The document contains the guidelines developed in the triangulation analysis method along with learning concepts explaining the learning theory supporting each guideline. Also, example projects illustrate possible applications of the design guidelines and potential future zoo exhibits designed specifically to engage visitor's cognitive processes.

To develop the design guidelines and measure designer's design approach, the innovative mixed-methods of the workshop, pre and post-survey and triangulation analysis provide fertile ground for future research. Additionally, the design guidelines led to future questions for how to engage zoo visitor's learning processes and how to create design guidelines.

Summary change in design approach

One benefit of using the workshop and survey in conjunction is the ability to verify and build evidence for the survey results with participant's discussions and designs. On the survey participant's design approach showed slight increases but when reviewed in the context of the workshop comments and sketches demonstrated greater increases. The formation of participant's goals increased as they evaluated zoo exhibits and made design decisions. Also, evidence from the workshop supported the survey findings of participant's formation of constraints as they applied their knowledge during the workshop. Similarly, the workshop supported survey observations of changes in participant's mental imagery. In contrast, the workshop did not reveal any additional evidence for changes in participant's personal preferences. Participants search pattern and order showed increases for the design stages indicating the application of their increased goals and constraints. Overall, participant's slight increase in design approach observed with the survey increased when contextualized with the workshop comments and sketches.

Goals

Generally, participants perceived learning as a very influential force for all goals in the design process from zoo's role in society, project objectives and personal design goals (Question 1). However, learning had a lower influence in personal goals compared to other design goals (Question 2) suggesting participant's goal formation for learning is lacking or they don't perceive their role in the design process to be critical in how visitors learn in zoo exhibits. The latter option is supported by two participants' comments in the workshop. They described the separation of roles between zoo exhibit designer and education staff.

The findings that participant's personal goals are lower than overall project objectives (Question 2) and the project learning objectives weakly influence design decisions (Question 20) suggest that if goals are to be modified to increase learning, the modifications need to begin with the zoo and project definition and scope. By increasing the definition of learning in the project goals may prompt designers to form more defined personal goals for learning. The modifications need to be specific enough to guide design decisions by describing how to engage visitor's learning processes. Since the project objectives could lack specificity if the objectives follow the mission statements of zoos because current zoo missions statements do not provide specific guidance in how to engage cognitive processes.

Slight increases in the influence of learning in the formation of personal goals (Question 2.4) saw slight decreases in their designing for cognitive processes (Question 19). The workshop showed more substantial increases in their discussions and designs. During the workshop participants demonstrated their goals in the structured design charrette. The structured design charrette process provided participants with examples of how to create goals for learning in the selection of goals, Concept Hierarchy Diagram and Cognitive Processes Diagram. After seeing examples of how to form goals participants then demonstrated the formation of goals on their own during the structured design charrette. During the processes they evaluated the designs by first forming goals to implement the constraints. For example, participant's analysis of the Cognitive Process Diagram used recalled learning theory information of Bloom's Taxonomy to set how the exhibit engages visitor's cognitive processes. Also, participants recalled the importance and use of prior knowledge during learning by identifying the types of information visitors need to recall to facilitate learning, resulting in the design strategies of unexpected elements.

Participants recalling learning theories are a good indication of participants developing goals because the application shows they have developed goals enough to recall the necessary prior knowledge to form constraints. It also indicates participants thought the information presented is useful in the design process. This is supported with a question on the survey asking participants if they would use the presented information during design. The average response increased 0.50 to 4.00 possibly filling a hole in the literature. However, the gap in literature participants identified on the pre-survey did not show increases suggesting (Question 22) participants did not view the information presented as existing literature.

The lack of knowledge possibly increases a disconnect between disciplines. This is supported by comments from the workshop. One participant delineated the roles of designers and educators and another participant described the challenges of interdisciplinary work, specifically timing of collaboration in the design process. In addition to the disconnect, a lack in knowledge about learning may not be adequate to form constraints used to develop goals in creating design concepts or to evaluate exhibits for learning.

With evidence from the workshop and the survey participants increased their formation of goals. From the survey participants slightly increased their formation of the goals. Larger increases were seen during the workshop with participants recalling and applying information during the designs. Suggesting the information presented contributes to existing literature.

Constraints

Participants demonstrated increases in their goals but also their formation of constraints. Survey responses indicate participants have the fundamental constraints for engaging zoo visitor's learning processes. Before the workshop, participants had generally moderate responses suggesting participants had some constraints. However, some constraints had very high responses such as learning varies between people and exhibits can encourage visitor to create meaning. Additional evidence of visitors prior knowledge used to form constraints is found in the workshop. During the snake example in the Experiential Learning activity participants identified the learning processes before the information was presented indicating they had the knowledge prior to form constraints. This suggests participant's intuition for learning is developing correctly in some cases; however, others did not have the same knowledge indicating a need for information about the learning processes.

Participants also showed an increase in confidence in using constrains on the survey in critical learning aspects such as applying knowledge, encouraging feedback and directing attention. In addition to the survey recording increases in participants learning, the workshop activities demonstrated participant's learning. During the Contextual Model of Learning participants identified factors from the theory outside the original context of the presented information indicating increases in synthesis of knowledge.

For participants to use their new knowledge about the learning theories they must translate the learning theories into constraints. Once constraints are created participants can use them in conjunction with the goals. This process was observed in participants during the structured design charrette when participants used Bloom's Taxonomy to evaluate their Cognitive Process Diagrams and the final designs. For participants to evaluate their designs for engaging learning processes they used the developed constraints to make design decision resulting in new designs for learning.

The use of the constraints during the structured design charrette and other workshop activities supports the increases in constraints found using the surveys by providing specific examples of participants using constraints to inform design decisions.

Mental imagery

Since participants demonstrated increases in their constraints they have the ability to identify how design decisions affect visitor learning. Participants can then use the constraints to inform their existing mental imagery and create new mental images from the workshop designs. In synthesis of the survey and workshop, participants did not create new mental images but modified their existing mental images with learning.

Participant's general description of their mental imagery demonstrated an insignificant increase in understanding of learning processes. However, the changes in the general descriptions indicate modifications to their existing mental images but not new mental images (Question 31). Participants showed minimal increase in their belief that visitors learn from exhibits (Question 3 and 4) as shown by changes in the survey.

Participant's mental imagery of specific design elements of context, organization, circulation and spatial relationships had mixed results. In general participants felt they had a strong enough grasp on designing for cognitive processes that they could encourage specific cognitive processes (Question 5). Additionally, they felt they could strategically engage cognitive processes in a specific sequence to create the visitor experience (Question 13). This was supported in the exhibit designs from the structured charrette with the visitor experience designed to engage learning processes in a specific order to achieve an overall learning goal. In the workshop, the organization in exhibits was influenced by visitor learning primarily through programmatic adjacencies. In the Polar Bear exhibit the sequence of the degraded and healthy habitat was designed to first encourage visitor's prior knowledge.

The strategies participants used is the context of the landscape and themeing showed significant increases on the survey (Question 14) and evidence is in the workshop designs which contained unexpected elements such as polluted water and degraded habitats. Participants also used visitor activities to engage visitors such as 'group think' in the otters design, biking to help the animals in the polar bear design, and evaluating a situation in the wolves design concept. These designs added to participant's mental imagery as shown on the post-survey.

However, other mental images of design elements such as exhibit circulation and spatial relationships were not found on the survey to influence learning (Question 15 and 16). The workshop had similar results in that no new circulation typologies were developed as was done during the personal charrette with networks and loops. Also, no new spatial relationships were found. Indicating participant's mental imagery of the design elements did not change in this area.

Participant's mental imagery showed minimal increases between the pre and post-survey and the findings were supported by the designs in the workshop. The open-ended question showed indirect changes but participants did not appear to have an in-depth understanding to identify specific exhibits or exhibit features. Participant's mental imagery may not have changed yet because they have not used the information presented to evaluate existing exhibits. While the participant's mental imagery as a whole was unable to be determined, but the participant's mental imagery of some design elements changed. Also, no changes in the visitor circulation and spatial relationships showed no changes in the survey or workshop. However, the exhibit context of landscape design and themeing along with the exhibit sequence responded to learning which was dramatically demonstrated in the designs produced during the workshop. Overall participant's mental imagery did increase with learning.

Personal Preferences

The changes in participant's mental imagery provide indications of possible changes in participant's personal preferences. Since the survey did not directly measure personal preferences, evidence comes primarily from designs in the workshop as potential presolution models.

The questions on the mental images addressing context suggest unexpected elements are a presolution model for stimulating visitor's recall of prior knowledge. The exhibit designs provide evidence in new design innovations leading to possible new presolution models such as comparing healthy habitat to unhealthy habitat.

In addition, to the presolution models for the physical design elements the design concepts are another form of presolution models. The influence of learning in design concepts is evaluated in the search order and pattern sections suggesting presolution models are not integrating learning. Even though participants generated design concepts during the workshop containing learning, participants might have not had the opportunity to develop enough concepts to create presolution models. As demonstrated in the low responses for the influence in creating design concepts, different alternatives and selecting concepts (Question 26-29).

Since participants did not create multiple presolution models their changes in their personal preferences could not be evaluated. However, based on participant's designs and mental imagery they have the potential to add new presolution models to their personal preferences.

Search pattern and order

Similar to personal preferences participant's search order and pattern is unique to them which could not be accurately gauged using the survey. However, using a general approach examining the typically design stages found an increased influence of learning in the design process.

The general design process showed significant increase of learning in the research and site analysis stages. The increase could be due to participants increase in constraints and goals for prior knowledge. Since visitor's prior knowledge would be investigated during these stages. During the workshop discussion about Gagne's Information-processing model participants identified the challenges of designing for visitor's prior knowledge. Designers must make assumptions about the prior knowledge visitors associate with design elements suggesting designers need to know more about visitors knowledge.

Participants also showed significant increases in the influence of learning in the design development design stage. This suggests a change in design approach because most of the design decisions will occur during the design development stages. The increase is contradicted by questions addressing events occurring during the design development stage. The influence of learning in generating concepts, design alternatives and selecting concepts learning role did not increase indicating participants did not know how to apply the constraints and goals in developing exhibit concepts for learning.

The low influence of learning in developing design concepts is interesting because during the structured design charrette participants developed design concepts for learning. Also, constraints and goals demonstrate increases on the survey which should influence concept development. The conflicting results could be explained by participant's comments during the workshop limiting the influence of learning. Participants indirectly alluded to factors outside the control of designers such as the financial viability influencing projects. For example participants did not develop a potential idea generated during the Multiple Intelligences section create your own adventure, citing feasibility issues. Also, sarcastic comments during the structured design charrette of adding opportunities for merchandise sales in the exhibit indicate finacial considerations. The outside factors could be important in the direction of projects which may be more influential factors than learning.

Participant's search pattern and order showed an increase in the influence of learning in the research and site analysis stages showing increased application of goals and constraints about learning concepts of prior knowledge. The design development stages also showed increases but the events of concept development showed conflicting results possibly explained by outside factors influencing the direction of exhibit projects.

Summary

In review of both the survey and workshop, participants changed their design approach to increase the influence of learning. The survey found participants increased their personal goals by recalling and applying learning theories during the structured design charrette. Also, participants demonstrated increases in their formation of constraints using their new knowledge about learning theories in evaluating designs and design decisions. Participant's new goals and constraints assisted them in modifying their existing mental imagery but showed no new mental image development. The increases in participant's goals, constraints, and mental imagery suggest participants have the potential to create new personal preferences but could not be determined, definitively. Their search pattern and order showed increases in the integration of learning, however outside factors could influence the ultimate implementation of their new design approach.

Even though participants changed their design approach, long term change is uncertain. The workshop was very short and may not be enough exposure to the material for participants to integrate the information to fully modify their design approach. Since their mental imagery was lacking they also may not know how to apply their learning outside the workshop resulting in no long term change in approach. If participants do change their approach it is also uncertain whether the change can overcome the influential overall goals of the client and project which may not be directly aligned with learning.

Design Guidelines

For other zoo exhibit designers and professionals to learn from the workshop findings and literature review, design guidelines were developed using the triangulation analysis method. The design guidelines which engage visitor's cognitive processes in zoo exhibits are compiled into an interactive document. To increase the reader's understanding and ultimate use of the guidelines, the learning theories supporting the guidelines are included as learning principles explaining how to use the guidelines. Additionally, example projects illustrate the potential application of the guidelines. The design of the document assists the reader in navigation with links between concepts, projects and guidelines using an Interactive PDF document format. For the design guideline document see Appendix G.

After the introduction readers have three choices for navigating the document by learning principle, example projects or guideline. This allows the reader to learn in multiple ways and facilitates different designer's search pattern and order. Once in the document, the navigation bar allows readers to follow links from the current page to related learning principles, guidelines and project examples.

In total 53 design guidelines were created using the triangulation analysis (Figure 4.1). For each guideline a brief description summarizes the guideline for the reader to easily form their own constraints for their own design approach. A comprehensive description of the learning concepts accompanies the guideline providing the reader with knowledge to apply the guideline. Links to other guidelines, learning concepts and example

Identity

1.0 All Identity guidelines
1.1 Explorer discovery
1.2 Facilitate facilitator
1.3 Professional information
1.4 Memorable experience
1.5 Recharger reflection

Attention

2.0 All attention guidelines
2.1 Powerful stimulus redirection
2.2 Powerful stimulus intensity
2.3 Strategic powerful stimulus
2.4 Exhibiting multiple items
2.5 Promote sequential scanning
2.6 Focusing device
2.7 Warn of distressing situation
2.8 Manage cognitive-emotional arousal
2.9 Cognitive-emotional learning
2.10 Familiar animals
2.11 Match animals and learning
2.12 Unfamiliar animals
2.13 Manage attention

Inform

3.0 All inform guidelines
3.1 Direct attention
3.2 Provide an example
3.3 Interactive guides
3.4 Maintain choice and control
3.5 Inform Identity

Recall

4.0 All recall guidelines
4.1 Common experiences
4.2 Question recall
4.3 Element recall
4.4 Context recall
4.5 Unexpected feature recall
4.6 Initial recall
4.7 Match emotions with recall

Grasp

5.0 All grasp guidelines
5.1 Link abstract to concrete
5.2 Familiar examples
5.3 Reduce the abstraction
5.4 Interactive experiences
5.5 Visceral experience

Guide

6.0 All guide guidelines
6.1 Relate to existing knowledge
6.2 Conceptual connections
6.3 Examples and demonstrations
6.4 Memories and emotion
6.5 Guide thought

Apply

7.0 All apply guidelines
7.1 Application of learning
7.2 Interpret feedback
7.3 Intrinsic rewards
7.4 Extrinsic rewards
7.5 Recall learning
7.6 Integrate prior knowledge
7.7 Evoke a positive state
7.8 Repeat concepts

Transfer

8.0 All transfer guidelines
8.1 Make relevant to daily lives
8.2 Bring learning into the zoo
8.3 Orchestrate learning
8.4 Within zoo coordination
8.5 Encourage divergent thinking

Figure 4.1
List of design guidelines

projects increases opportunities for synthesis of the information.

The learning principles section of the document is organized into nine sections. For each learning principle learning concepts related to the principle are explained. Within each section, background information describes visitor learning concepts providing readers with the necessary information to understand how to use the guidelines and information to recall in achieving their personal design goals.

The third section of the design guidelines document includes seven example projects illustrating zoo exhibits employing the design guidelines. The example projects demonstrate possible applications of the design guidelines and how multiple guidelines work together. Not only do the example projects illustrate the application of the guidelines but also new mental images and presolution models. For each example project, a montage envisioning the exhibit form and a narrative describing visitor's experiences explains how the exhibit facilitates learning processes.

The example exhibits integrate design ideas from the personal charrette, workshop and literature. For example, in the Primate Adaption exhibit the visitor activity of wearing a gorilla suit is adopted from Robinson's exhibit concepts (Robinson 1996). Also, design strategies without enough evidence to become guidelines such as a network of visitor circulation is included in the example project Four Lives demonstrating future possibilities.

The design guideline document has the potential to improve the design of exhibits by creating exhibits which engage and facilitates visitor's cognitive processes. Not only do the guidelines have the potential to achieve the

Figure 4.2
Montage illustration of an example project

conservation mission of zoos by providing designers with vital information, but also assists them in their learning and augmentation of their design approach. Both the genesis and validation of the guidelines required innovative mixed methods incorporating expert testing by zoo design professionals, personal experience and investigation of literature.

Into the Future

The innovative mixed-methods research strategy required the combination of existing research methods such as the workshop and survey, but also involved novel uses of those methods. The framework of the survey using Chan's factors to measure design approach change after a workshop proved successful. However, lessons were learned for future researchers using the methodology.

Personal Charrette

For future research in the design profession my process of using a personal charrette could be invaluable to other researchers. The personal charrette could be critical in guiding research because the process captures the intuitive synthesizing power of designers and allows the research to directly relate to design. Before developing the thesis and research question about design approach, I was interested in how to improve visitor learning in zoo exhibits by evaluating current built works for the presence of the learning theories I had researched. In attempting to evaluate the projects, the methods continued to not provide the design guidance I had hoped would come from the research since the findings would come from built works. If the exhibits were currently not applying the theories then no new findings would emerge informing design or the findings would only identify current strategies. This methodological dead-end lead me to consider how I would use the learning theories during the personal charrette. This alternative path led to the charrette, and the findings directly relate to design as they will be useful to other designers.

The personal charrette allowed me, as a designer, to explore, through application, information I had learned from the literature review by testing ideas. During the design processes, I was freed from the confines of the research studies in the literature. I was able to synthesis the literature with my design knowledge and test ideas exploring the application of the learning theories. Perhaps other researchers in design would find similar creative liberation leading to understanding of information and new research questions as it was for me. The personal charrette was critical to the generation of the thesis and was also vital in developing the content of the survey and workshop.

The personal charrette played an instrumental role in selection of the theories presented in the workshop. Only the most influential theories in the personal charrette were included in the workshop ensuring participants received the most important information. Also, the activities in the workshop were guided by the personal charrette. One activity in particular, the structured design charrette, was taken directly from the personal charrette. During the workshop structured design charrette, the process participants followed and techniques they used were developed during the personal charrette.

In addition to shaping the research methods, the designs from the personal charrette became data inputs for analysis in developing the design guidelines. The personal charrette designs were compared to the workshop designs in the triangulation analysis directly influencing design guideline development.

Ultimately, the personal charrette was pivotal in the direction of the project to focus on how designer's design approach changes leading to new design guidelines. To understand how design approach changes the survey using Chan's factors was developed.

Survey

Chan's five factors which generate a personal design style proved successful as a framework for constructing the pre and post-surveys. The framework helped to target the survey questions at characteristics of individual's design processes to understand how they personally changed. Chan's factors also provided guidance during analysis by describing relationships to evaluate between sets of questions.

Even though the factors provided the topic for questions it did not provide specific direction for the content of the questions. If the survey is to be repeated more specific questions are needed to increase the precision of the survey. For example, the constraints questions about learning fundamentals were basic questions already known by participants due to the overall high response rate. A pilot study would be useful to establish a baseline of designer's existing knowledge about learning to develop more specific questions. Similarly, more specific questions about exhibit elements and characteristics could provide greater insights into participant's mental imagery and personal preferences. Instead of using Likert questions a new technique such as having participants evaluate a situation may be more successful in determining participant's mental imagery and personal preferences. Another option may include new techniques such as having participants evaluate images of exhibits or have them provide a solution to a simple design problem.

A challenge with the study is the limited ability for statistical analysis due to the small sample size. One strategy for maintaining a small number in the workshops while increasing the overall sample size of the survey is to add additional designers who do not participate in the workshops but take the survey. This second control sample could then be used to compare to designers who participated in the workshops to evaluate the effectiveness of the workshop. In addition to creating a larger sample size for statistical analysis the overall sampling would have greater diversity of professional experience and design philosophy.

Workshop

The workshop proved to be a useful tool in combination with the survey by capturing supporting evidence in participant's change in design approach. The interactive elements of the workshop appeared to be an effective way to both assist participants in their learning increasing their potential to change their design approach. Also, the workshop captured professional's expertise directly through comments and discussions but also indirectly through their sketches which is used to support survey results.

Not only was the workshop important to the survey but also proved to be a useful tool in conjunction with the triangulation method to develop new design guidelines. The workshop collected data in an analyzable form to use in the triangulation analysis, grounding the design guidelines in professional's experience.

Critical to using the workshop with the other methods are the sketches. The workshop can improve the sketches produced by participants by providing a context from which they can make design decisions. During the workshop the most successful charrette sessions were ones with a well-developed context, like the structure design charrette. The context needs to be detailed enough to inform design decisions but not predispose designs in such a way which influences the creation of design guidelines.

Triangulation analysis

When using the sketches and other comments in the triangulation methodology to develop design guidelines, take precautions to not over generalize or take the comments and sketches out of context. To prevent this, a more rigorous documentation of the process needs to be developed to show the origins and evidence for each guideline. Perhaps methods from grounded theory could provide some guidance in the use of recording the process. Possibly a matrix could be used to record the relationships found in the analysis process.

In addition to the documentation process, conducting a pilot study would be an addition to the study. Originally a pilot study was planned but due to time restrictions did not occur. A pilot study improves a research project first by providing the presenter opportunities to practice the presentation for timing and delivery. Practice also helps the presenter in leading discussions and moderating participant's different perspectives. Secondly, the pilot study provides opportunities to test the activities in the workshop for effectiveness in facilitating participant's learning and providing engaging activities. Also, the context provided for the charrette activities can be tested for its influence in the designs.

Future research

The mixed-methods approach was successful in this project and has potential future applications in other projects. This project also provides new directions for research in design approach, how to create design guidelines and testing of design guidelines.

Future studies building on the learning design guidelines could investigate other cognitive psychology and learning theories. In doing research for this project, I found a number of additional theories which have potential application in the zoo context, but due to time restrictions were excluded from the workshop. For example, social learning theories such as Vygotsky and Bandura; and constructivist theories such as Bruner's discovery learning, Lave's situated learning, and experience-based learning were also considered (Leonard 2002). Additional research could also focus on designing for specific age groups since the learning capabilities and processes change with age.

In addition to cognitive theories, theories describing how human emotions affect their conservation behavior could be fertile ground for investigation since emotions play a significant role in the visitor experience. This is importance because during the workshops and my personal charrette, designers instinctively did not separate emotions from the learning process. Designers strategically designed spaces to evoke emotions and sequence them into the visitor experience, but used their intuition to do so.

Perhaps more pressing than cognitive or affective theories is in behavior change theories since growing environmental problems are requiring changes in lifestyle. Behavior change theories are theoretical frameworks which describe why and how we decide to modify our behavior. Knowledge is part of how we change our behavior but other aspects such as perception, social norms and convenience play a role. This research lays the groundwork for developing guidelines for behavior change theories. Potential theories for application currently used in the zoo context include Social Cognitive Theory, the Theory of Planned Behavior, and the Staged Model of Behavior change (Ardoin 2009).

In addition to exploration of different theories, future studies could investigate the development of design guidelines in different disciplines, topics and design communities using different bodies of literature and theories. Also, comparative studies investigating differences between participant's changes in design approach and the quantity and quality of guidelines developed. In addition to comparative studies for evaluating the validity of guidelines engagement with experts could be promising in determining appropriateness and applicability of the guidelines in practice.

Design guidelines

In addition to applying this methodology in other subjects and theories, research needs to evaluate the effectiveness of the guidelines once implemented in designs. First, zoo exhibit designers can apply the guidelines in new projects. The guidelines can be equally applied in retrofits of exhibits. In Coe's experience he suggests exhibits have a lifetime of no longer than 20 years and proposes a strategy of changing the educational programs to revitalize exhibits while maintain the basic infrastructure of the exhibit (Coe and Dykstra 2010). The guidelines could be one possible tactic for implementation of the strategy by informing the creation of the new visitor experience, updating the themeing and exhibit context, along with other interpretation elements while keeping the original structure of the exhibit enclosures and infrastructure.

Once designers use the guidelines, then how they employ the guidelines is an important question for the future development and refinement of design guidelines. Research to determine how effective the guidelines are as a learning tool would be useful for the future development of design guidelines. Important factors for evaluation would be the organization and effectiveness of the interactive navigation in helping the reader to make connections between the information, and the quantity and depth of information needed to achieve understanding. Another important component of the guidelines needing evaluation is the example projects. Significant time was invested into developing the examples with the intent that the examples would demonstrate possible application of the guidelines to increase the reader's understanding. The use of examples could be a valuable aspect of complex design guidelines however their effectiveness needs to be evaluated to justify the effort exerted on the development of the example projects.

Besides understanding how designers learn from the guidelines, how they employ the guidelines in the design process is another important area for future research. An understanding of how designers use the guidelines would be very beneficial for future design guideline manuals. Research could investigate designer's design processes, specifically how they make design decisions and how their design philosophy influences their design approach. The findings would be valuable when developing new guidelines to understanding how to present and frame the information most effectively for designers use. Findings could also provide insights into what processes and techniques to target with the guidelines when the guidelines address not only the built form but design process and design philosophy.

Another important variable to study which influences how to frame and present the guidelines is variations in application of the guidelines between designers with different design approaches and philosophies. The findings would help the design of guidelines developed specifically to restrict or allow design freedom. From the workshop experience of interacting with different design professionals they have different philosophies which greatly influence how they understood information presented during the workshops, suggesting designers would interpret and apply the guidelines differently.

Exhibit designs

In addition to understanding how designers use the guidelines, future research is needed investigating the effectiveness of exhibits designed using the guidelines to engage and facilitate visitor's cognitive processes. Research could determine if visitors actually engage exhibits as intended by the design concept. Evaluations would possibly require new research tools to measure visitor's thought processes during exhibits. Currently, most studies in the literature look at post-effects of learning and how people use exhibits, not how visitors are thinking during exhibits. This research would be conducted in the long term once the guidelines had been implementation in the design of an exhibit.

One design strategy developed from the guidelines needing specific research is how context affects visitor's cognitive processes. Researchers have already studied this subject; however, previous research focused on studying how visitors perceive animals in natural landscapes verses unnatural surroundings such as concrete and barred enclosures. Instead, new research is needed to understand the effects of different types of natural contexts. For example, how do visitors perceive a degraded landscape or a natural urban environment compared to a pristine landscape typically mimicked in zoos?

Another question includes how people learn when encountering distressing elements and situations. Further exploration is needed because using these types of elements in exhibits were found in both the personal charrette and workshop. Participants used the elements to stimulate recall of prior knowledge and frame visitor understanding. Also, the elements are important for physically illustrating concepts because "our audiences are so highly visual that if the cognitive message isn't aligned with what they're seeing, they disconnect (Gwynne 2007)." Therefore, if exhibit messages are to present conservation and environmental issues then the problems need to be demonstrated to visitors.

Reevaluating design approach

For the guidelines to be most effectively applied it may require more than just following the design guidelines. Application of the guidelines may require a change in not only design approach but philosophically. Designers may need to reevaluate the primary objective of exhibits and how exhibits can best achieve those results. If the objective of the zoo and exhibits contained is conservation, then designers need to play a greater role in helping visitors to learn pro-environmental behavior leading to conservation. The 2005 World Zoo and Aquarium Conservation Strategy states "the aim should be for education to permeate all aspects of the zoo or aquarium's operations (WAZA 2005, 36)" This should apply to the design approach of zoo exhibit designers resulting in all design decisions being to some degree influenced by learning.

If exhibit's educational objectives are for pro-environmental behavior a philosophical change of the concept of learning may require redefining. Learning in exhibits need to not only include increases in knowledge but also engagement of learning processes and critical thinking processes useful in enacting the conservation message outside the zoo exhibit. The example projects in the design guidelines document begin to demonstrate how this approach changes the visitor experience with the activities and situations designed to engage these processes while also providing conservation information.

Even if exhibit designers employ the guidelines, the guidelines are not enough to create exhibit designed for learning. Collaboration between the exhibit designer and interpretive designer and zoo education staff is needed if all the elements function together creating a complete system. The project examples illustrate this collaboration in that the information and the actual details of interpretation elements and activities are not described in detail because an interpretive designer would design the content. The guidelines act as a mediator between exhibit designers and educators as providing designers with a base knowledge to begin asking educators the correct questions and developing concepts integrating learning processes. Further integration of education experts in all phases of the design processes assists zoo exhibit designers in integrating educator's contributions in the design process resulting in exhibits more holistically designed for learning.

New visitor affordances

In addition to designers changing their conception of zoo exhibits, visitors may need to change their affordances of the zoo. If the project examples are any indication of potential uses of the design guidelines then zoo exhibit experiences become more interactive. The visitor experience shifts from a typically passive experience of viewing animals to an interactive experience engaging visitors cognitively, emotionally and physically. These interactive experiences become more dynamic with the experience changing for each visit as they participant in activities. Visitors may come to expect exhibits to engage them in a participatory experience through the dynamic nature of the interactive experiences.

In addition to how visitors engage exhibits their expectations for what they encounter may change. Visitors may encounter organisms currently not typically encountered such as plants and microorganisms which are more successful at communicating and engaging visitors with learning content more effectively. Visitor's affordances can change to accept this because as long as the activity is fun and rewarding visitors will enjoy the zoo. It may then no longer be necessary for visitors to see charismatic megafauna to fulfill their visit needs. Visitors may also encounter different landscapes and environment not typically experienced such as degraded habitats or urban landscapes. These landscapes confront topics which challenge visitors to think about conservation issues. Visitor's affordance of the zoo itself may change generally to think of zoos more like museums or science centers where visitors encounter a diversity of topics directly connected to animals. This description of zoo exhibits engaging cognitive processes comes to reflect some of Hancocks's vision of future zoos (Hancocks 2001).

Conclusion

Exhibits using the learning design guidelines contribute to achieving zoo's mission of conservation by engaging and facilitating visitor's learning processes. In the exhibits, visitors engage their cognitive processes which result in increased learning potentially leading to pro-environmental actions when they leave the zoo. For exhibits to stimulate and facilitate visitor's cognitive processes designer's application of the guidelines may require a rethinking and augmentation of their design processes which challenges zoo exhibit designer's current design approach. The information presented during the workshop which led to increases in the influence of learning in participant's design approach is also contained in the design guidelines document. The information and organization of the content could lead to other designers augmenting their design approach. This reevaluation of their design approach may lead to improvement as Coe describes "innovations may come from introspective analysis of the basic assumptions on which present zoos are based (Coe and Dykstra 2010)."

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Appendices

Figure 5.0
Hippos

Appendix A - Workshop Invitation

Appendix A contains the workshop invitation email to perspective zoo design architectural firms.

What interactive workshop investigating how zoo exhibit design can increase visitor learning of education and conservation messages

Learn how to increase visitor learning to achieve zoo's mission of education and conservation. In the hands-on charrette type workshop, learn how the science of cognitive psychology and education informs the design of zoo exhibits. During the workshop participants explore the internal thought processes people use while learning through an interactive charrette. The day culminates with the design of a hypothetical exhibit applying the information presented on theories of learning. The results of the design workshop charrette will be analyzed to understand how top zoo designers would integrate learning theory concepts to increase visitor learning of education and conservation messages.

Why for zoos to achieve their missions of education and ultimately conservation

If zoos are to achieve their mission of conservation, visitors must leave the zoo with the knowledge necessary to carry out environmentally responsible behavior. To learn the conservation messages embedded in the interpretation, landscaping, themeing, and animals, visitors need to use thought processes to learn the information. From the workshop, learn how exhibits engage visitor's thought processes with zoo messages to increase the acquisition, learning, and retention of the educational content. Thus, increasing zoo exhibits ability to facilitate and encourage visitors to think about their role in conservation.

Who zoo designers who desire to create experiences promoting visitor learning through the design of zoo exhibits

This workshop is for zoo designers who desire to increase learning in their designs by creating exhibits which engage visitor's thought processes. By integrating new knowledge into design process and methods, zoo designers can understand how exhibit goals and characteristics of visitor learning can organize concepts, enclosures, and animals into an experience encouraging visitors to think deeper about zoo messages. The new approach can result in design strategies, typologies and styles which potentially increase visitor learning of zoo messages.

When September 29 in St. Louis, Missouri at the St. Louis Zoo

This day-long workshop gives zoo designers the opportunity to: 1) learn the internal thought processes people use to learn, called cognitive processes 2) observe an existing zoo exhibit to understand how the exhibit currently engages cognitive processes 3) design a hypothetical exhibit applying the design approach to cognitive based zoo design. After the workshop, charrette findings and workshop outcomes are analyzed and compiled into a set of guidelines for others to use and learn about cognitive based zoo design.

Thank you for your time,

Russell Ploutz

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Appendix B - Workshop Presentation

Appendix B contains the slides presented during the workshop along with the scripted text for each slide.

Good morning and thank you for coming to the workshop today. I value your time and understand the commitment you have made to be here. I thank the (zoo or Jones and Jones) for graciously offering to host the workshop today. My name is Russell Ploutz and I am a graduate student in Landscape Architecture at Kansas State University. I have with me Kirby Barrett a recent graduate who will assist me with note taking and documentation.

My Master of Landscape Architecture thesis which brings us together today investigates how contemporary research on cognitive process and learning theories can be applied to positively affect zoo exhibit design and increase learning during zoo visits. The desired outcome is a zoo design guideline document to be disseminated to participants and zoo design professionals, zoos and other zoo related organizations to improve learning in zoos.

To make sure everyone understands the research project and its anticipated outcomes, I would like each of you to read the Informed Consent Statement provided at this time.

Do you have any questions regarding your participation in the workshop or the measures outlined to protect your identity, including how the video recording will be used?

Do you have any questions regarding signing the Informed Consent to allow me to include your name as a contributor to the zoo design guideline document?

Please let me reiterate you do not have to sign the consent form and if you are uncomfortable with any aspect of the workshop format you are free to leave before we proceed. You may also choose to sign the form at the end of the day regarding your desire to have your name included as a contributor to the design

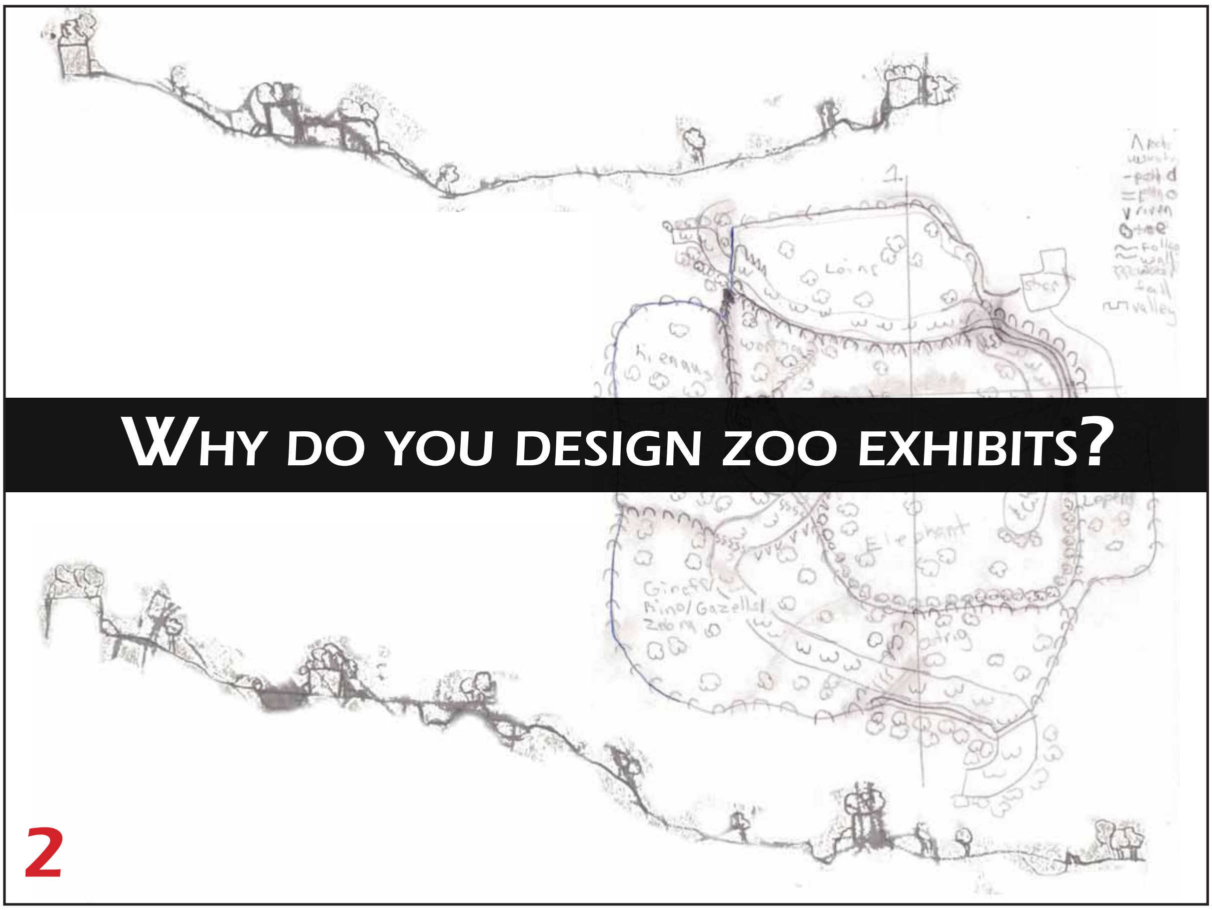
guideline document, and you may choose to reconsider your signing or providing consent at any time.

Great, thank you for your time in completing the requirements for conducting research regarding human subjects.

As outlined in the Informed consent, the first activity of the workshop is an anonymous survey regarding contemporary zoo exhibit design integration of learning theories and cognitive process. Please take a few minutes to complete the survey if you so choose. Note the video is not being recorded during the surveys.

Before we get started I would first like to explain that this presentation was given in St. Louis last week. To maintain consistency in the study between the two research sites I will be reading some of the presentation so that I present information in the same way.

My interest in designing zoo exhibits began when I was very young. I designed my first zoo exhibit at the Olive Garden in Topeka, Kansas after visiting the Kansas City Zoo. I was inspired by the African exhibit, which consisted of many different African ecosystems spread out over a large area. Since then I have been interested in designing zoos. I believe my fascination with zoos is the idea of being able to recreating a distant landscape which I could easily visit. Zoo visits condense a trip to the real place, which would take many days, into a few hours. One design concept that I became obsessed with was recreating the African savanna, with all the quintessential animals. The challenge of the concept, which I have pondered many times since, lies in creating the perception of being immersed in an endless plain populated with many animals. My vision then was to replicate the images from wildlife documentaries and create the feeling of being in a massive landscape which I was familiar with growing up in the sparsely populated and wide open Kansas landscape.



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After many years of thinking about the exhibit and zoos in general, I realized that zoos could never recreate the wild in its accuracy, spontaneity or harsh reality which I dreamed of. Also, I began to think about the problems facing the animals and landscapes I enjoy. During college I was exposed to the driving forces and my connection to the problems threatening animals. With this new knowledge I began to see opportunities in zoo exhibits which could communicate messages explaining the problems and potential solutions threatening wildlife. My motivation for designing zoo exhibits shifted from replicating habitats to conserving and protecting animals and their habitats through visitor learning.

To begin the workshop I would like you to, in 2 minutes, briefly write down why you began designing zoo exhibits. You can write your responses in the workshop manual under Interaction 1.0.

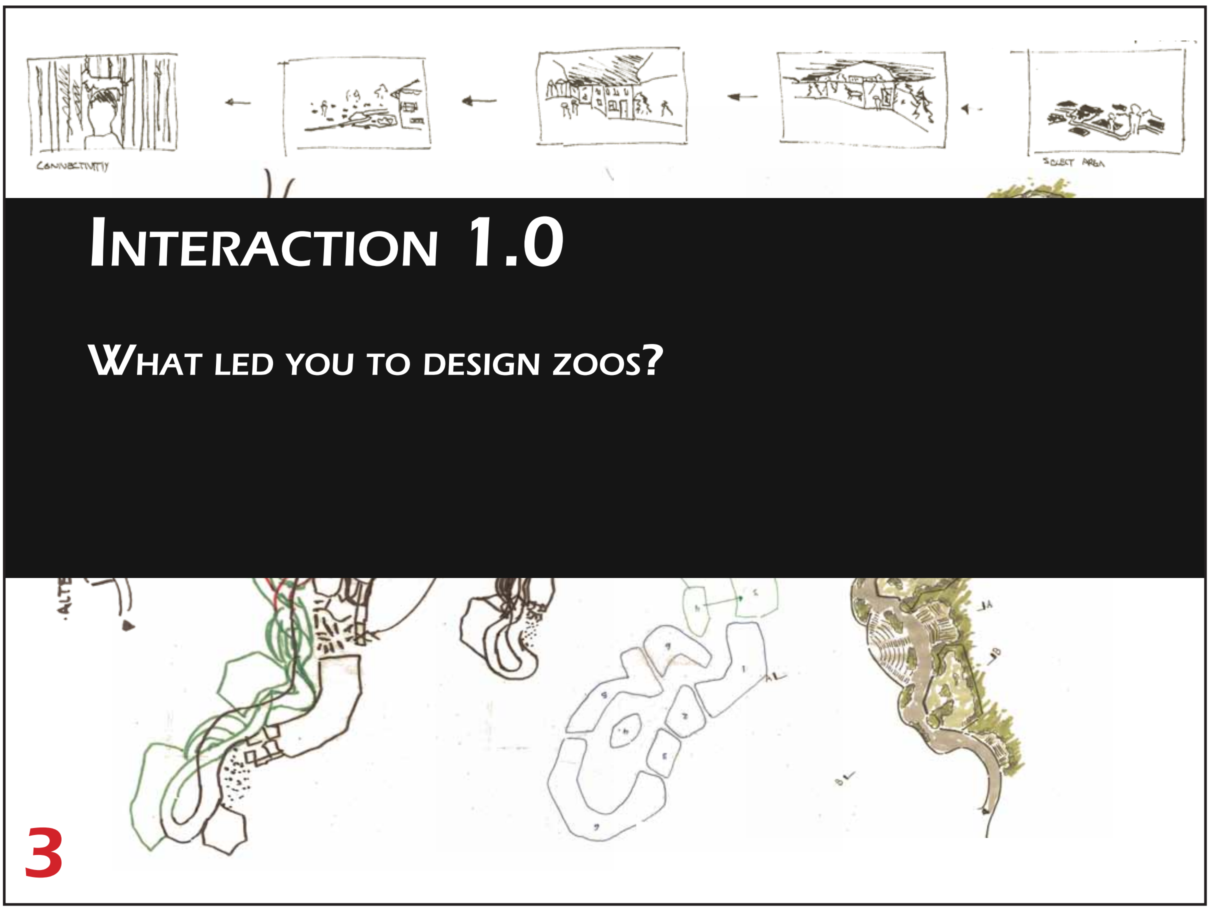
Now, I would like you to divide into groups and share with each other why you began designing zoo exhibits.

Paper: Workshop Manual

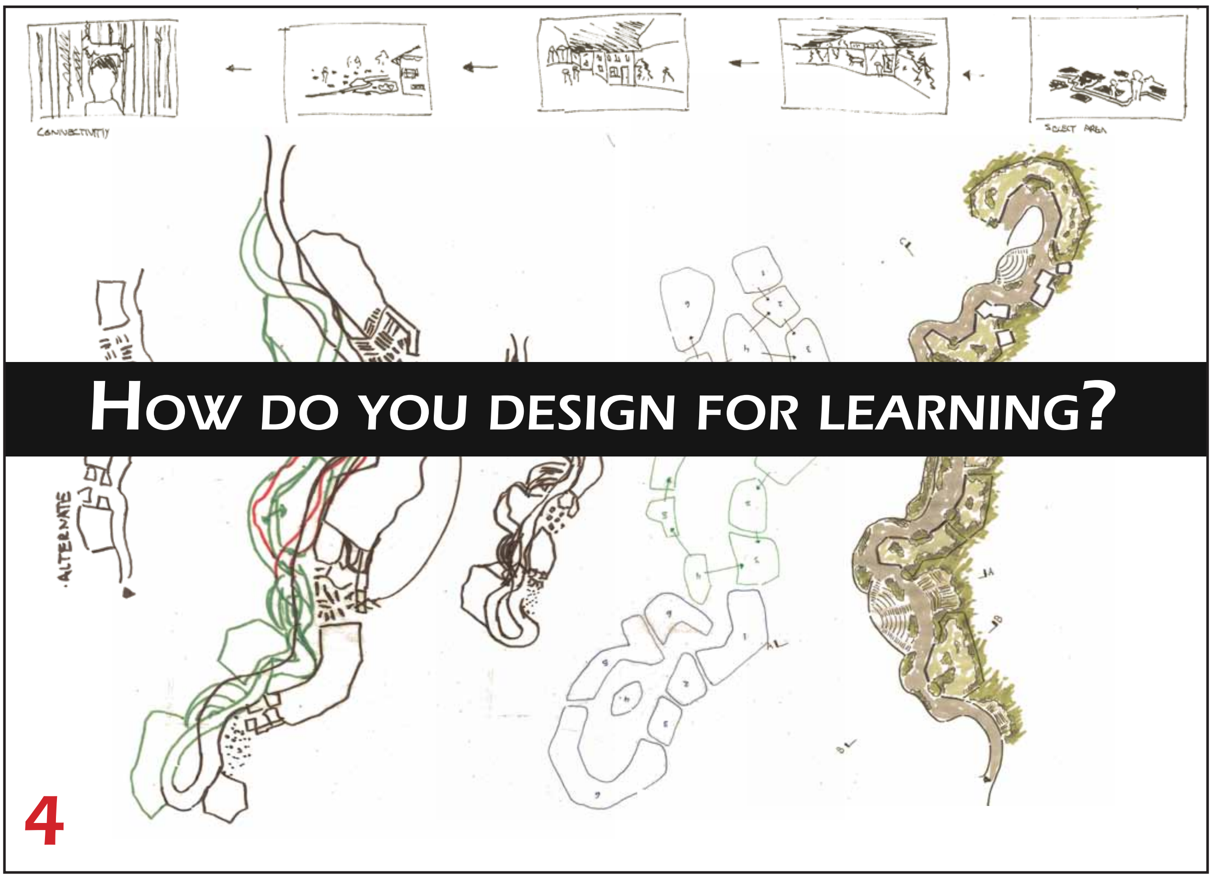
Time: 10

Additional questions for discussion

What role does learning play in your motivation?



How important is learning in your exhibit designs? What makes zoo exhibit successful learning environments? What learning processes are occurring?... How can we design for learning? I hope by the end of the day we all have answers to these questions and a better understanding of how people learn.



4 How do you design for learning?

We talk about learning but what does it mean to learn? I believe that learning is often considered the ability to consciously recall new information where learning is viewed as an outcome. Visitors are treated as black box into which information is presented and the outcome of recalling information is the measure of success. However, learning is much more complex and diverse. Instead, learning is more accurately described as a process of transforming information into knowledge. This more accurately describes learning and places emphasis on how information becomes knowledge. Learning is a process of sensing the physical environment and using mental processes to perceive, understand, interpret, remember and interact with the environment. The mental processes called cognitive processes are how we think, learn and solve problems. By viewing learning from this perspective, design shifts from providing information to encouraging learning processes by facilitating those processes we use to learn.

Again, the internal thought processes we use to think, learn and solve problems are called cognitive processes. During zoo visits we use cognitive processes to decide what to attend to, make observations, understand those observations and make meaning from the observations. To designing for our cognitive processes, the exhibit designer is concerned with visitor's attention, perception, meaning making, information recall and memory.

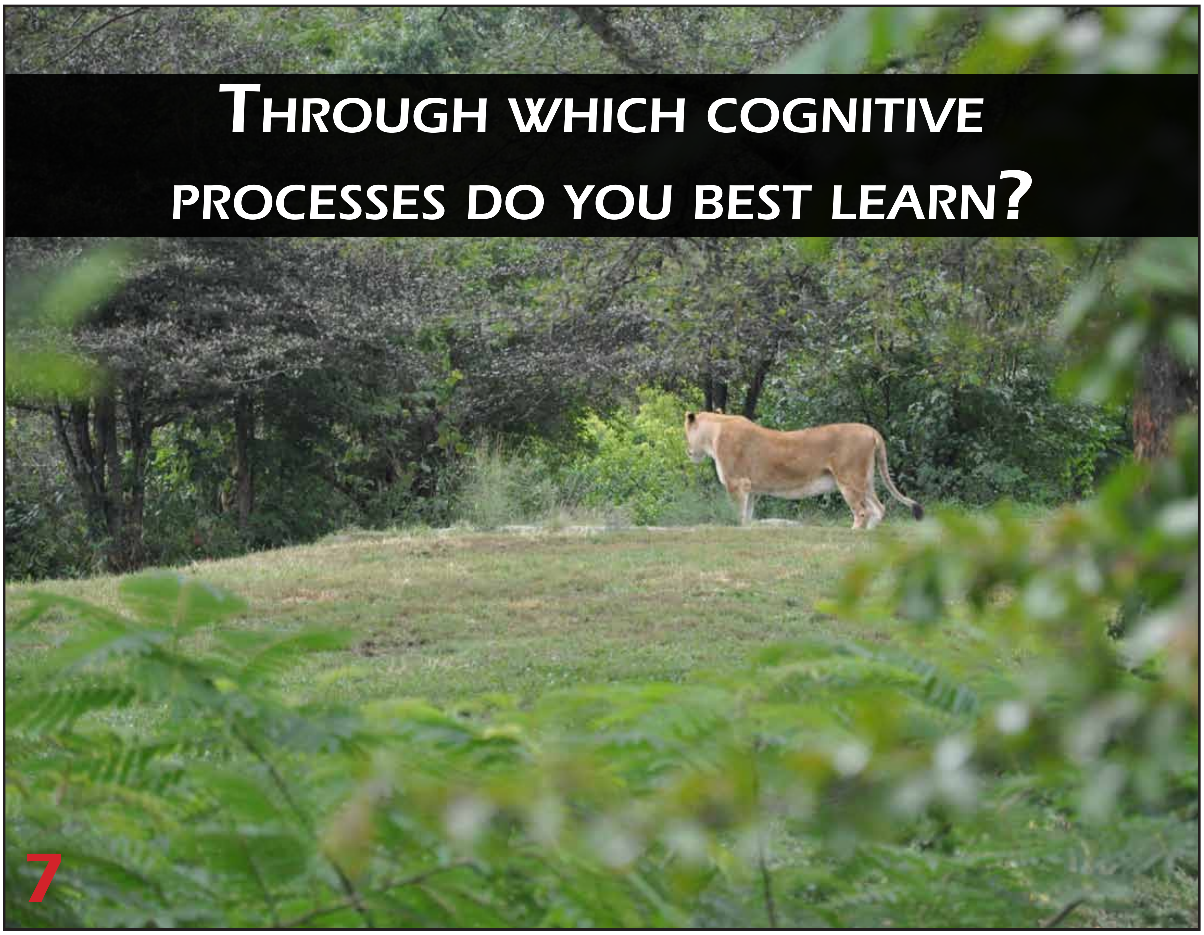
How do we design for cognitive processes? We currently design for some cognitive processes by modifying viewing angles, spatial relationships and viewing perspectives of animals. We know that by displaying animals in naturalistic landscape instead of sterile cages increases our ability to make connections between animals and the animal's habitat or landscape. By modifying the spatial relationship, to move animals above or at eye level, we perceive animals respectfully. Additionally, by placing cultural features of the animal's native landscape in exhibits, we connect the animal to its natural landscape and local people. How do we make these connections to learn? Do we intuitively recognize the connection? Do we read signage to make the connection? Do we recall information to make the connection?

Central to my thesis is the idea that if exhibit designers know how we learn and make these connections, using our cognitive processes, then their designs can increase our learning about animals, their habitats and conservation.

Imagine a zoo visit where you walk from one enclosure or viewing area to the next possibly engaging cognitive processes by talking with other group companions or playing with friends. At the next exhibit, you watch two lion cubs playing with each other and you mimic their wrestling. A keeper or docent is there talking about the lions and we touch lion fur at an interactive display. As we leave the area we read a sign about the social life of lions and remember the cubs wrestling. We used different cognitive processes to perceive, understand, interpret and remember the different situations.

How do we engage different cognitive processes for the different scenarios?

How can zoo exhibits facilitate these different types of cognitive processes on learning desired zoo messages?

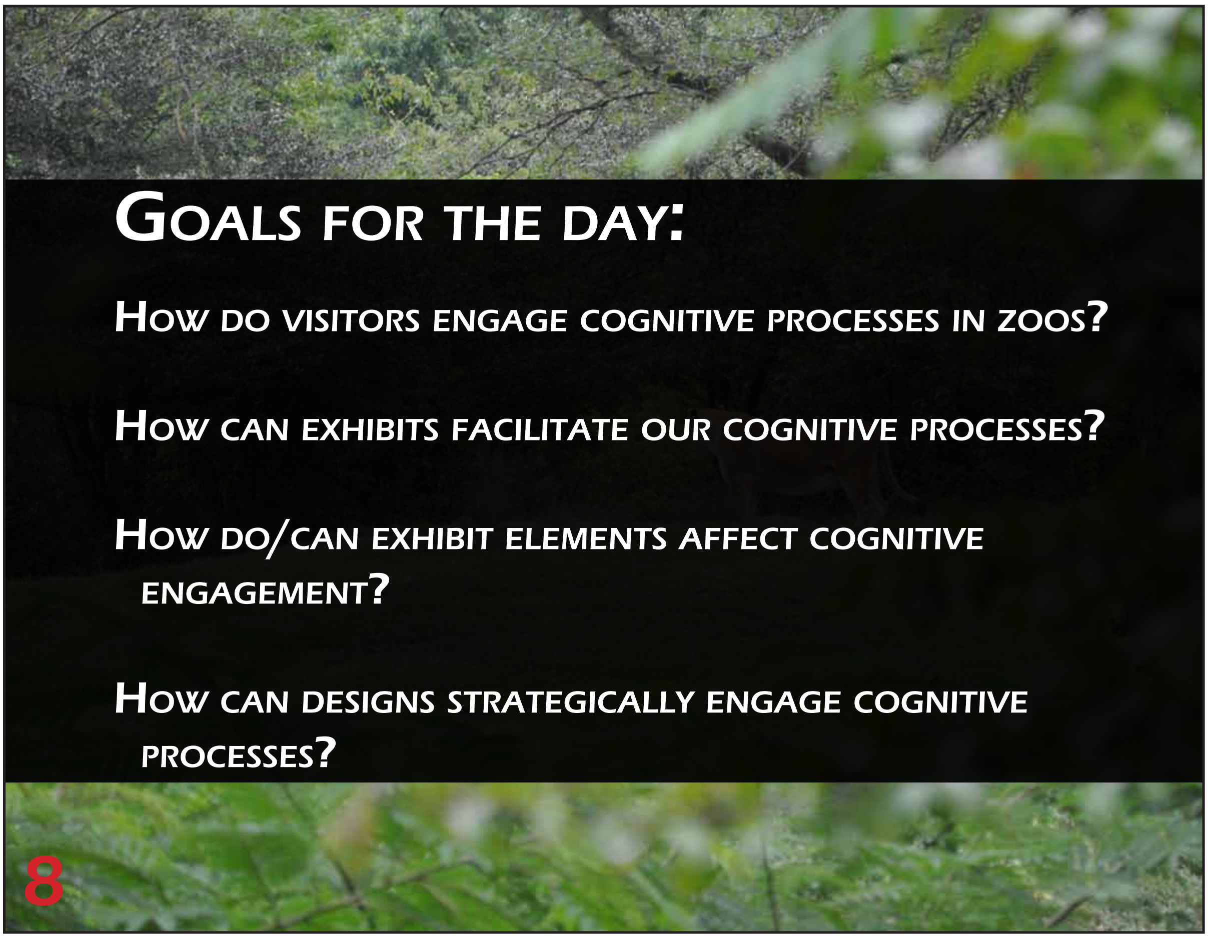


In my research for this project I had a hard time finding literature explaining how to design the whole exhibit for learning. This workshop is designed to discover how zoo design professionals would apply the research presented on learning theories and cognitive processes to help me understand and develop a guidebook for designing an exhibit specifically for learning and engaging visitor's cognitive processes. The information presented today is a synthesis of an extensive literature review on learning theories from education and cognitive psychology.

To understand how my learning of this new material influenced my design process, I engage in a personal design charrette for zoo exhibits to understand if learning about cognitive processes influenced my designs. Analysis of my design responses indicated distinct influences of my new knowledge. Is this novel to me?.. Or, would other zoo designers also modify their approaches to exhibit design with the same knowledge? I could have made the outcomes of my personal design investigations into Russell's guidelines for zoo exhibit design, however, I am passionate about animals and their habitats and conservation, and realize the value in your experience as validation, extension or contradiction of my outcomes. Thus the workshop concept is to determine how other designers would apply information on learning theories and cognitive processes to zoo exhibit design.

I am keenly interested to see if designers with much more zoo design experience than I would use the information about cognitive processes in similar or different ways. Ultimately, I want to report the findings of this work so all zoo designs could benefit from conclusions drawn. I also want to understand how participants in the workshop would integrate this information into future exhibit designs.

After the workshops I will analyze the outcomes of the



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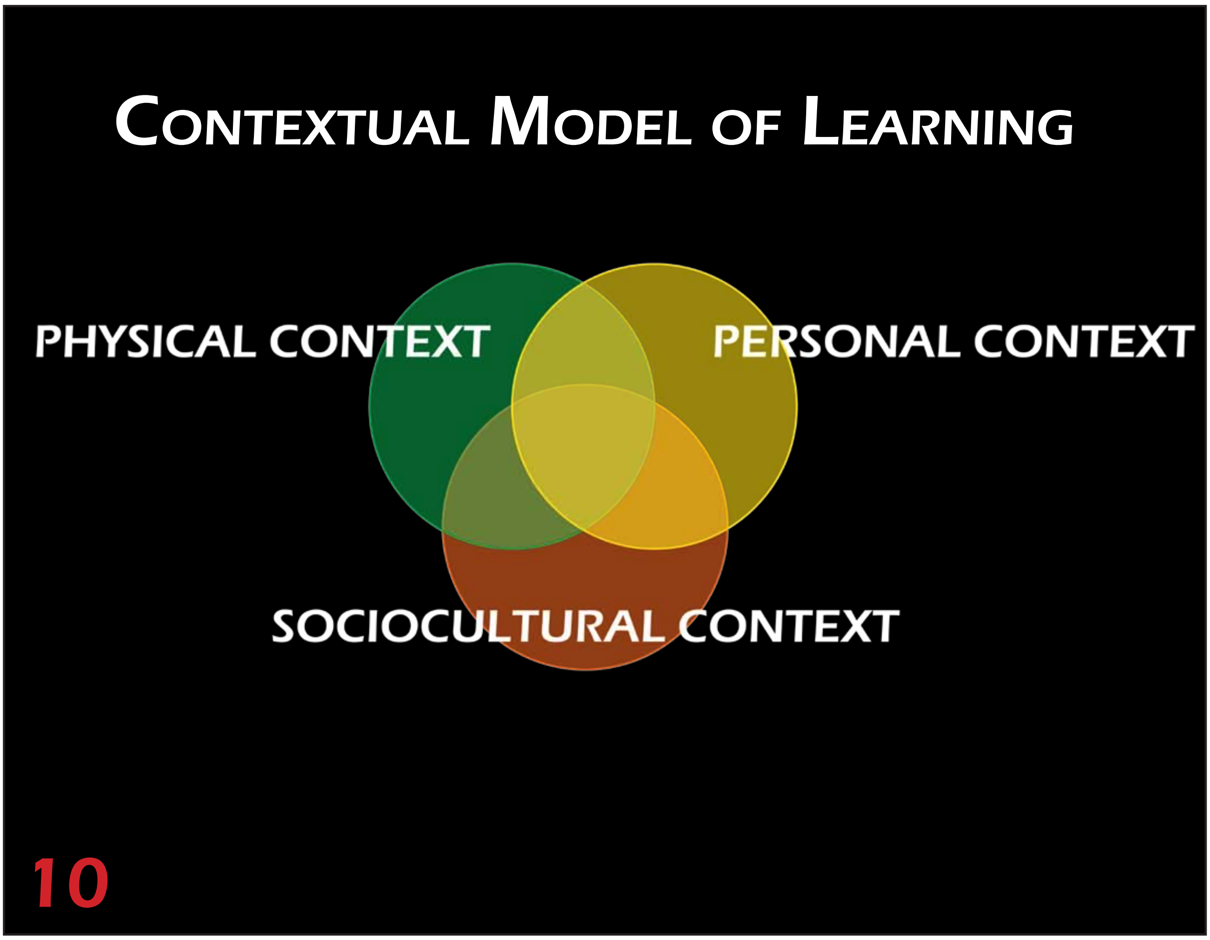
brainstorming and sketching activities to synthesize into guidelines, strategies or typologies for how to incorporate learning theories and cognitive process into exhibit designs. The guidelines, strategies and typologies will be complied into a booklet for zoo designers to reference when designing exhibits for learning.

So the information presented today explores cognitive processes starting with our internal states and working outwards exploring exhibit design and our interactions with animals and the environment. First, we will understand how prior knowledge, motivation, cognitive preferences and social situation influences how we interpret and make meaning. Then we will investigate the cognitive process we use to learn from the physical environment. We will also explore how the environment influences where we direct our attention, perceive the environment and understand the experience. Lastly, we will discover how we engage our cognitive processes as we interact with the environment.

Let's take a look at a learning experience. Think about what is affecting their learning.

Participants watch a video of visitors watching lions.

Many factors influence learning during zoo visits. Generally the factors are categorized into three suites, or contexts, the physical, sociocultural and the personal. The Physical Context describes how the physical environment inside and outside the zoo influences learning. The Sociocultural Context describes how learning is influenced by the people we interact with and the Personal Context explains how the unique characteristics of the visitor affect learning.



Zoo exhibits are multi-sensory environments which can potentially disorient us. We need information to navigate zoo exhibits so we feel comfortable in the space. If we are stressed we may be distracted from learning. We also need to understand what and how we are to learn and how to use the presented information, called conceptual orientation. By providing conceptual orientation, we know how to create meaning because we know how the information conceptually relates to other information.

Zoo exhibit design affects learning especially our perception of animals. The spatial relationships can increase our respect for animals when we are in a lower position. Displaying animals in natural landscape causes us to perceive animals to be part of nature.

Learning in zoos is not complete until we recall the information in situations outside of zoos such as museums, schools, work and daily activities. Recalling information reinforces and supports learning because it contextualizes the information.

Physical Context

11

Zoo visits are social situations and much learning occurs by interacting with others. Learning increases because other visitors, such as parents, help interpret and create meaning for others. This facilitation not only helps the learner, but also the facilitator as they strengthen their learning as they share their knowledge and experiences.

Interaction also occurs outside the immediate group of companions. We encounter zoo keepers, docents, demonstrations, and other visitors who share information and assist in creating meaning. They can answer questions and encourage us to think deeper about the information presented.

Sociocultural Context

12

The Personal Context is important to understanding how learning occurs because learning is unique to us. We each bring to the zoo a different set of prior experiences and knowledge. Prior knowledge is important, as we shall see, as the day progresses. We use prior knowledge to frame and contextualize new information and new situations. It also affects what we find interesting because we seek out what is familiar and comfortable. In zoos we expect and desire the ability to choose what to attend to and how to create meaning. What and how we choose to engage information is different for all of us because we each have different preferences for cognitive processes.

Let's review the video to see how the factors influenced the visitor's learning experience. One thing that you don't get from the video is that the sign is about how lions are similar to house cats.

As a group discuss the factors of the physical, sociocultural and personal context influencing learning in the exhibit. In four minutes lists the factors in the situation which increased and decreased learning.

Paper: 11x17

Time: 10 min

Physical Context

- Conceptual organizer is a hierarchy of text about how all cats are similar
- Advance organizers are a glass door allowing visitors to see into the area so that they have some idea of what to expect.
- The floor to ceiling windows create a space in which we feel mutually open to viewing.
- Themeing elements such as the rock extend from the visitor space to the animal space
- Space allows for close viewing access.
- The information from the sign about cat behavior could be reinforced when they encounter a house cat such as at home.

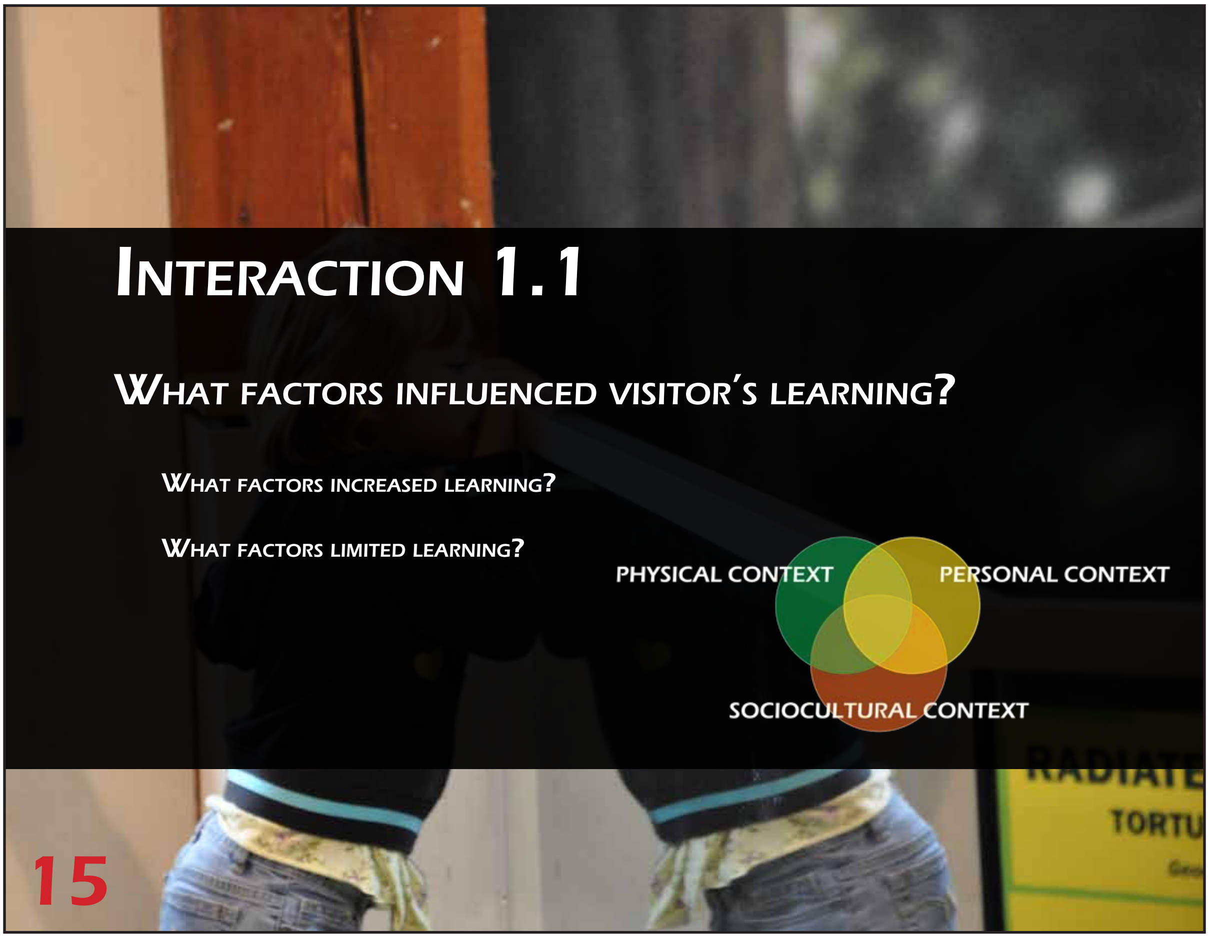
Sociocultural Context

- The child walks in he says there are lions and cheetahs. Then his dad corrects him.
- The man with a beard reads the sign and then talks with his friends.

Personal Context

One visitor recalling information about the Lion King movie, calling the lions Simba and Nala.

The three contexts or factors set the frame for how learning occurs but does not describe how learning occurs. The information presented today will continue to be referenced through the lens of these three factors.



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Before we can understand how learning processes occur, we first need to understand and respect the fact that we are all different. Learning processes are unique to each of us. The processes are shaped by our prior knowledge, motivation and learning preferences. We use our existing knowledge and experience to contextualize and frame new information and experiences. This influences what we find interesting and how we create meaning which forms our motivations for visiting. The needs and expectations for visiting affects our learning and behavior during zoo visits.

First, let's look at two of those personal factors, motivation and interest. To understand the reasons visitor come to zoos and what they expect and need from visits we need to understand what visitor's desire from zoo visits. With this understanding we can design exhibits to engage their cognitive process while fulfilling their needs and expectations for the visit. Exhibits can achieve cognitive engagement by self-motivating visitors instead of imposing cognitive engagement.

How does a visit differ when you go for work compared to when you go on the weekend with your kids? How does your behavior change? What do you want out of an experience when you go to a zoo for the first time compared to the local zoo you have been to many times? When you visit a zoo do you wander until you find something that piques your interests, or do you look for a quiet place to relax and enjoy an animal?

All of these questions can be answered by the Identity you enact for zoo visits.

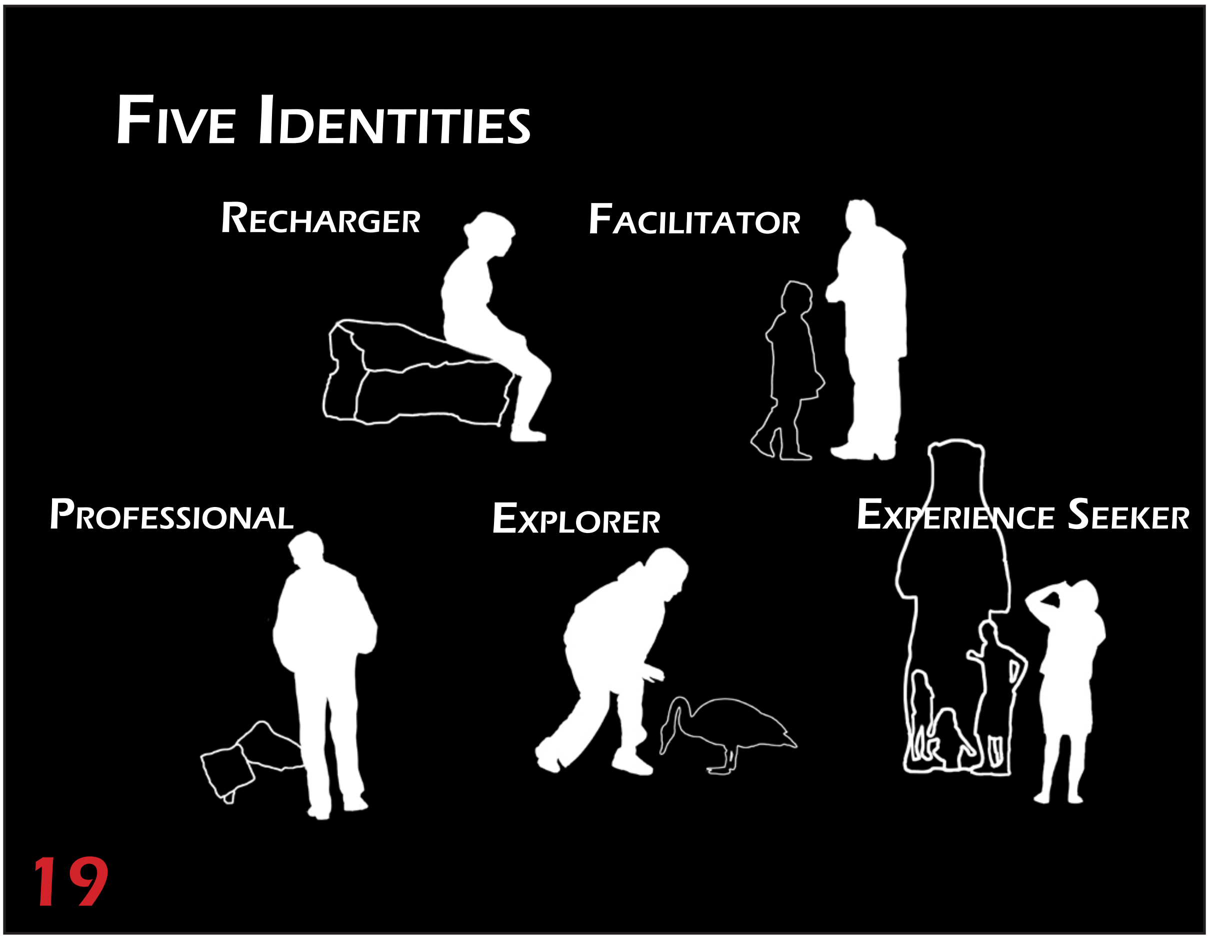
When we visit zoos we come for a specific reason with expectations and needs. The reasons for visiting drive visitor behavior and explain why people act the way they do. We view a zoo as having affordances which we believe a visit fulfills. For example, parents believe that bringing their children to zoos provides opportunities to interact with them and opportunities for fun and learning. Due to the perceived affordances, we come with expectations and motivations called an Identity. An identity is "a complex sociological and psychological construct assembled from a myriad of sources, including a visitor's prior knowledge of and experience with the setting, perceived social relationships and expectations, the social and cultural meaning s/he attributes to the institution, and personal interests". An identity is how we view ourselves and how we perceive others to view us.

For example, when I go to the zoo with my sister I act in such a way I believe a good brother would act by engaging her in conversation and activities. While we are looking at animals I ask her questions to start conversations because our time at the zoo is now some of the only time we get to spend together. I also want others to view me as a good older sibling who gives his sister attention and enjoys spending time with her.

Five zoo visitor Identities have been classified in zoos. The Explorer comes to fulfill their curiosity. Facilitators come to fulfill the needs of someone else they are with at the zoo. The Professional comes for a specific reason to increase their knowledge about the zoo or activities at the zoo. Experience Seekers come to 'collect' a unique 'experience'. Rechargers come for self- reflection and rejuvenation.

Identities are dynamic. We could be taking our kids to the zoo one day and visit the next day for work; acting very differently for each visit. Also, multiple Identities can be enacted at one time. For example, when I take my sister to the zoo I am facilitating her visit but I am also very focused on the exhibit design.

Identities are important to understand because it is the lens the visit is filtered through. Our identity frames the visit which is unique to a particular moment in time and space. Identities are important to understand for learning because Identities reveal what types of information we want to encounter and how we want to engage the information. In observing an exhibit, different information is recalled for different Identities. For example, if a visitor approaches a bear exhibit a Facilitator may point out the bear to their companions and ask them where bears live, recalling information they know their children know and understand. Whereas, a Professional may notice the bear's behavior or detailing of the rockwork and recall the type of rock being replicated. Identities also explain why some experiences are more memorable than others. When a visit fulfills an Identity's needs the experiences are more memorable because the experience reaffirms who we are.



A child comes to an aviary and runs into a exhibit. She moves quickly from one display to another. Then she stops on one object for a few minutes. This pattern seems random, however is clearly explained by her Explorer identity. She was in search of something which piqued her interests. When she found an egg she was interested because of her prior knowledge based on a birds nest in her backyard. As she ducked into the egg, she was oblivious when she left the rest of her group behind because she wanted to find something interesting to her.

Visitors who come to the zoo to fulfill their curiosity are Explorers. They are interested in general discovery of information and not necessarily concerned with whether other group members enjoy the zoo visit. Explorers are one of the largest groups of visitors in zoos. They visit frequently and therefore have an understanding of how zoos are organized and what activities zoos have to offer other. They have a general interest in learning, but not necessarily a specific topic. In learning they rely on their prior knowledge to determine how they attend, frame and make meaning.

During exhibits Explorers want new and surprising opportunities and events such as temporary exhibits or in-depth programs. They also want the ability to customize the exhibit experiences because they don't like prescribed ways to experience the exhibit. Instead they want to browse for interesting information and opportunities to exercise their minds through discovery. To assist them in browsing they need visual and intellectual clarity to identify information to determine what to engage.

Explorers are the most similar to designers; however, research suggests that designs are not meeting their needs. Explorers want to push their intellectual abilities with greater challenge.

EXPLORER

20 HOW CAN VISITORS CREATE THEIR OWN LEARNING EXPERIENCE?

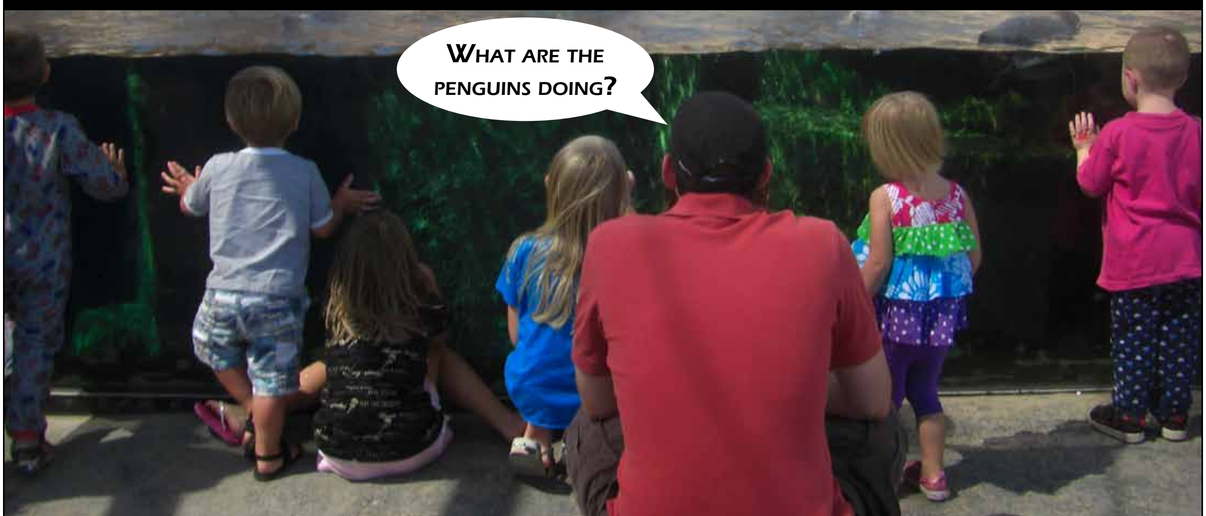
A parent brings their children to the zoo. They go into an exhibit about a wetland. A sign describes water conservation and the effect of the wetland shrinking He asks his kids why the water is important to the animals. He directs their attention to the sign and asks them question about animals, water and their habits. He helps the children understand water conservation because he wants the kids to stop leaving the sink running.

Visitors who come to fulfill the needs of someone they care about are Facilitators. There are two types of Facilitators. Facilitating Parents focus on satisfying the needs of their children by translating and interpreting the shared zoo experience. The experience is centered around their child's fun and learning, not themselves. The other type is Facilitating Socializers, who focus on fulfilling a friend or companion's visit and may not be interested in the content of the zoo, rather than facilitating the experience they take the Identity of their companion.

Facilitators don't separate learning from fun. Learning should be designed for the Facilitator's prior knowledge, experience and interest because the Facilitator interprets the experience. Also, Facilitators may or may not be knowledgeable about the zoo content.

Facilitators need opportunities to socialize and interact with their companions. For Facilitating Parents, exhibits need to provide intergenerational interactions and activities to engage parents and children together. They need tools to help their companions learning such as signage explaining how to communicate the information to their children. They also need spatial and conceptual orientation to simplify navigation because of the potential distraction of watching their children.

FACILITATOR



21 WHAT EXHIBIT ACTIVITIES ENCOURAGE INTERACTION BETWEEN FACILITATORS AND THEIR COMPANIONS?

A family is on vacation in San Diego. The relatives they are visiting encourage them to go visit the zoo and describe which exhibits they need to see. When the family goes to the zoo they go to the suggested and the most advertised exhibits, making sure they experience the most important attractions.

Visitors who come to 'collect an experience' are Experience Seekers. They come for a new or famous exhibit which presents a unique experience. Experience Seekers are motivated by the idea of being there not necessarily the content of the zoo.

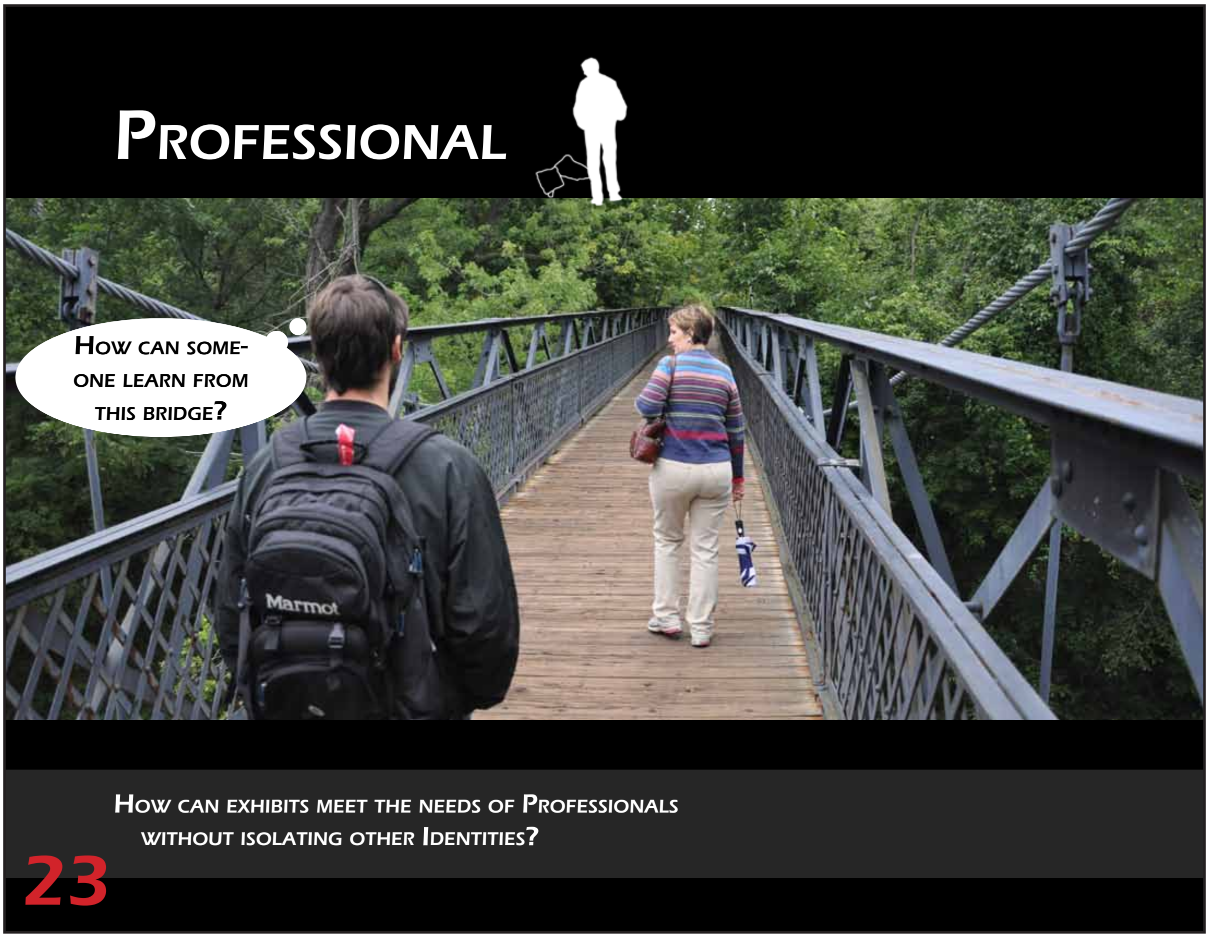
Experience Seekers need good orientation to navigate unfamiliar exhibit spaces with the most important attractions highlighted. They want a unique experience different from other local attractions. Since they are there primarily to 'collect' an experience, they need opportunities to remember the experience.

When I go to the zoo I focus on the details of the exhibits. I think about how the exhibit is communicating the messages of the zoo to visitors. I typically spread my attention equally throughout the exhibit focusing on the details.

Visitors who come with a strong knowledge, interest in the zoo and specific reason for the visit are Professionals. They are interested in advancing their knowledge about their profession, hobby or job. Visits are focused on accomplishing a task and they are conscious of the specific task. They understand the zoo and are in-tune with goals and activities of the zoo.

Professionals have a large body of knowledge and are highly focused on increasing their knowledge from the zoo exhibit. They are looking for in-depth information and references.

Professionals are interested in premium programs such as behind-the-scenes tours, interaction with experts, lectures and seminars. They do not follow the 'prescribed' visit experience. Instead they attend to what is important to them, which is typically different than other Identities because of their highly focused visit objectives. They prefer an experience with minimal distractions and small crowds.

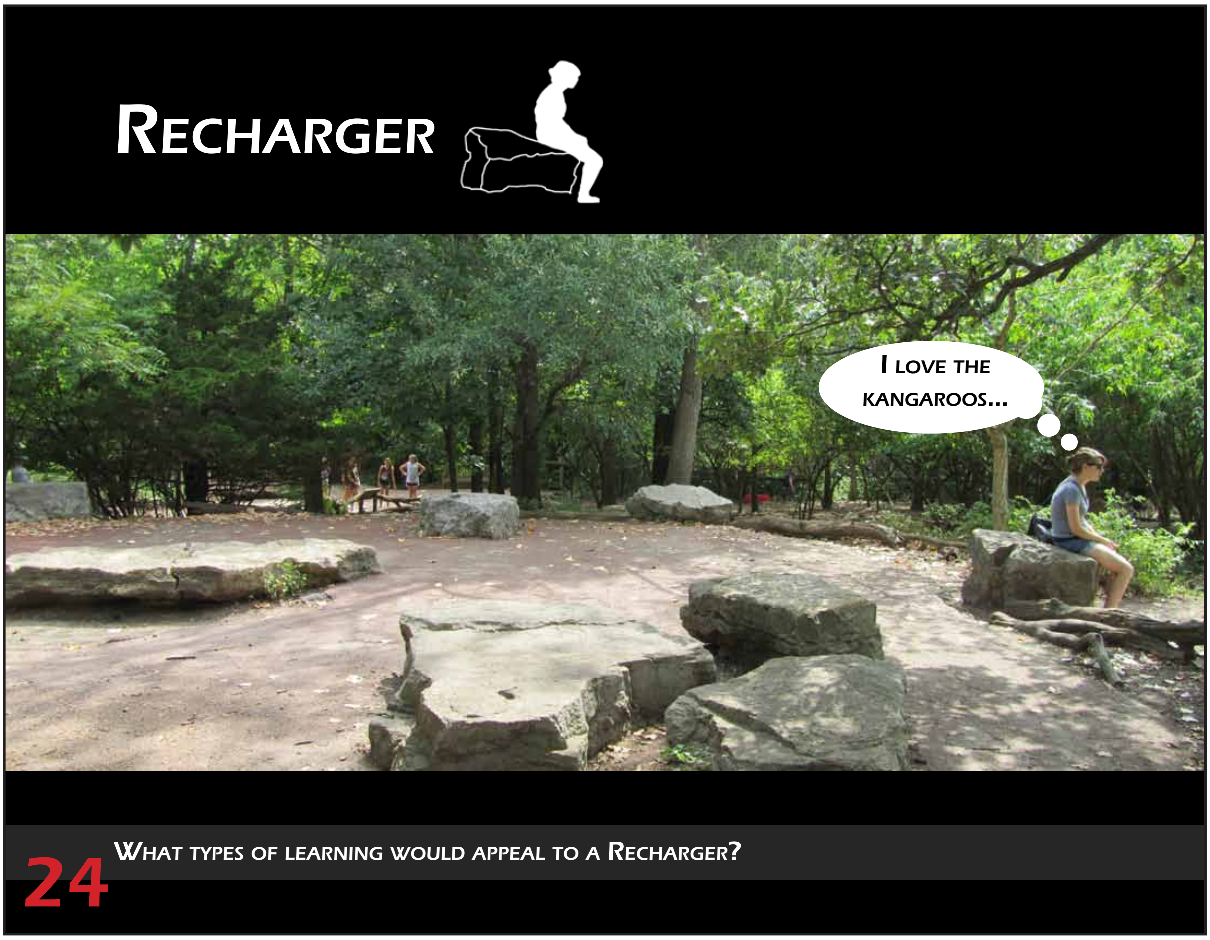


An elderly couple comes to the zoo once a week. The go to the same bench in the aviary. Birds fly over their heads and the waves of the ocean rush up on the beach in front of them. They typically do not read the signs or attend all the exhibits, instead prefer to stay in their quiet spot enjoying the animals.

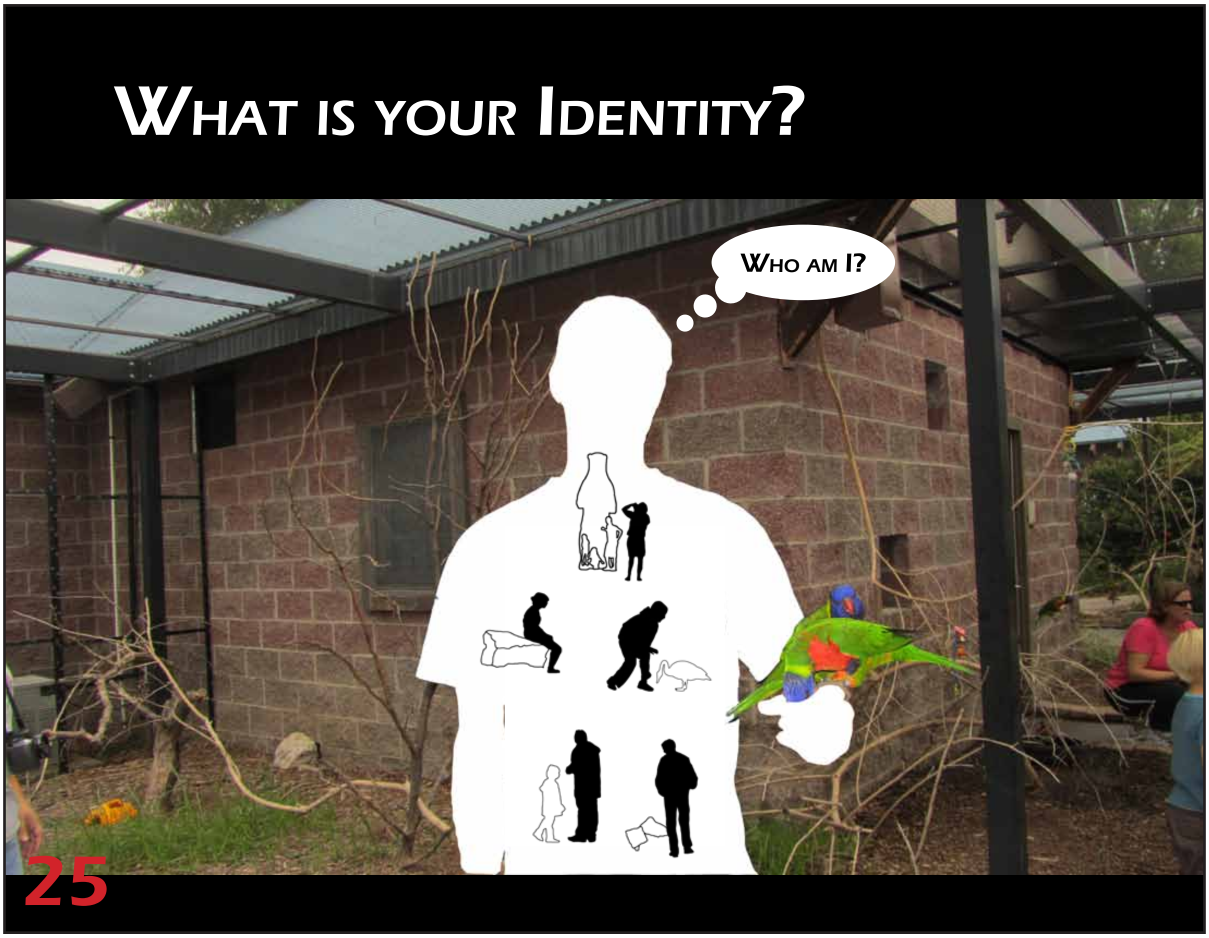
Visitors who come to reflect, rejuvenate, or bask in the wonder of the place are Rechargers. They are looking for a quiet place to relax.

Rechargers likely understand the content of the zoo; however, it is not what motivates their behavior and visit.

Rechargers are looking for quieter programs. Exhibits need to create places for Rechargers to balance other noisier identities such as Social Facilitators. They require little orientation because they are repeat visitors.



Identities are important to understand because if we understand what visitors expect to accomplish from zoo visits then we can integrate learning into meeting their needs.



Now, I would like you to, in one minute, write down what Identity you generally enact when visiting a zoo using the workshop manual.

Next, I would like you to write down how your behavior and learning was influenced by your Identity in two minutes using the workshop manual.

As a group share how your Identity influenced your learning. Use the 11 x 17 paper to list how the exhibit facilitated the needs of your identity. Group responses for the five different identities on five different sheets of paper.

Time: 15

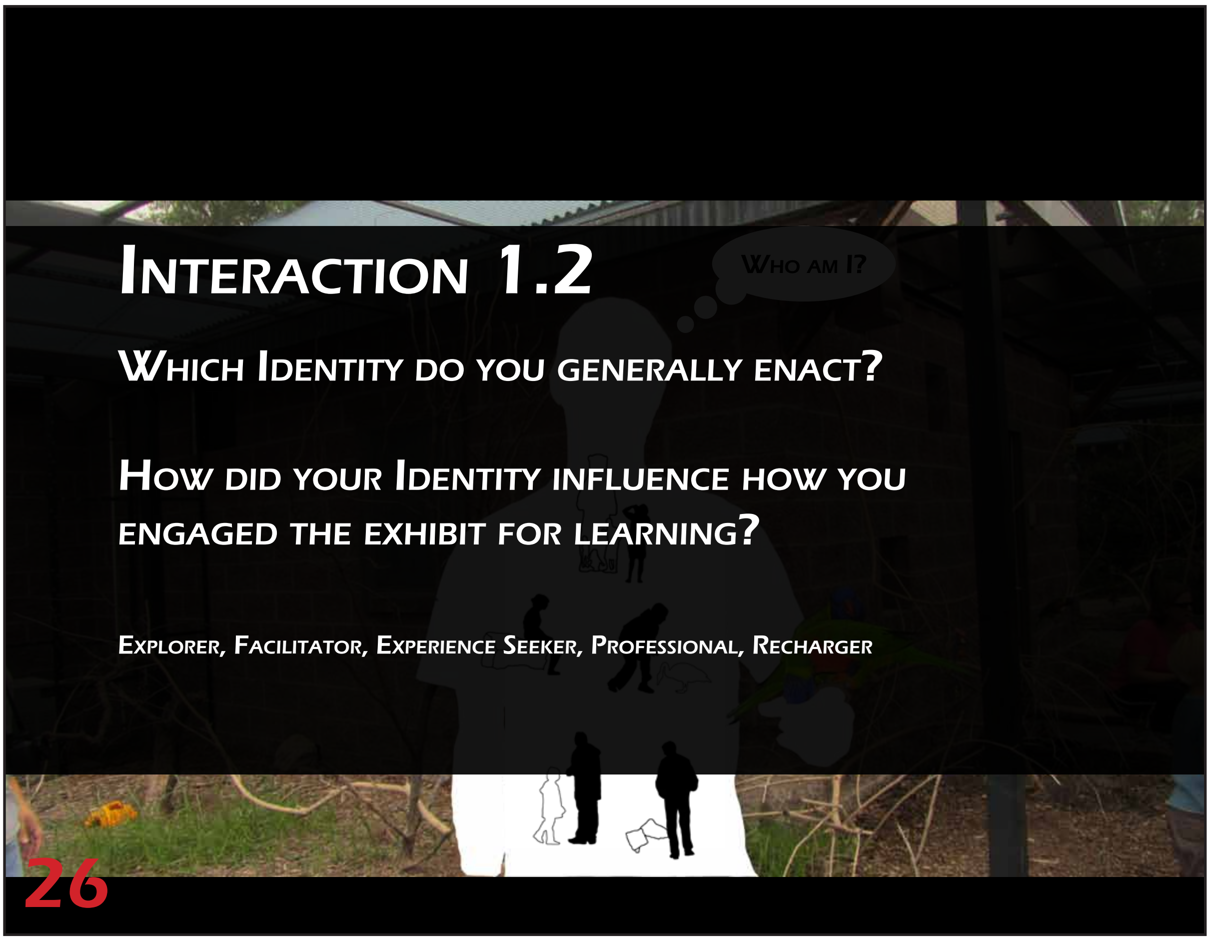
Paper: 11x17 with different Identities already labeled.

Questions:

Why did you act the way you did?

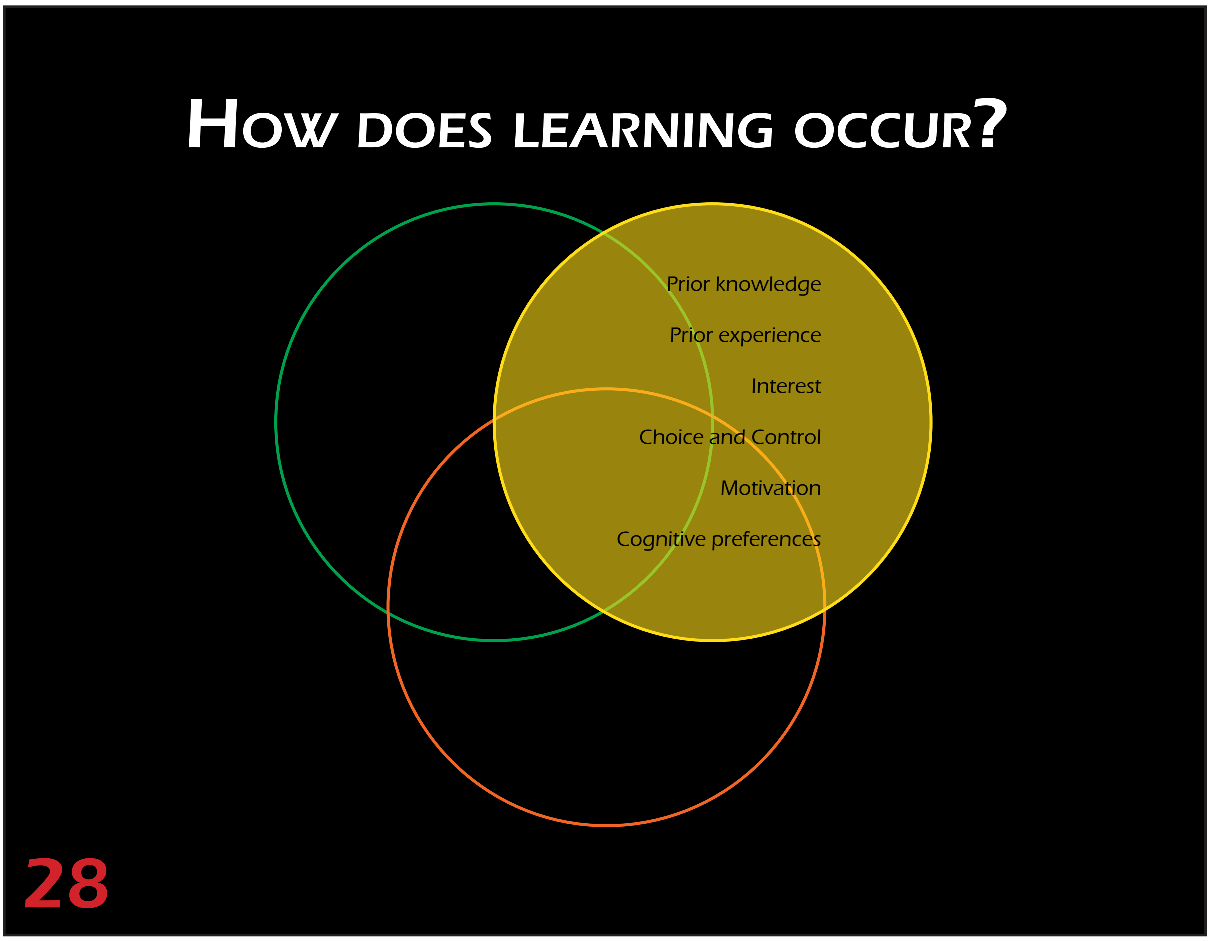
What did you engage?

What information did you recall?

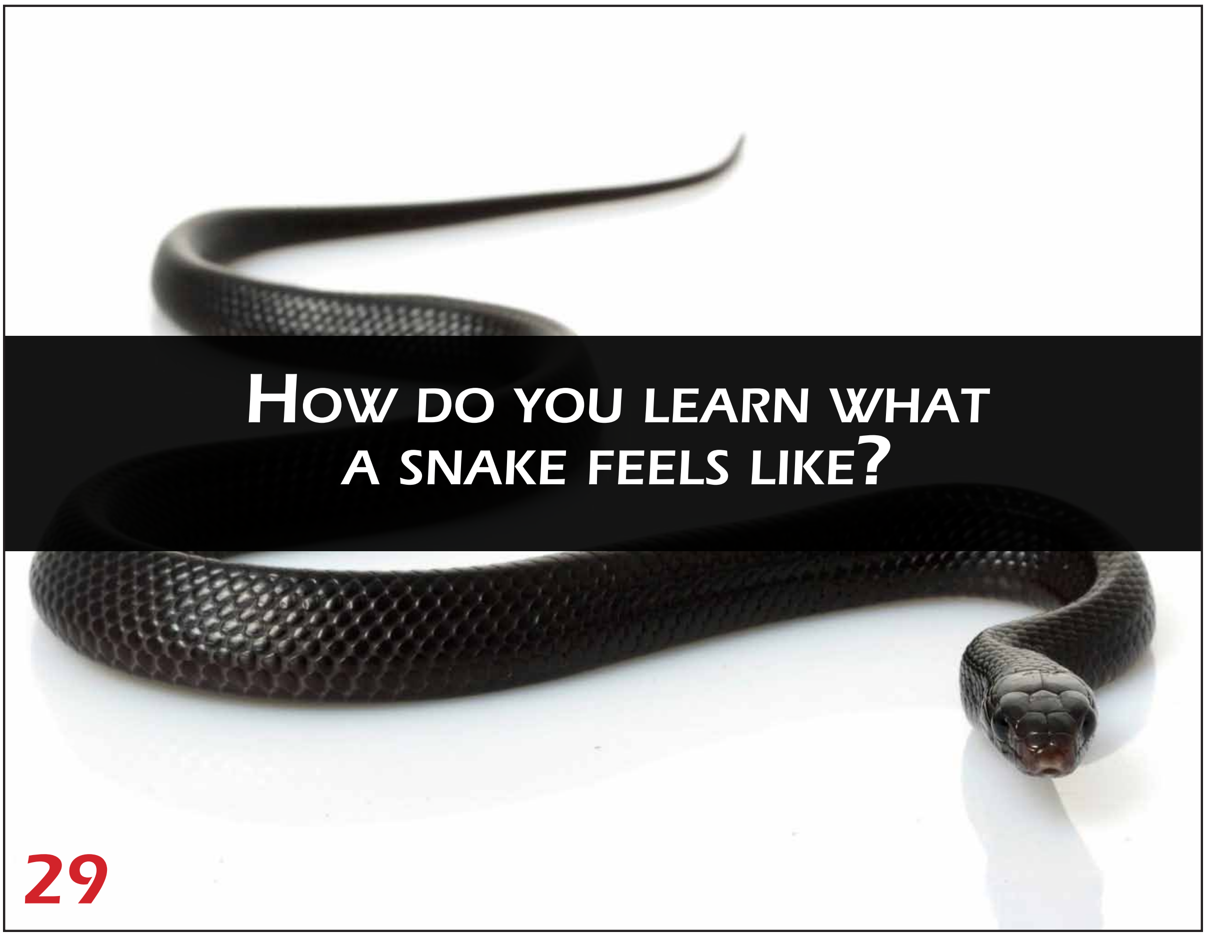



Who am I?
15 minute break
27

So far we have discussed what affects learning but not how learning occurs. Just as motivations and zoo expectations are unique to us; learning is a personal process distinct to the individual. We develop preferences for different cognitive processes called learning styles. Learning styles influence how we approach problems, interact with the environment and think about information and situations. We want to choose cognitive processes to use because we want to control our understanding and make meaning. To design for different cognitive preferences we need to understand the different ways learning occurs.



How would you learn what a snake feels like if you have not touched a snake before? What steps would you take in your physically and mentally to move from a state of no knowledge to having knowledge.

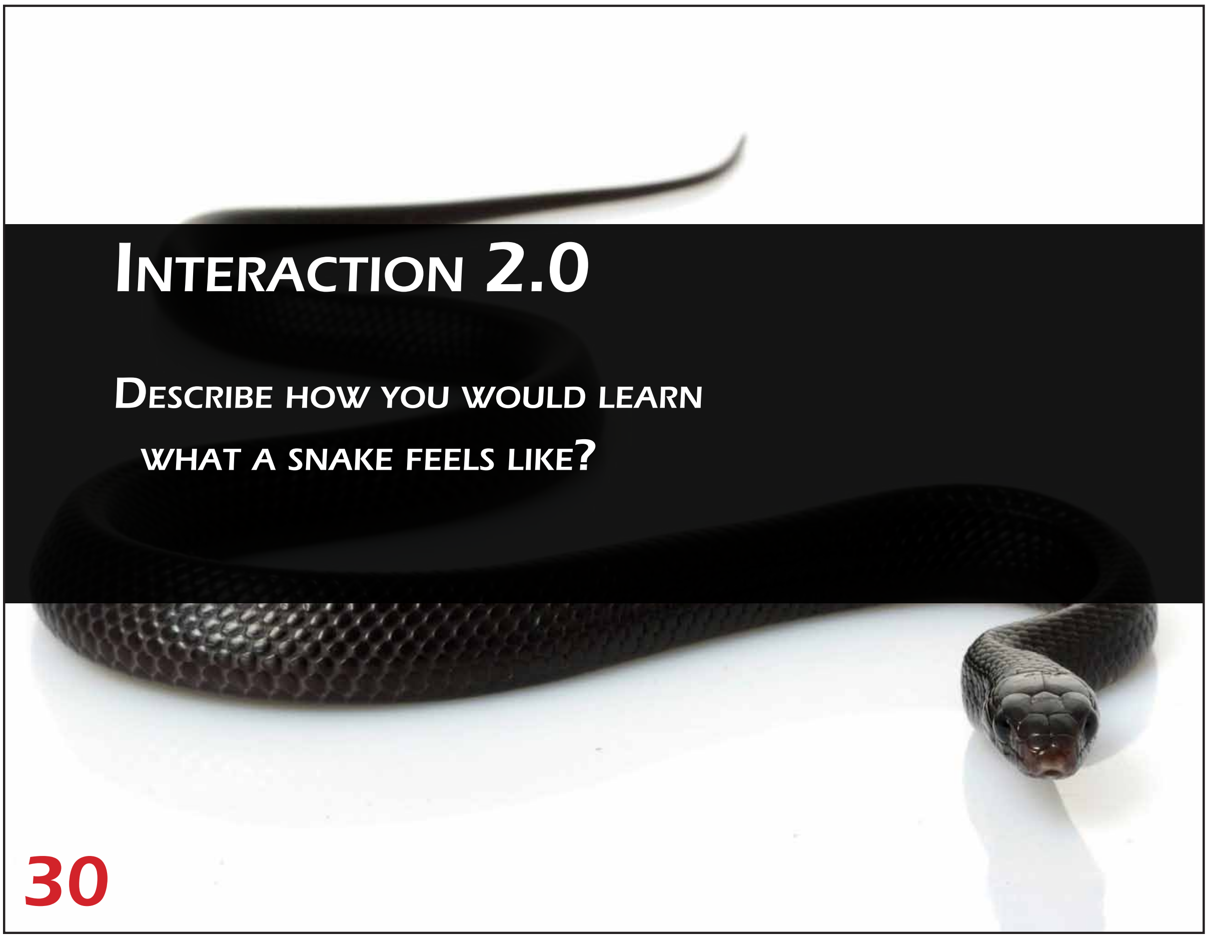


With your team quickly list the mental and physical steps someone would use to learn what a snake feels like for the first time, using the 11 x 17 paper.

Paper: 11 x 17

Time: 2 min

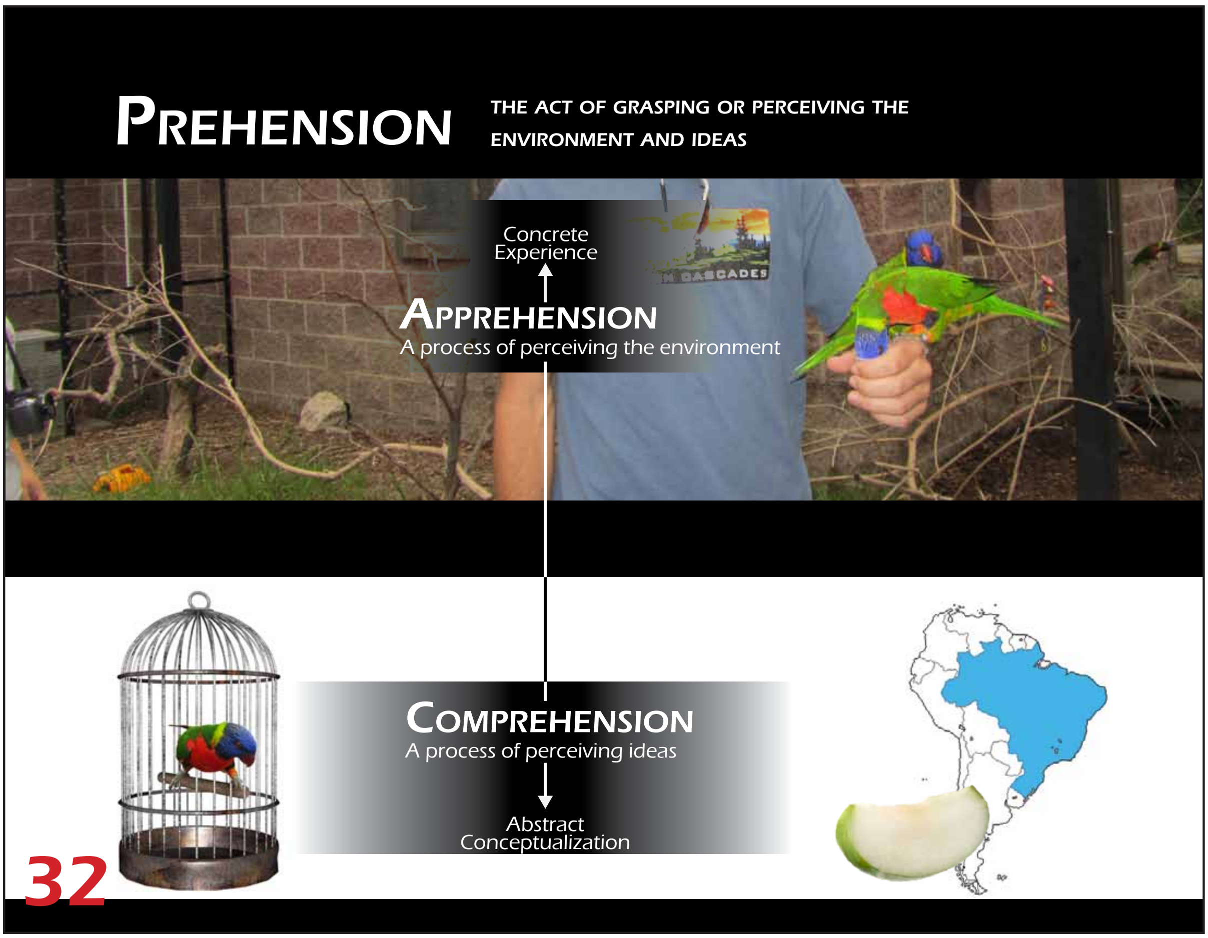
How does learning actually occur? One would touch the snake using their fingers to feel its scales, muscles and temperature. Internally they filter and combine the stimuli with existing information comparing what they already know, or what they thought they knew such as snakes are slimy. They then use a process to combine existing knowledge with the information from touching the snake into meaningful knowledge by reforming their mental idea of a snake. The conceptualization could be further reinforced by using the concept when they explain the experience to someone else.



The Experiential Learning model explains the process of learning what a snake feels like. Let's look at the Experiential Learning model in detail to understand how learning occurs, using a personal experience of mine with Lorikeets.

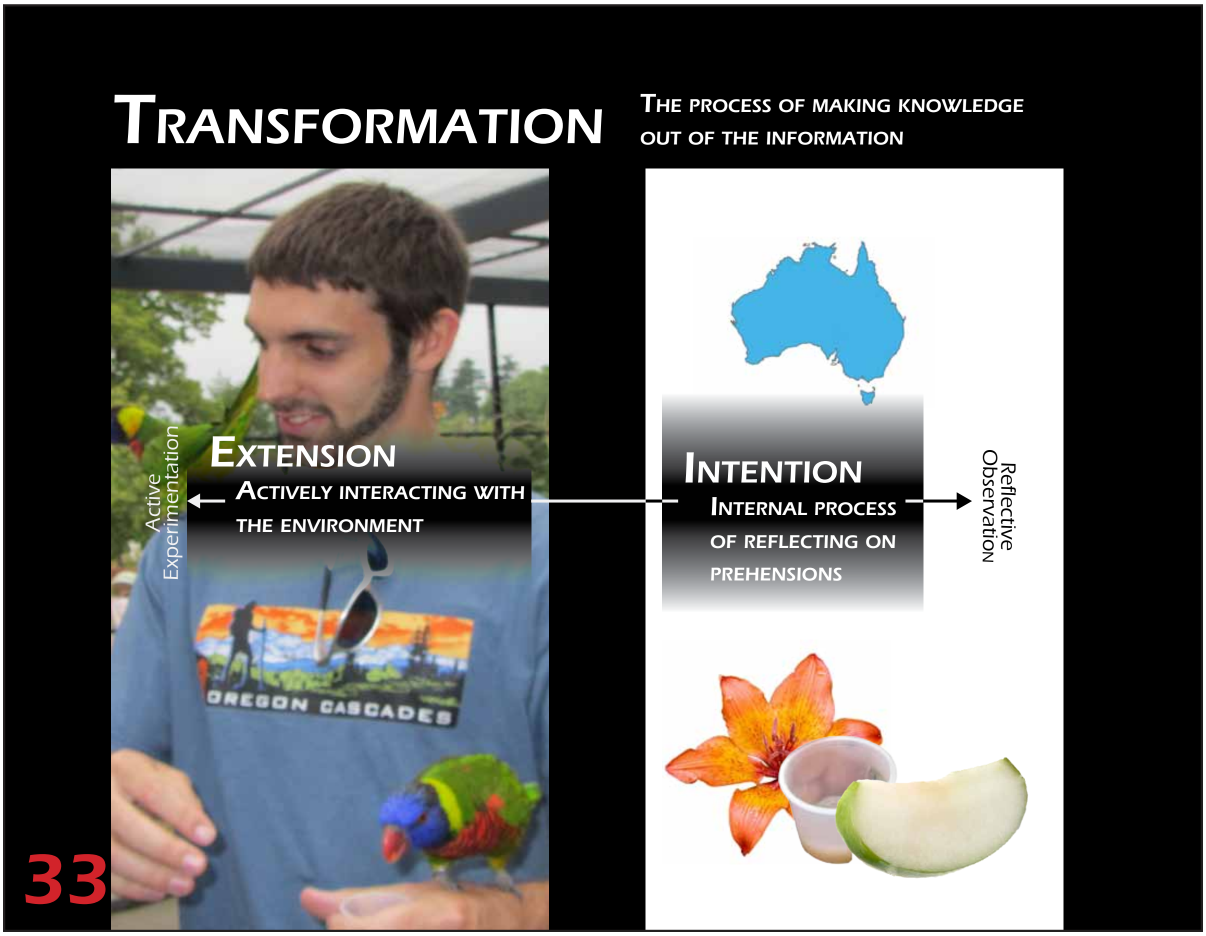
Learning occurs through two modes with two opposing processes. The processes are how we perceive the environment and transform information from the environment into knowledge. The first mode is Prehension which is how we perceive or grasp the physical environment or ideas (point to the slide show). The first process of Prehension is Apprehension which is the act of perceiving the physical environment. It is what we hear, see and feel during a concrete experience, the image on top. Concrete experiences are immediate personal experiences – the here-and-now. Much of the zoo experience is through concrete experiences; which is why zoos are special places of learning. Apprehension occurs when the bird is perched on my hand, as I observe the bird using their specialized tongue, and listening to the keeper explains where Lorikeets live.

Opposed to Apprehension is Comprehension. Comprehension is a process of internally grasping or perceiving an idea or concept abstractly. Abstract conceptualization allows people to remember concrete experiences and communicate the concepts by condensing the complex experience into a single concept. Many of the messages zoos communicate are abstract concepts such as ecological and biological functions. For me when I thought of a Lorikeet I brought to mind they live in Brazilian rainforests, they are pets and eat fruit.

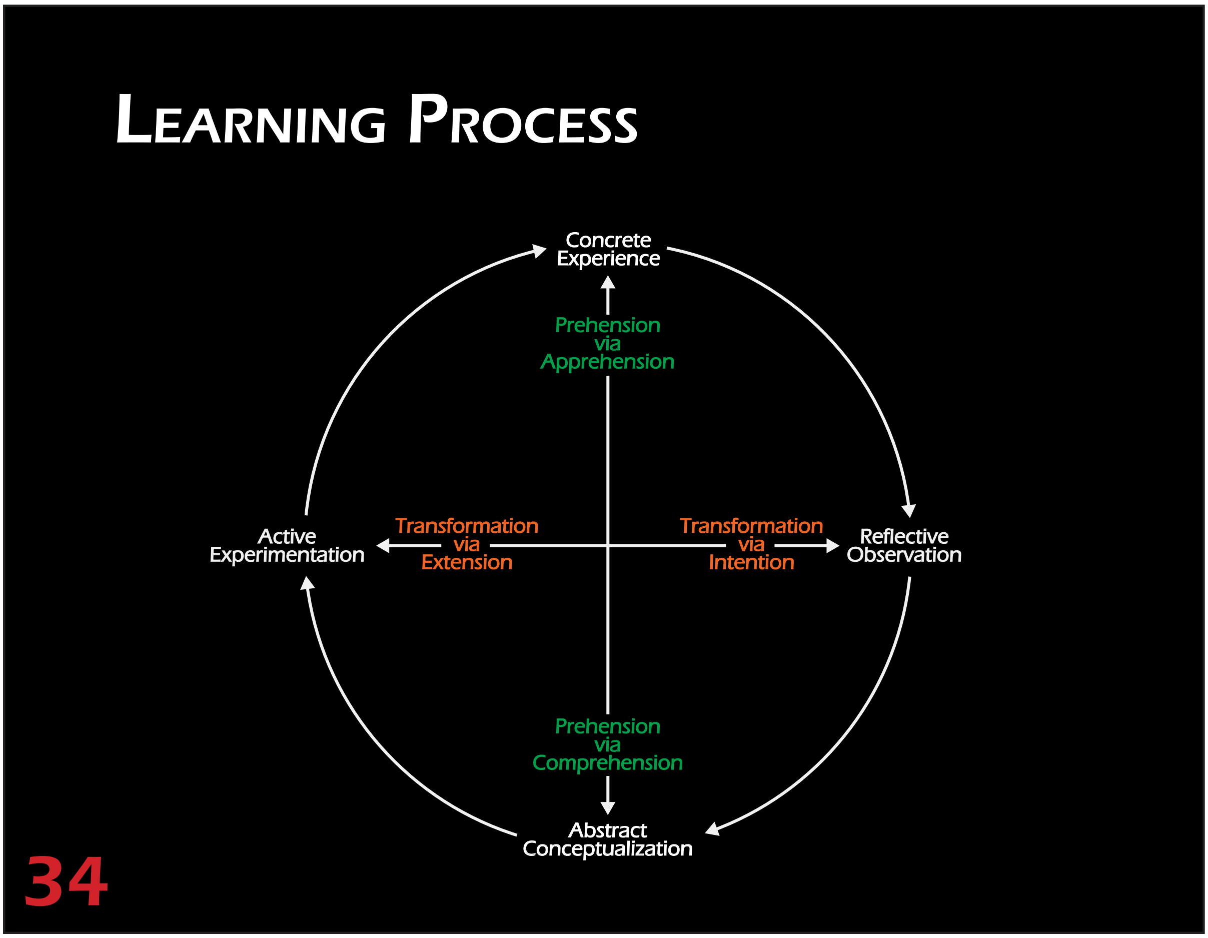


The second mode is transformation which is the process of turning Prehensions into knowledge. The first process, Intention, is the internal process of reflecting on Prehensions. By internally reflecting on observations, information is transformed into knowledge using cognitive processes. In the zoo much learning requires Reflective Conceptualization because much learning content is passively perceived such as reading and observing animals. For me I combined my knowledge about what Lorikeets eat, fruit, with information from the experience such as nectar. I also transformed where Lorikeets live from Brazil to Australia.

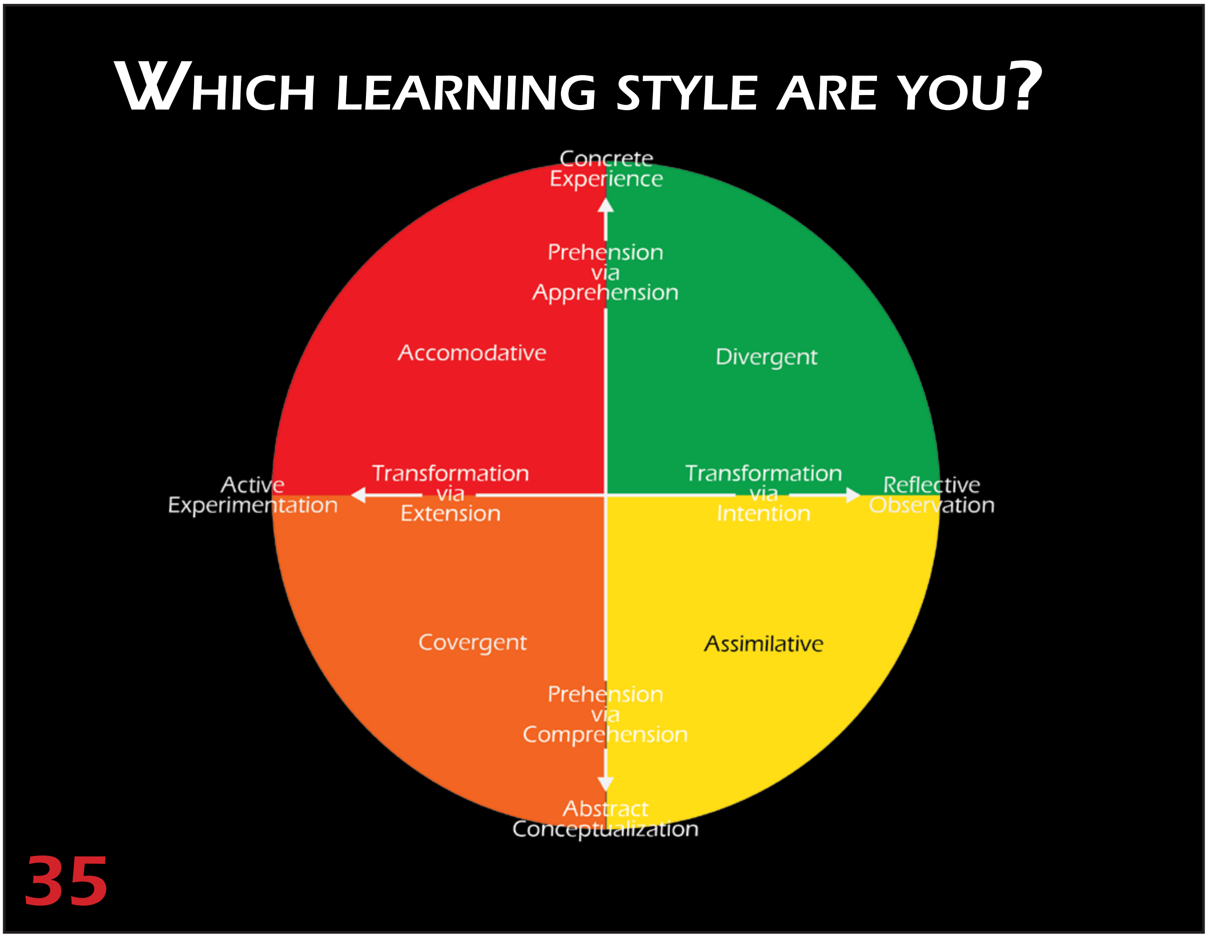
Opposed is Extension (point to the slide show). Extension is the process of interacting and manipulating the environment to create knowledge by actively experimenting with the physical environment. Learning in zoos has the potential for many Extension processes because the zoo has many opportunities for interaction and engagement with the physical environment. I learned about the specialized tongue of the Lorikeet by extending the cup of nectar to get a better look at the tongue.



The learning process doesn't have to start with a concrete experience but can begin at any stage. Also, the time it takes for the process to occur can be a short amount of time occurring in a few seconds or a longer process such as days, months or years. For example, in school a student listens to information about chimpanzees building nests in trees for sleeping during biology class. He creates an abstract conceptualization of the chimpanzee sleeping in a nest using cognitive strategies to remember the information such as creating a mental image or using an acronym to remember facts. Three months later he visits the zoo for a class fieldtrip. At the chimpanzee exhibit he recalls that chimpanzees build nests in trees for sleeping. He tests the idea by looking at the ground for chimpanzees and does not see any. Then he looks up into the trees and sees large bunches of leaves and branches with hand drooping over the edge. The student reconfirms his conception of a chimpanzee transforming his first abstract conceptualization formed during the biology class by concretely experiencing the animal behavior.



We use all the stages during learning however, tend to linger or rely on certain stages more than others. The preferences for different stages in the learning process result in learning styles unique to us. Preferences for Prehension and Transformation processes create four generalizable learning styles.



Now, briefly, in two minutes, write down a learning experience in the zoo using the workshop manual.

Sketch and write down how the different learning stages occurred during the experience using the 11 x 17 paper.

Paper: 11 x 17

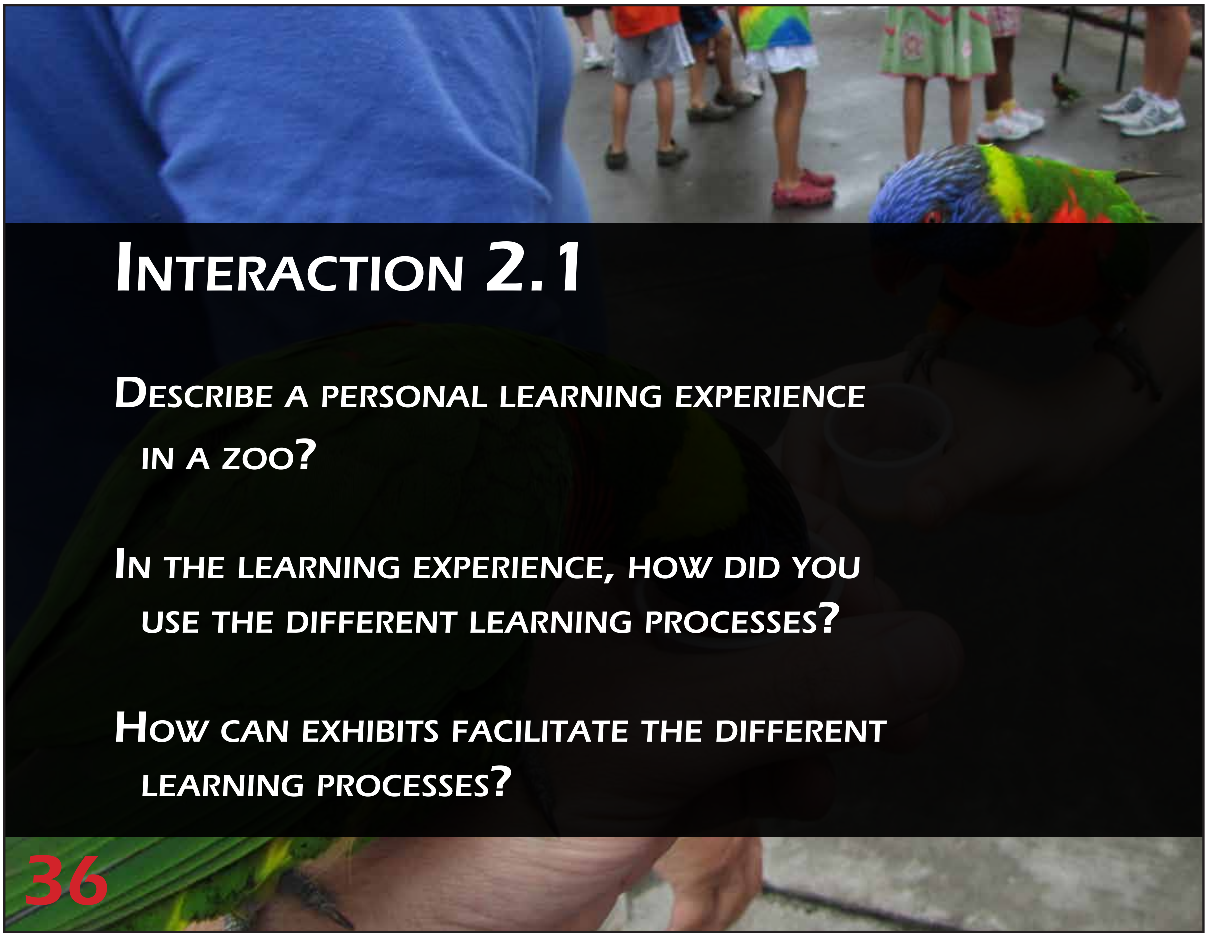
Question:

What physical features of the exhibit facilitated the stages?

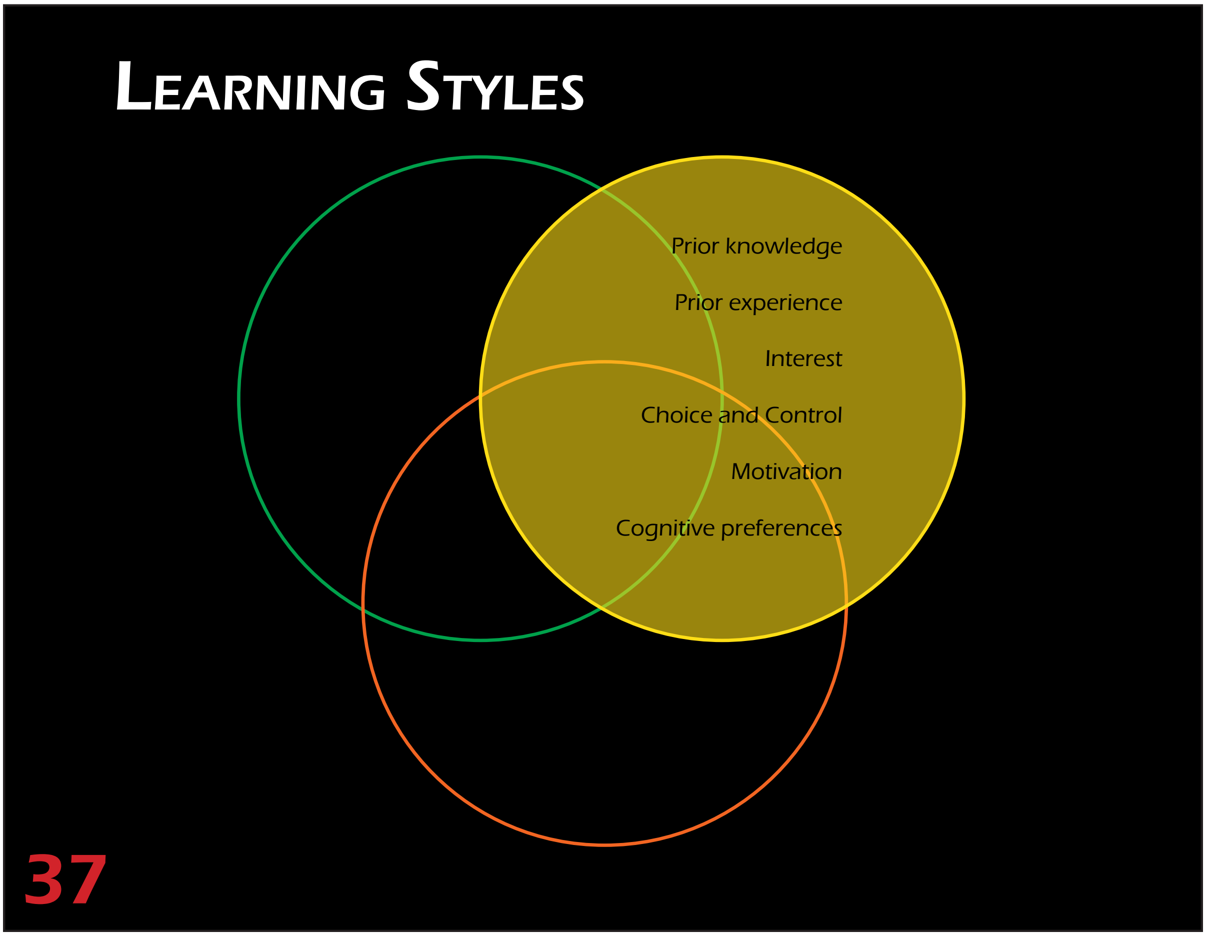
What made the experience memorable?

With your team share how your learning experience engaged learning processes.

Time: 10 min



Similar to the Experiential Learning preferences, we have different: "abilities for solving problems, making products by solving problems, identifying problems, and providing valued services." The different abilities are called Multiple Intelligences and are considered learning styles. Most people have all of them in varying amounts and combinations, and we use them in unique ways specific to us.



Imagine a visitor who chats with and listens to her companions. She enters into an exhibit where she reads a sign about 'a lucky break for Marsupials' which is about plate tectonics and evolution. It explains "breaking up is hard to do and took millions of years, but set Australia apart from the rest of the world". She enjoyed the double meaning of the word 'break'. Later in the exhibit her brother asked "why are all these animals so weird?" She remembered the pun on the sign and explained to him that marsupials evolved differently from other more familiar animals over millions of years.

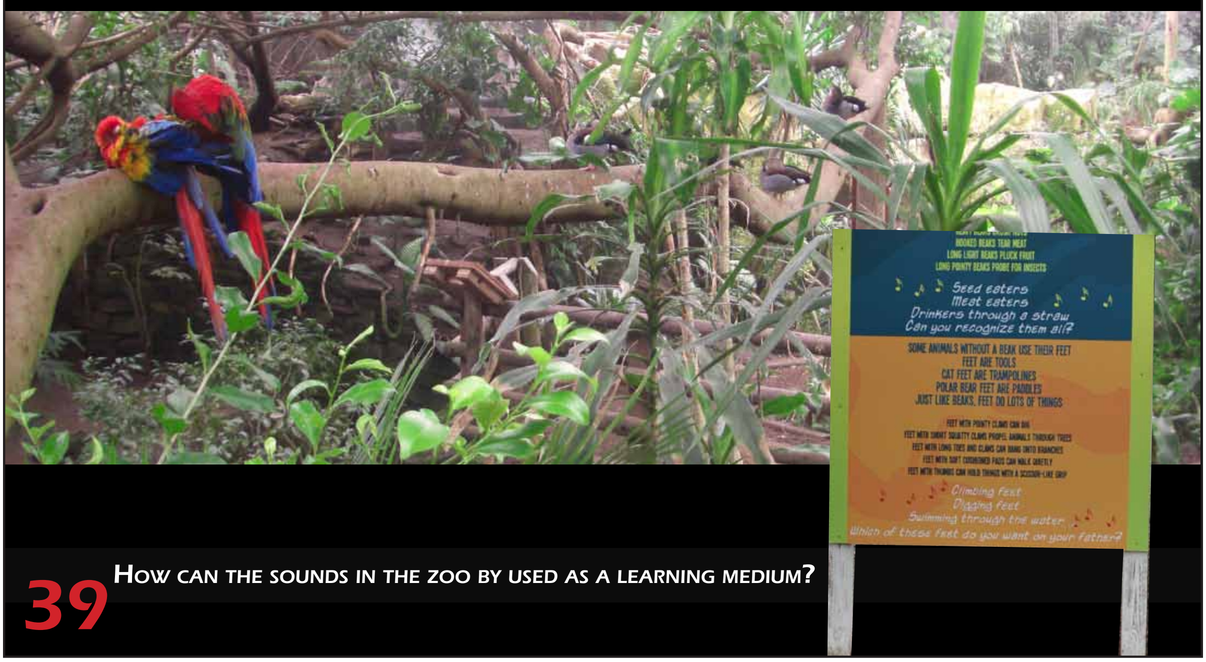
The Linguistic intelligence is the ability to use words and language in speaking, listening and writing. People strong in this intelligence are sensitive to sounds, rhythms and the meanings of words. They are skilled at remembering words, explaining concepts and using language. They are also good at using language to persuade others to act and use language for reflection. In the zoo visitors use the Linguistic skill to read signs, listens to zoo staff and in talking to their companions.

Now imagine the mother of the two children whistling while they walk. When they enter into the rainforest building a sign has information about different animals presented as lyrics to a song. The group moves from one small enclosure to the next where the lyrics are repeated on the sign. She sings the information to the children as they view the animals. They then enter into the large open forest aviary. A small red bird perches on the railing singing. Later in the exhibit she recognizing the same species of red bird by separating out the call from all the other calls of the birds, sound of flowing water and excited visitors.

The Musical intelligence is the ability to recognize tonal patterns, environmental sounds and rhythms. People strong in this intelligence are sensitive to pitch, rhythm and timbre and the emotional qualities of music and sounds. They use music and sounds to remember and learn non-musical information. Their strengths are in discerning different instruments and sounds; recognizing melodies; and when sounds are out of tune. In zoos the visitor experience is full of many sounds from visitor conversations, animal vocalizations, environmental noises, and mood setting music.

MUSICAL

ABILITY TO RECOGNIZE TONAL PATTERNS, ENVIRONMENTAL SOUNDS AND RHYTHMS



39 HOW CAN THE SOUNDS IN THE ZOO BY USED AS A LEARNING MEDIUM?

Let's return to the family in the chimpanzee exhibit. The brother reads a sign about the time budgets of chimpanzees. He concludes that there should be a proportionate number of animals behaving to the total amount of time in the day. However, after observing the animals he finds this untrue. Then he sees a sign about the typical behavior at specific times of the day. He then compares the behavior to the sign and finds this to be true.

The Logical intelligence is the ability of inductive and deductive thinking/reasoning, numbers, and recognition of abstract patterns. People with this intelligence are skilled in solving problems and making rational decisions by using logical reasoning to make connections between information. They enjoy metaphors, discerning relationships, performing complex calculations, and scientific reasoning. The strength of Logical thinkers is their problem solving ability. They look for consistency in models and logical series. In the zoo, visitors use logic to draw conclusions between observations and presented information.

Let's stay with the brother but examine the beginning of the day. He grabbed a map and identified the meerkat exhibit and led the family to the exhibits without taking a wrong turn. At the meerkat exhibit is a sign with graphics illustrating meerkat behavior. Next to the sign there is a rubbing station of different animal behaviors. Before finishing the rubbing he takes the paper and crayon to the animal exhibit and begins sketching the animal paying close attention to its behavior.

The Spatial intelligence relies on the sense of sight and being able to visualize an object, create internal mental images and navigate space. It is the ability to recognize relationships of objects in space, create graphic representation, manipulate images, and active imagination. They express clearly seeing images in the mind and skills at drawing and designing but also geometry, navigation and viewing landscapes from plan.

In zoos visitors use their spatial intelligence extensively to understand interpretive graphics, observation of animals, and imagination. Visitors also use the intelligence to navigate zoo exhibits.

SPATIAL

ABILITY TO VISUALIZE AN OBJECT, CREATE INTERNAL MENTAL IMAGES AND NAVIGATE SPACE

HOW CAN THE SPATIAL INTELLIGENCE BY ENGAGE BEYOND UTILITARIAN UNDERSTANDING OF GRAPHICS AND NAVIGATION?

41

Now, with you groups develop exhibit concepts for how to design for the intelligences of Linguistic, Musical, Logical and Spatial. For each concept, use a different piece of 11 x 17 paper. When sketching ideas make sure to annotate how people are thinking and what they are doing.

Paper: 11 x 17
Time: 20 min

Share with the groups the different examples.

Questions:

What do visitors do?

How are concrete experiences used to learn abstract concepts?

How are intention processes facilitated?

How are extension processes encouraged?

Also, during the meerkat exhibit the sister is manipulating all the interactive exhibits and takes every opportunity to touch animals. She cranks a handle to play a recording of information about animals. At one interactive exhibit she mimics meerkat behavior by climbing and digging like a meerkat using gloves with claws. Later in the zoo exhibit, she observed aardvarks digging and recognizes how the claws are helping it dig.

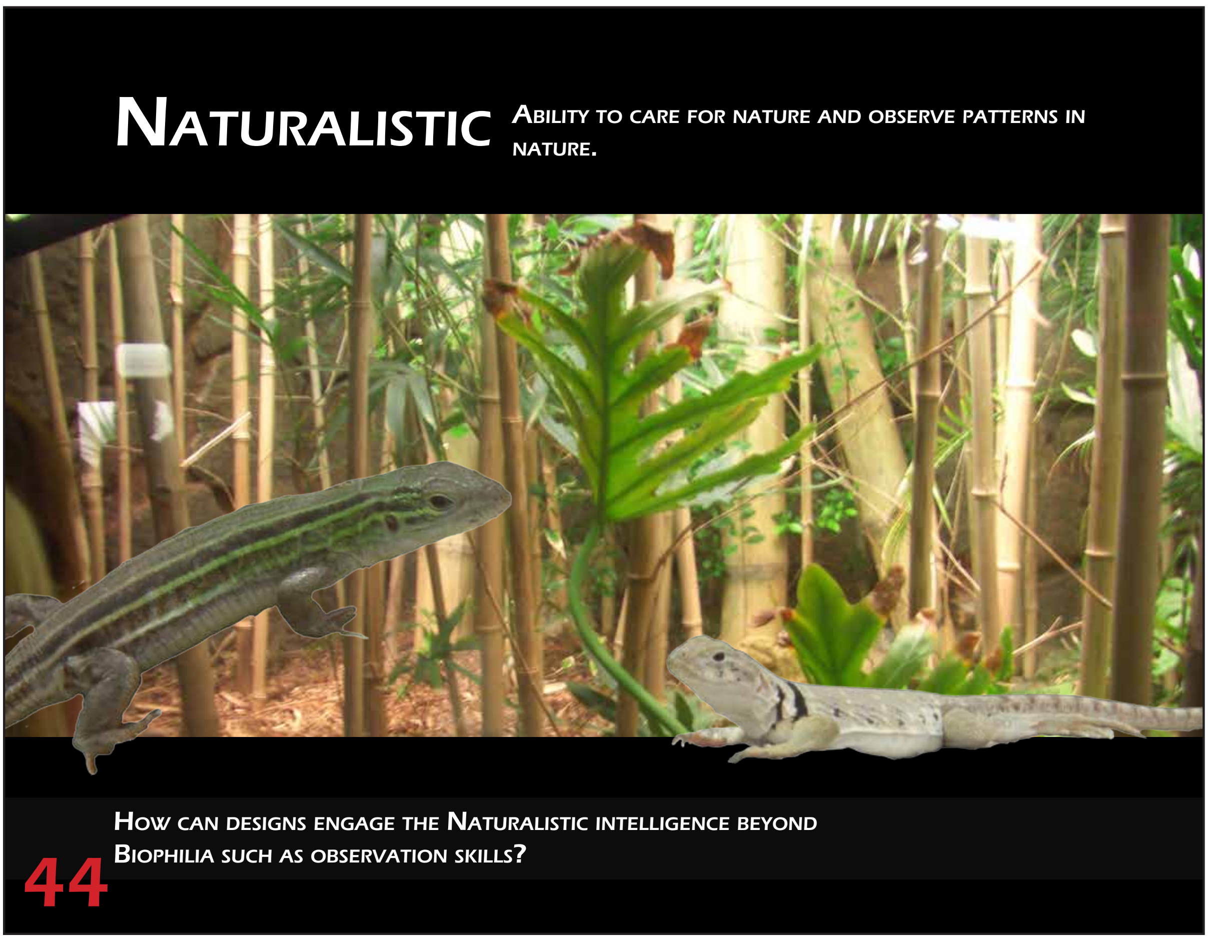
The Kinesthetic intelligence relies on the brain's motor cortex which controls bodily motion. It is the ability to control voluntary movement, control of pre-programmed movements, awareness through the body, connection between the mind and body and mimetic abilities. People with this intelligence enjoy role-playing, dancing, creative movements, and games. They express skills in concrete tasks with their hands and tasks requiring good coordination. In addition to accomplishing physical tasks, people with this intelligence use movement as a way to remember and learn information. The zoo visit is a physical activity and increasingly zoo exhibits and interpretations integrate interactive activities such as touch pools with animals and manipulative interpretation to increase learning.

KINESTHETIC ABILITY TO CONTROL VOLUNTARY MOVEMENT AND MAKE CONNECTION BETWEEN THE MIND AND BODY

43 HOW CAN KINESTHETIC ACTIVITY BE A LEARNING ACTIVITY?

We have yet to talk about the father. He is quiet and an introvert. He loves the animals and enjoys being in their presence to watch them. In the Herpetarium he recognizes the slight yellow stripes of the lizard. In the next jewel box he notices a similar lizard except that it has red stripes. He concludes they are related and confirms his theory by referencing the labels.

The Naturalistic intelligence relies on our innate Biophilic qualities as humans and the ability to observe patterns in nature. People with this intelligence express big picture thinking, observation skill, perceiving relationships by classifying, protection for nature, and environmentally friendly behavior. People come to zoos to observe, engage and be surrounded in nature.



Let's return back to the dad in the Herpetarium. After moving from a group of exhibits about a series of related lizards, he thinks about the experience. He recognizes that he has made the connection between lizards adaptation and their habitats. His thoughts shift from his learning to how his behavior impacts the lives of lizards. He is part of a larger system and is aware of this belief that all animals have a right to exist. To help his children understand the other snakes and lizards he expresses this belief by asking them if they believe animals are equal to people.

The Intrapersonal intelligence relates to inner states of being, self-reflection, metacognition, and awareness of spiritual realities. It is the ability to understand one's self by engaging their inner states of being, self-reflection and metacognition. People use this intelligence to set goals, identify and expressing emotions, reflect on the wonder and purpose of life and understand their learning. They express their skills by reflecting on important issues in life and deep psychological and philosophical issues, analyze themselves and have the courage to express their own opinions. In zoos parents believe the setting provides an opportunity for their children to learn morals respecting nature and understand their place in the world.

INTRAPERSONAL

ABILITY TO UNDERSTAND ONE'S SELF BY ENGAGING THEIR INNER STATES OF BEING, SELF-REFLECTION AND METACOGNITION.

45 **HOW CAN EXHIBIT DESIGNS FOCUS REFLECTION ON TOPICS OF THE ZOO MISSION?**

To conclude the zoo visit we will examine the sister and the mother. They enter into an exhibit where the mother talks with her daughter explaining what the information means. The exhibit talks about conservation and that monkeys are being hunted. The daughter asks why people would want to eat them. Then the mother tells her that the people are very poor and have no other choice because of the civil war in their country. She explains that to help the monkeys we need to help stop the fighting and get people food to eat other than monkeys.

The Interpersonal intelligence relies primarily on person-to-person communication and an understanding of personal relationships. It is the ability to take the view point of others; understanding others feelings, opinion, and beliefs; working cooperatively; sensitivity to others moods, motivations, and feelings; and verbal and non-verbal communication. A person with this intelligence enjoys collaborative learning, conflict management, learning through service and appreciates personal differences, multiple perspectives and solving local and global problems. They express skills in social relations, making contacts with other people and get along with different types of people. In zoos much learning occurs through socialization both between parents and children but also through interactions with zoo staff.

INTERPERSONAL

ABILITY TO TAKE THE VIEW POINT OF OTHERS AND COMMUNICATE VERBALLY AND NON-VERBALLY WITH OTHERS

HOW CAN EXHIBIT DESIGNS NOT ONLY INCREASE SOCIALIZATION BUT ALSO UNDERSTANDING OF OTHERS?

46

Now, with you groups develop exhibit concepts for how to design for the intelligences of Kinesthetic, Naturalistic, Intrapersonal, and Interpersonal. For each concept, use a different piece of 11 x 17 paper. When sketching ideas make sure to annotate how people are thinking and what they are doing.

Paper: 11 x 17
Time: 20 min

Share with the groups the different examples.

Questions:

What do visitors do?

How are concrete experiences used to learn abstract concepts?

How are intention processes facilitated?

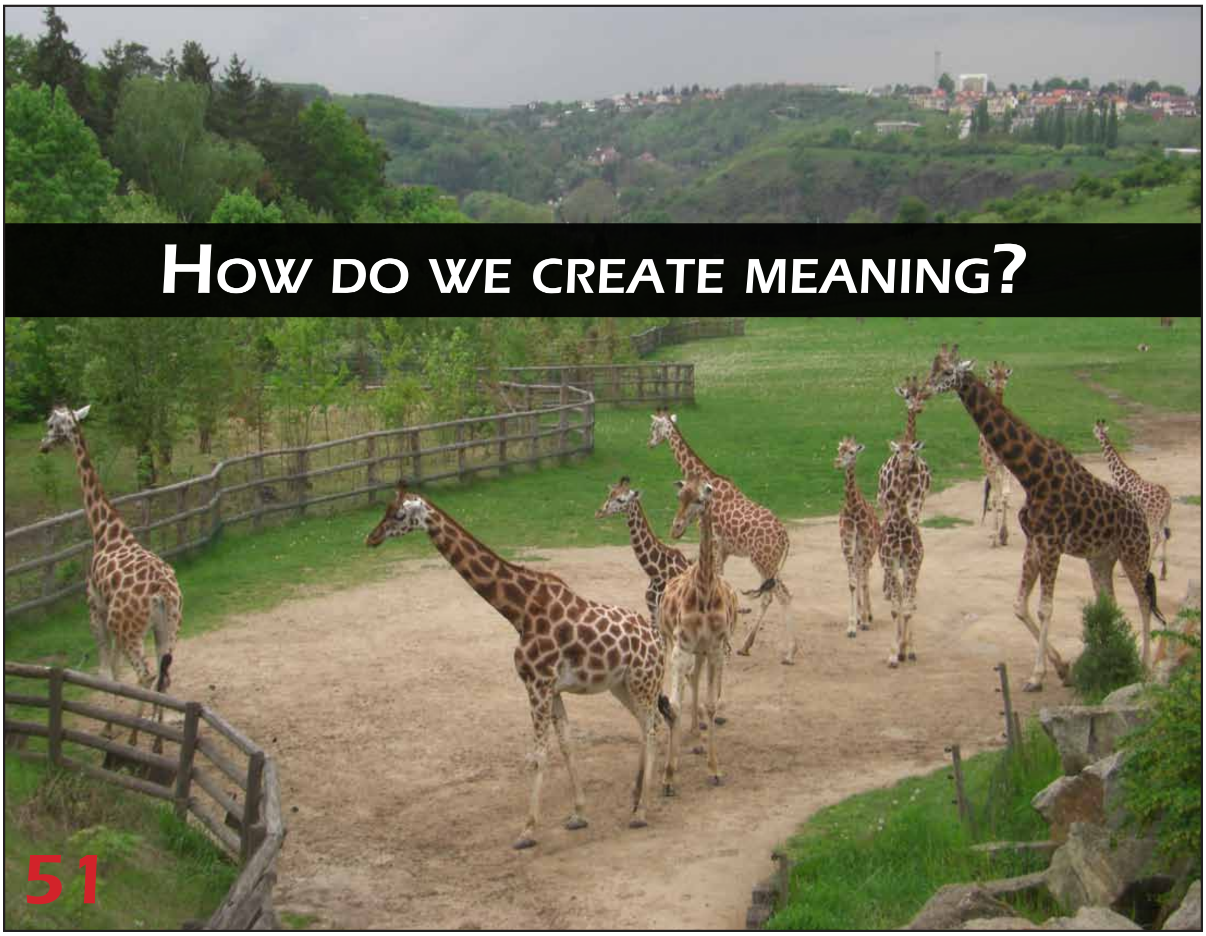
How are extension processes encouraged?

BREAK FOR LUNCH
48

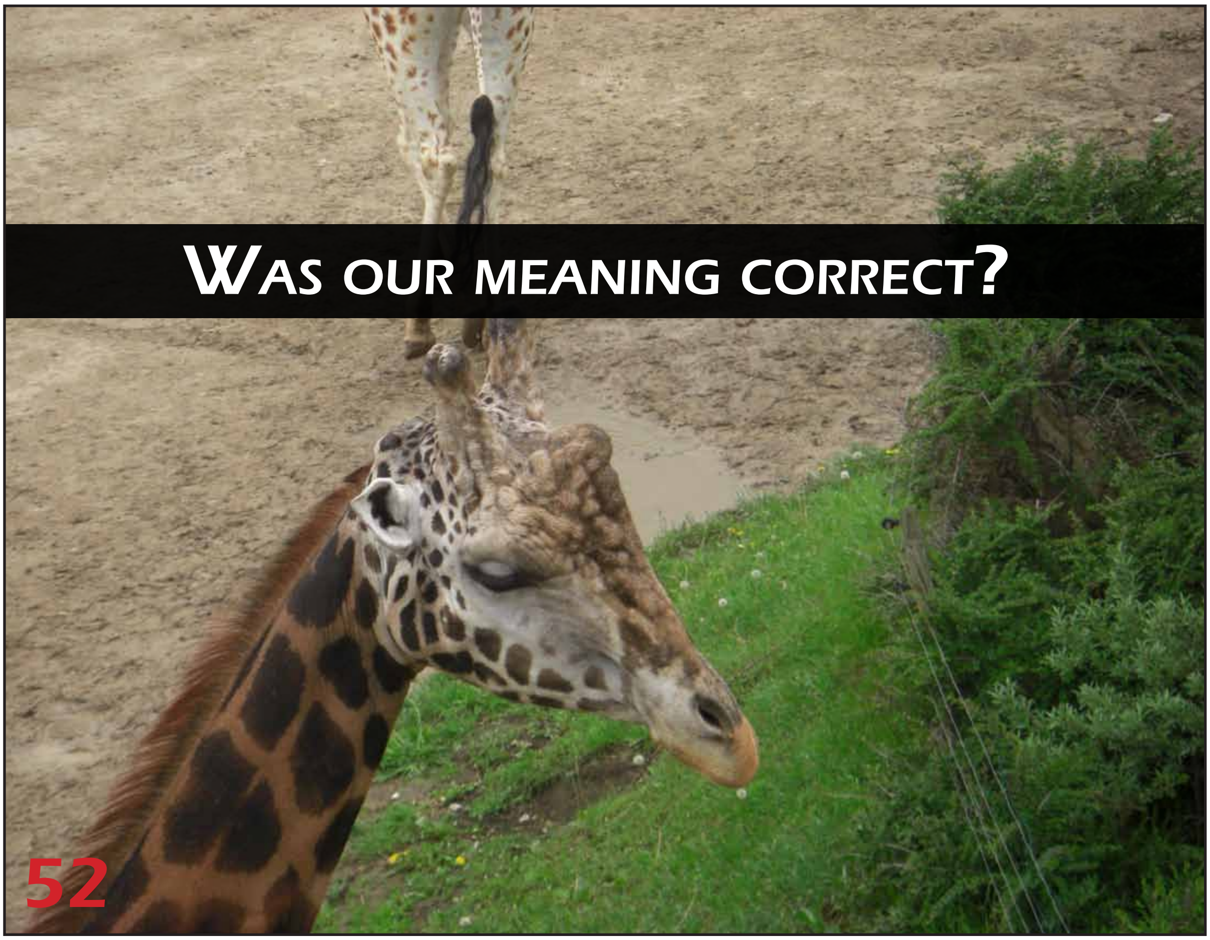
I would like you to imagine one of my zoo experiences. My senses registered many environmental stimuli from the landscape, animals and the weather. I was aware of a multitude of sensual stimuli but unfocused. I received the stimuli and then filtered them by scanning the exhibit for something of interest, called selective perception. Then when the trees open up to a clearing I selectively filtered the stimuli to what I found most interesting, the giraffes.

I walk up to the railing and look out into the plain. As I lean on the railing, I notice red signs containing graphics, images and text explaining the different patterns and colors of the different giraffe sub-species. I focused my attention on the sign which was bright red. I read that Giraffe's color patterns change from one geographic location to another. The information was temporarily stored in my short-term memory. The changing geographic location cued me to recall prior knowledge about evolution and adaption. I was interested in the information because it was a concrete example of an abstract concept I had learned in school.

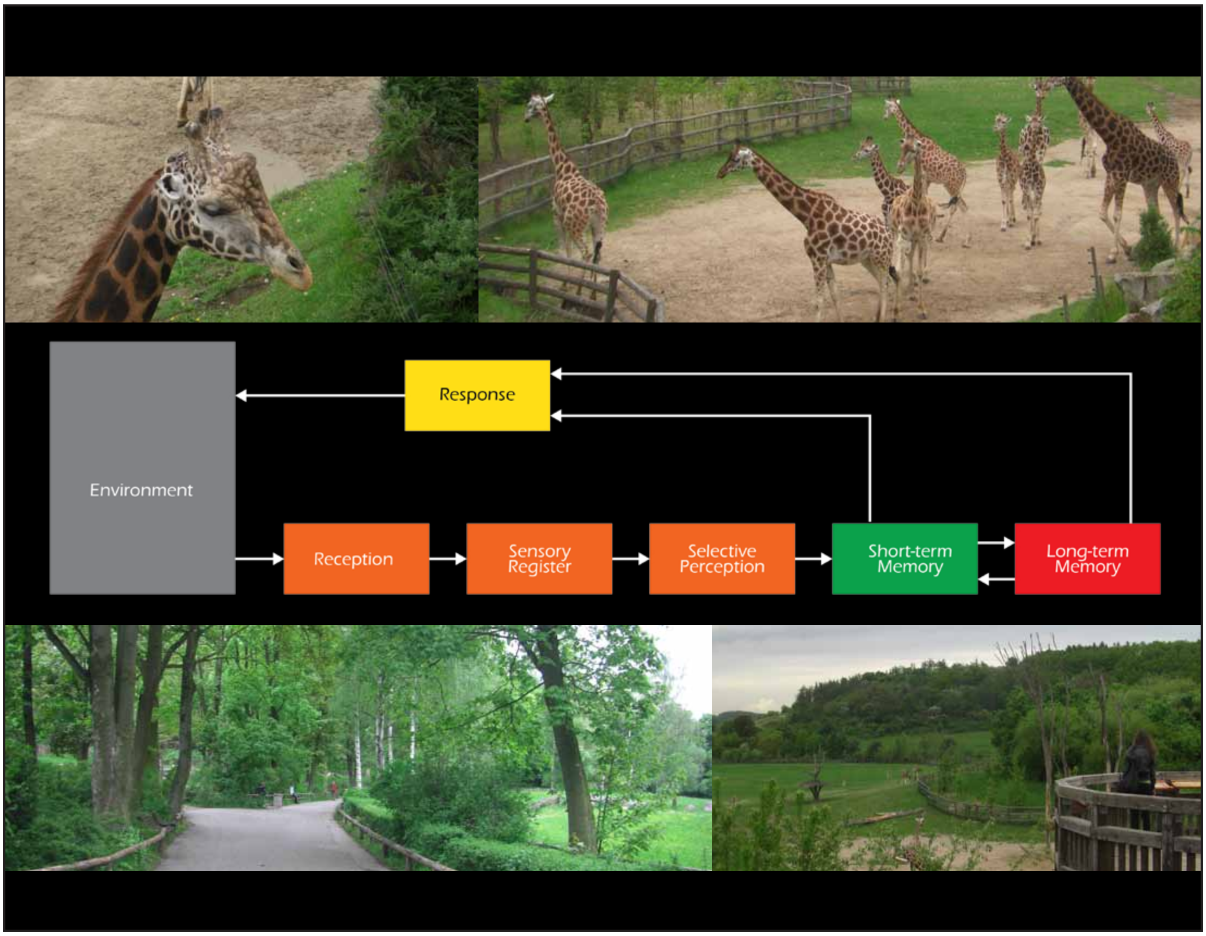
My prior knowledge of evolution contextualized the information encoding the information with meaning, transferring the information to my long-term memory. If I did not make the connection to my prior understanding of evolution and adaption I probably would not have remember the information.



I then used the information to identify the different geographic regions native to the giraffes. I observed the giraffes, recalling the newly learned information and formed hypotheses. I then determined if my hypotheses were correct by comparing the tags on the giraffe's ear to the corresponding tag on the sign. When I knew my learning was correct my knowledge was reinforced.



The learning process is multi-scalar. It could occur at a design element scale such as reading a sign or during the entire exhibit. For each of the learning processes, instructional stages have been developed to guide the facilitation of the learning process.



Now, refer back to your learning experience. Briefly write down how the Information-Processing model occurred during the learning experience you described earlier in the workshop manual. How did the design facilitate the four learning stages of attention, acquisition, recall and respond.

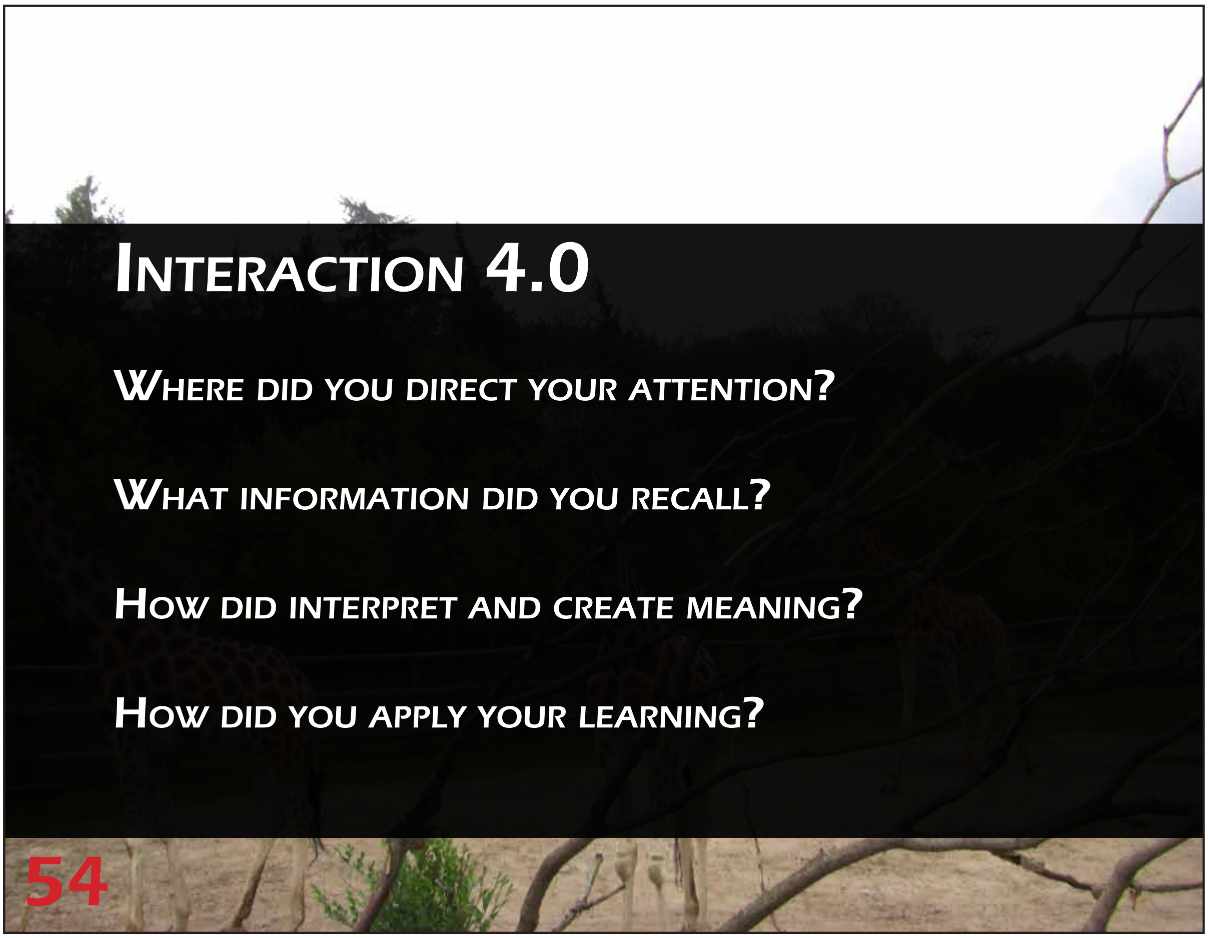
With your group share how the model explained how the design facilitated the learning experience. List the ideas into the four main stages of attention, acquisition, recall and respond.

Question

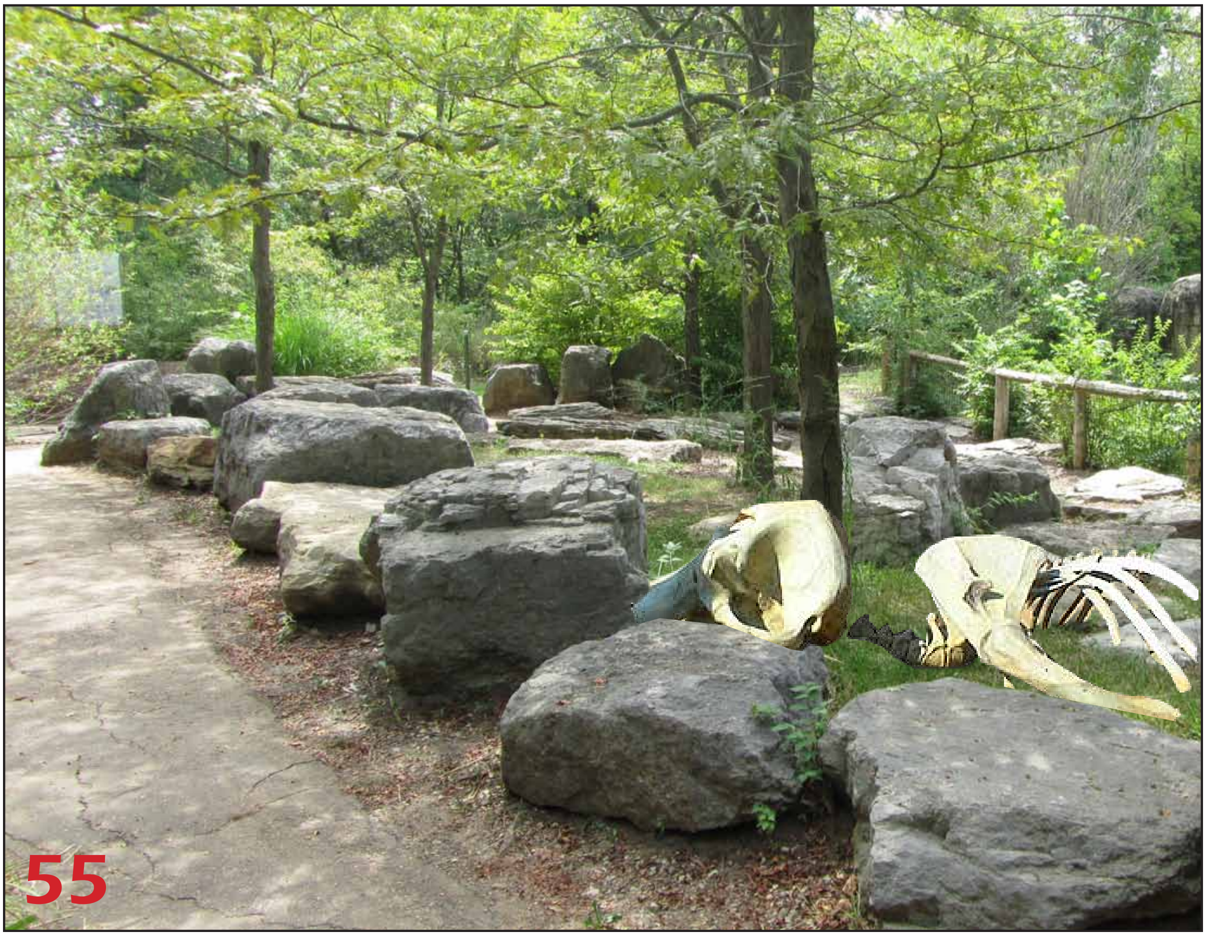
How could the stages be better facilitated by the design?

How were the stages limited by the design?

Time: 5

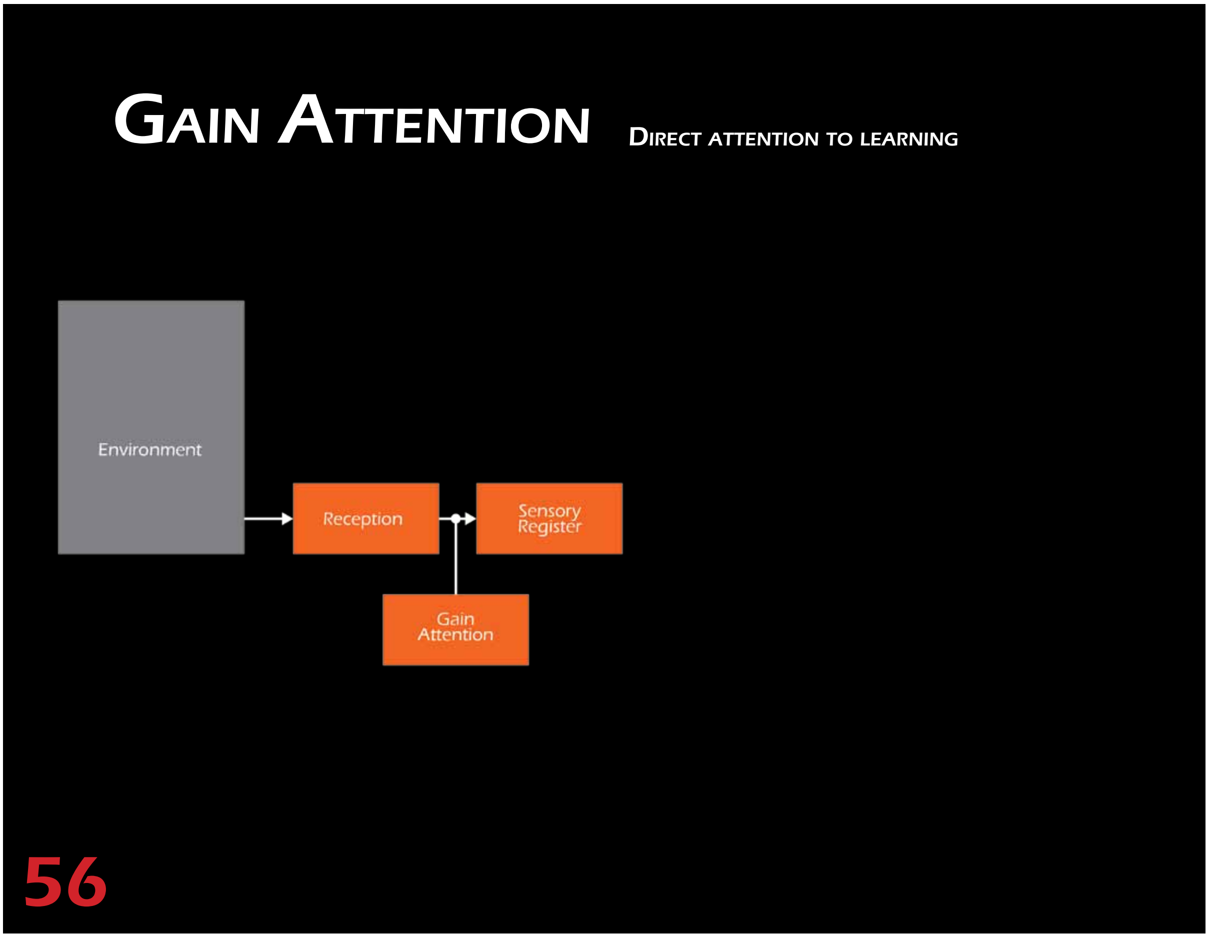


A visitor enters into an exhibit walking along a pathway leading to a half buried elephant skeleton missing the tusks. He directs his attention to the large unexpected feature. Upon approach, a sign asks 'what bones are missing?' Then as you walk pass the skeleton another sign asks 'where are the tusks'. What do you think the exhibit is going to be about?...



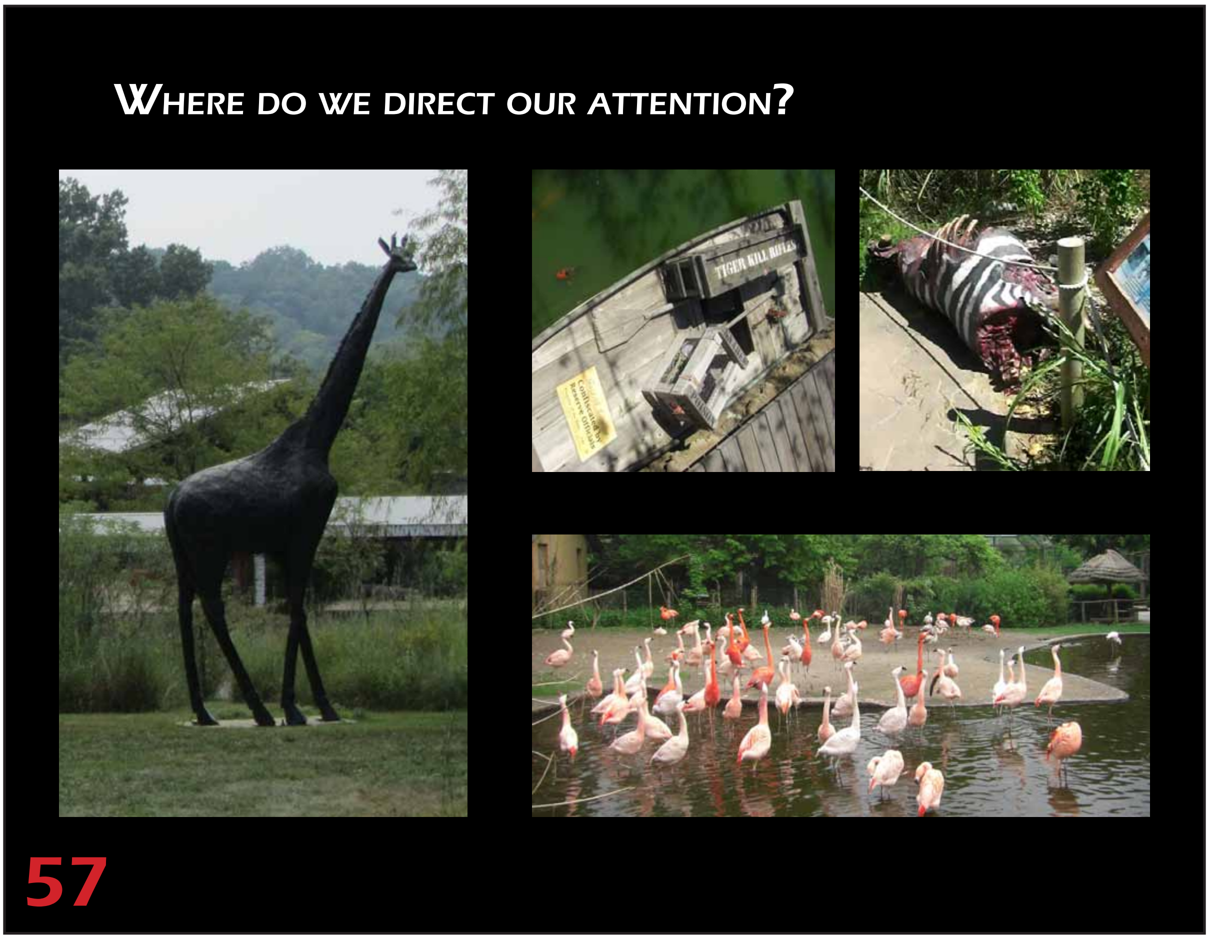
The first instructional stage addresses the process of registering stimuli from the environment. A stimulus which contrasts its surroundings captures our attention, such as elephant bones. Gaining our attention focuses us onto the information to be learned, elephant conservation.

To focus our attention we use three searching processes. The first is an orienting process which is an automatic response to a powerful stimulus like a loud sound. A more controlled process is simultaneous searching, which is scanning the environment for something which 'pops out.' A similar process is sequential searching which is scanning one object then moving to the next. In the example a sequential search process was probably used.



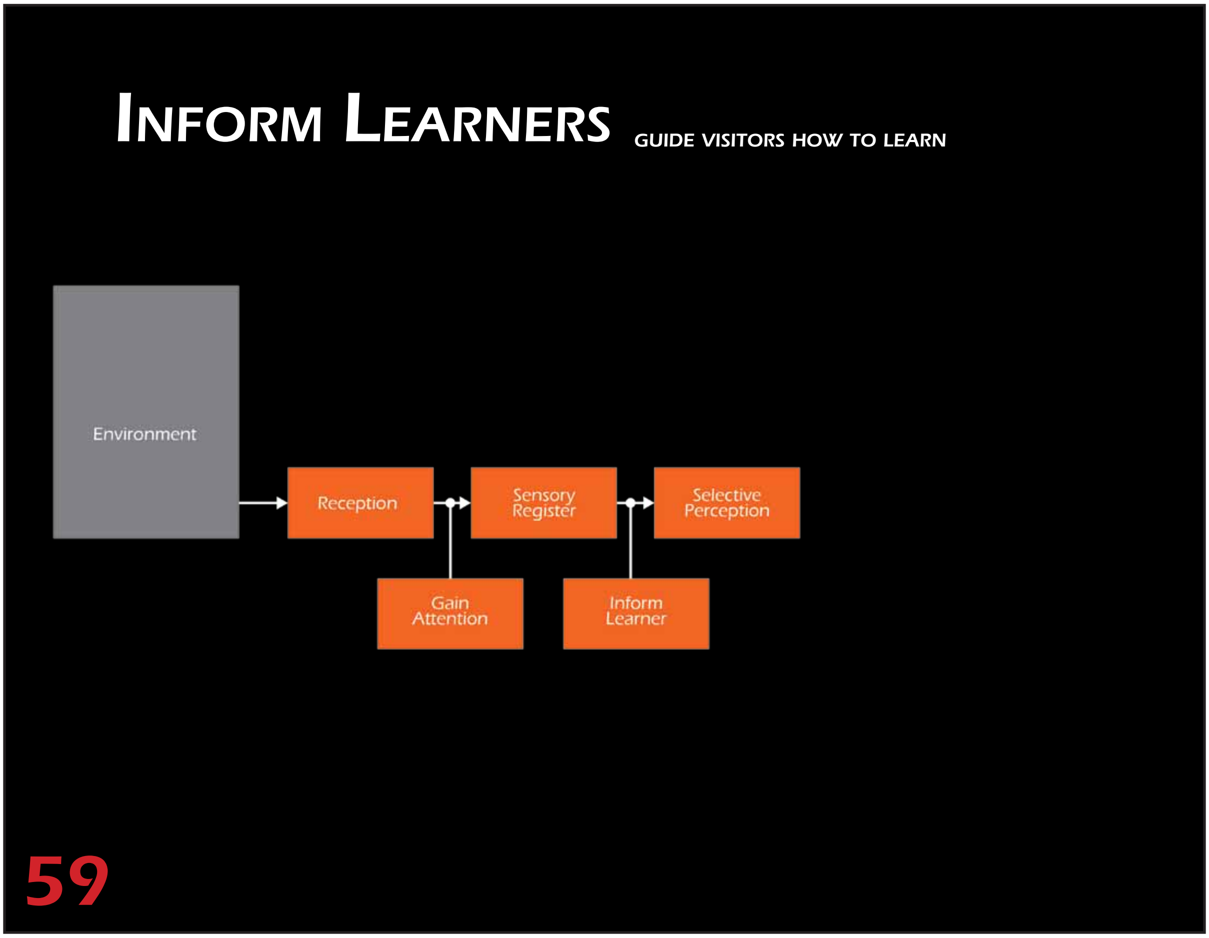
Our attraction is generally captured by a contrasting element. By changing the physical features of exhibit elements such as increasing the size of elements, isolation from other objects, and multisensory exhibits capture our attention. Characteristics of the animals also affect attention such as their size, activity and familiarity. Our interest can be captured by piquing our emotions or cognitive activity such as a controversial image.

Stimulus should match the learning content. For example, if I slapped the table your learning focus was captured on orienting processes. If I had hit the table for the sequential scanning processes you probably would have been distracted.. The exhibit needs to manage how we attend to exhibit elements by sequencing elements to minimize competition between design elements. Circulation pathways need to ensure there is equal chance of us capturing our attention on the most important elements. Also, powerful stimuli need to be carefully designed and sequenced to not distract from learning.



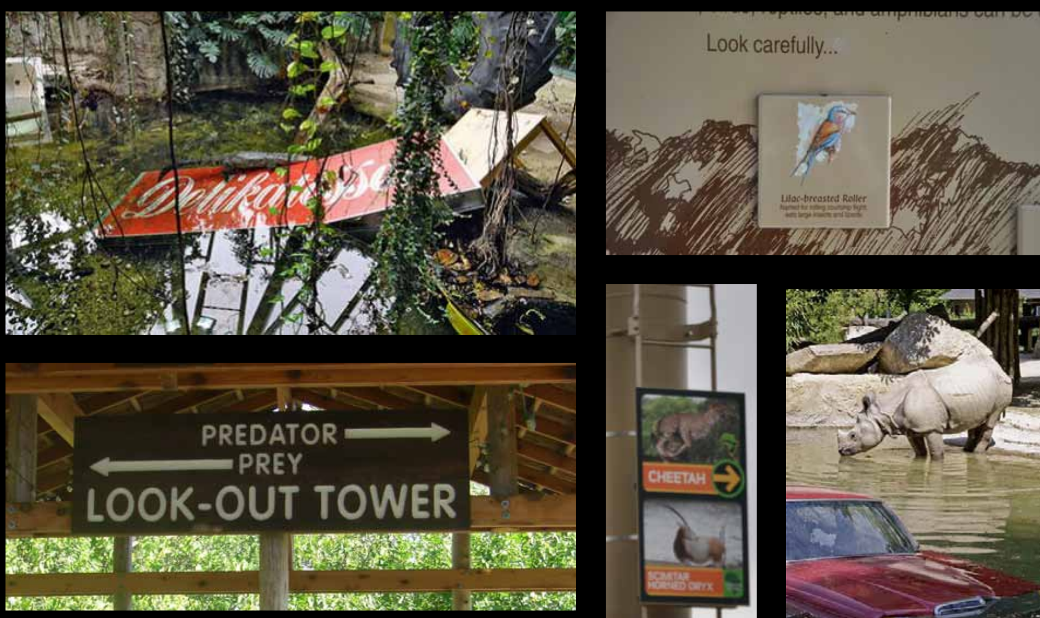
After encountering the elephant bones visitors walk down the pathway. A sign across the pathway says 'welcome to the Kruger Game Reserve' and a sign points toward the ranger station asking 'where are the elephants?'

The sign explains what the exhibit will be about and cues visitors up to search for elephants. In addition to helping visitors direct their attention, exhibits need to explain how to learn.



Exhibits cannot force us to learn, but exhibits can suggest and guide how we learn. We need to know where to direct our attention and know how to learn. Exhibits need to give us the tools to use our choice productively. The signs could guide us in directing our attention on looking for a specific bird, relationships or identifying between predator and prey animals. Instructions are the most direct method however other mediums are possible such as questions, handouts, games, demonstrations and examples. More subtle methods could be used for example the images in the upper left and lower right direct us to think about the situation in a particular way. What do you think about? Do you think about the animal in the context of environmental problems?

How would you act in these situations?



What exhibit elements beside signs could guide learning?

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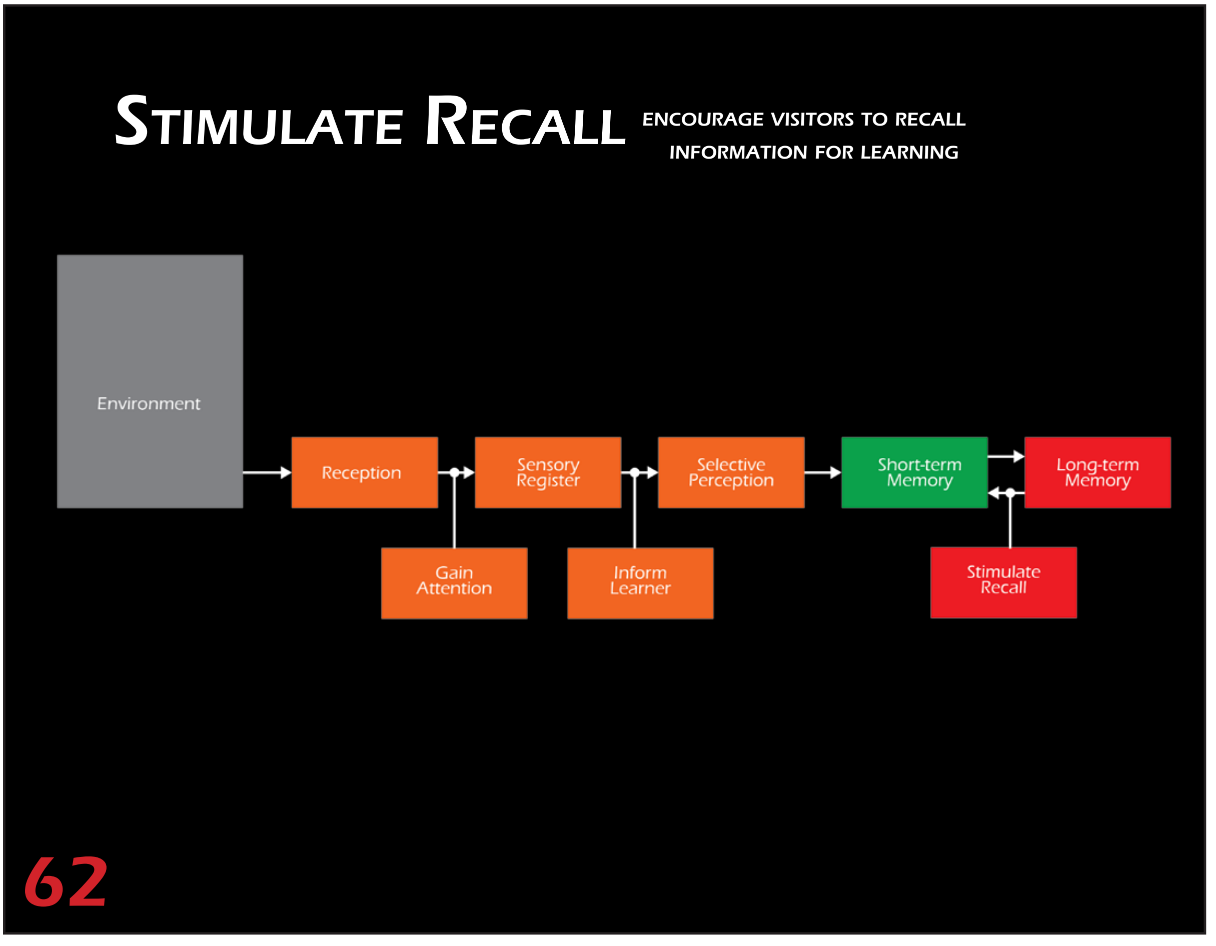
Visitors then pass by a small sign asking "why are elephants in danger?' Along the pathway elephant tusks are placed in the ground. What do you recall about elephants?...

During learning prior knowledge and experiences is recalled to frame and contextualize new information and situations. As we have seen in the Intention process of Experiential Learning model prior knowledge is built upon during learning – remember touching a snake for the first time – and recall needs to occur for learning to be successful. To facilitate this process exhibits can encourage and guide us to recall foundational concepts needed to understand the new information or contextualize the information in a specific way.

Possible ways to stimulate recall in exhibits are using questions and exhibit elements. In the first example, the first is formal interpretation elements such as a sign asking "why are elephants in danger." Recall could also be encouraged through informal interpretation elements such as elephant tusks. Would you recall they are hunted for their ivory?



Here is another example from an art installation. What information do you recall with the juxtaposition of bison with train tracks? Do you recall information about the American West, the near extinction of the buffalo, or American capitalism?

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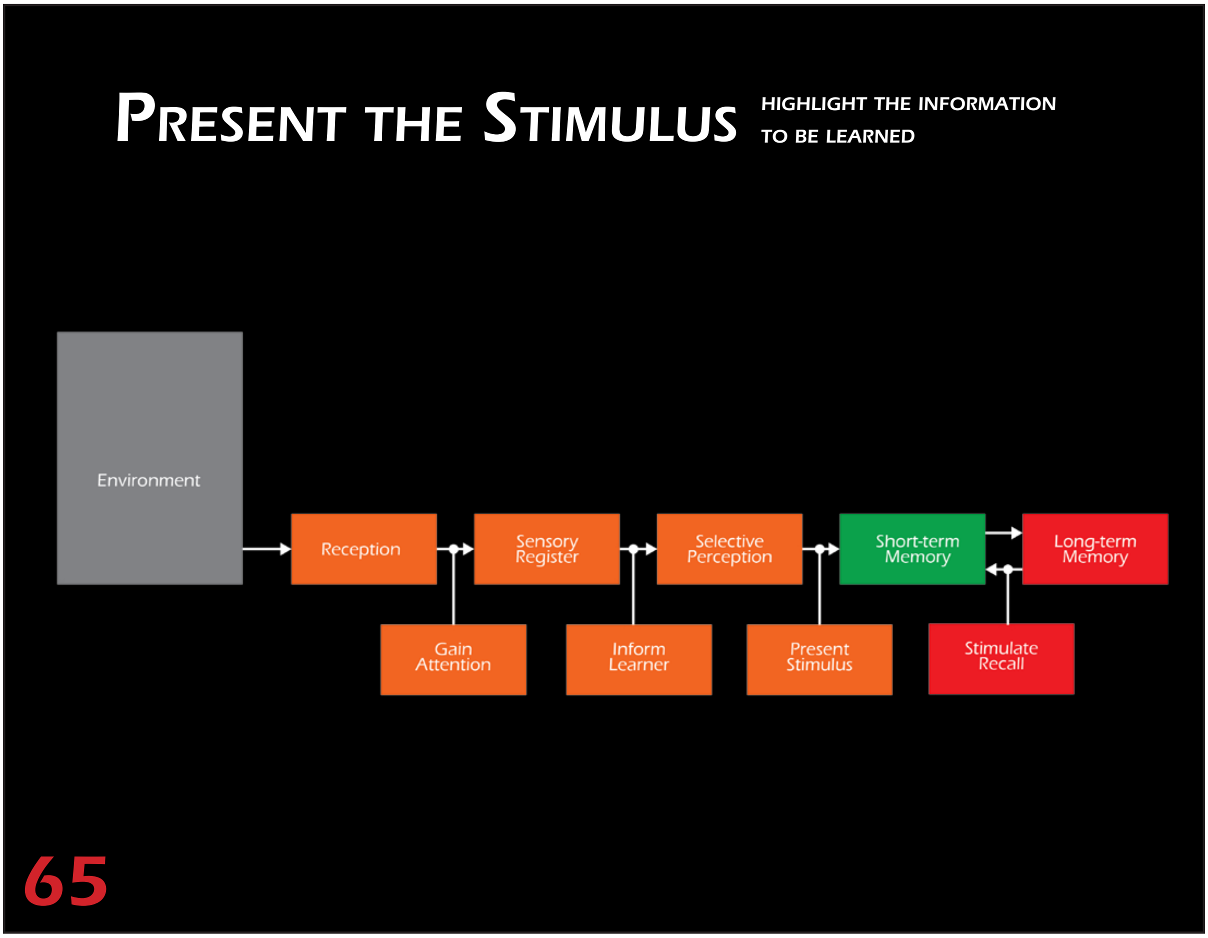
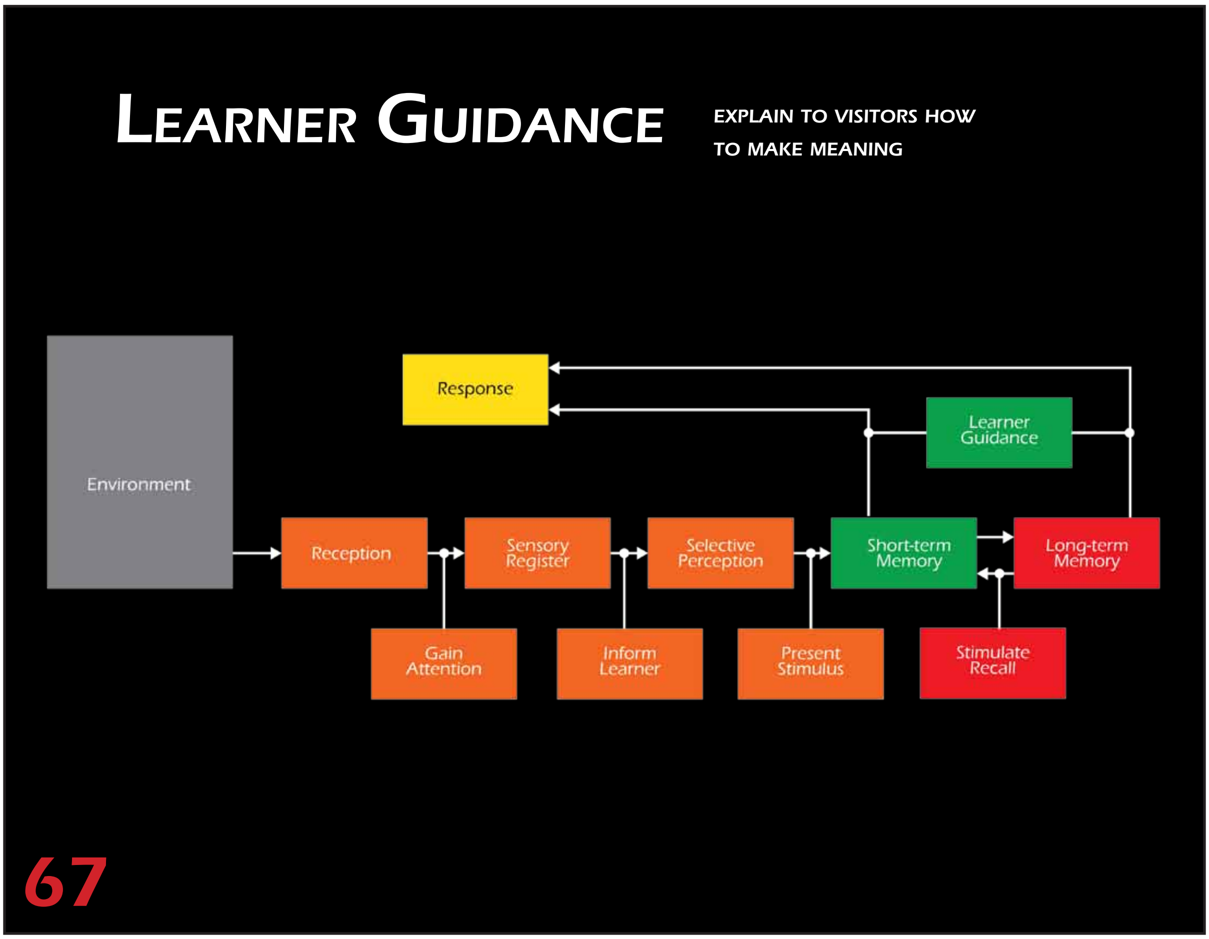
After walking past the elephant tusks, he enter into a ranger station. A docent is dressed as a ranger who is sharing information about ranger's tasks of protecting elephants. As part of their tasks they track elephants to determine if elephants are safe and not disturbing people. Visitors are then encouraged to find the elephants by following evidence of their behavior to make sure the elephants are safe.

The most important information needs to be highlighted so we know what to learn. The interactivity of talking with the docent attracts visitors to listen to the information. In zoo exhibits the information to be learned could be the animal, interpretation or visitor activities. Use strategies from the gaining attention stage can be used to highlight the information.



When they are talking with the ranger he shows examples of evidence from elephant behavior and how to use the clues such as stripped tree bark, foot prints and a picture of a watering hole to follow and find the elephants.

In the zoo we interpret what we are seeing and experiencing to understand the situation. We use our prior knowledge and presented information to understand the experience and determine if the information is meaningful and worth the effort of committing it to memory. This process of transferring information to the long-term memory can be facilitated by suggesting a meaning. A meaning could be suggested by an example, demonstrating how the information is useful, or make the information relevant to the visitor. In the example, the ranger explained how the information is used.



Can a meaning be suggested more subtly? How do you make meaning from this situation? If the information in the interpretives was about the changing climate of penguins would you think about your use of fossil fuels contributing to climate change?

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Refer back to your learning experience how were these stages present? With your team develop ideas for facilitating the processes using the 11 x 17 paper. If they weren't how did one of your multiple intelligence ideas facilitate the processes?

Paper: 11 x17

Time: 5-10

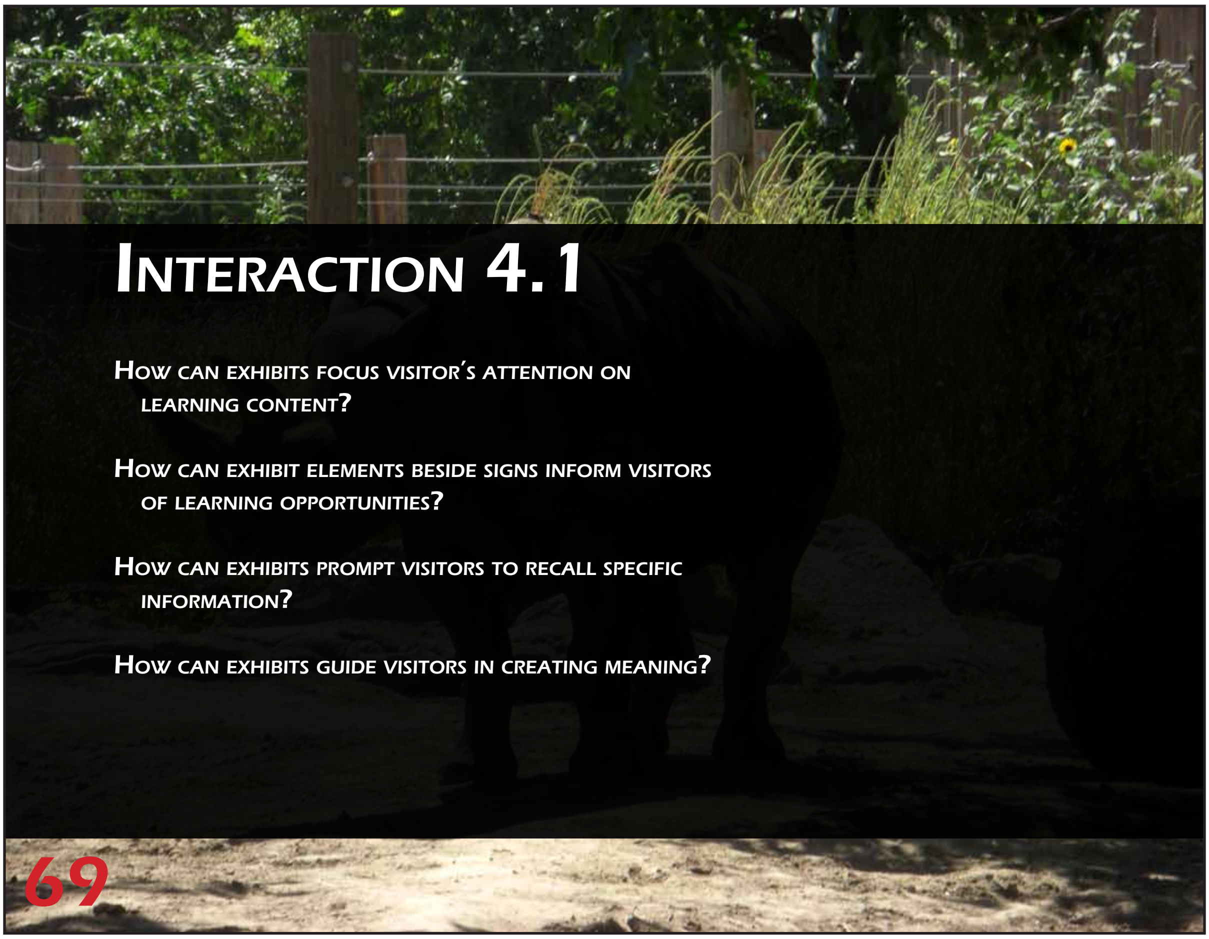
Questions:

How can exhibits focus visitor's attention on learning content?

How can exhibit elements beside signs inform visitors of learning opportunities?

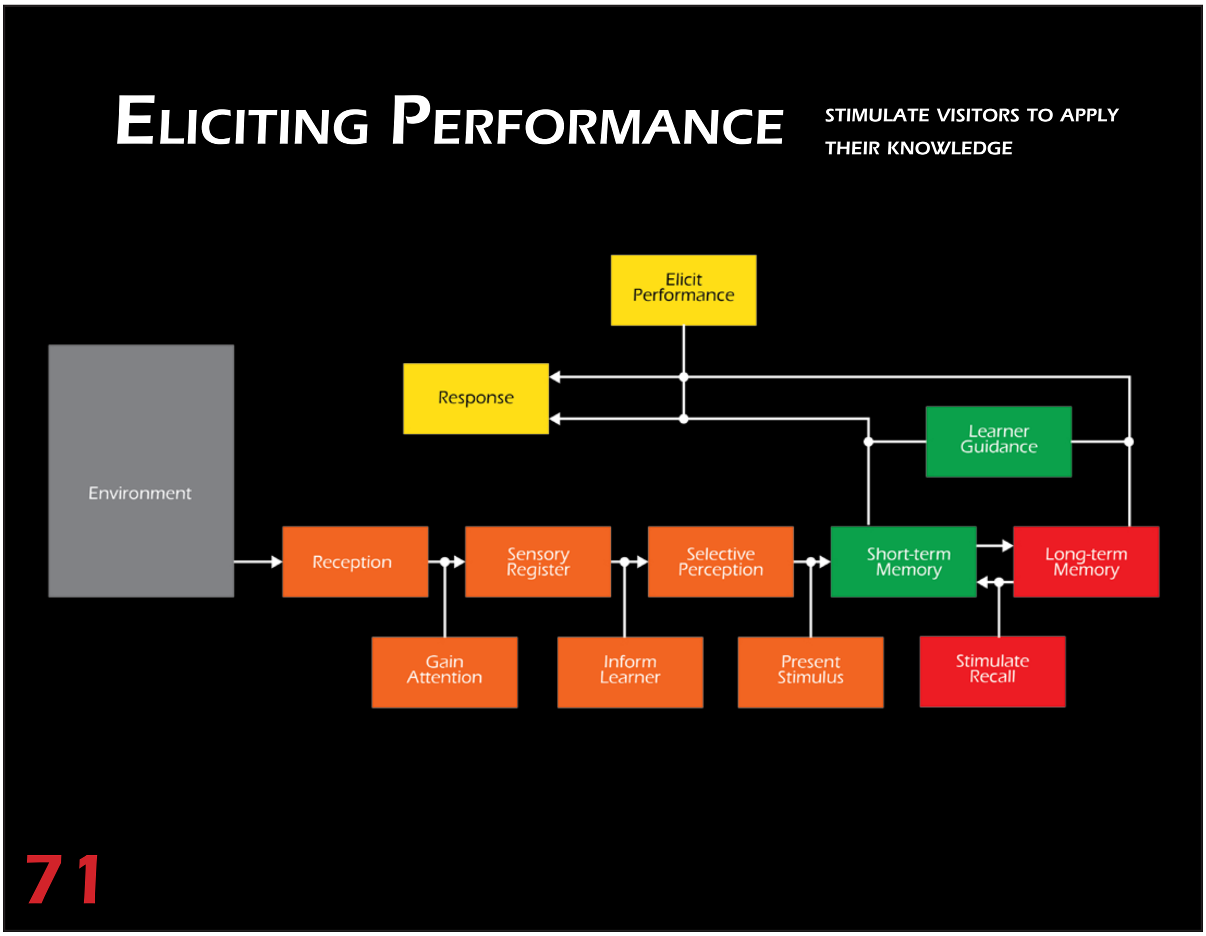
How can exhibits prompt visitors to recall specific information?

How can exhibits guide visitors in creating meaning?



He then leaves the ranger station and walk down the pathway looking for elephant clues. When he reaches a junction in the pathways two clues are present. One is from an elephant and the other is from a different animal. By following the different clues the path leads to the animal which created the mark.

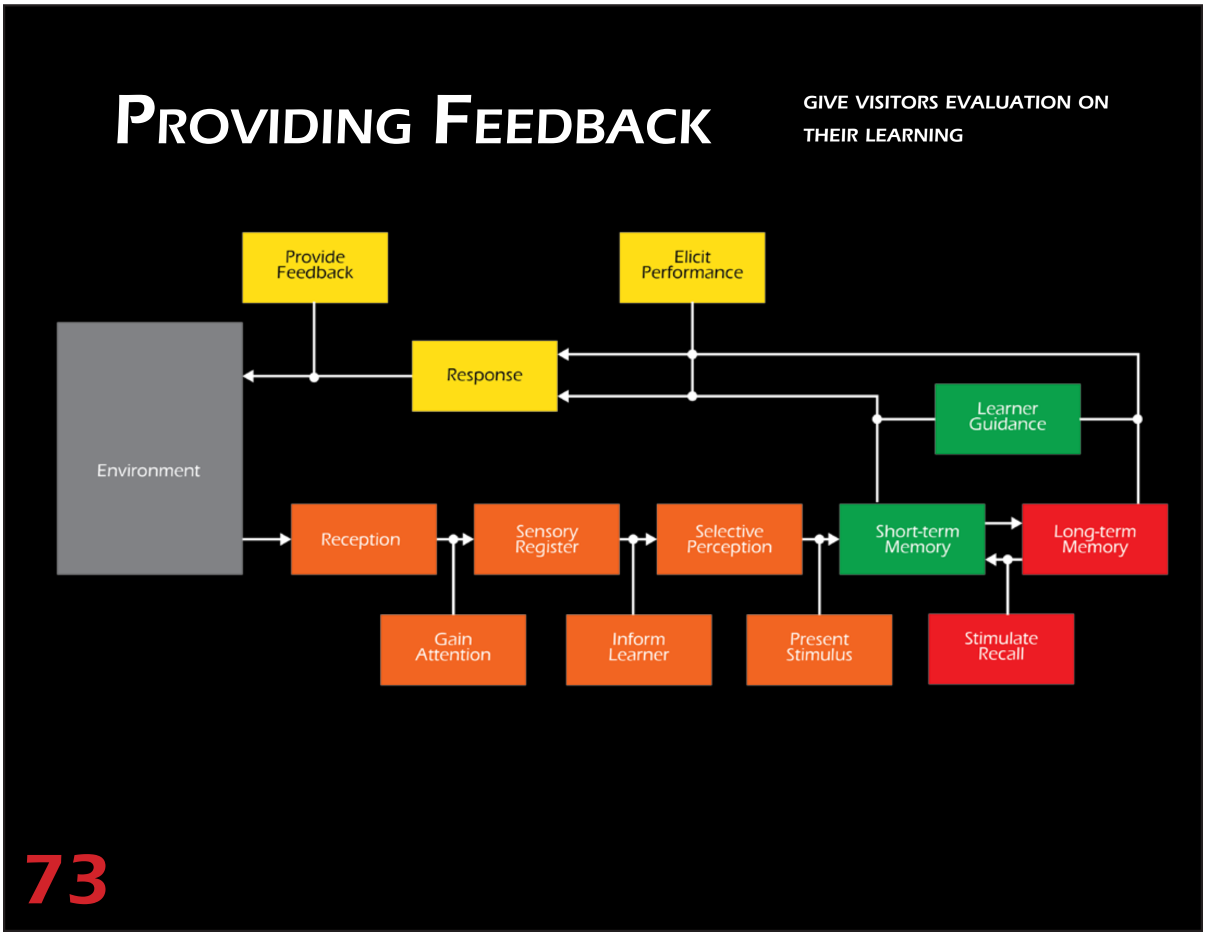
When we use the information we learned our understanding, memory and ability to apply the information in new contexts increases. Exhibits can encourage us to use the presented information by performing our learning. In addition to increasing learning, performance demonstrates to us our learning of information. We can perform our learning by pushing a button corresponding to the correct answer or more complex responses of forming opinions, solving problems or making decisions. In the example, visitors chose a pathway to go down based on the clue in the exhibit.



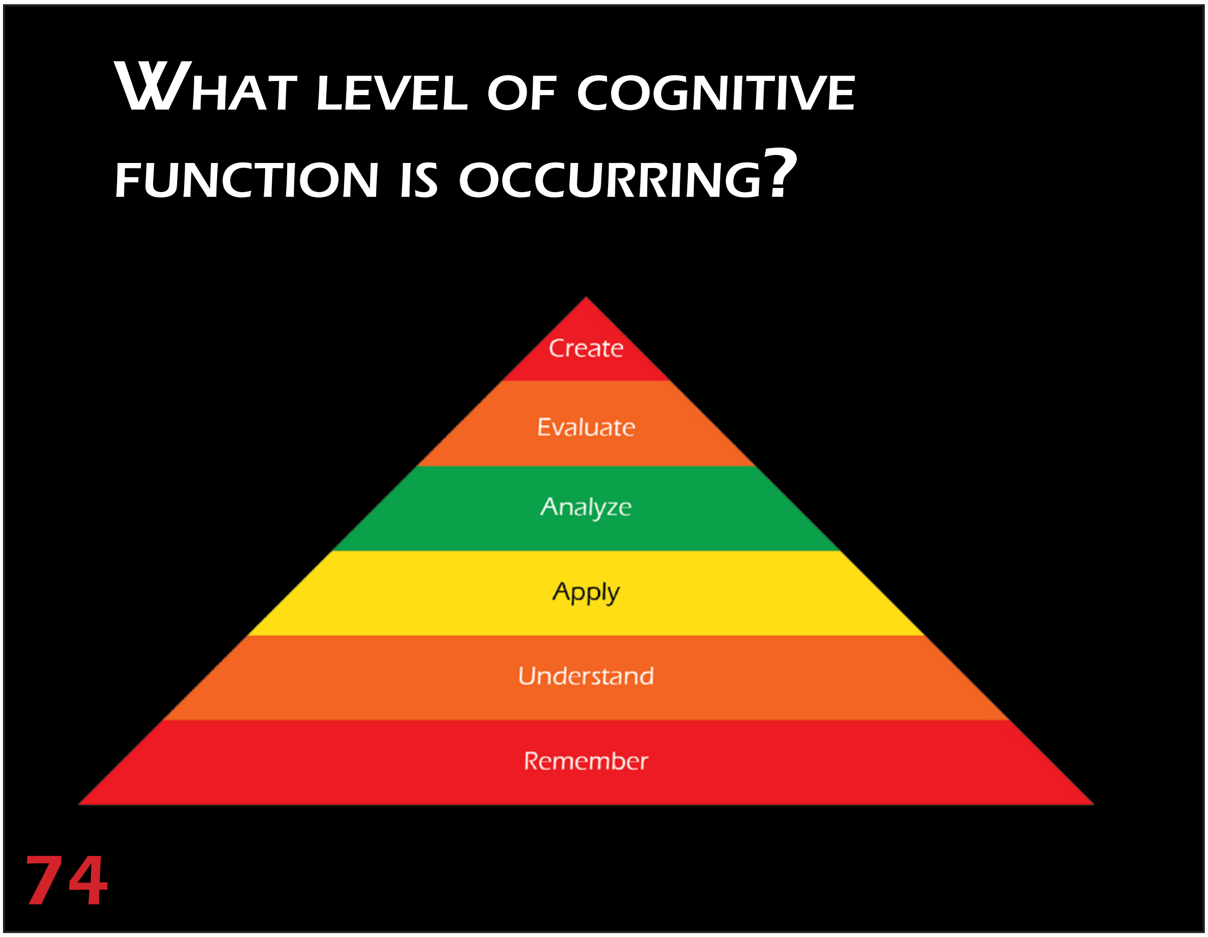
After he chooses a direction he walks down a pathway they encounter the animal that made the mark. If visitors found an elephant then they selected the correct clue. Conversely, if they found a different animal then they selected a clue which was not made by an elephant.

Once we perform we need to know if our performance is correct. Feedback could be a new stimulus from the environment communicating the correctness of the performance such as a parent telling their child they read the sign correctly. Or, feedback can be built-in meaning the act of performance is feedback such as the visitor achieving the desire result of finding an elephant.

When feedback is correct it functions as a reward for the behavior. Rewards can be extrinsic in the form of physical objects such as a sticker. Or, intrinsic rewards can improve our internal states such as pride or confidence. When providing feedback it should support learning by maintaining our control of understanding and meaning making. Feedback should avoid telling visitors they are incorrect but guide them to coming to the correct conclusion.



The act of identifying a clue and connecting it to an animal and then applying what the clue means outside of the context of the ranger talk requires cognitive processes to understand and decide which pathway to walk down. By engaging visitors in greater cognitive function their understanding increases. The cognitive processes encouraged by exhibits can be evaluated using Bloom's taxonomy. The taxonomy increasing from simple to complex with simpler processes being used in higher processes. The taxonomy can also be used for guidance in creating more engaging visitor activities.

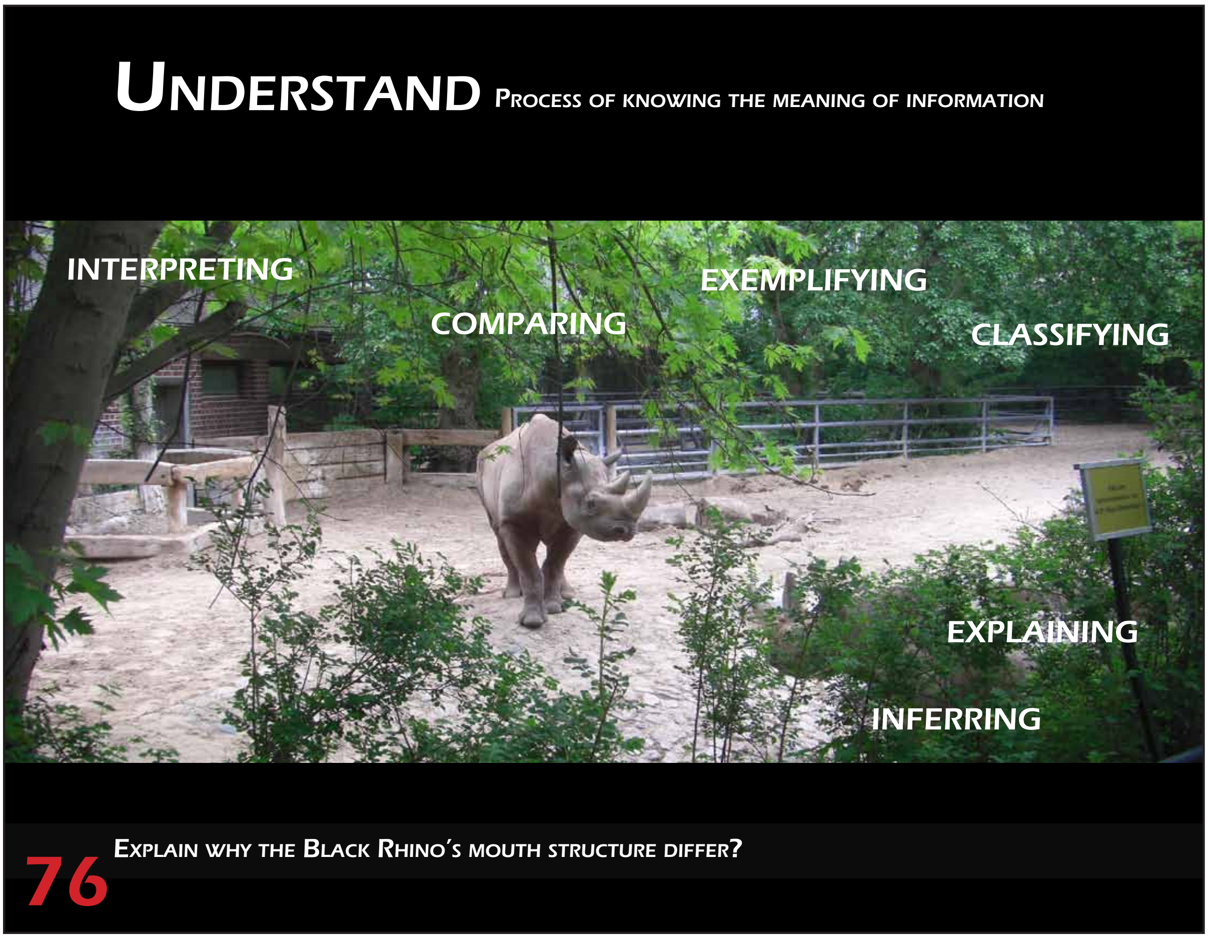


A visitor walks into an exhibit about Rhinos. He approaches the first viewing area with a simple sign asking "what type of animal is this." From his past experience he recalls that it is a rhinoceros. As he walks away from the viewing area a sign explains that the animal is a rhinoceros.

This cognitive process of remembering what a rhinoceros looks like is the simplest of cognitive processes. Remembering is recalling and recognizing terminology, facts, and patterns or more complex information such as classifications, methods, and theories.

Next, a series of signs explains the differences between White and Black rhinos, specifically their preferred diet and the mouth structure. An interactive exhibit replicates the prehensile upper lip of a Black rhino and the rounded lips of a White Rhino. Visitors try to grab different types of plants with the two different mouths to learn first-hand how the mouths are better suited for specific types of vegetation. A sign next to the viewing area of rhinos ask "what type of vegetation is the rhino eating", "what does the mouth look like", and "is it a black or white rhino?" He then recalls that the mouth structure and vegetation associated with the Rhino and infers it is a Black rhino.

This cognitive process of understanding the relationship between mouth structure and vegetation preferences is Understand. It is the Process of knowing the meaning of information. Understanding is used in Interpreting, exemplifying, classifying, inferring, comparing, and explaining. Understanding is limited to demonstrating and applying the information in similar contexts.



After he identifies the type of Rhino he then walks to the next viewing area where he sees giraffes. At the exhibit a sign asks ‘why are giraffes necks so long?” “what do giraffe’s eat.” He uses what he knows about rhinos adapting to vegetation types and applies the concept of adaption to the giraffe concluding giraffes have long necks because they prefer leaves of tall trees.
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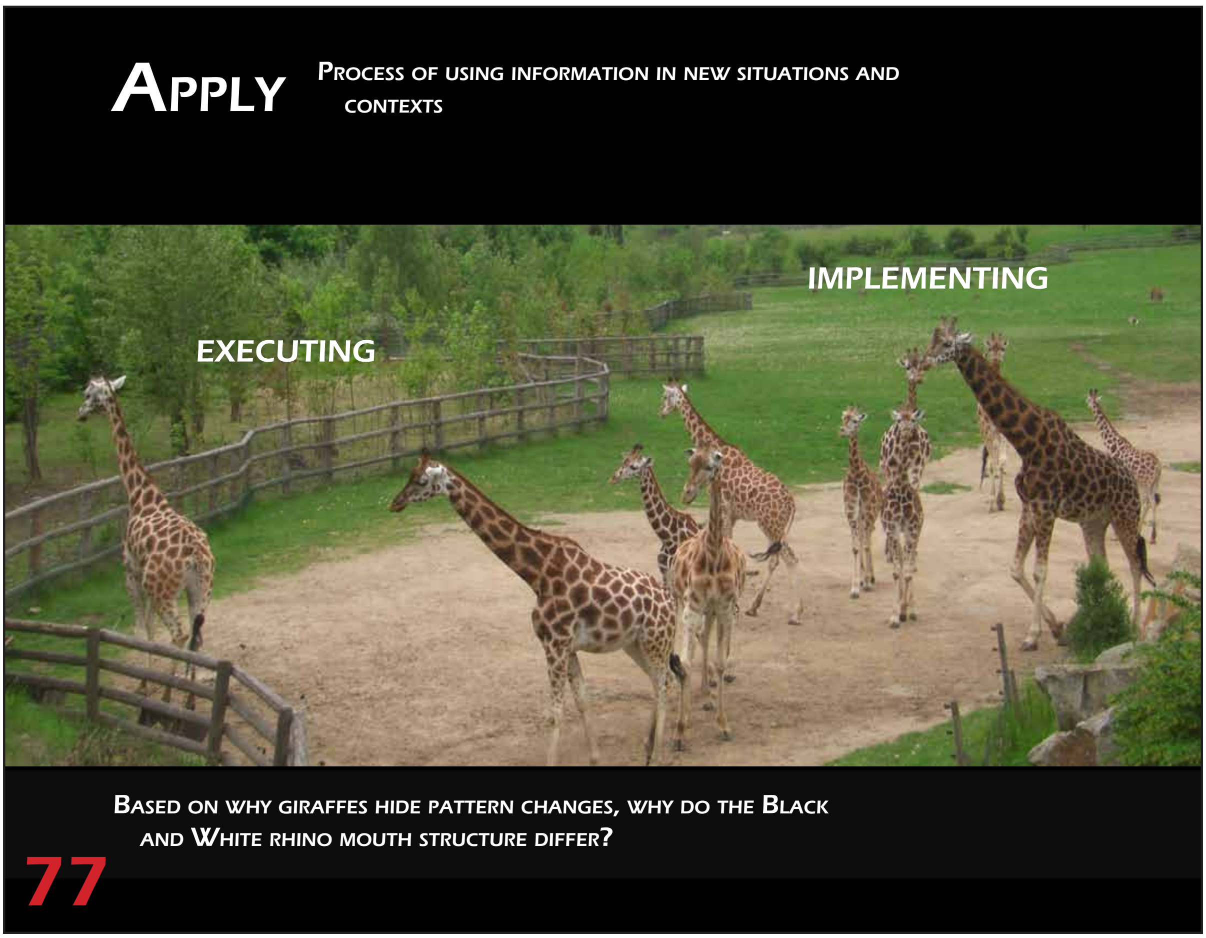
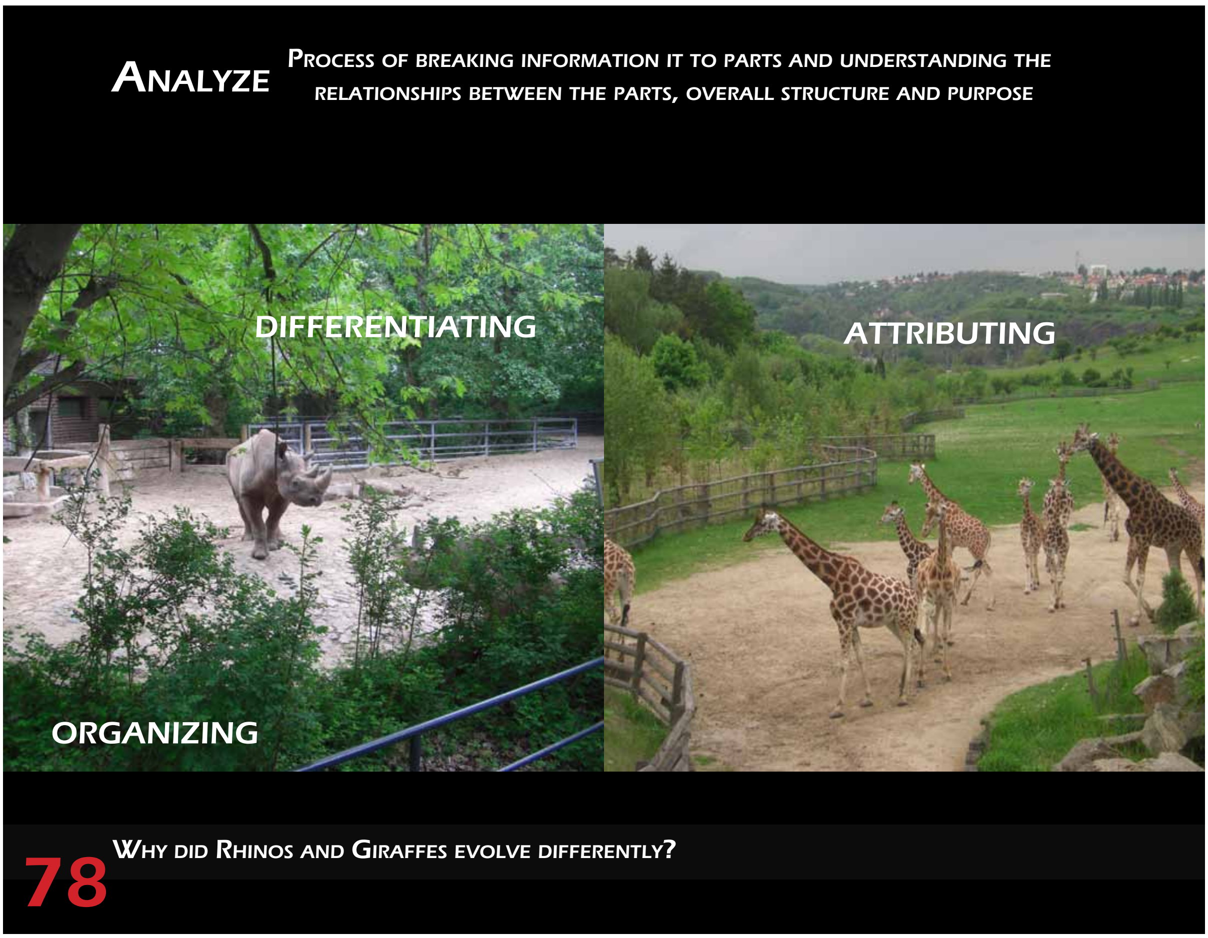
This cognitive process of using what he knows about rhinos to giraffes is Apply, it is the process of using information in new situations and contexts. Processes of executing an implementing information in new contexts are examples.



After he moves to the next exhibit he is asked 'why the rhino population has declined'. He then needs to recall and understand the relationship between slow reproduction learned from evolution and rhinos are hunted for their horns. He attributes population decline to over hunting.

The cognitive process is Analyze, it is the process of breaking information into parts and understanding the relationships between the parts, overall structure and purpose. Processes of differentiating, organizing and attributing are examples.

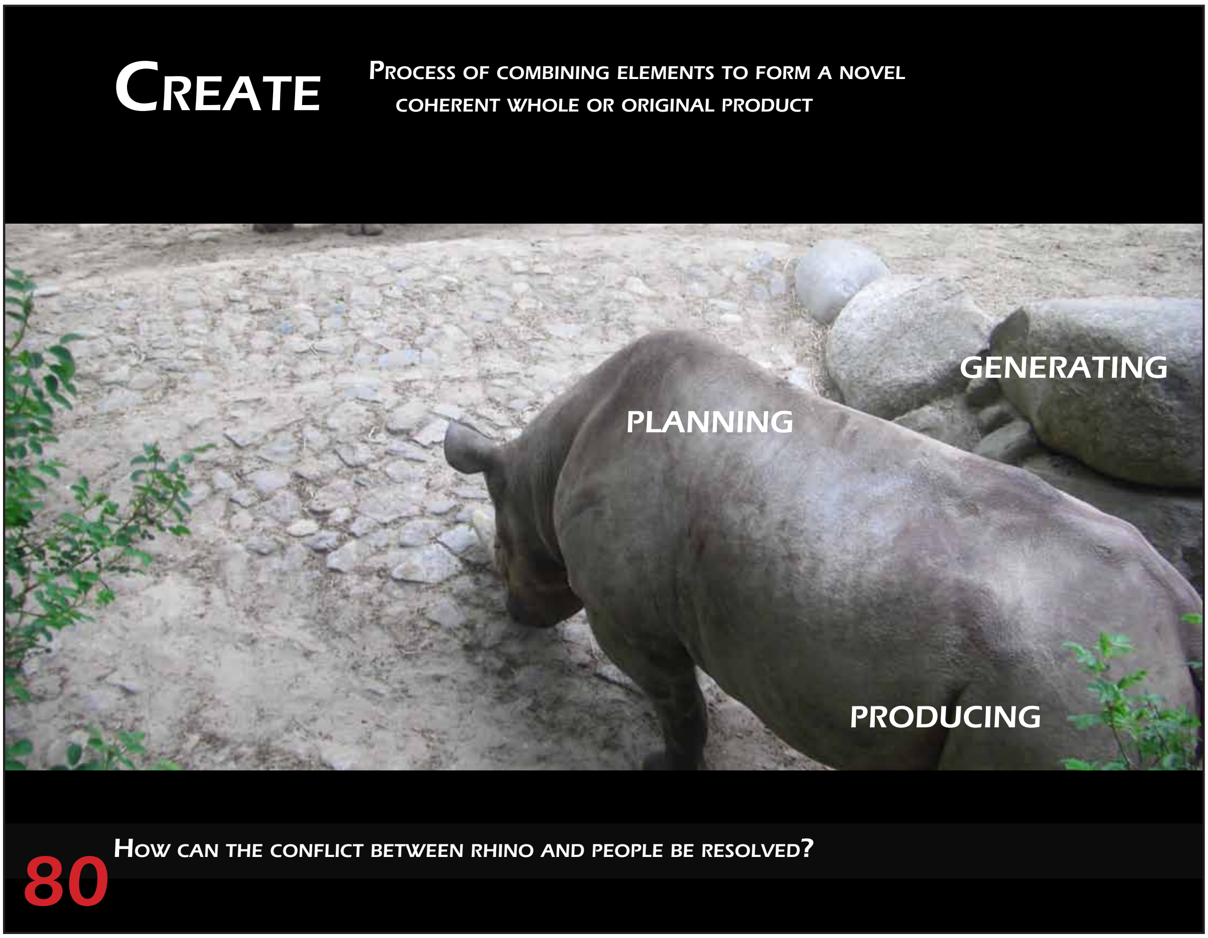


He then enters into a conservation breeding station. The exhibit presents facts about Rhino conservation explaining information about historic population numbers, current population, reintroduced population, sales of rhino horns on the black market, and conservation efforts. As he walks out of the building he is asked if 'rhino conservation efforts are successful?' He evaluates conservation by walking through different doors one for yes, no or maybe. Through the yes door visitors see evidence for more conservation, through the no door visitors see successful conservation programs, and through the maybe door visitors see both successful conservation and a need for more conservation.

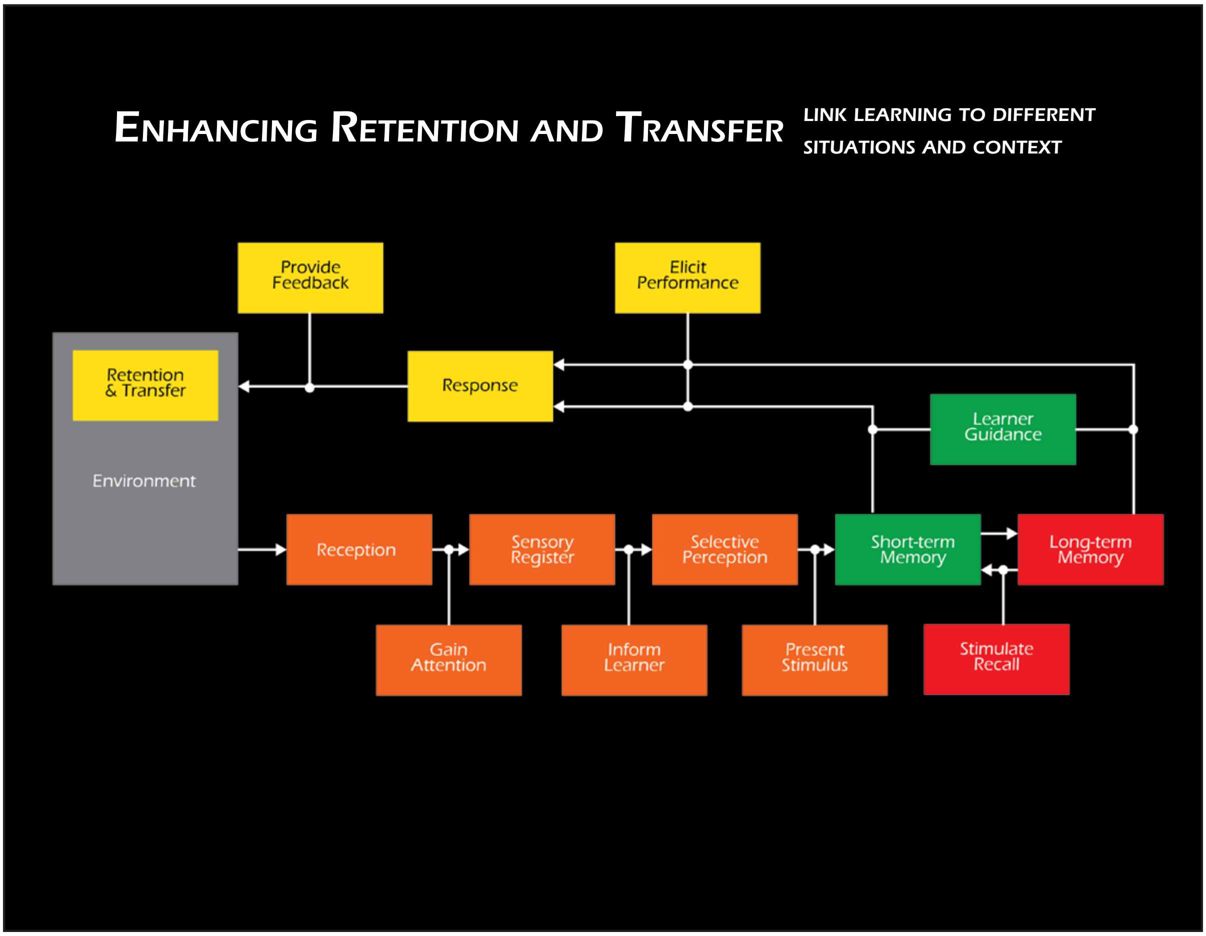
This cognitive process of access rhino conservation from the information in the exhibit is Evaluate. It is the process of making judgments based on criteria and standards. The acts of checking and critiquing are acts.

After leaving the conservation breeding station he then enters into a ranger station. Where he is asked to develop a solution to rhino conservation. He uses information from the exhibit such as Rhino diet, Rhino behavior, and conflicts between Rhinos and people to draw areas in the simulated 'conservation park' experienced during the exhibit for where Rhinos and people should live.

This cognitive process of developing a solution to conservation is Create. It is a process of combining elements to form a novel coherent whole or original product. Processes of generating, planning and producing are examples.



Learning is not really complete until the information is used outside the zoo. Memory and understanding increases when the information is contextualized and applied. Information in zoos can be recalled and applied during zoo, work, media and daily life. For information to be applied, the information needs to be relevant to visitors. Relevancy increases when information is familiar. In the elephant conservation example information could be applied and compared to tracking animals in your own backyard.



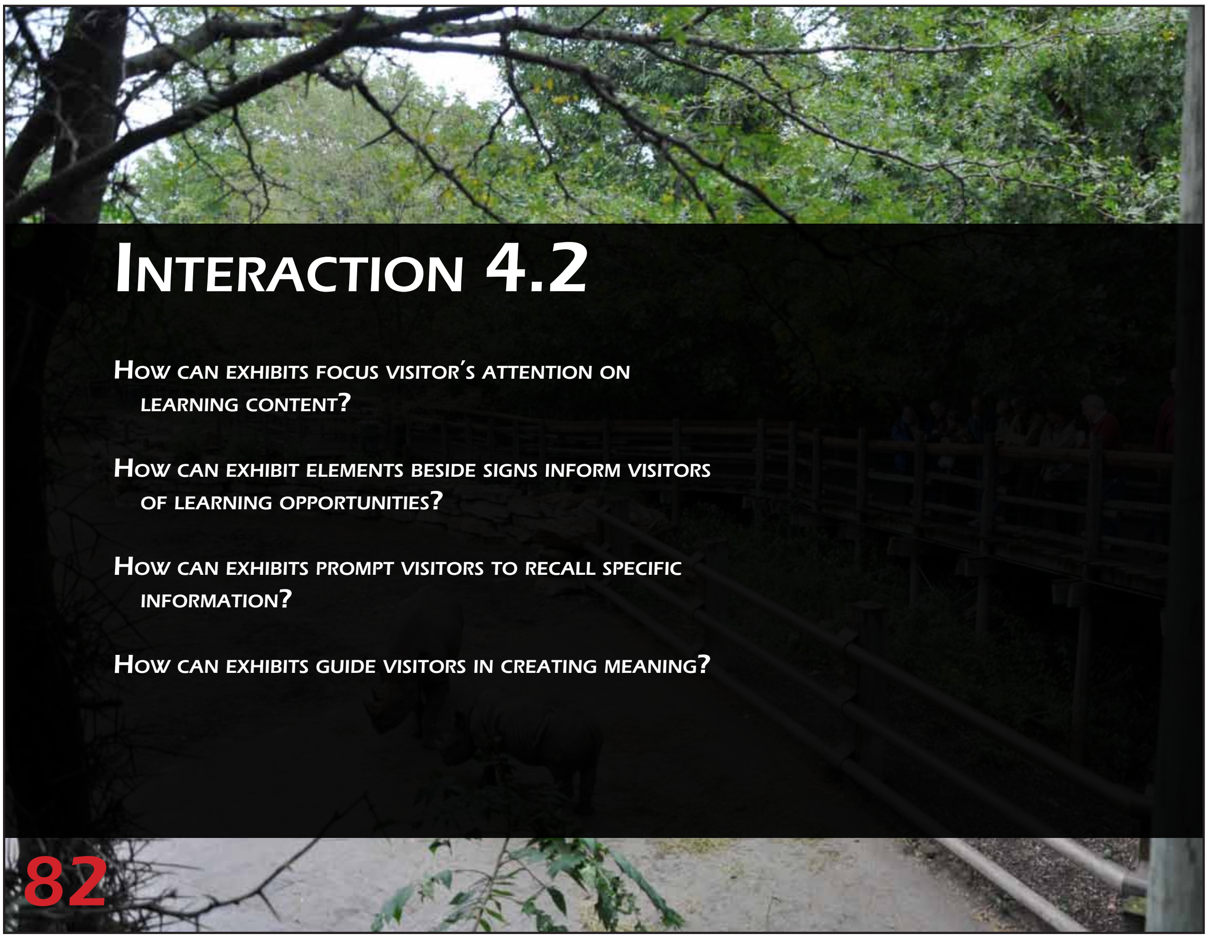
Now, refer back to your zoo learning experience from before (Interaction 2.1). Take two minutes to write what level of cognitive processes occurred during the experience in the workshop manual? Explain how the design encouraged your cognitive engagement.

Paper: 11 x 17
Time: 5 min

With the team share your level of cognitive processes and how the exhibit encouraged your level of cognitive engagement. Then generate ideas for increasing the cognitive processes on 11 x 17 paper.

Question:

What was the cognitive level achieved during some of the design brainstormed for the multiple intelligence?




15 MINUTE BREAK
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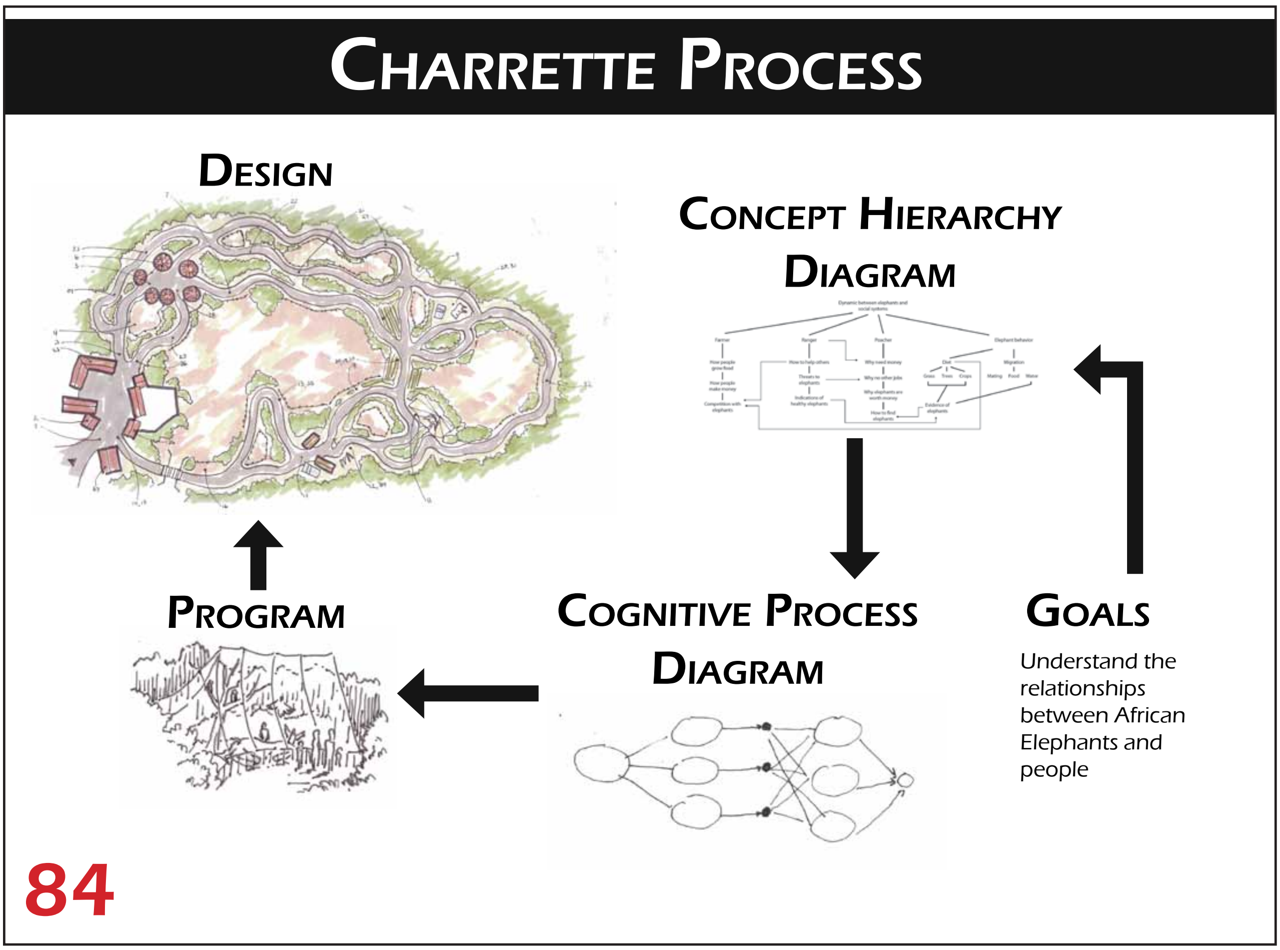
Now we will apply what we have learned today to design a hypothetical zoo exhibit. This is the process we will follow starts at the end and working towards the beginning. For the final design we will use traditional design communication methods of plan, section, perspective as needed to communicate the design intent, focusing on explaining what visitors are thinking and doing. (image of final plan) We will then use two different diagrams, one for developing visitor's cognitive engagement and the other for organizing the content of the exhibit. The first diagram, the cognitive process diagram, develops and organizes the visitor's cognitive experience – how they will think and what they will do. This diagram is to understand how learning occurs during the exhibit. (image of cognitive process diagram) The second diagram is the concept hierarchy diagram which organizes the messages of the exhibit. It organizes the sub-concepts needed to understand the overall concept (image of the concept hierarchy diagram). Before the diagrams are created, the goals and messages of the project are developed to guide the direction of the design. (Example) But first, we need to select a topic for the exhibit.



Select a conservation or environmental issue which is important to you or one you are interested in, for example in one of my personal design charrettes I selected elephant conservation. Take two minutes to write the topic in the workshop manual.

In designing, exhibit goals guide design by giving purpose to the project and provide objectives for design decisions. How do goals inform design decisions pertaining to visitor learning?... Project goals need to be specific enough to guide what visitors are to learn and how the messages are to be learned. Without articulated goals, the design has no frame for which design decisions are made and no way to validate the effectiveness of the built exhibit for learning.

In the elephant conservation example the overall learning goal is for visitors to 1) understand the relationships between African Elephants and people in the complex economic, social and natural systems of the place. 2) The messages need to explain to visitors the interconnections between the systems. These two goals describe the content of the exhibit but not how visitors are to learn the information. The next two goals describe how visitors learn during the exhibit. 3) Visitors are to use the presented information with their prior knowledge and values to make decisions, which is a create cognitive process. When they make decisions 4) visitors learn the interconnections between the different systems by experiencing the consequences of their decisions, which is an evaluate cognitive process. For each decision made during the exhibit the experience changes to reflect those decisions.

For the exhibit to be successful visitors need to enjoy the exhibit. How are the goals communicated so that the different Identities respond positively to the goals? How do the exhibit goals fit within your Identity's needs and expectations for the visit? Recall the Identity you enact when going to the zoo. For example, as an Explorer I would want a customized visit and a challenge. The exhibit concept is built around understanding the consequences of my actions which are unique to me creating a customized experience. Facilitators would also enjoy the exhibit because they would need to help their companions make decisions and interpret the consequences.

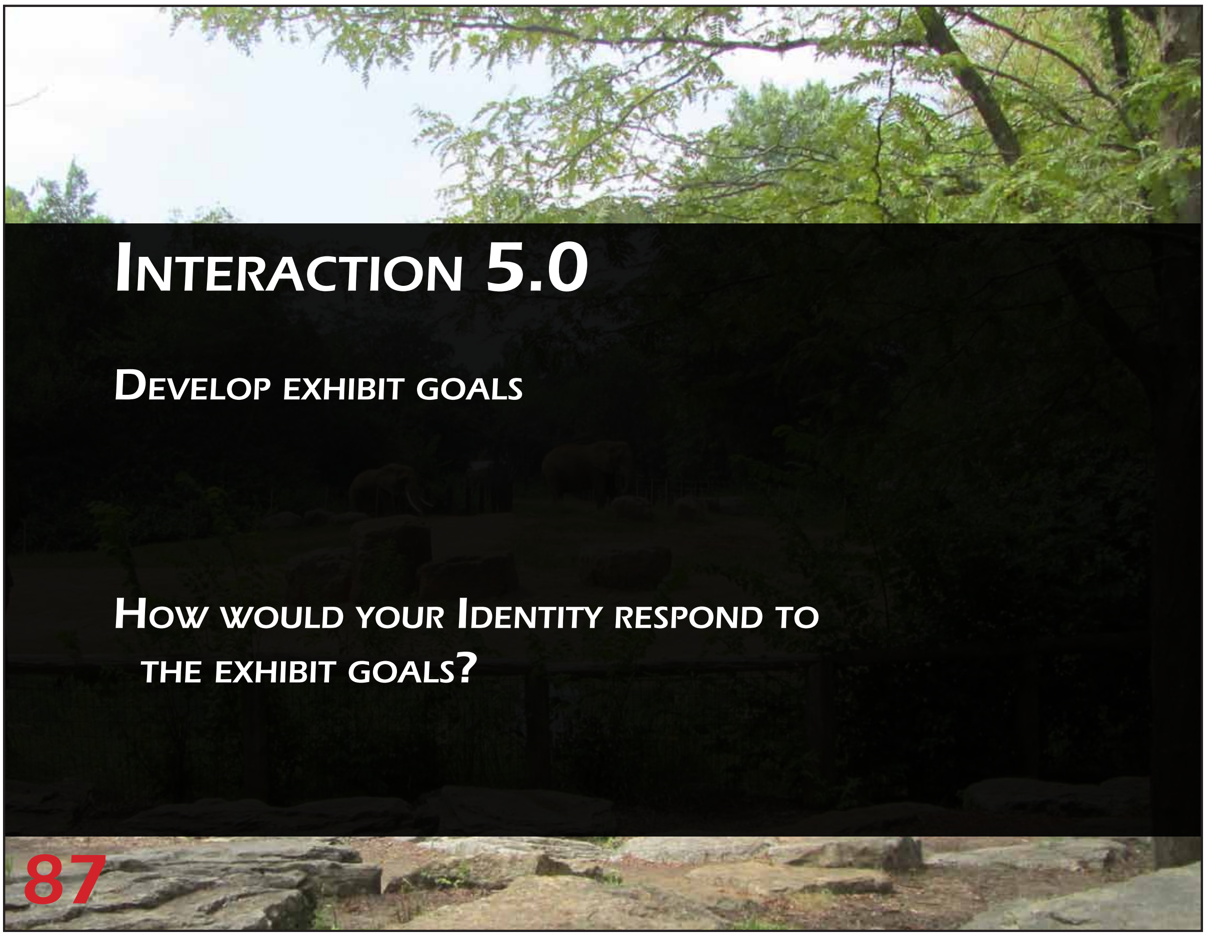
Now, develop the exhibit goals and messages. Make sure to develop what visitors are to learn from the exhibit but also the general strategy for learning the information. You have 5 minutes to develop the goals. Write your ideas in the workshop manual.

Share with the other groups. While sharing with each other explain how the content and learning strategy would appeal to your Identity. Make sure to write notes in the workshop manual.

Questions

How would your Identity respond to the exhibit goals?

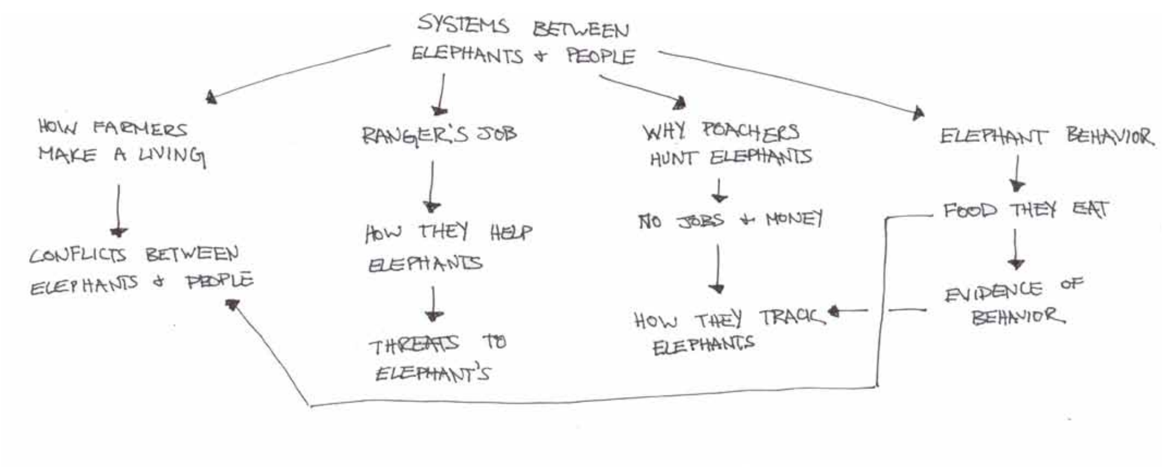
How would your Identity respond to the learning strategy?



How are the exhibit goals achieved? What information do we need to learn to understand the zoo messages? Exhibit messages require an understanding of some prerequisite information to understand the overall concept. For example, to understand the importance of elephant conservation we need to understand that elephants take a long time to reproduce and are hunted at a greater rate than the population can sustain.

Organizing the messages helps to identify how information is presented. For example, before explaining how to help elephants we need to understand why they are in danger. The identification and organization of the concepts helps present the information with conceptual clarity. We will use a Concept Hierarchy Diagram to organize the presented information. The Concept Hierarchy Diagram contains information presented in the exhibit and prior knowledge to be recalled for effective learning. In the elephant conservation example, the presented information was organized based on four players in the ecosystem a farmer, a ranger, a poacher and an elephant. This is the diagram I outlined when I began the charrette.

CONCEPT HIERARCHY DIAGRAM



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Now, develop the Concept Hierarchy Diagram by sketching on the 11 x 17 paper. Identify the sub-concepts of the message and organizing them for effective learning. You have 10 minutes to complete this activity.

Handout the 11 x 17 paper
Time: 15

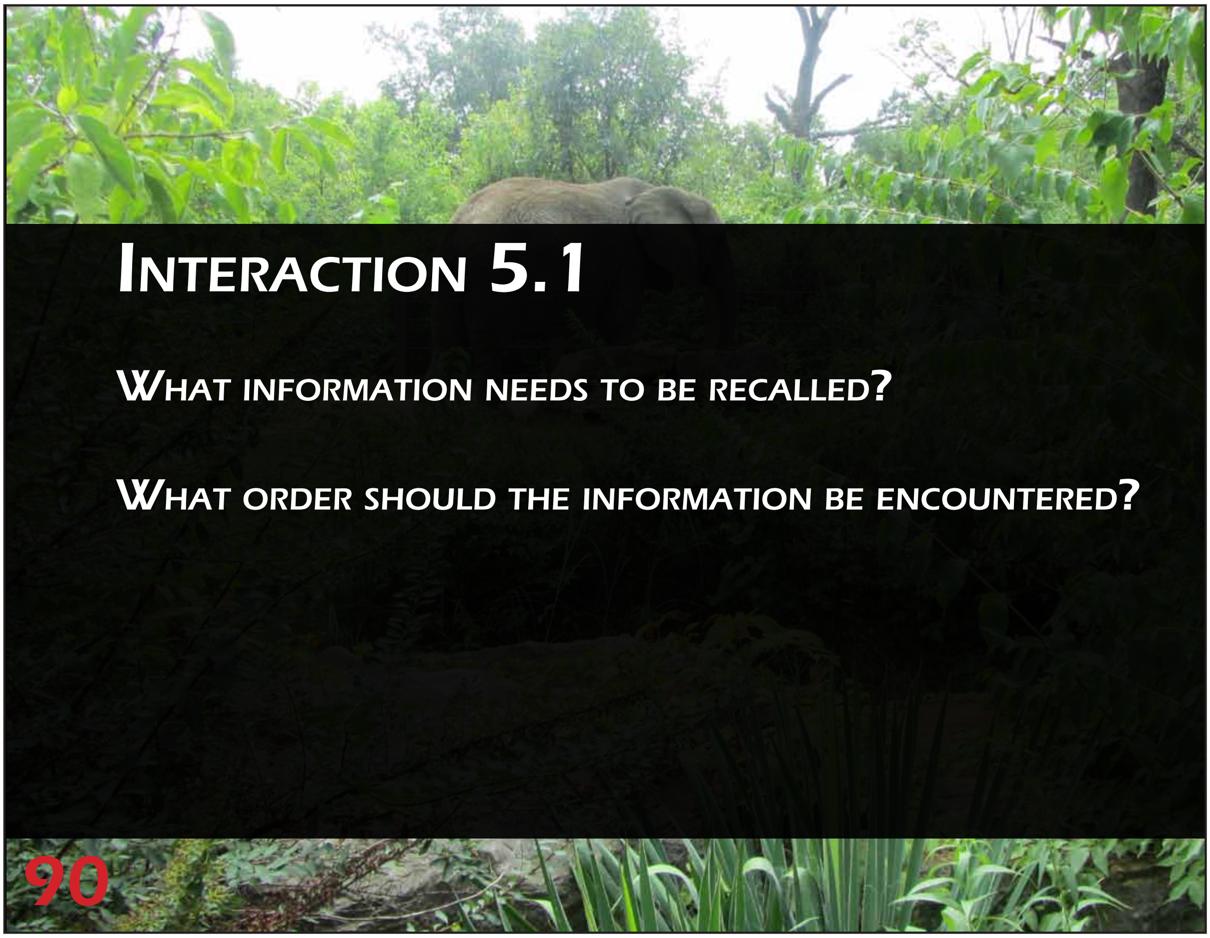
Share with the groups the Concept Hierarchy Diagram. Discuss both the information presented in the exhibit but also the information recalled. As you are sharing describe the types of information you would recall for the other group's diagram. Make notes of how other people will recall information and what would prompt them to recall the information in the workshop manual.

Questions

What is the general strategy for organizing the information.

What information needs to be recalled?

What experiences will recall the information?

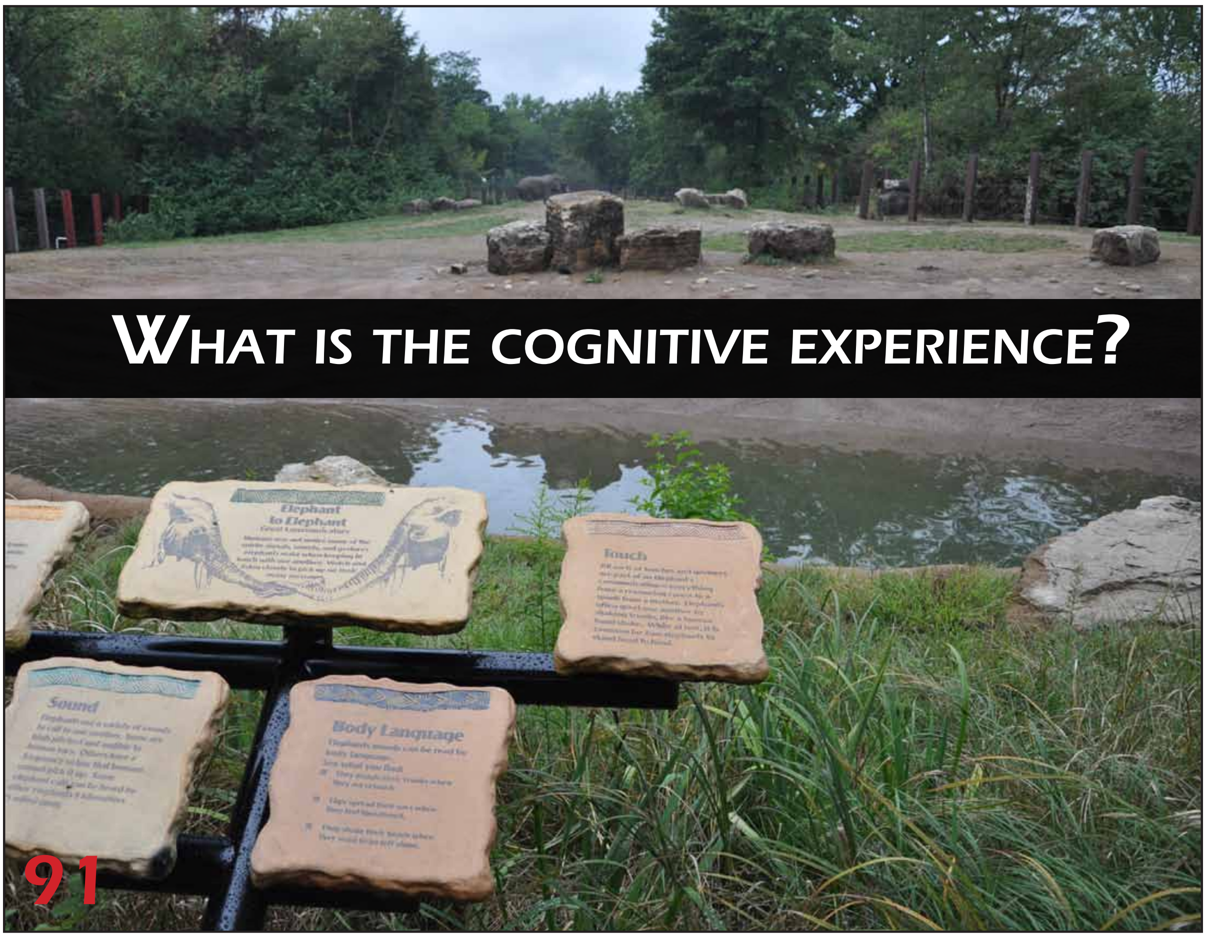


How are we to learn the messages of the exhibit? What cognitive processes will we use to understand the experience? From what we have learned today we can guide visitors in using their cognitive processes. To design the cognitive experience we need to organize and create the experience.

Critical here is the fact that the information to be learned needs more designing than the messages and intellectual content, because if visitors do not engage their learning processes then no information is learned. How visitors learn is depended on the type of information which is based on the goals.

Is the information best understood from a concrete experience? Or, is the information best understood through abstract conceptualization? In the elephant conservation example, information could be presented, abstractly, in a sign listing why people hunt elephants, or visitors could understand the reasons concretely via role-playing. To understand the drivers of poaching it would help visitors understand the causes of poaching by experiencing the information through first-hand experiences.

Also think about specific cognitive processes used to learn the information which the exhibit can stimulate and facilitate. For example the elephant conservation design encourages visitors to recall information in the African boma community area. The exhibit encourages visitors to recall, a cognitive process, information about how we raise cattle locally using fences and feedlots through cultural features and questioning signs, for example "where does your food come from?" and lassos and saddles. We are then encouraged to compare, a cognitive process, our farming with the local African livestock methods to explore the differences.



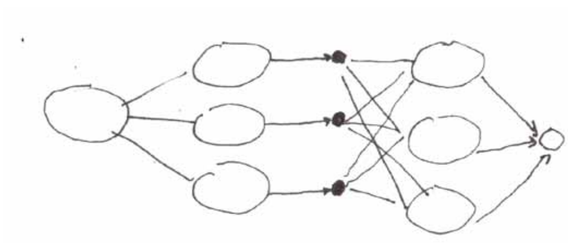
Visitors desire engagement opportunities such as interactive exhibits and greater intellectual challenge.

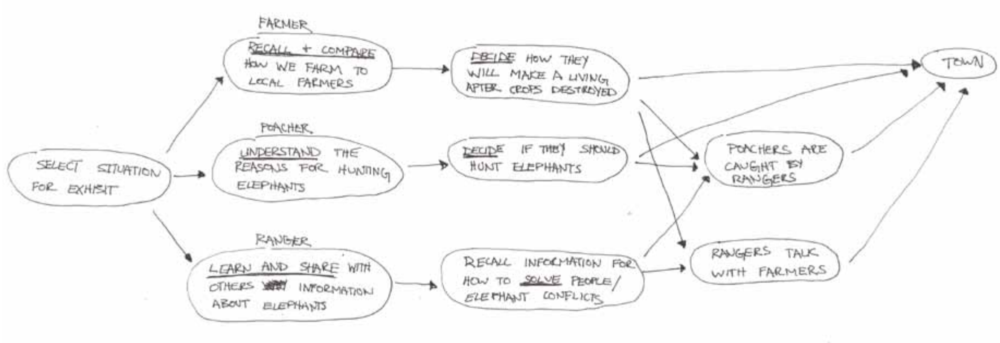
cont. from slide 91

Exhibits can provide opportunities for visitors to engage the exhibit by applying their learning. Application of learning increases learning by contextualizing learning and reinforcing learning through practice. In the example, visitors make decisions which encourage cognitive processes to a level of apply and evaluate. The visitors are given built-in feedback is provided by the experience responding to their decisions. External feedback could also be used such as making fictional money throughout the exhibit which is used to support conservations at the end of the exhibit.

A Cognitive Process Diagram is used to organize and plan the intended visitor cognitive experience. Diagram the general strategy for how visitors will encounter and think about the situation. The top diagram is a sketch diagram for the elephant conservation example in which visitors make a decision and are directed to a different situation transferring scenario tracks of farmer, ranger or poacher. The diagrams should explain the general visitor circulation pattern and how they will think. Further develop of the diagram integrates the messages from the concept hierarchy diagram.

Cognitive processes diagram





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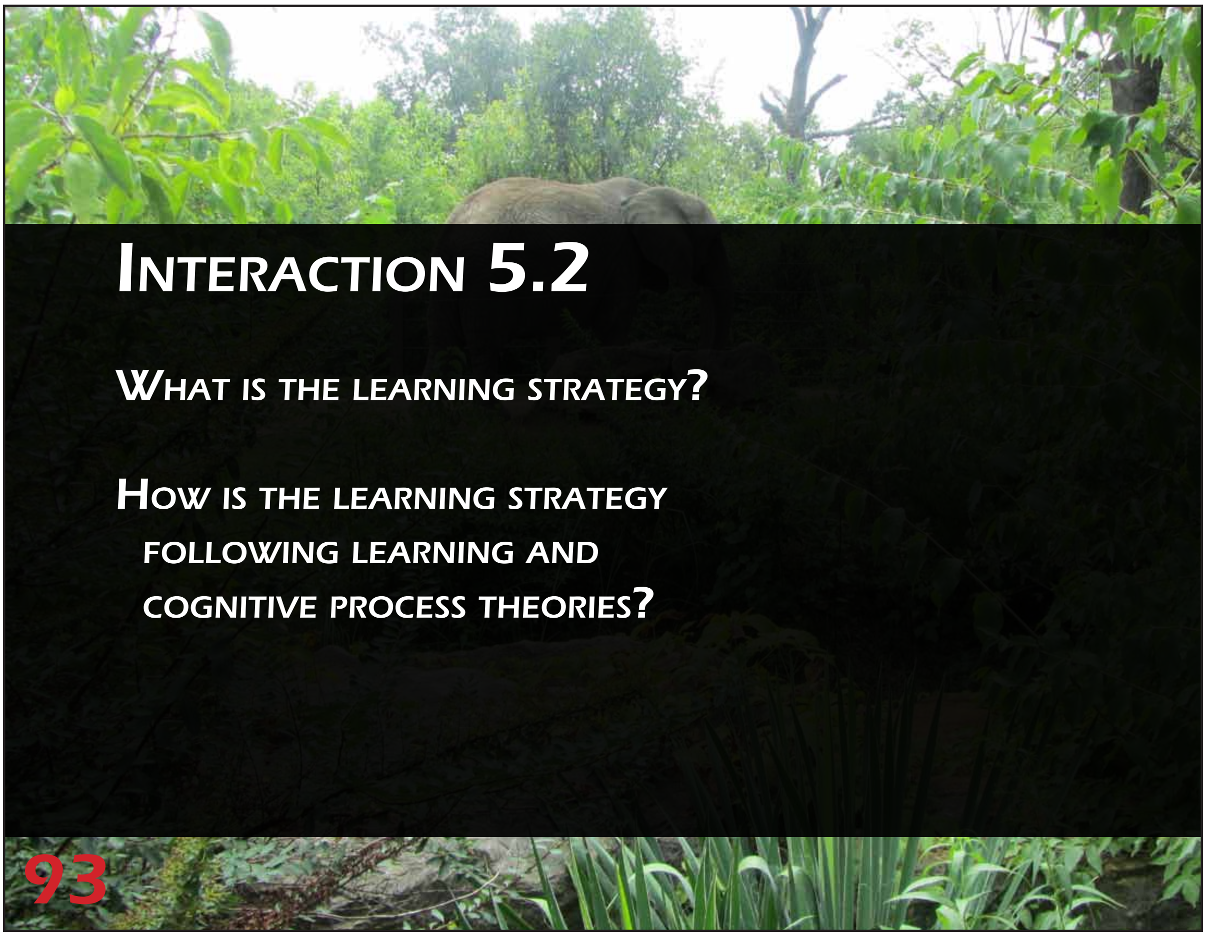
Now, develop how visitors are going to learn the messages from the concept hierarchy diagram. The cognitive process organizes how visitors are to learn the information, how they could think and which cognitive processes the exhibit will facilitate. Sketch the diagram on the 11 x 17 paper. You will have 10 minutes.

Time: 20

Paper: 11 x 17

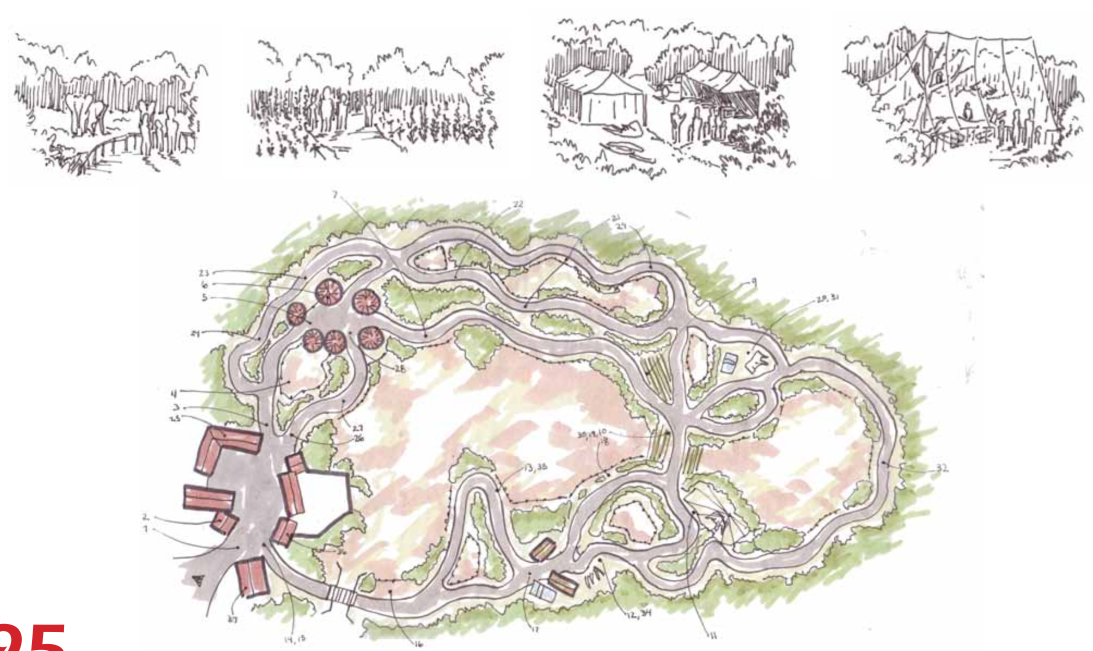
Share with the group the Cognitive Process Diagram and discuss how the visitor learning strategy following learning and cognitive process theories.



From what we have learned today we can facilitate and engage specific cognitive processes. The way the information is presented and contextualized can be designed to engage visitor's cognitive processes. Designs can guide visitors in how to engage the exhibit and how to contextualize and frame the experience to make meaning, remember the penguins and the oil well. The exhibit can encourage recall of information such as in the bison and railroad track image. Design the exhibit to encourage visitors to think about the presented information as intended. Ensure different types of visitors can engage and understand the information differently. In designing the experience guide our attention and the focusing of our attention to create meaning.

Now, program the exhibit animals, design elements and visitor activities following the concept hierarchy diagram and the cognitive process diagrams. To program the exhibit, it may be helpful to quickly vignette the experience or write a narrative. When you are developing the experience communicate not only the design features but what visitors will be doing and how they will be thinking. After you have sketched the experience begin laying out the exhibit in plan. Include quick sections, elevation or perspectives to communicate the concept, focusing on how visitors will think and do during the experience.

PROGRAM AND DESIGN



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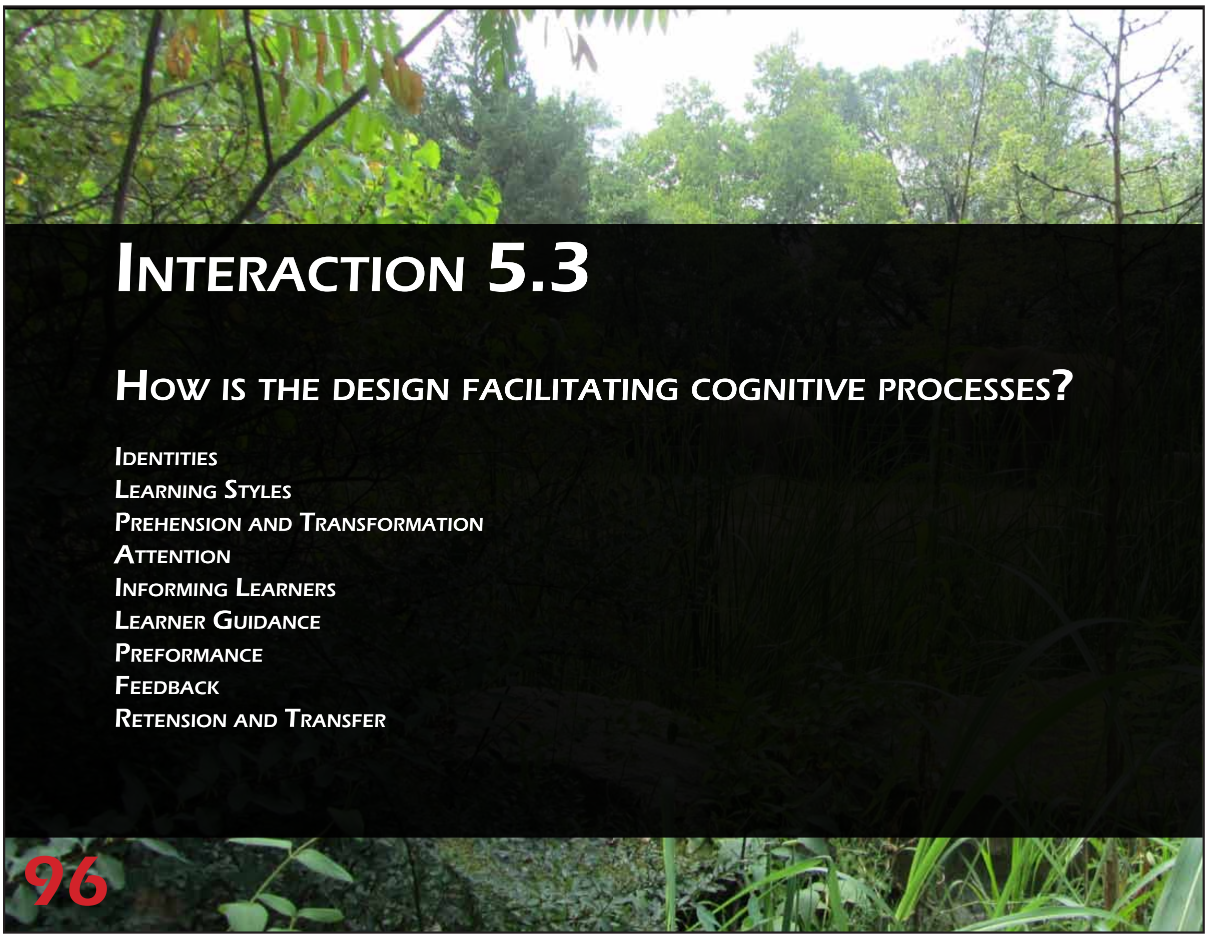
Develop the exhibit program including but not limited to the animals, cultural features, landscape, interpretive elements, and theming to create the visitor experience. You will have 30 minutes to complete the design. I have trace if you prefer it to the 11 x 17 paper.

Time: 45

Paper: 11 x 17 and trace



Now, let's share each other's design concepts.

Then participants discuss as a complete group the influence of learning and cognitive process theories on design.

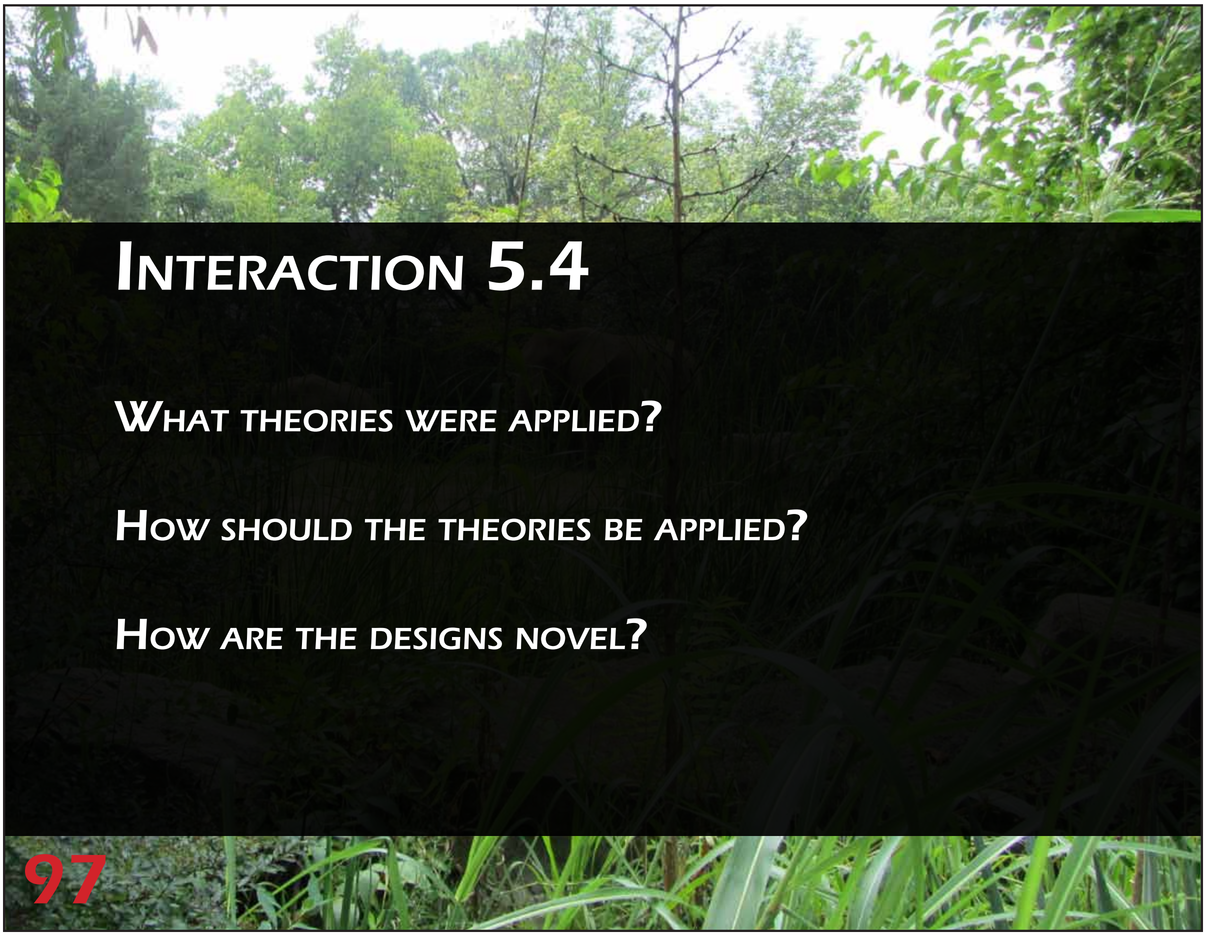
Questions:

Are the designs novel?

Is the approach a useful addition to the design process?

Do you think people will learn from the exhibit?

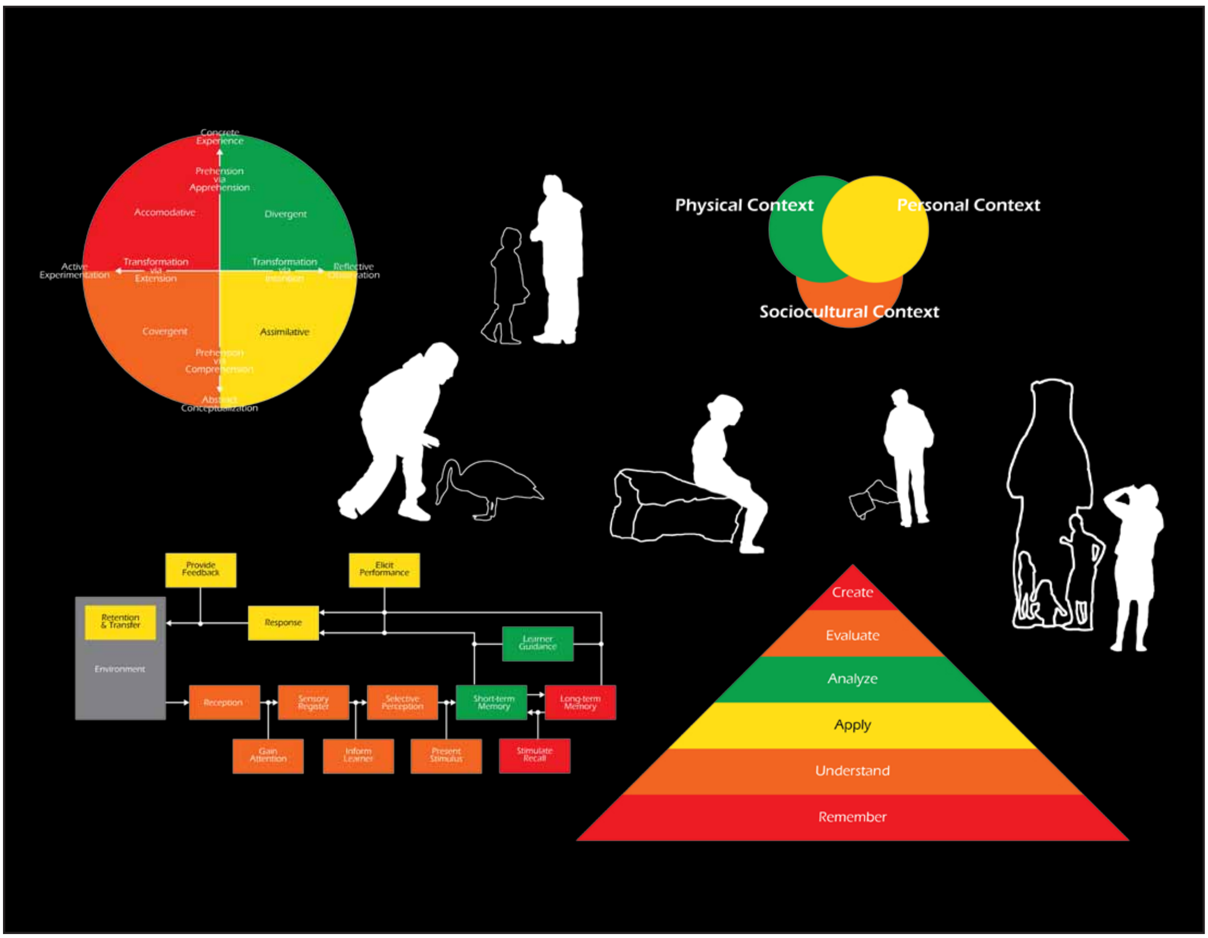
Do you think people will actual recall and think about the information as you have intended?



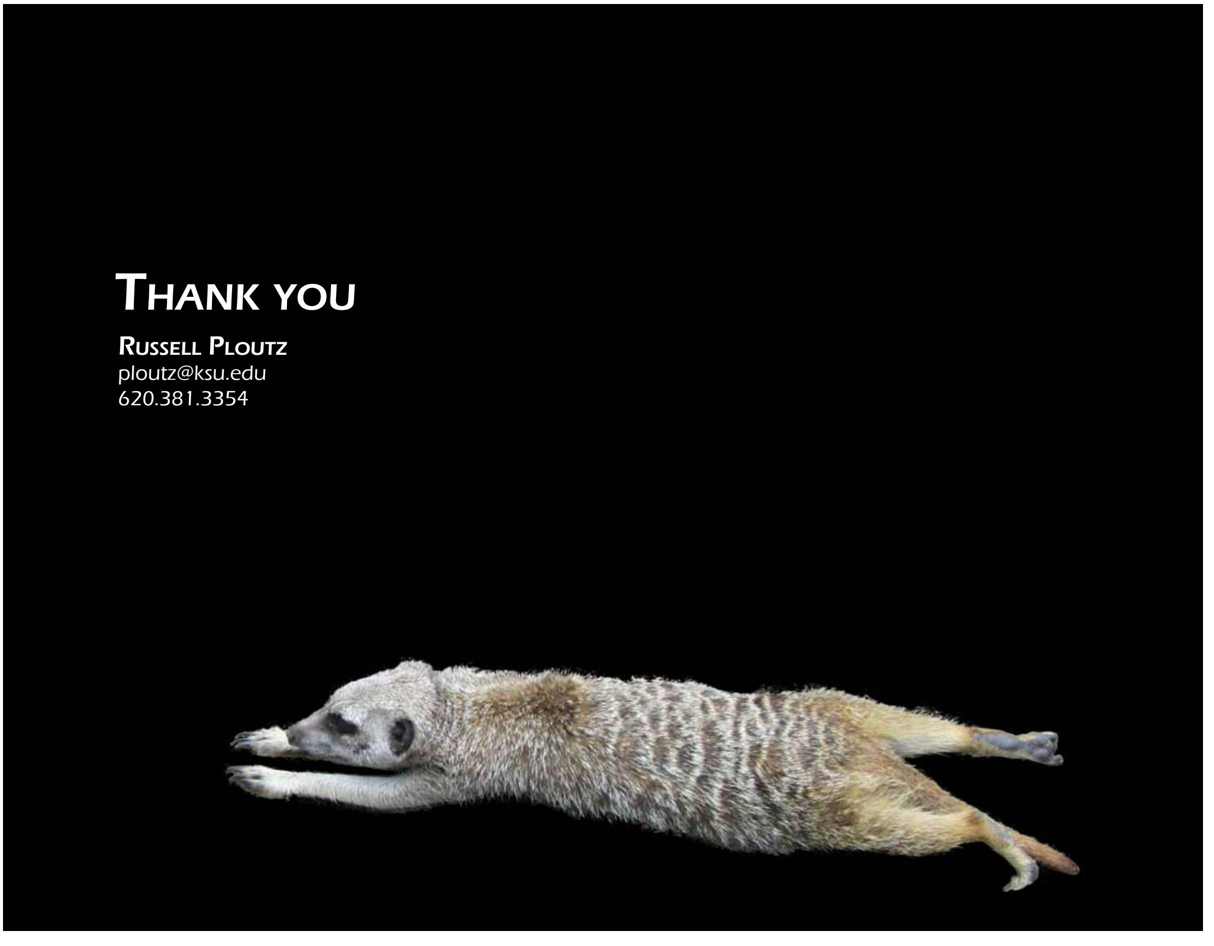
From what we have learned today exhibits do have the potential to capitalize on existing opportunities and redefine the zoo experience by engaging visitors cognitive processes. Improving visitors learning will help zoos in achieving conservation and you can help contribute to conservation through your designs.

You can augment your approach to zoo design by engaging visitor's cognitive processes to create enjoyable, unique and fulfilling zoo experiences. Someday I hope to visit zoo exhibits where I come expecting to learn something which I will use outside zoos.

Zoos can design for learning by facilitating our cognitive processes. Every visitor is unique but by understanding how learning occurs and how learning processes differ we can engage those processes increasing visitor's learning. An integration of learning theories in design has the potential to achieve zoo mission of conservation by improving learning.



I would like to thank all of you for taking the time out of your schedules to participate today. If you have any questions here is my contact information. Before you leave, if you could complete this quick survey to provide me with feedback on the workshop it would be greatly appreciated. After completing the survey you are free to leave. Again, thank you for your time.



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Appendix C - Workshop Manual

Appendix C contains the workshop manual given to participants before the workshop. Participants could respond to workshop activities and make notes during the workshop in the manual. After the workshop, the manuals were collected then scanned and e-mailed to participants for their reference.

ACHIEVING CONSERVATION:
COGNITIVE BASED ZOO EXHIBIT DESIGN

RUSSELL PLOUTZ
SEPTEMBER 29, 2011

NAME: ______________

WORKSHOP MANUAL

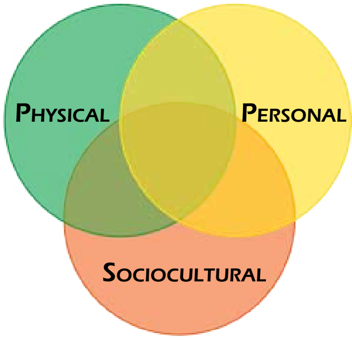
APDESIGN
LANDSCAPE ARCHITECTURE
/ REGIONAL & COMMUNITY PLANNING
THE COLLEGE of
ARCHITECTURE, PLANNING & DESIGN // K-STATE

KANSAS STATE
UNIVERSITY

Interaction 1.0

What lead you to design zoos?

Contextual Model of Learning



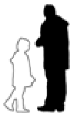
Physical Context
- Advance organizers and orientation
- Design
- Reinforcing Events and Experiences

Sociocultural Context
- Within-Group Mediation
- Facilitated Mediation by Others

Personal Context
- Prior knowledge
- Prior experience
- Motivation
- Choice and Control
- Cognitive preferences

Identities

Explorer - Come to fulfill their curiosity
- Interested in general discovery of information
- Want choice to customize the visit
- Opportunities to exercise their minds



Facilitator – Come to fulfill the needs of someone else
- Translating and interpreting the zoo experience for others
- Learning is not separate from fun
- Opportunities to socialize

Experience Seeker - Come to 'collect' an 'experience'
- Motivated by the idea of being there
- Overview and not deep understanding
- Opportunities to remember the experience

Professional - Come to increase their knowledge
- Come for a specific reason to increase their knowledge
- Have a large body of knowledge
- In-depth information and references

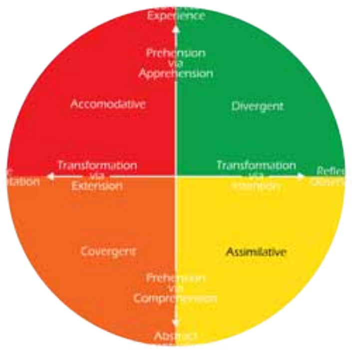
Recharger - Come to reflect and rejuvenate
- Bask in the wonder of the place
- Likely understand the content of the zoo
- Learning does not motivates their behavior

2

INTERACTION 1.2

FOR YOUR LAST ZOO VISIT, HOW DID YOU ENACT YOUR IDENTITY FOR LEARNING?

EXPERIENTIAL LEARNING



PREHENSION – THE ACT OF GRASPING OR PERCEIVING THE ENVIRONMENT AND IDEAS

Apprehension (Concrete Experience) – a process of perceiving the environment

Comprehension (Abstract Conceptualization) – a process of perceiving ideas

TRANSFORMATION – THE PROCESS OF MAKING KNOWLEDGE OUT OF THE INFORMATION

Extension (Active Experimentation) – actively manipulating the environment

Intension (Reflective Observation) – process of reflecting on prehensions

INTERACTION 2.1

DESCRIBE A PERSONAL LEARNING EXPERIENCE OCCURRING IN A ZOO.

3

Multiple Intelligences

Linguistic - Ability to use words and language in speaking, listening and writing

Musical - Ability to recognize tonal patterns, environmental sounds and rhythms

Logical - Ability of inductive and deductive thinking/reasoning, numbers and recognition of abstract patterns

Spatial - Ability to visualize an object, create internal mental images and navigate space

Kinesthetic - Ability to control voluntary movement and make connection between the mind and body

Naturalistic - Ability to care for nature and observe patterns in nature

Interpersonal - Ability to take the view point of others and communicate verbally and non-verbally with others

Intrapersonal - Ability to understand their self by engaging their inner states of being, self-reflection and metacognition

Interaction 4.0

For your learning experience (Interaction 2.1)...

Where did you direct your attention?
What prior learning or experiences did you recall?
How did you interpret and create meaning?
How did you apply your learning while in the exhibit?

4

Bloom's Taxonomy

Remember - Process of recalling information

Understand - Process of knowing the meaning of information

Apply - Process of using information in new situations and contexts

Analyze - Process of breaking information into parts and understanding the relationships between the parts, overall structure and purpose

Evaluate - Process of making judgments based on criteria and standards

Create - Process of combining elements to form a novel coherent whole or original product

Interaction 4.2

For your learning experience (Interaction 2.1)...

What level of cognitive processes did your thinking reach during the experience?

5

INTERACTION 5.0

EXHIBIT TOPIC

EXHIBIT GOALS

6

Interaction 5.1

Sketch the Concept Hierarchy Diagram.

How do visitors recall prior knowledge and experiences to understand the concepts?

7

INTERACTION 5.2

SKETCH THE COGNITIVE PROCESS DIAGRAM.

HOW IS THE LEARNING STRATEGY FOLLOWING LEARNING AND COGNITIVE PROCESS THEORIES?

8

INTERACTION 5.3

HOW IS THE PROGRAM FACILITATING COGNITIVE PROCESSES TO ACHIEVE THE GOAL OF THE EXHIBIT?

INTERACTION 5.4

HOW SHOULD THE LEARNING AND COGNITIVE PROCESS THEORIES BE APPLIED?

HOW ARE THE DESIGNS NOVEL?

Appendix D - Survey

Appendix D contains the informed consent form and survey instrument which participants wrote in their answers. The pre and post-survey are identical except for the gray top header was black for the post-surveys.

KANSAS STATE UNIVERSITY
INFORMED CONSENT TEMPLATE

PROJECT TITLE: Achieving Conservation: Cognitive Based Zoo Design

APPROVAL DATE OF PROJECT: 9/28/2011 **EXPIRATION DATE OF PROJECT:** 12/15/2011
(both dates will be provided in the approval letter, dates must be in place before distributing to subjects)

PRINCIPAL INVESTIGATOR: Eric Bernard
CO-INVESTIGATOR(S): Russell Ploutz
CONTACT NAME AND PHONE FOR ANY PROBLEMS/QUESTIONS: Russell Ploutz 620-381-3354

IRB CHAIR CONTACT/PHONE INFORMATION*:*

- Rick Scheidt, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.
- Jerry Jaax, Associate Vice President for Research Compliance and University Veterinarian, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.

PURPOSE OF THE RESEARCH: This Master of Landscape Architecture Thesis investigates how contemporary research on cognitive process and learning theories can be applied to positively affect zoo exhibit design and increase learning during zoo visits. The desired outcome is a design guideline document to be disseminated to zoo design professionals, zoos and other zoo related organizations to improve learning in zoos.

PROCEDURES OR METHODS TO BE USED: To investigate how learning theories and cognitive processes can influence zoo exhibit design, free workshops are planned for zoo design and zoo education professionals in St. Louis, Missouri, and Seattle, Washington. The workshops begin with an introduction to the project and an anonymous survey regarding contemporary zoo exhibit design integration of learning theories and cognitive process. Participants in the workshop are not required to respond to the survey or specific questions within the survey if they so choose and all responses are anonymous.

The workshop format presents information about contemporary learning theories and cognitive processes and engages participants in small group, or breakout brainstorming and sketch sessions focused on application of presented material in zoo exhibit design. Participation in the dialog and brainstorming sessions is voluntary and only group outcomes will be recorded making participation anonymous to individuals. Outcomes of group activities including brainstorming ideas and sketches will be collected for analysis and integration into a zoo exhibit design guideline document to be disseminated to zoo design professionals, zoos and other zoo related organizations to aid design decision making and improve learning in zoos. This document is seen as a collection of ideas by the zoo design community. If participants choose to, by signing this informed consent, their names will be included as contributors to the guideline document.

The workshops conclude with an anonymous survey regarding contemporary zoo exhibit design integration of learning theories and cognitive process to be compared to the first survey for the purpose of measuring changes in zoo design approach based on workshop learning. Again, participants in the workshop are not required to respond to the survey or specific questions within the survey if they so choose and all responses are anonymous.

The workshop will be video recorded only for the purpose of reference by the investigators to ensure accuracy and precision of documenting activity outcomes. The video will not be used in the publication or released in any form.

LENGTH OF STUDY: Workshops are planned for one day in each city and are to be concluded by mid-October 2011 with final thesis documentation by December of 2011 and guideline dissemination by January 2012.

RISKS OR DISCOMFORTS ANTICIPATED: None. During the workshop you are not required to respond to any questions, and all participation is voluntary and anonymous.

Last revised on May 20, 2004

BENEFITS ANTICIPATED: The findings from the workshop regarding new and novel approaches to zoo exhibit design focused on increasing learning processes will be compiled into a set of guidelines and made available for use and reference after analysis and synthesis. If participants choose they can sign the informed consent below to have their name included as a contributor to the zoo design guideline document.

EXTENT OF CONFIDENTIALITY: All participation in the workshop is anonymous unless signed consent is given to include a participants name as a contributor to the zoo exhibit design guideline document. All survey responses are completely anonymous. Outcomes of workshop brainstorming and sketch sessions are planned to remain anonymous to specific individuals, rather providing citation to breakout session teams, for example Team A or Team B. Participants choosing to sign the informed consent, waive their right to anonymity in the zoo design guideline document and their name will be added as a contributor. All participants will remain anonymous in the thesis text concerning survey outcomes document, except in the appendix containing the zoo design guideline document where those provided consent to be listed as a contributor will be noted.

By signing this document your name will be recognized in the zoo exhibit design guideline publication. Your participation in this workshop will not be compromised by choosing not to sign the consent form. The video will be destroyed at the conclusion of the thesis defense and will not be made available or public in any form.

TERMS OF PARTICIPATION: I understand this workshop and surveys conducted during the workshop are research being conducted for a Master of Landscape Architecture, and that my participation is completely voluntary. I also understand that if I decide to participate in this study, I may withdraw my consent at any time, and stop participating at any time without explanation, penalty, or loss of benefits, or academic standing to which I may otherwise be entitled.

I verify that my signature below indicates that I have read and understand this consent form, and willingly agree to participate in this study under the terms described, and that my signature acknowledges that I have received a signed and dated copy of this consent form.

Participant Name: ____

Participant Signature: ____ **Date:** ______________________

Witness to Signature: (project staff) ______________________________ **Date:** ______________________

Last revised on May 20, 2004

ACHIEVING CONSERVATION:

COGNITIVE BASED ZOO EXHIBIT DESIGN

This Master of Landscape Architecture Thesis investigates how contemporary research on cognitive process and learning theories can be applied to positively affect zoo exhibit design and increase learning during zoo visits.

The following anonymous survey consists of 31 questions and will require approximately 15 minutes of your time to complete. Apart from the time spent in completing the survey, no risks or discomforts can be anticipated by your participation in this survey. Your responses will not be linked to you in any way and are completely anonymous. Your participation is completely voluntary and you are not required to complete the survey. If you feel uncomfortable answering any of the questions, you may leave them blank.

If you have any questions regarding this research, please feel free to contact the investigators:
Eric Bernard
302 Seaton Hall
Manhattan, KS 66506-2909
785-532-3944
ebernard@k-state.edu
Russell Ploutz
ploutz@k-state.edu

If you have any questions or wish to discuss any aspect of this research with an official of the University, contact information for the appropriate persons is provided below:
Rick Scheidt, Chair, Committee on Research Involving Human Subjects
203 Fairchild Hall
Kansas State University
Manhattan, KS 66506
(785) 532-3224
Jerry Jaax, Associate Vice President for Research Compliance and University Veterinarian
203 Fairchild Hall
Kansas State University
Manhattan, KS 66506
(785) 532-3224

Please consider all of the following questions in the context of contemporary zoo exhibits or their design.					
1	How important is each objective in the zoo exhibit design process.	Very important	Important	Slightly Important	Not Important
	Education				
	Entertainment				
	Animal Well-being				
	Conservation				
2	To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitor's thought processes?	High degree	Some Degree	Low Degree	Not at All
	Zoo mission				
	Zoo exhibit proposed objectives				
	Zoo exhibit proposed message				
	Personal design goals for the zoo exhibit				
		Strongly Agree	Agree	Somewhat Disagree	Disagree
3	Visitors learn from zoo exhibit designs.				
4	Zoo exhibits encourage visitor learning.				
5	Zoo exhibits facilitate visitor's learning by encouraging their thought processes.				
6	Zoo exhibit designs facilitate visitor's motivation for learning.				
7	Zoo exhibits guide visitor's learning by directing their attention to the most important learning feature.				
8	Zoo exhibits prompt visitors to recall prior knowledge.				
9	Zoo exhibits engage visitors in the most important learning content.				
10	Zoo exhibits assist visitors in creating meaning from the exhibit experience.				
11	Zoo exhibits reinforce visitor learning by encouraging visitors to apply their knowledge.				
12	Zoo exhibits provide visitors with feedback on their learning.				
13	The visitor experience in a zoo exhibit is designed to engage a sequence of thought processes.				
14	The zoo exhibit landscape, design elements and theming are designed to create a environment which encourages specific cognitive processes.				
15	The spatial relationships between a visitor and animal are designed to encourage visitor's to think about the zoo exhibit in a specific way.				
16	Zoo exhibit circulation organization is designed for visitor learning.				
		Strongly Agree	Agree	Somewhat Disagree	Disagree
17	Learning is the transformation of information into knowledge.				
18	People think about and learn the same information differently.				
19	Engaging visitor's thought processes is a personal goal when designing zoo exhibits.				
20	Zoo exhibit learning objectives help guide design decisions.				
21	Information about visitor learning is recalled and employed during the zoo exhibit design process.				
22	Methods and literature pertaining to design for visitor learning are adequate.				
23	Visitors apply and recall information learned in zoo exhibits outside of zoos.				
24	Visitors apply and recall information learned outside of zoos as they experience zoo exhibits.				

		High degree	Some Degree	Low Degree	Not at All
25	To what degree does visitor learning influence the following design stages?				
	Research				
	Site Analysis				
	Programming				
	Concept development				
	Design Development				
	Construction Documentation				
	Post-Occupancy Evaluation				

		Always	Frequently	Occasionally	Never
26	Visitor’s existing knowledge and interest is considered in the zoo exhibit design process.				
27	How visitors learn guides conceptual design.				
28	Strategies for how visitors learn change for different design alternatives.				
29	Selection of a zoo exhibit design concepts is based to some degree on how visitors learn.				

		Very willing	Willing	Maybe willing	Not at all
30	How willing are you to employ additional information about how people learn in zoo exhibit design?				

31	Which exhibit(s) best engage visitors in learning?

Appendix E - Workshop Products

Appendix E contains the sketches and ideas generated during the workshop. Sketches from both workshops are presented together for each Interaction which resulted in sketches.

Interaction 1.1 - Contextual Model of Learning

- Families talking / Diff Groups
- Proximity to animals
- Information Seeking
  - animals
  - interpretives
  - eachother
- Relating Prior information (simba/nala)
- Conceptual Orientation – ~~relating~~ viewing animals in their "natural" environment

Rosey, Kelly, Stacy!

⊕

- PARENT REF. PRIOR KNOWLEDGE (SIMBA/HOUSE CAT)
- VIEW WINDOW ALLOWED MORE INTERACTION AMONG GUESTS
- LESS INFO. = PEOPLE BUILT OWN KNOWLEDGE + SHARE
- FOCUS MORE ON ANIMALS THAN SIGN

LIMITED

- NOT MUCH INTERACTION BETWEEN PEOPLE + ANIMALS (SPACE)
- INFO. IN CORNER

Interaction 1.2 - Visitor Identity

Explorer

- Moving around until something catches your eye → wander away from group.
- Interactive stuff
- Touch and interact with animals.
- Don't want to listen to the authority.

Facilitator

- Prior knowledge
- Sea Lion Show
  - I explain stuff from previous shows
  - Add a bit more from research
  - Bragging to show awesomeness

Intera

Experience Seeker

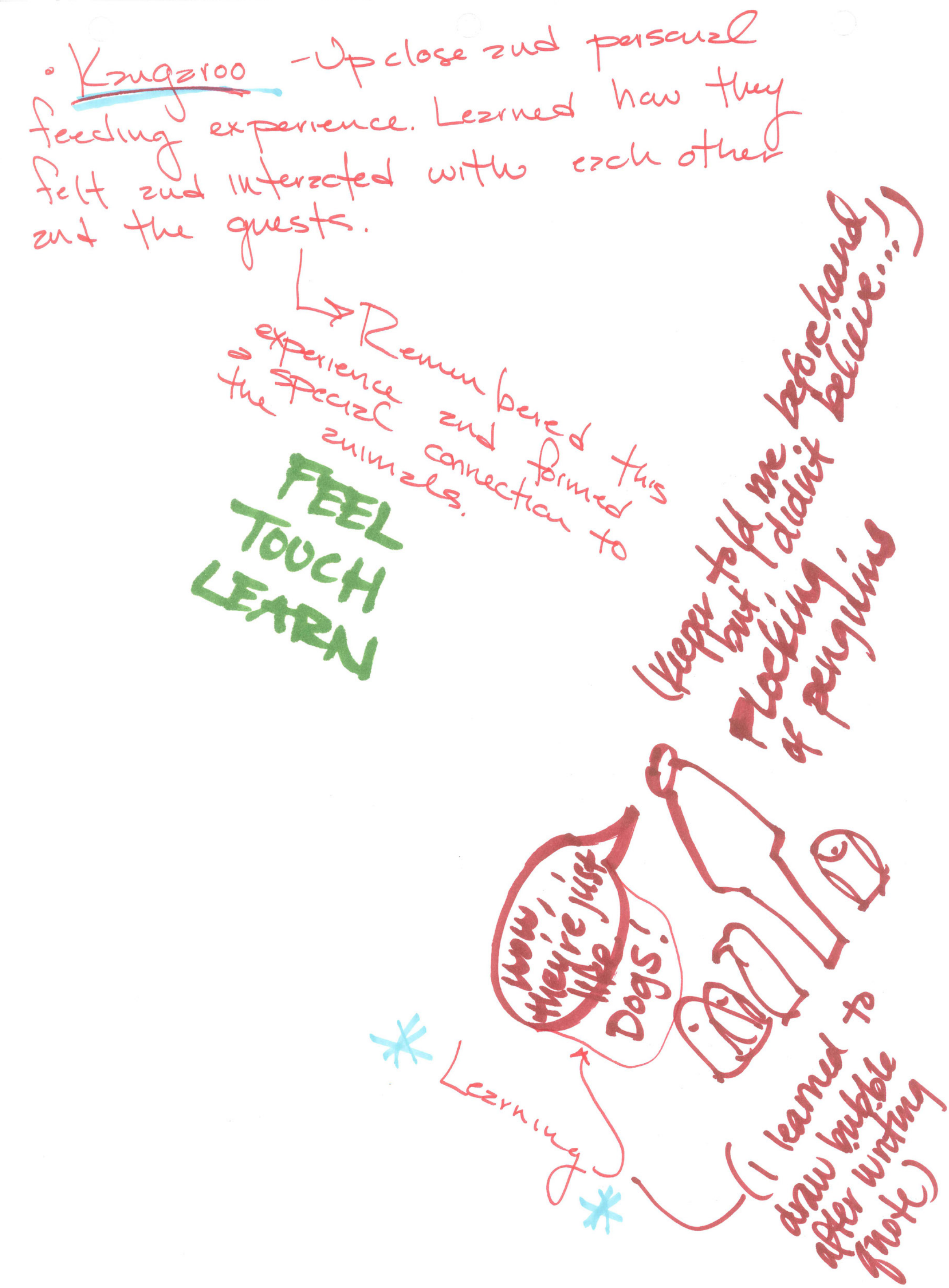
- Skipping certain things
- Sharing experiences w/ people back home
  - ↳ photo ops, social media.
- Unique and never before.

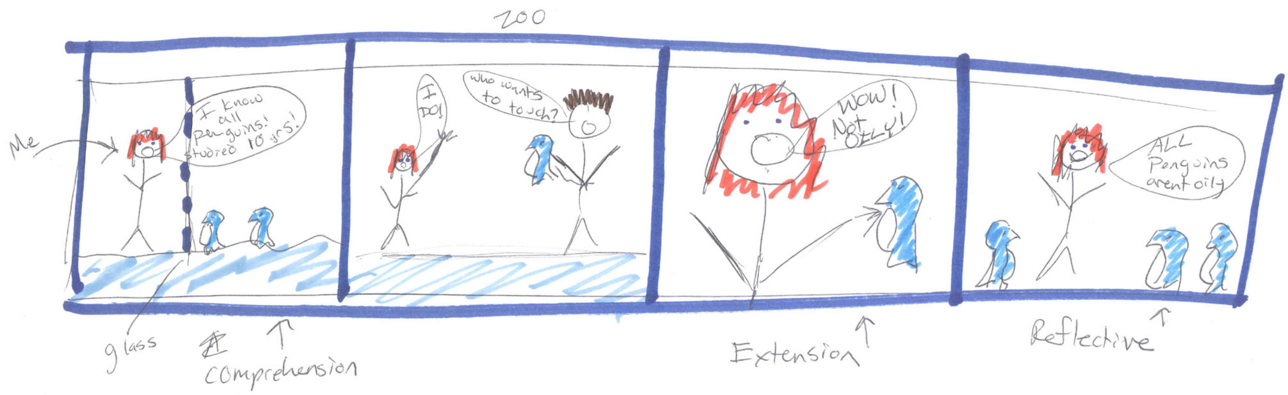
Professional

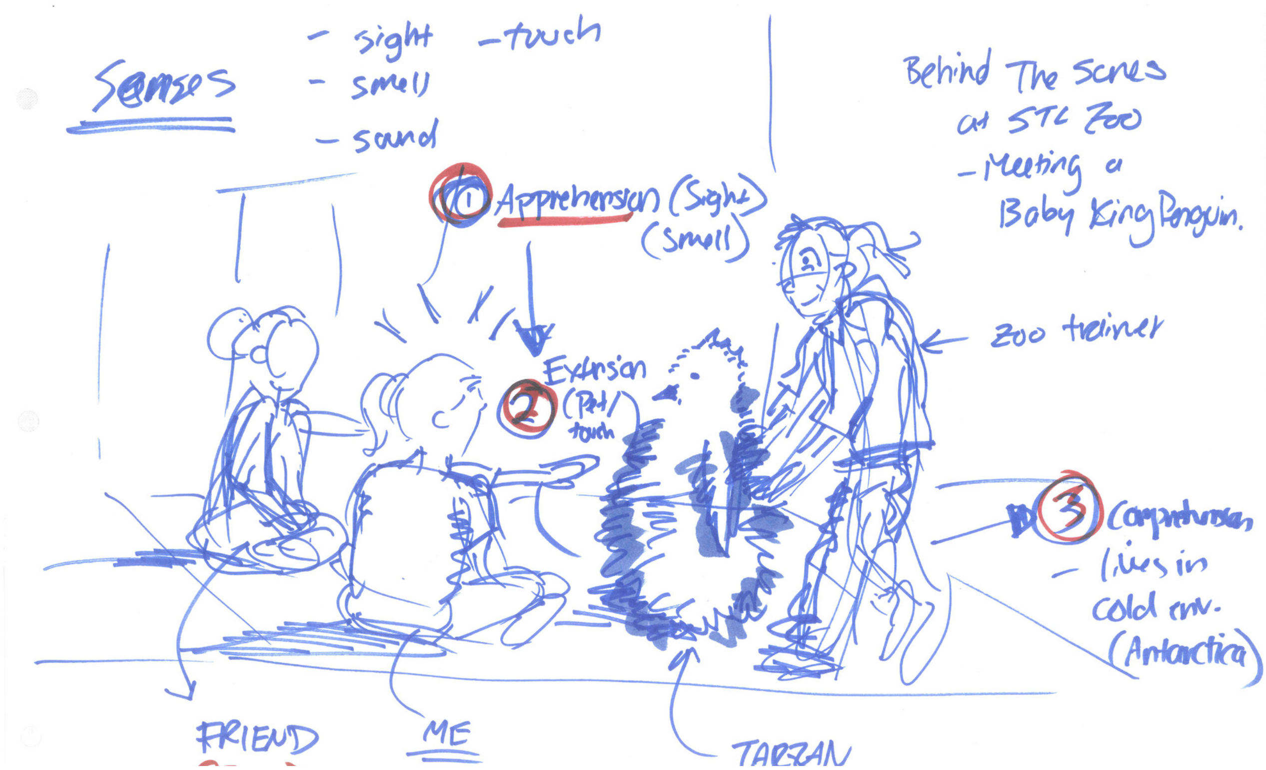
- Looking at detail
- Learning from mistakes
- Evaluating everything.

Recharger

- Active animals
- Sensory experience → pretend I can talk to them
- Spiritual → connection.


• Kangaroo - Up close and personal feeding experience. Learned how they felt and interacted with each other and the guests.
Remembered this experience and formed a special connection to the animals.
FEEL
TOUCH
LEARN
(keeper told me beforehand, but I didn't believe...)
Flocking of penguins
Wow, they're just like Dogs!
Learning
(I learned to draw bubble after writing quote)


ZOO
Me
I know all penguins! studied 10 yrs!
glass
Comprehension
I DO!
Who wants to touch?
WOW! Not OILY!
Extension
ALL Penguins arent oily
Reflective

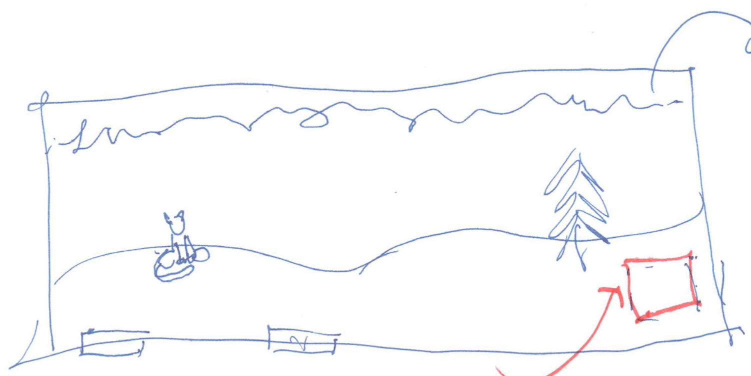

Senses
- sight
- smell
- sound
- touch
Behind The Scenes at STL Zoo
- Meeting a Baby King Penguin.
1 Apprehension (Sight) (Smell)
2 Extension (Pet/ touch)
zoo trainer
3 Comprehension
- lives in cold env. (Antarctica)
FRIEND
ME
TARZAN

Interaction 3.0 - Multiple Intelligences

Linguistic

- "Word Play
- Speaking Interactive –
- Crossword – observe and fill in crosswords based on obsenation
- Word Search – ex. Cheetah
  based on exhibit sign

- signage
- speaking



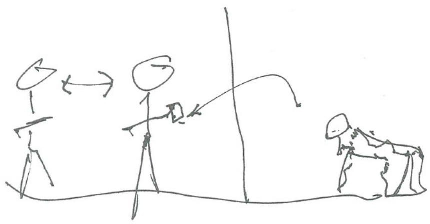
simple quote or poem: (emotion or catchy, clever

- Multiple levels of info.

Too much info. at a time for me to remember and take away. Other types of people can relate and take away from these signs.

Linguistic

- TRAIN CHIMPS TO RESPOND TO "WORDS" SO THAT THE PUBLIC HAS THE PERCEPTION OF "TALKING" to THE CHIMPS. SHOWS THAT CHIMPS CAN LEARN MEANING.



ONE PERSON CHOOSES A CARD THAT DESCRIBES A CHIMP "COMMUNICATION". THE OTHER PERSON TRIES TO ANTICIPATE THE MEANING OF THE CARD.

Musical

- Animal Recorder that recognizes 'Pitch' & 'quantity' w/ start + stop for guests to test knowledge
- Music tempo to show animal's speed (in background) or 'gait'
- interactive animal "sound maker" -> visitor makes sounds of animal by stepping on sound maker
- code diagram shows how.

Musical

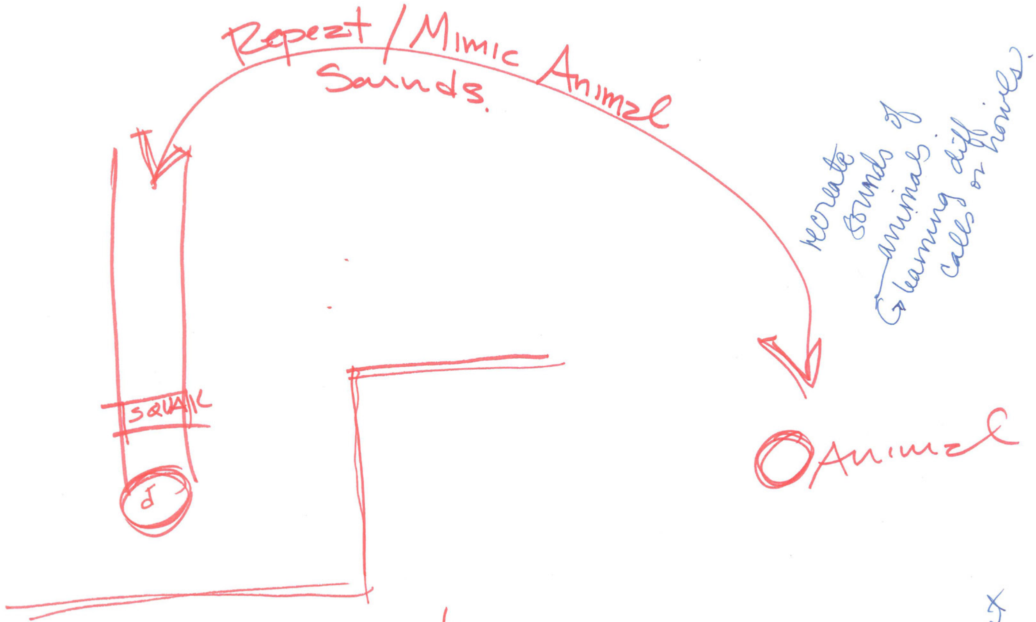
PLAY A RECORDING OF MANY ANIMAL SOUNDS AT ONCE.

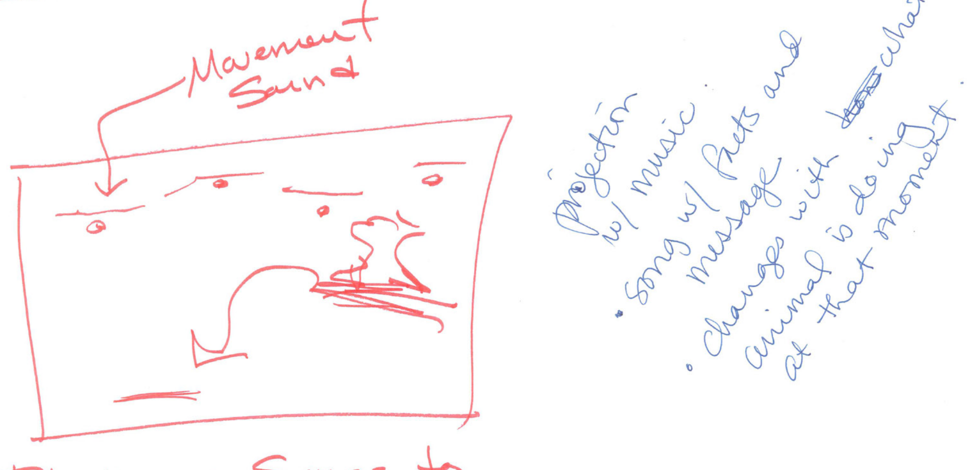
TRY TO SEPERATE OUT THE SOUNDS.

- HORSE WHINNY.
- HIPPO SNORT.

COMPARE & CONTRAST SETTINGS

OCEAN ENVIRONMENT VS RAINFOREST.



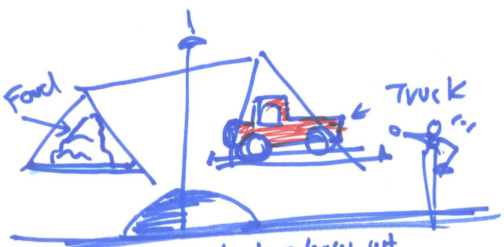


Rhythmic Songs to remember information or animal actions.

- Play game or puzzle against an animal
- Figure out how to engage an activity inside the exhibit
- Choose your own adventure
  - Animals interact with you along the adventure
    ↳ CHOICES

LOGICAL!

- Spatial Diagram combined eating stats to calculate end result of what they per day.
  - Eat 10lbs a day
  - 1 truck holds 1000 lbs
  - -5 Elephants
  - - how often does food them
  - Number relationships



- scale to show wt. comparisons
- Environment terrain determines migration pattern/ skills to survive/ adapt.
- Dot plan showing groupings, migration patterns, diff colors showing over lapness (prey/predator) or Wolf packs
- Depletion Rates

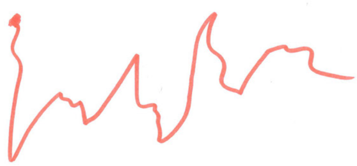
ENVIRONMENT
- CHANGES
- INTERACTS

↳ ADVENTURE

CHALLENGED TO FIND YOUR WAY

— Spatial

- Graphs based on animal sounds/pitch



- Picture Diagram showing how much they eat (Elephants) + tying into Logical

- ~~Interactive w/ music~~
  Interact a lot w/ logical ideas
  - Dot plans show extinction rate

Kinesthetic

MIMIC THE ANIMAL

- special views after them. you mimic

climbing

jumping

eating

running

fighting

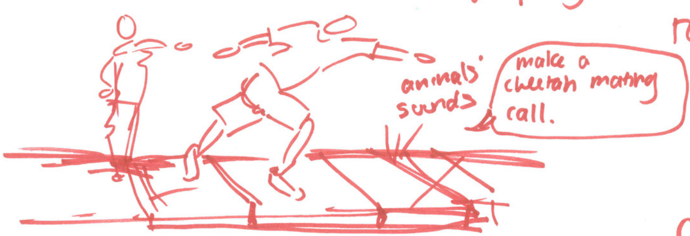
dressing up

imaginative

- cause & effect
your movements cause action inside the exhibit.

KINESTHETIC!

- make animal sounds by jumping on noise maker - use guide to form animals communication



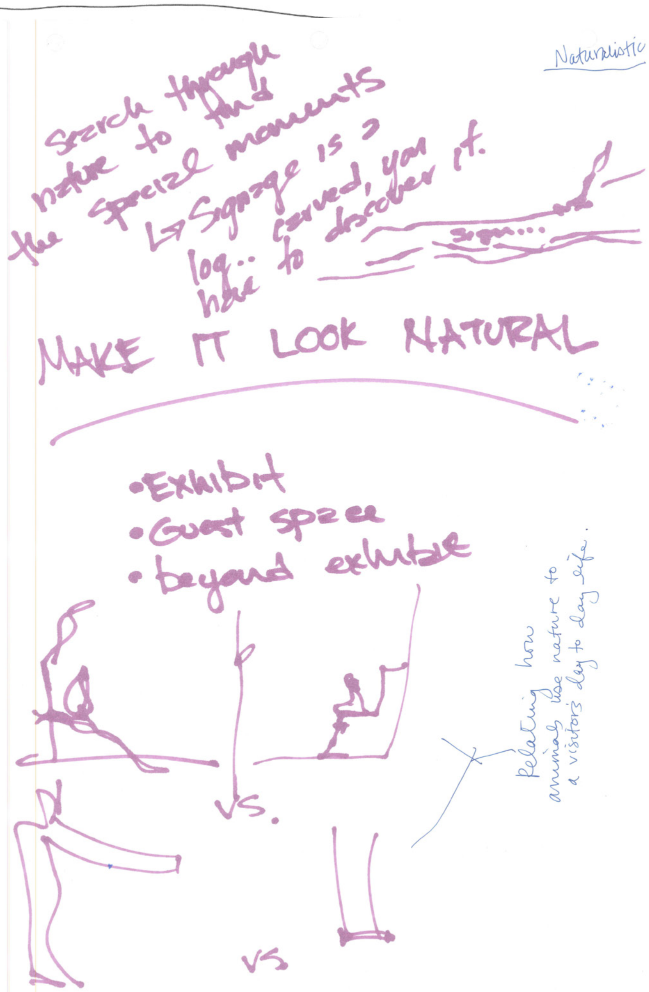
(see other Boards

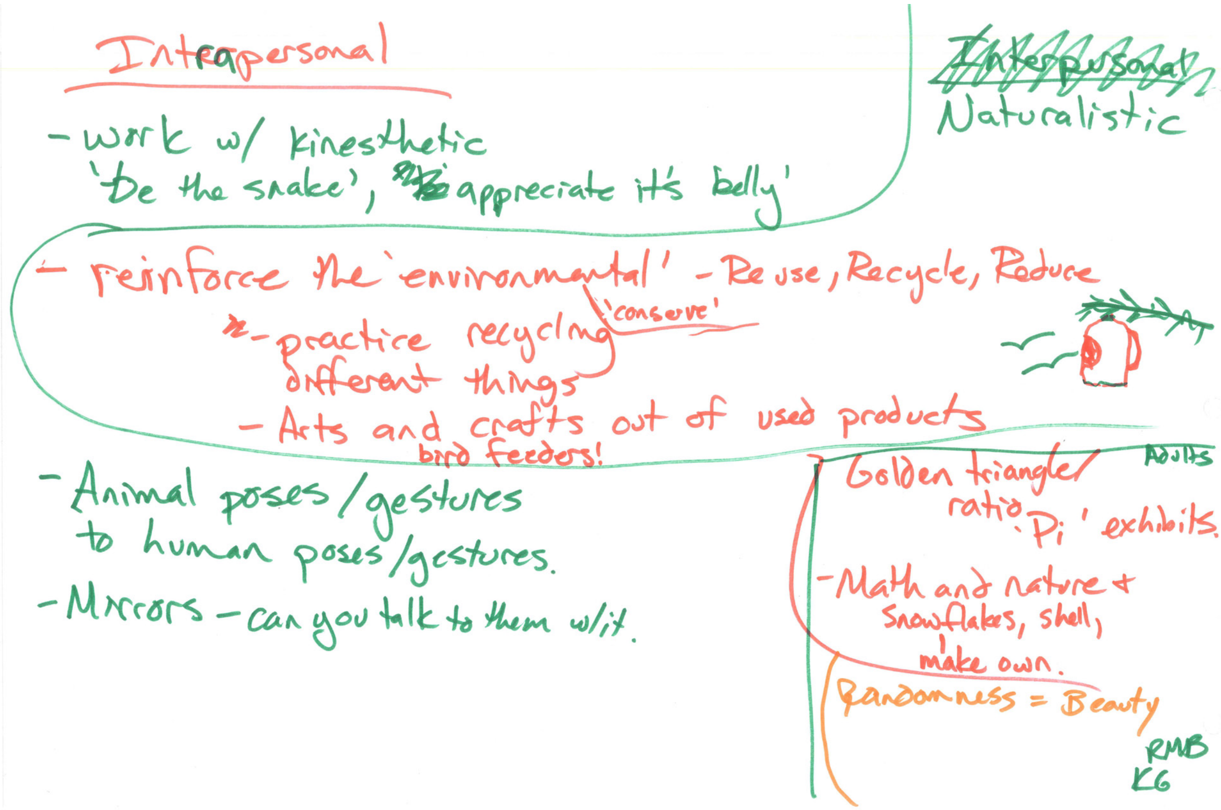
- imitate animal poses & gestures - how are they similar to you?
- what does it mean?

KG RMB

Kinesthetic

Naturalistic





Intrapersonal

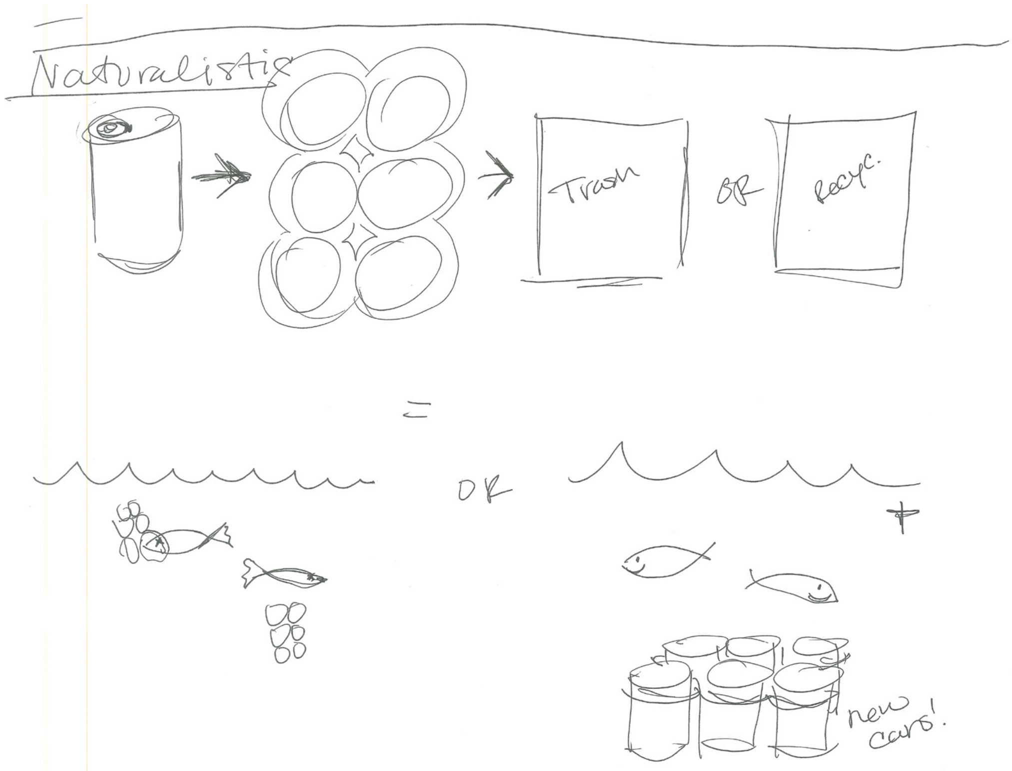
- work w/ kinesthetic
  'be the snake', appreciate it's belly'
- reinforce the 'environmental' - Re use, Recycle, Reduce
  - practice recycling 'conserve'
    different things
  - Arts and crafts out of used products
    bird feeders!
- Animal poses/gestures
  to human poses/gestures.
- Mirrors - can you talk to them w/it.

~~Interpersonal~~
Naturalistic

- Golden triangle/ ratio 'Pi' exhibits. Adults
- Math and nature + Snowflakes, shell, make own.

Randomness = Beauty

RMB
KG



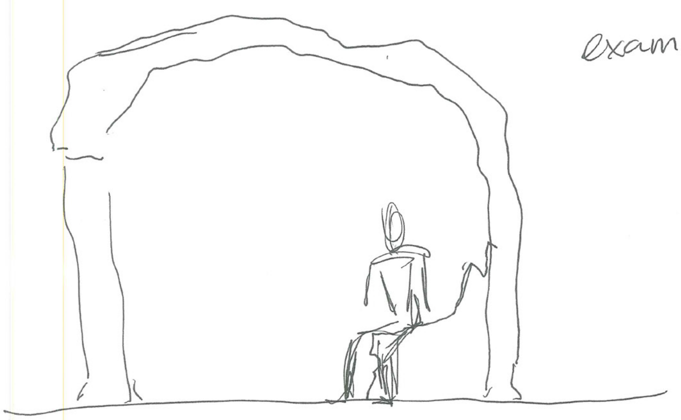
Intimate encounters
• one on one with
environment.

Be the
animal, not just
mimic the animal.
→ understanding
life strategies.
↓
problems and
problem solving.

Understand the problems
they encounter and help
them solve them.

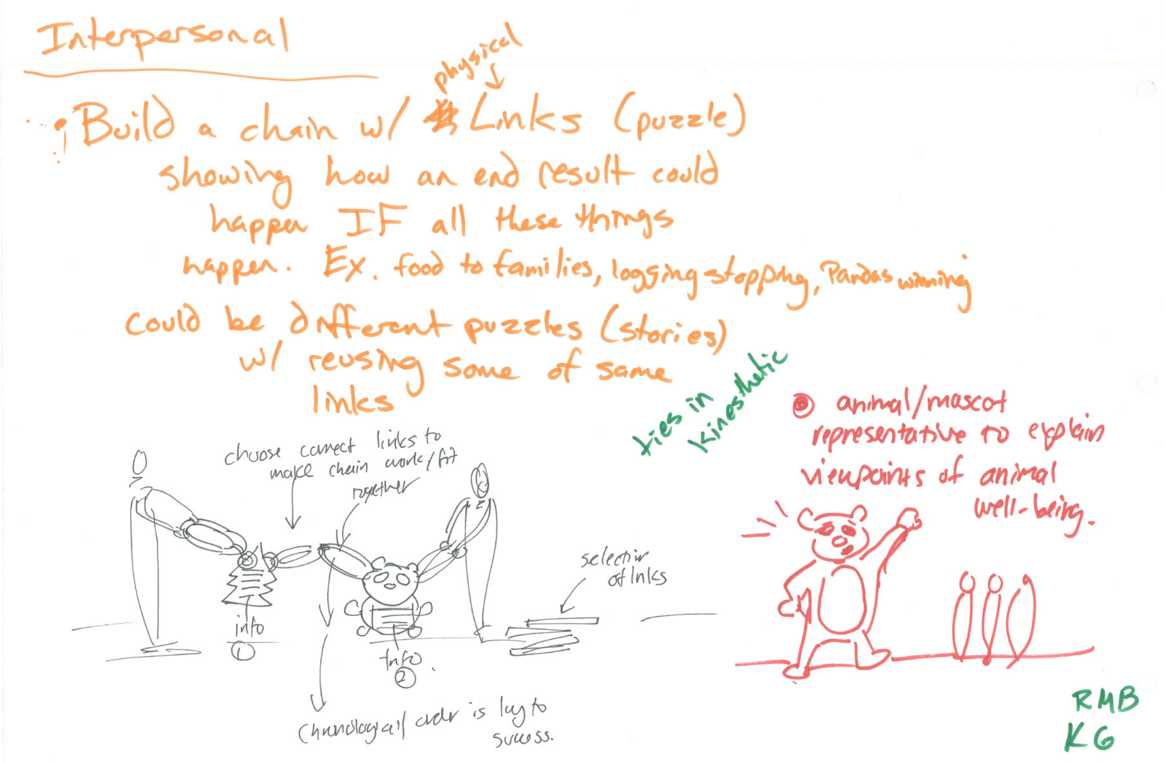
- Small encounter
w/ animal =
connection

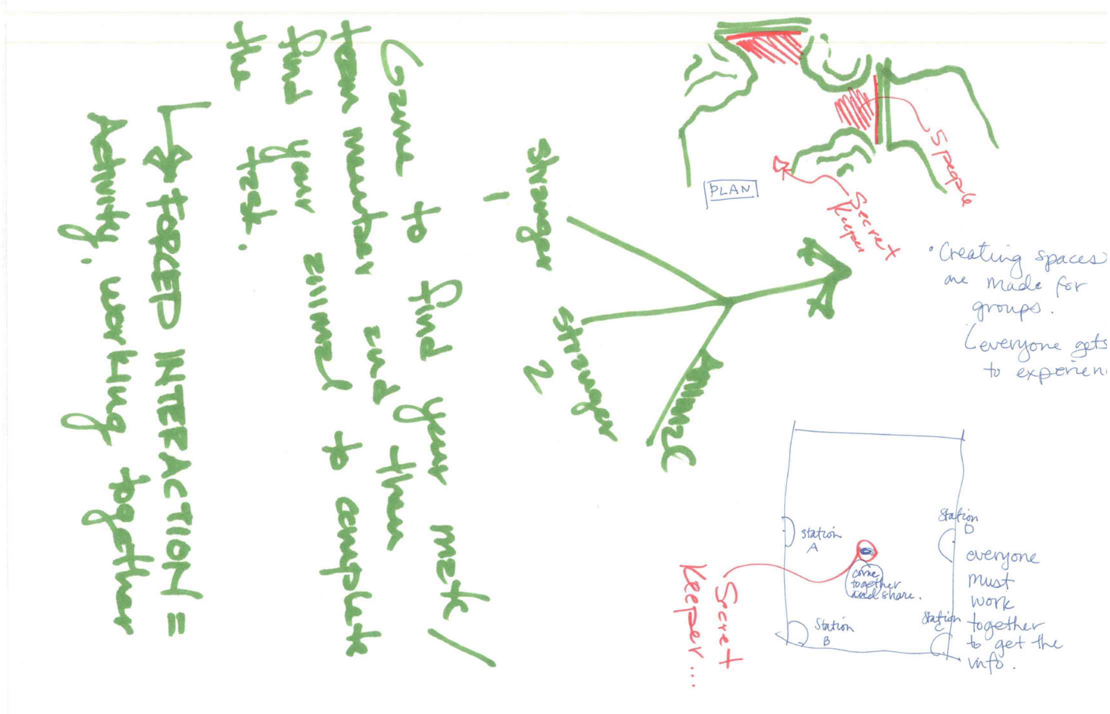
• reflection Zone



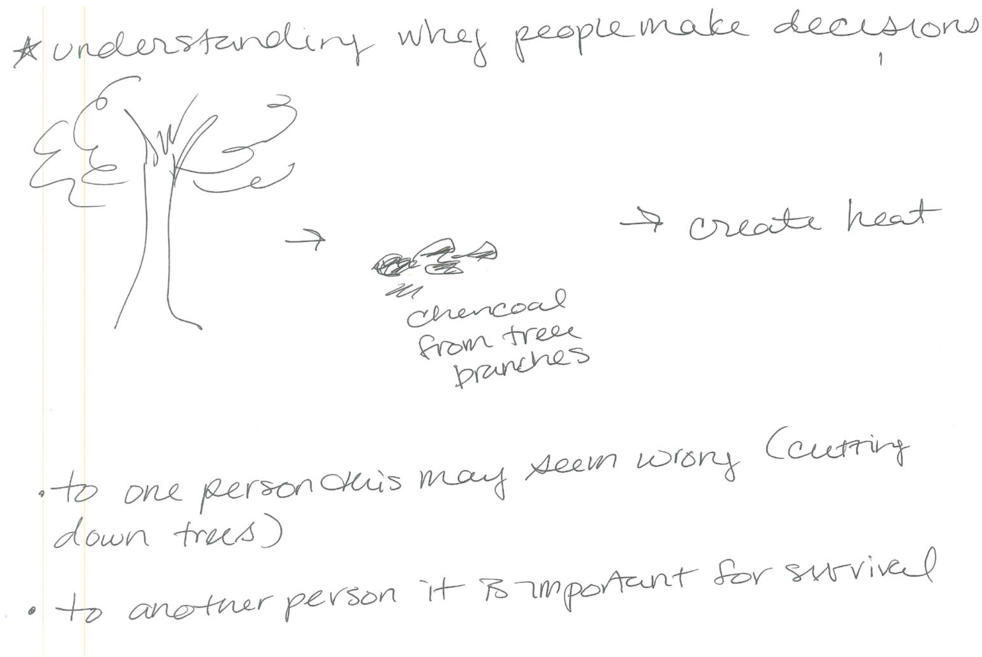
example: Cave → visitor
can sit and reflect.
experience a bears
habitat. see what
a bear sees, feel what
a bear feels.

• small space,
large enough for one
person to sit & think
alone.

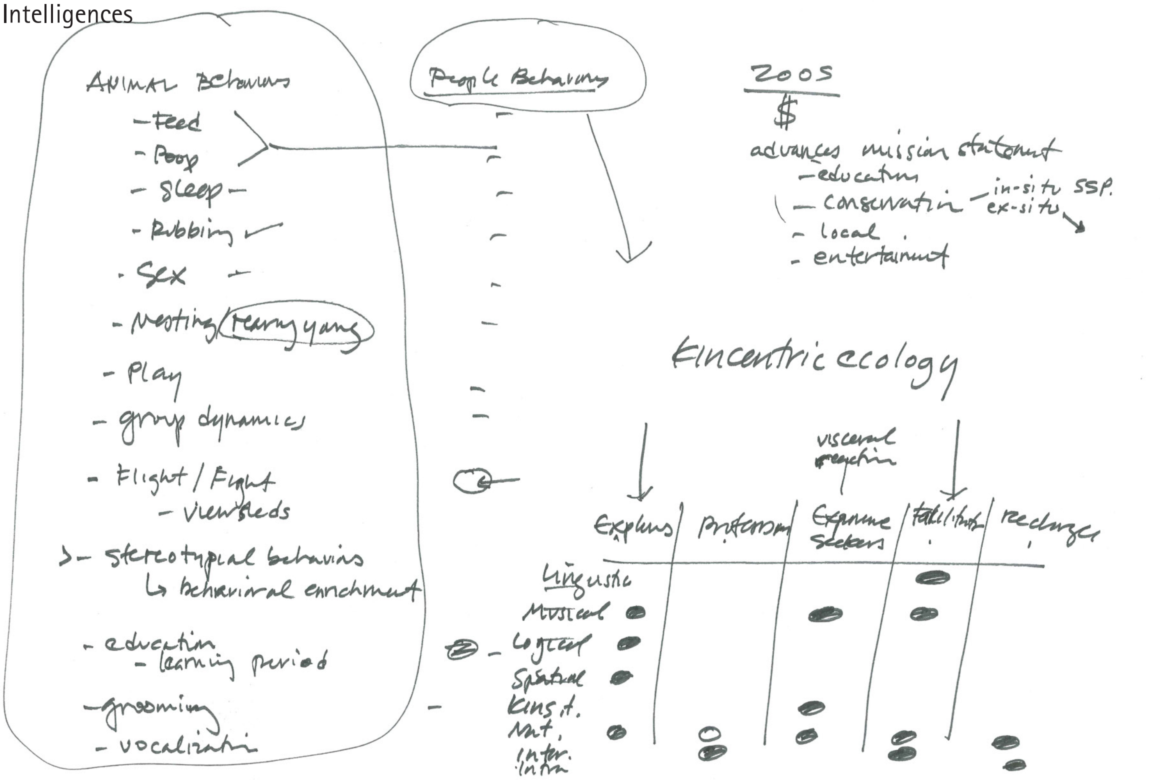

Interpersonal
Build a chain w/ physical Links (puzzle)
showing how an end result could happen IF all these things happen. Ex. food to families, logging stopping, Pandas winning
could be different puzzles (stories) w/ reusing some of same links
ties in kinesthetic
animal/mascot representative to explain viewpoints of animal well-being.
choose correct links to make chain work/fit together
selection of links
info 1
info 2
chronological order is key to success.
RMB
K6

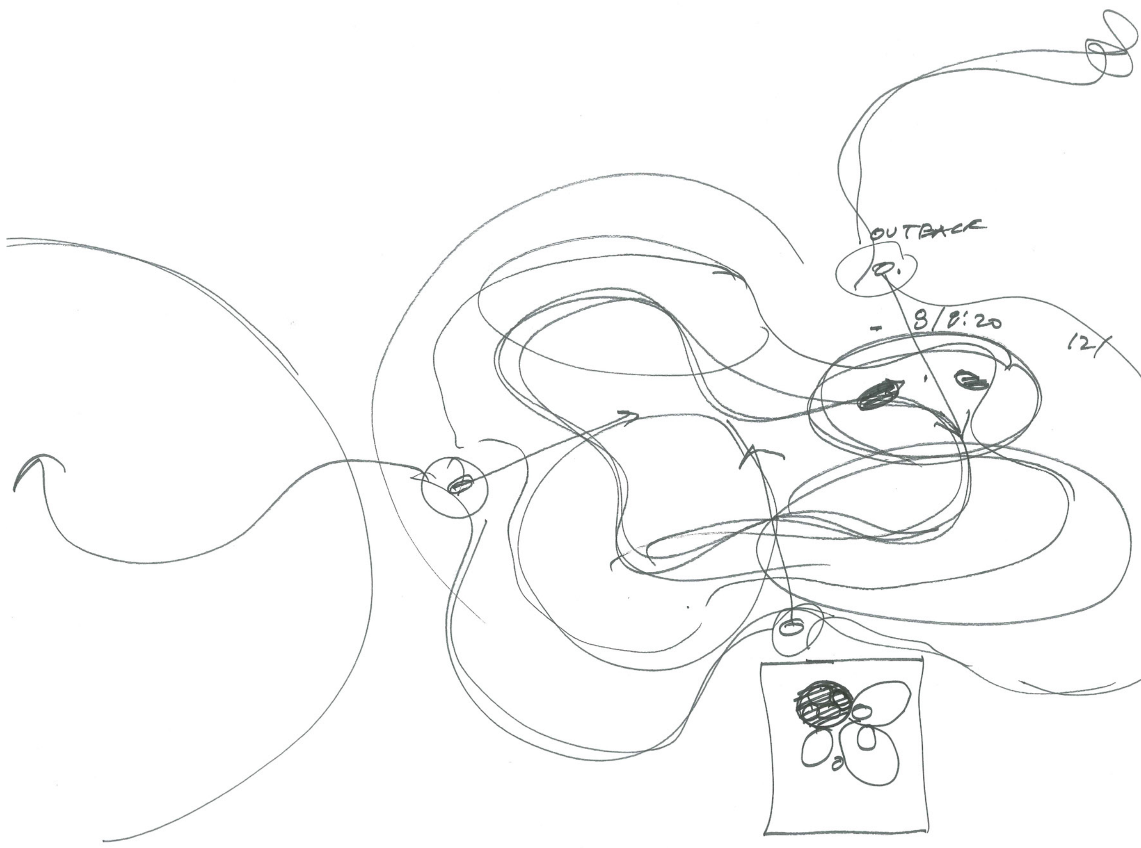

Stranger 1
Stranger 2
FORCED INTERACTION =
Activity, working together
PLAN
5 people
Secret Keeper
Creating spaces are made for groups.
Everyone gets to experien
Station A
Station B
Station C
Station D
come together and share.
everyone must work together to get the info.
Secret Keeper...

Interpersonal



All Intelligences




OUTBACK
8/8:20
12/

Interaction 5.0 – Structured Design Charrette
Otter exhibit

Topic

Conservation techniques to conserve recycle, reduce, reuse to help save our oceans/water system → recovery from the Gulf disaster

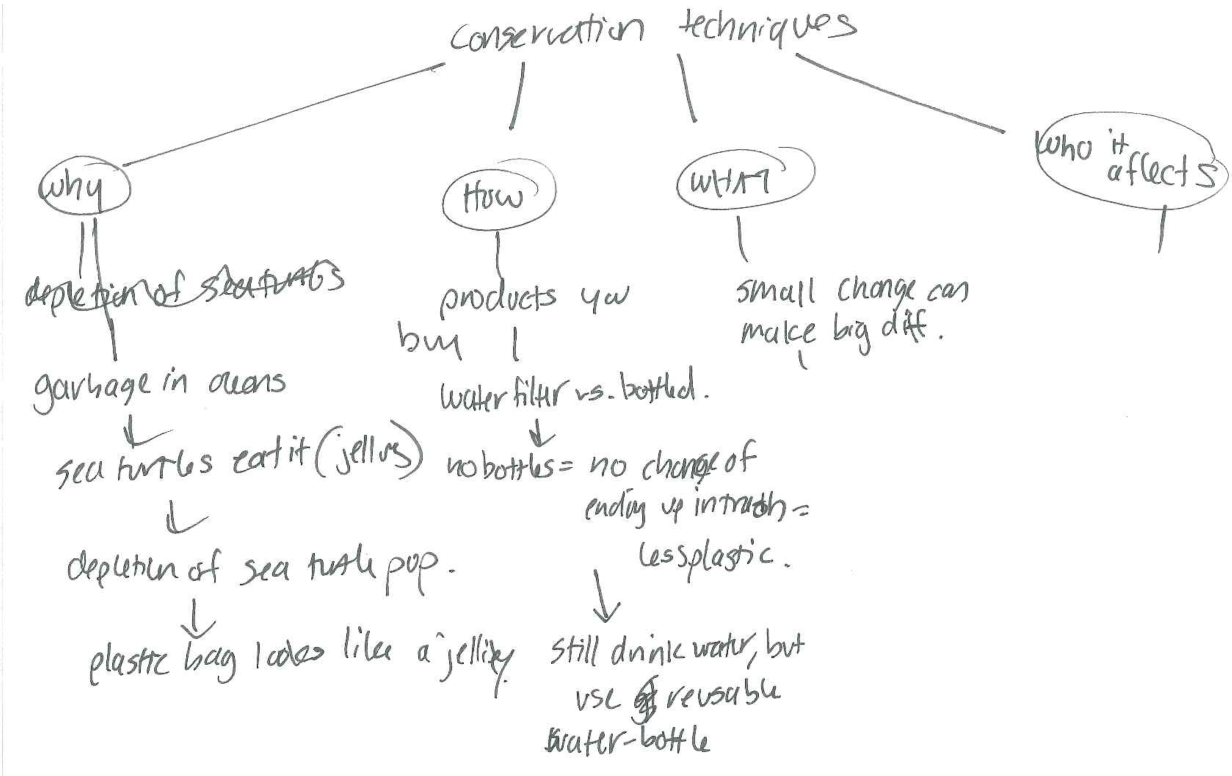
Goals

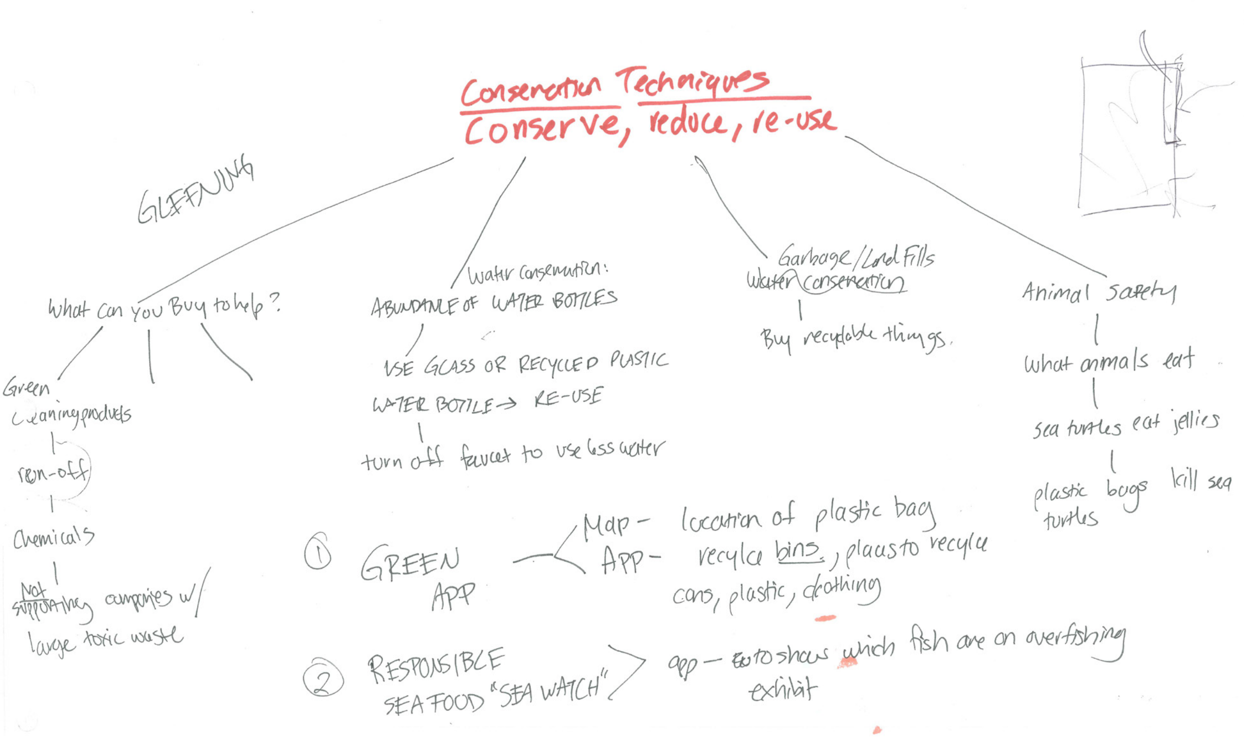
- create awareness of individual's daily actions
- ~~create~~ instill a desire to make small changes in activity (~~recycle more~~ learn what you can recycle) – use glass, not plastic, reduce waste, rely more on public transportation.
- understand that your old toothbrush may end up in a river or ocean → look to buy recycled materials. → or stuff that can decompose

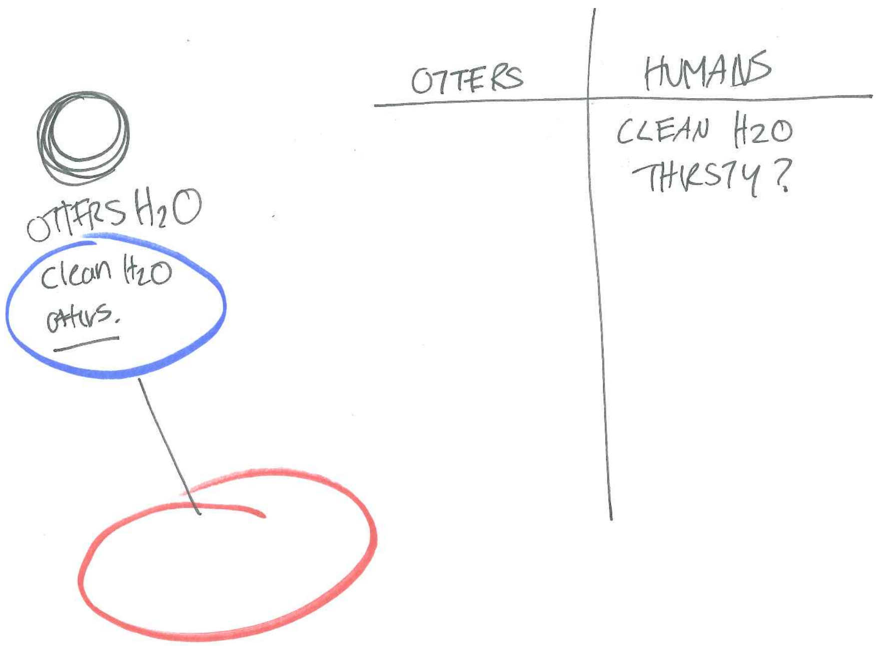
"Do you buy bottled water?" where do those bottles end up?

- understand how your actions can generate a series of events that may contribute to the Environmental issue.

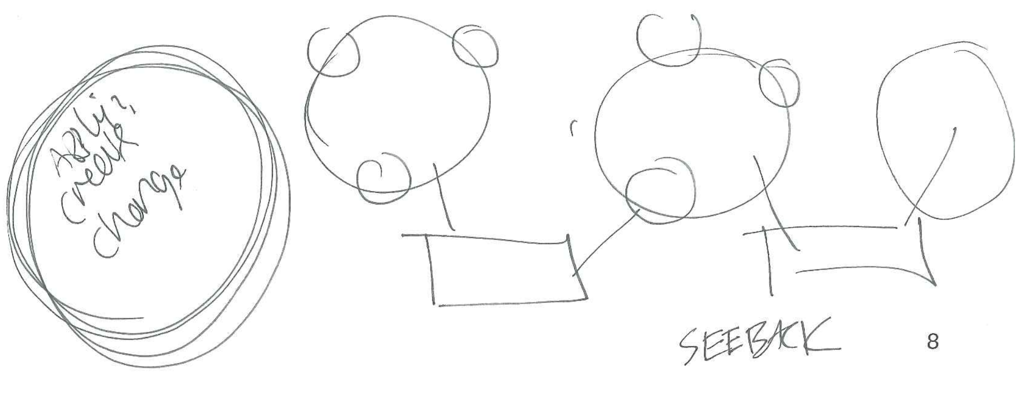
Concept Hierarchy Diagram



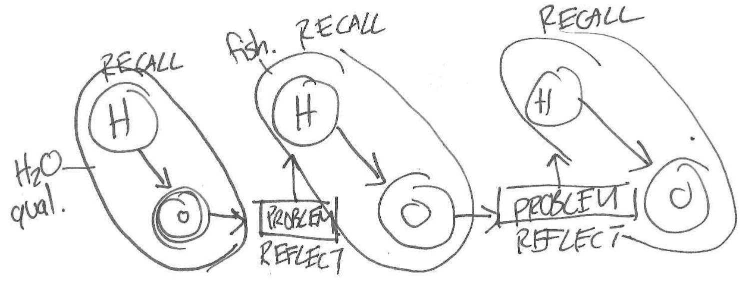




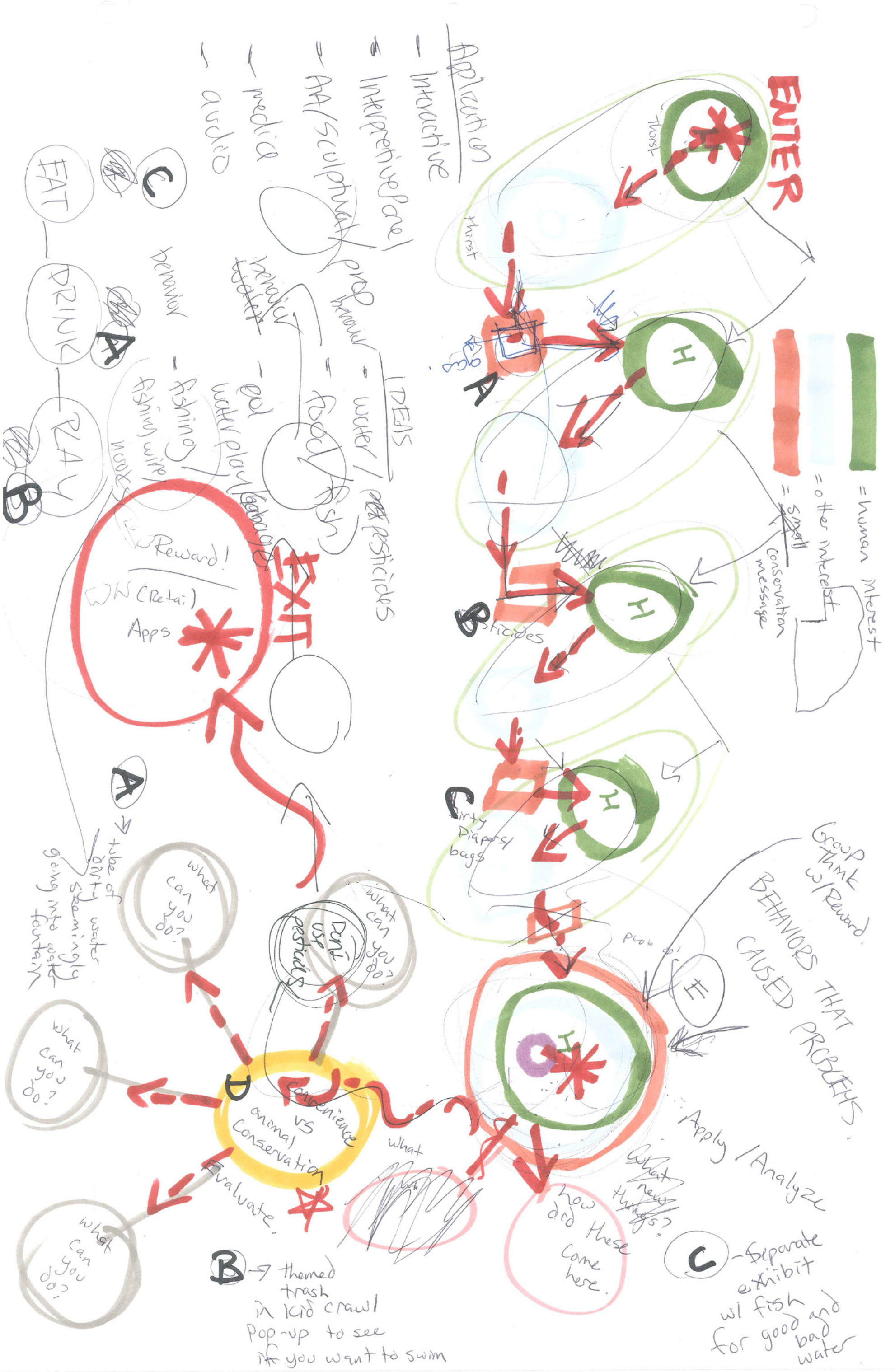
How is the learning strategy following learning and cognitive process theories?



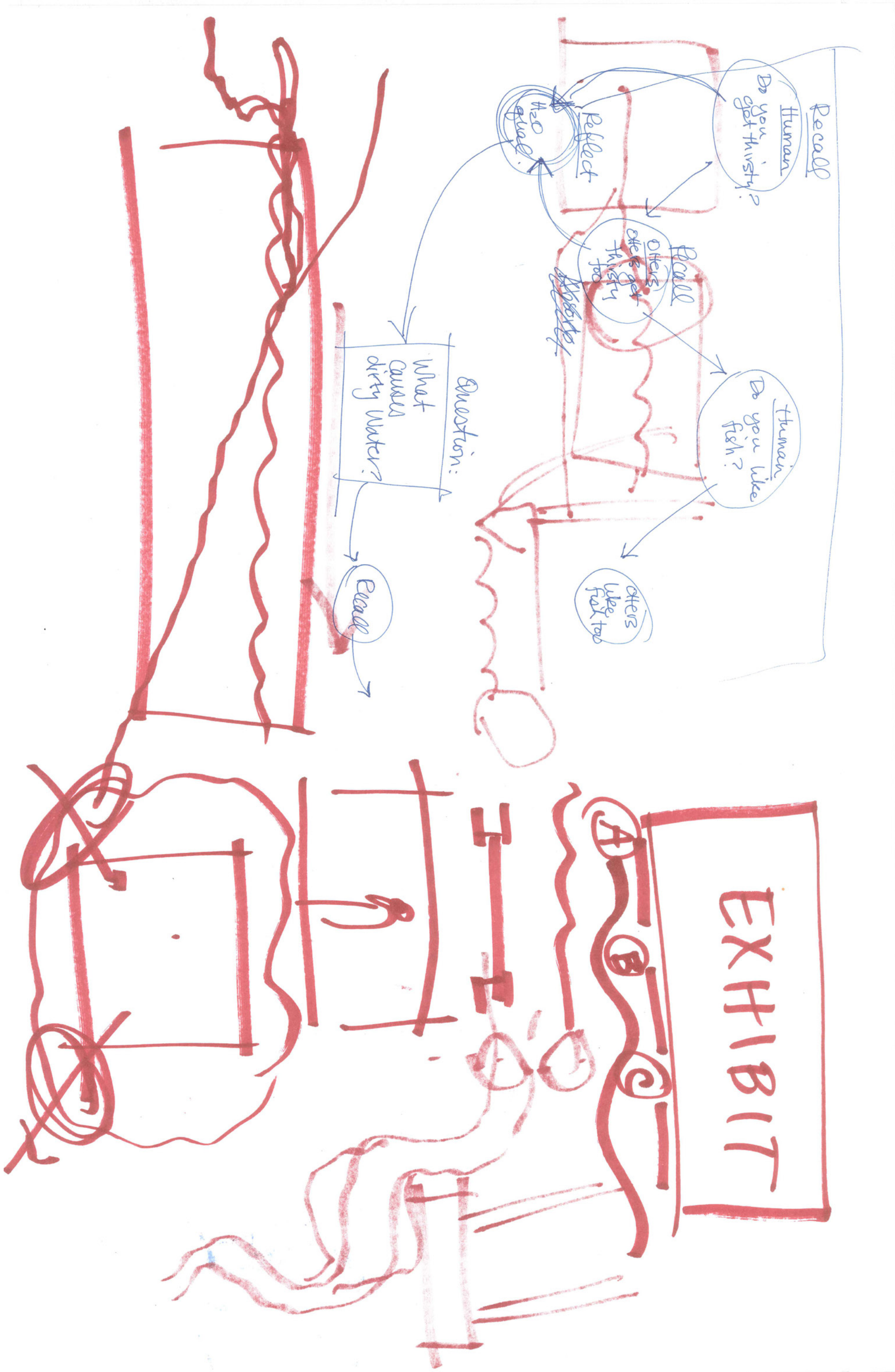
8



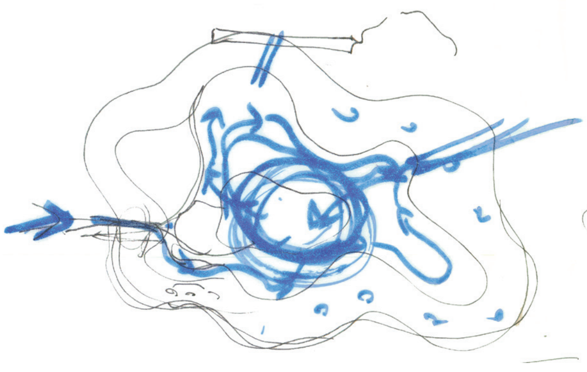
Cognitive Process Diagram

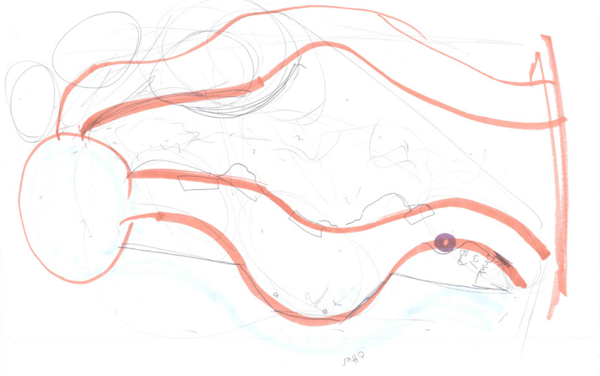


Process Sketch

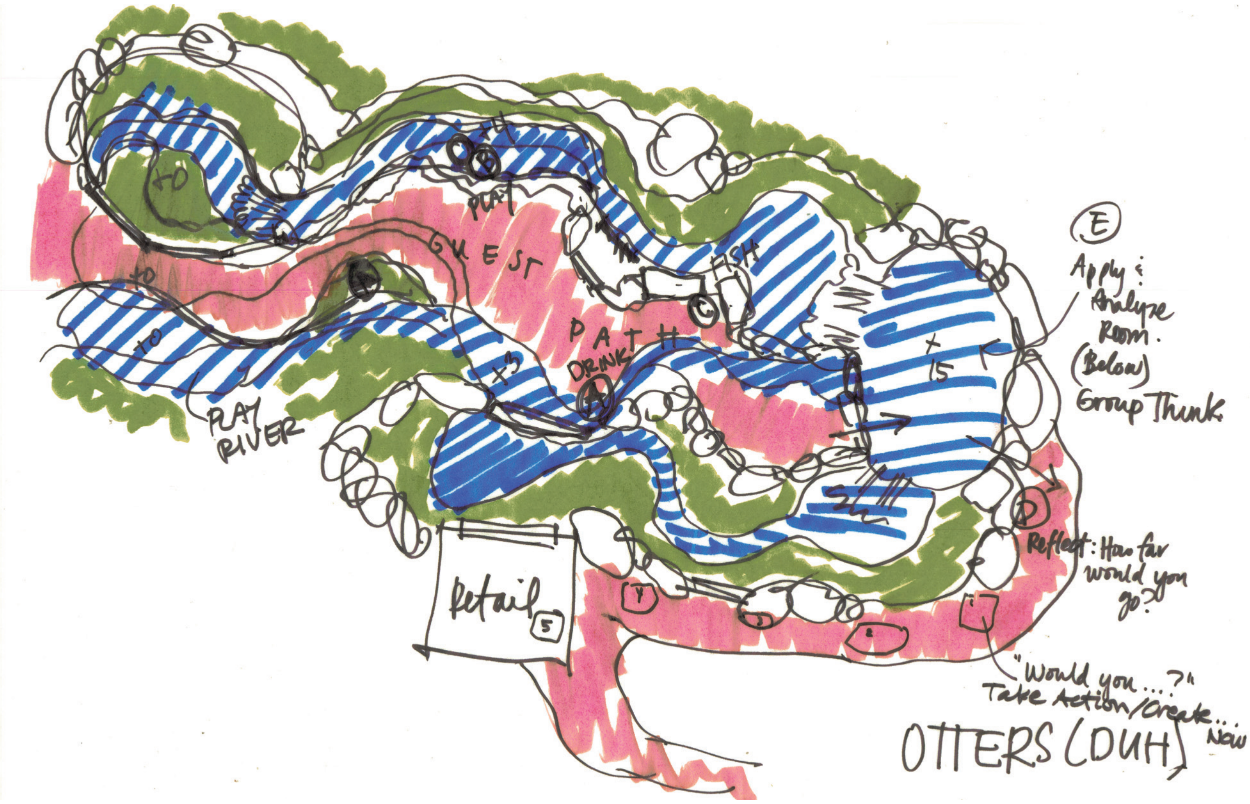


Process Sketch

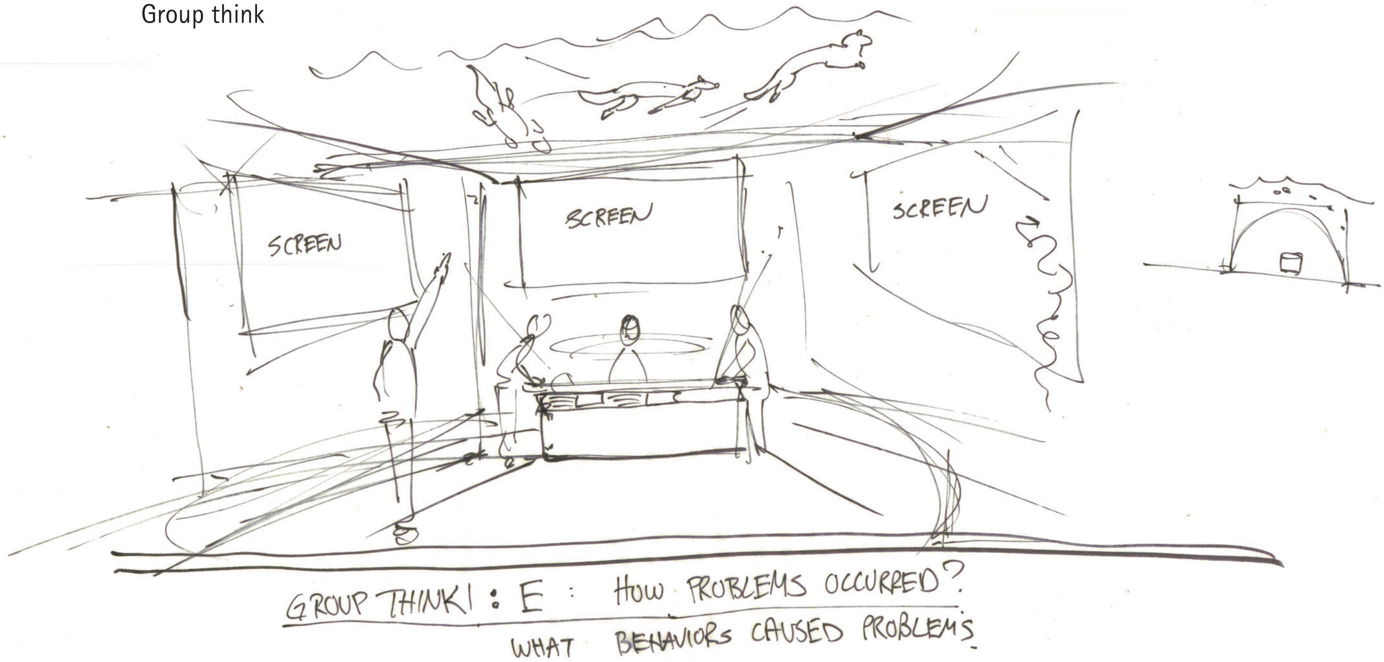




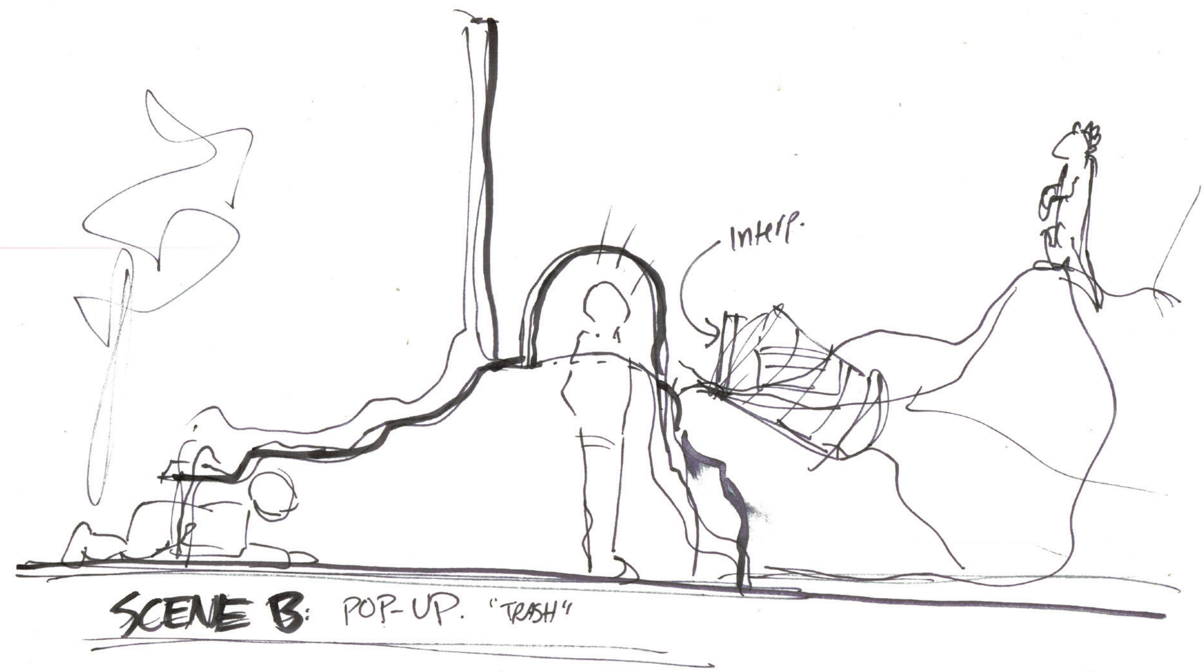
Plan



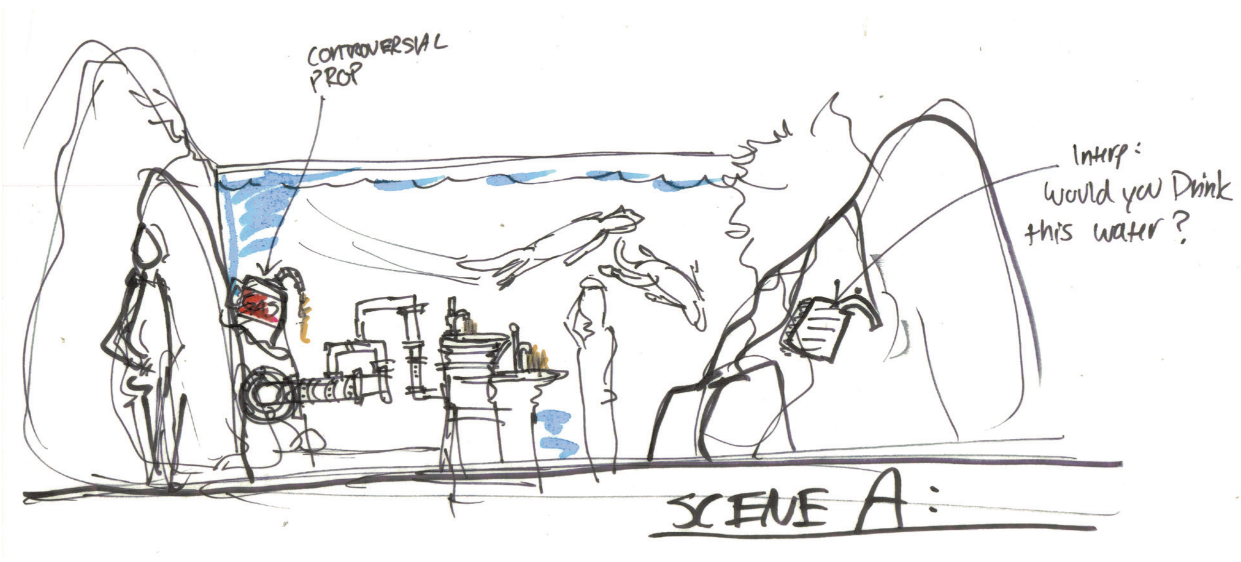
Group think



Section



Section



Polar bear exhibit

Topic

Polar Bears → how our interaction w/ the environment has had an impact on polar bear habitat

Exhibit Goals

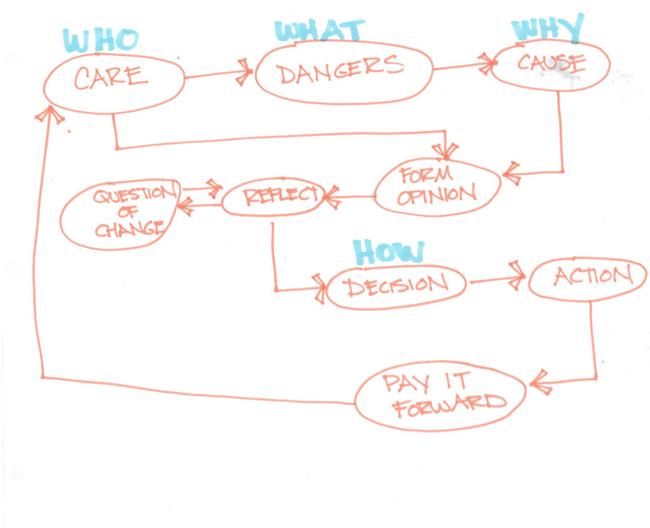
→ have visitors understand polar bear habitat
↳ what they need to survive
→ " " " in what ways polar bears are threatened (change in climate)
→ " " " what they can do to help
→ exhibit should be true to polar bear habitat & keep the polar bears mentally stimulated

---

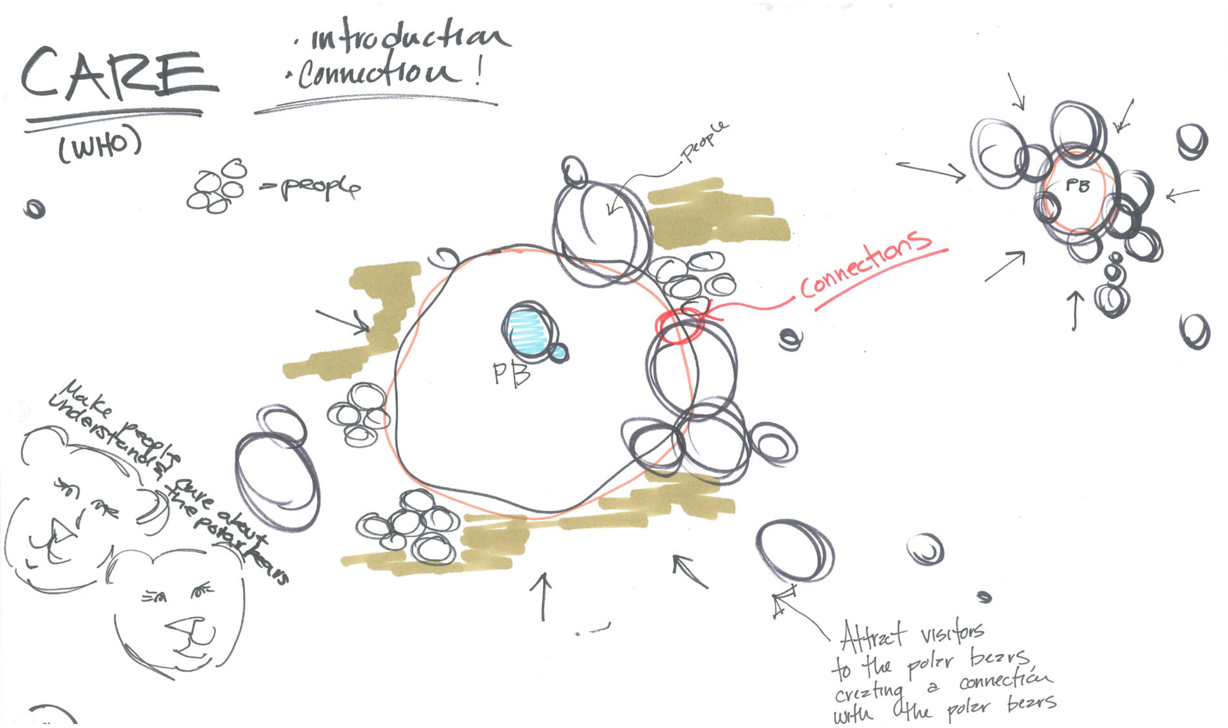
these goals can be achieved through images that will have a strong impact
↳ images of polar bears in wild
→ easy statistics

· will make people care about the well being, visitors should want to share what they have learned w/ others
(pass info around = more ppl want to help)

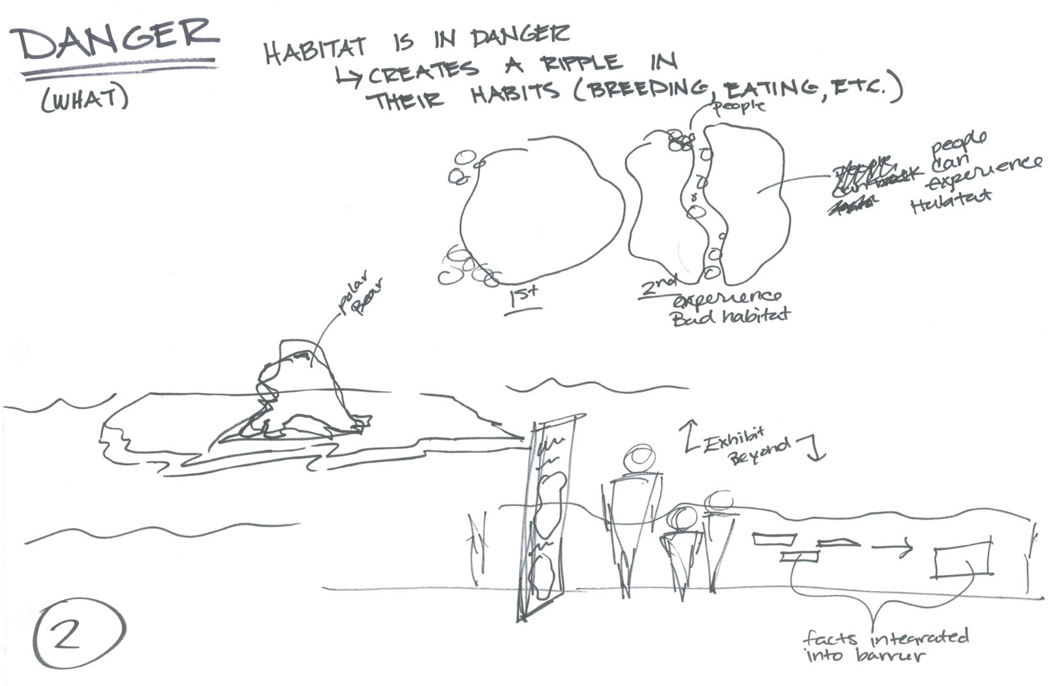
Cognitive Process Diagram



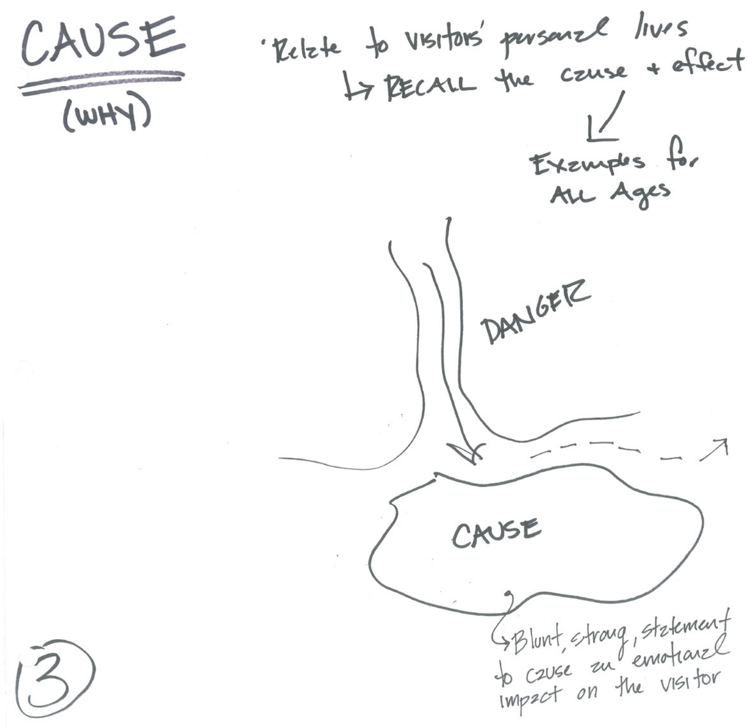
Care stage



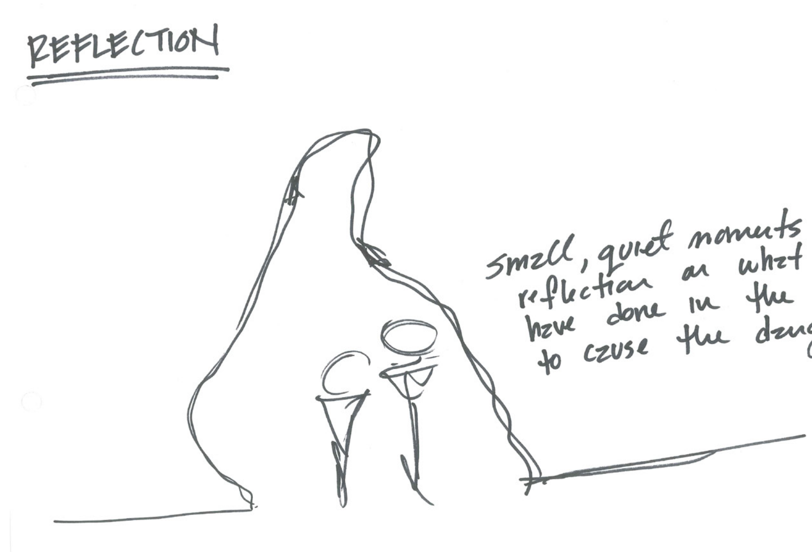
Danger stage



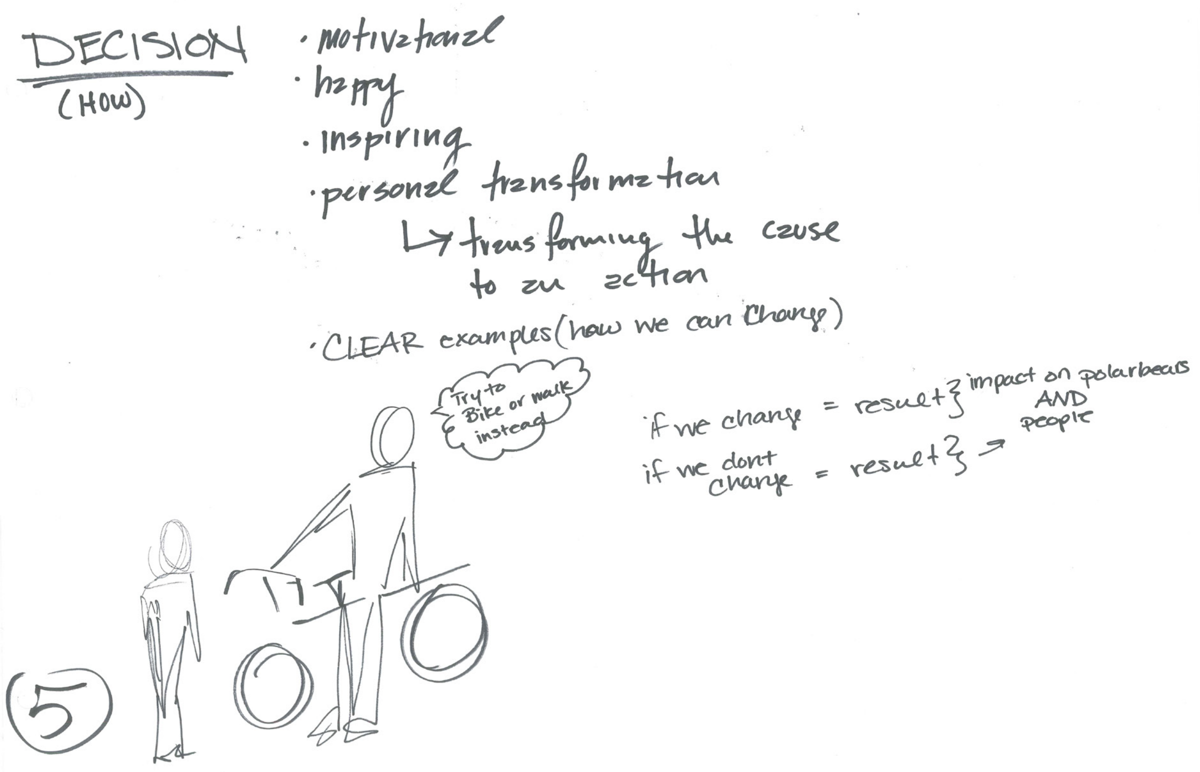
Cause stage



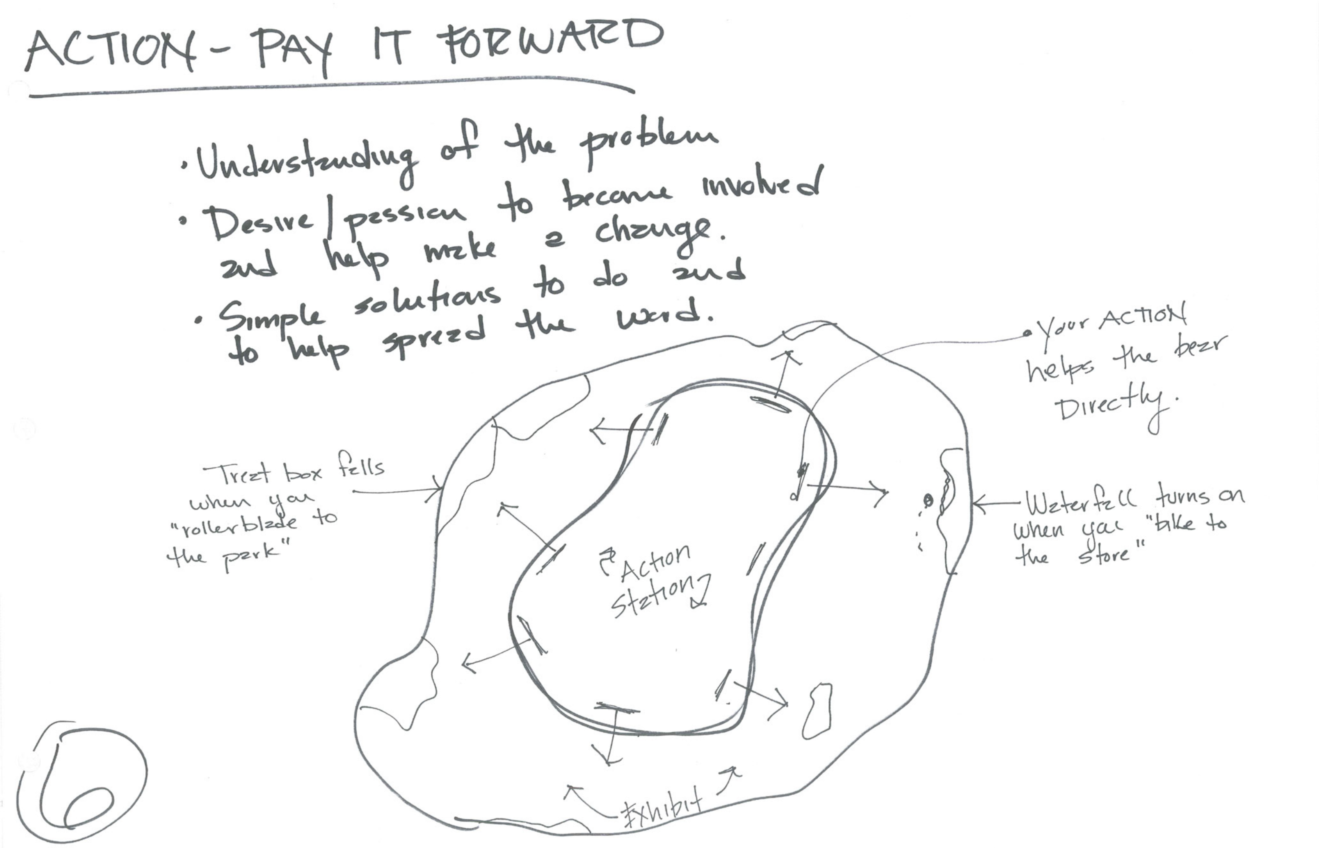
Reflection stage



Decision stage

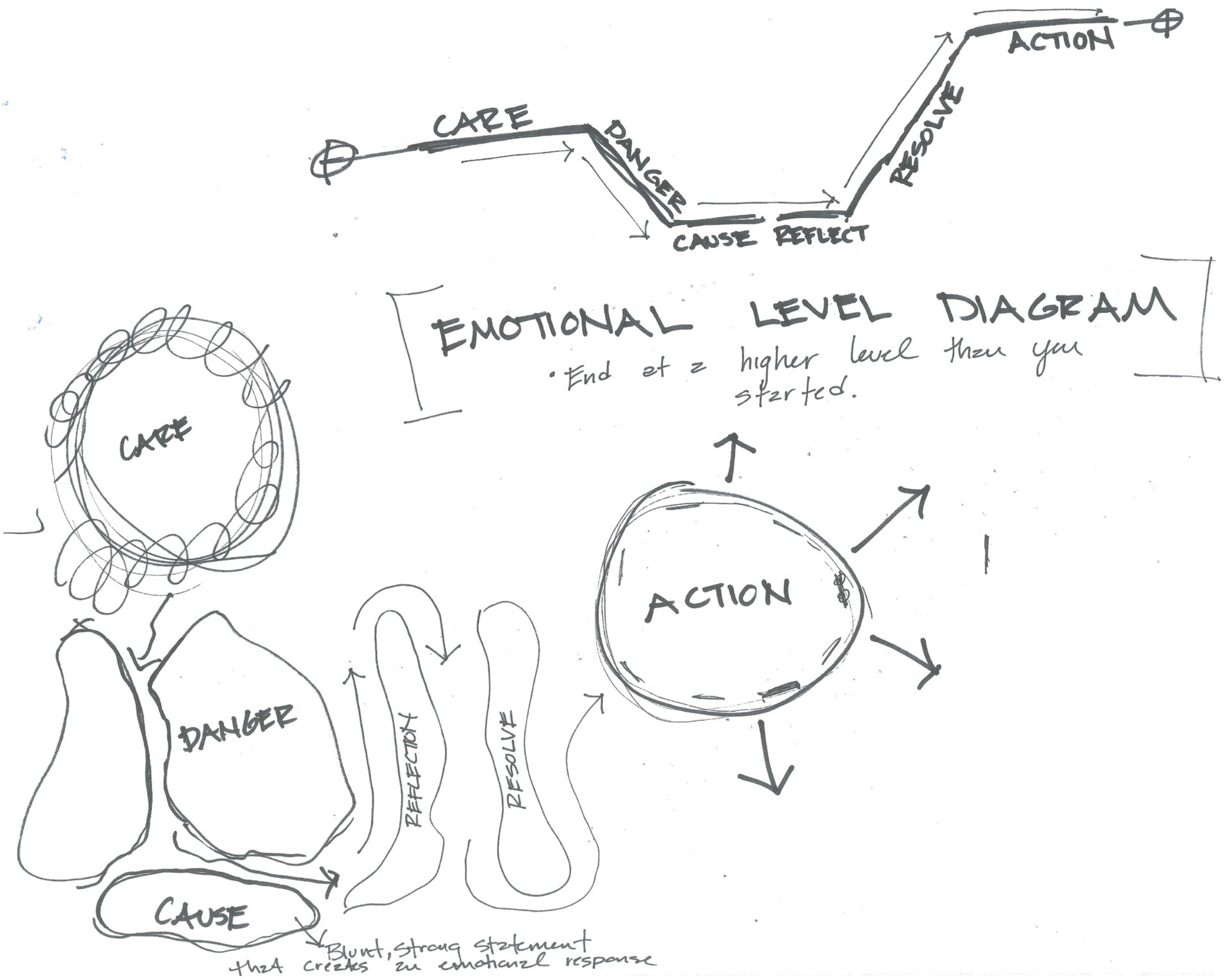


Action stage

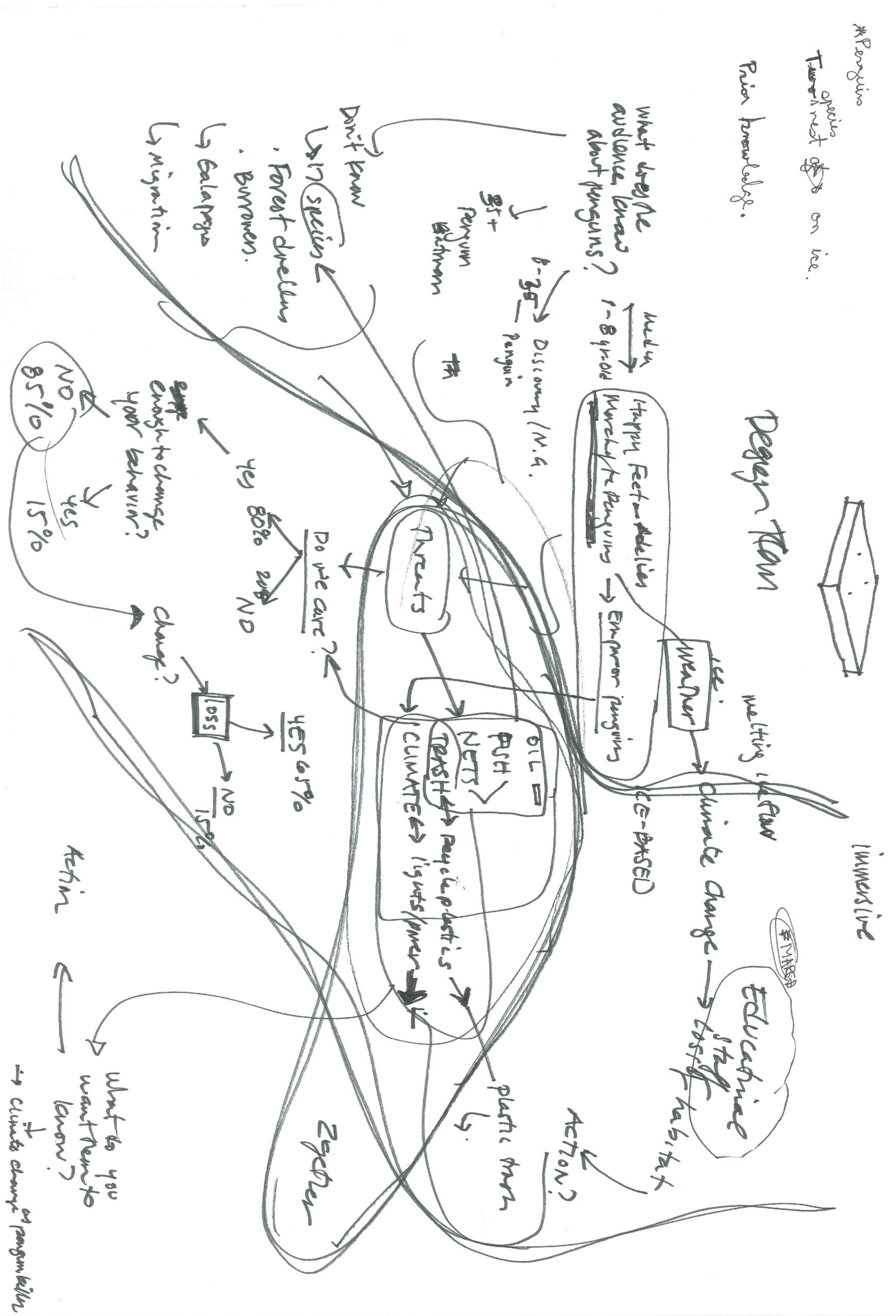


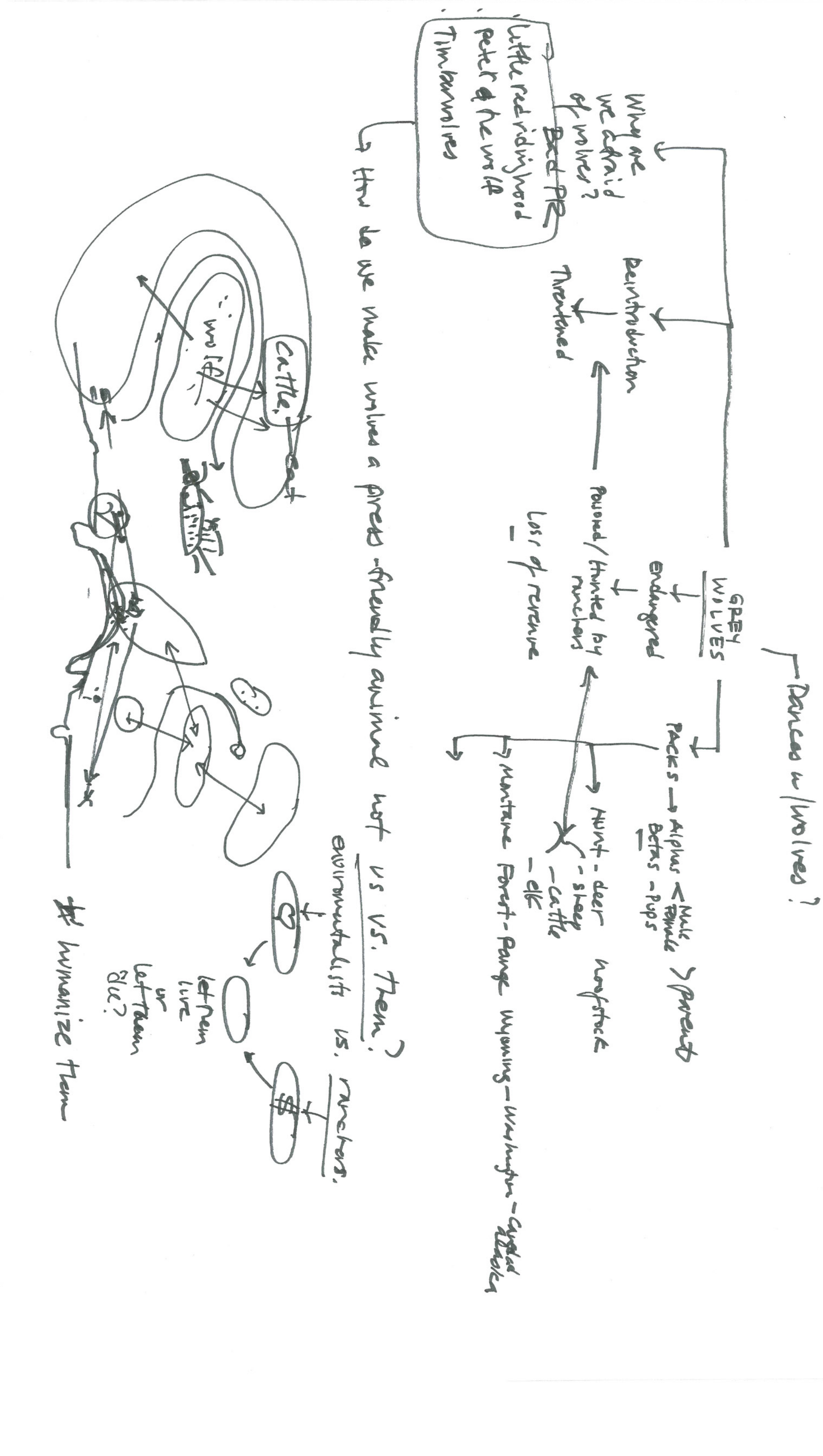
Plan

Cognitive + Emotion Diagram



Wolf exhibit




Dances w/wolves?
GREY WOLVES
Why are we afraid of wolves?
Bad PR
Little red riding hood
peter & the wolf
Timberwolves
Reintroduction
Threatened
Endangered
Poisoned/Hunted by ranchers
Loss of revenue
PACKS
Alphas
Male
Female
parents
Betas
Pups
Hunt
deer
sheep
cattle
elk
hoofstock
Montane Forest-Range
Wyoming
Washington
How do we make wolves a press-friendly animal not us vs. them?
environmentalists vs. ranchers.
let them live or let them die?
humanize them
cattle
eat
wolf

Appendix F - Survey Results

Appendix F contains the pre and post-survey results. For each survey question the average and standard deviation are compared. Also, both workshops were grouped together as one sample size.

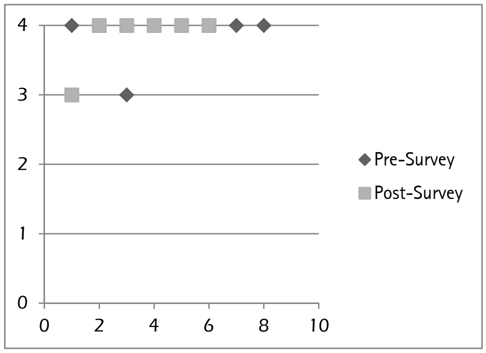
Pre-Survey	
Mean	3.88
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.35

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.04
Count Difference	2

Question 1.1 - Education

How important is each objective in the zoo exhibit design process?



	Mean	SD
Pre-survey	3.88	0.35
Post-survey	3.83	0.41

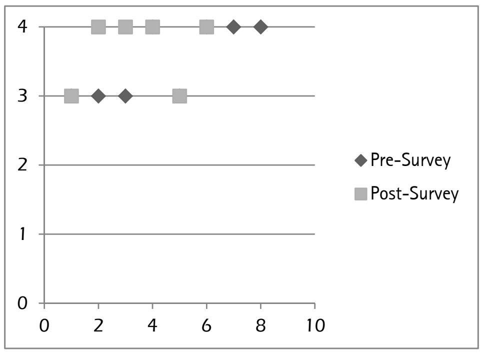
Pre-Survey	
Mean	3.50
Mode	3
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.53

Post-Survey	
Mean	3.67
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.52

Analysis	
Mean Difference	0.17
Count Difference	2

Question 1.2 - Entertainment

How important is each objective in the zoo exhibit design process?



	Mean	SD
Pre-survey	3.50	0.53
Post-survey	3.67	0.52

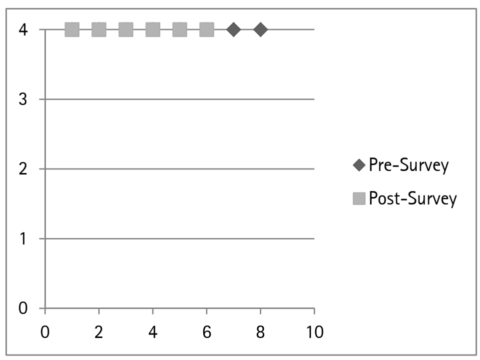
Pre-Survey	
Mean	4.00
Mode	4
Median	4
Maximum	4
Minimum	4
Count	8
SD	0.00

Post-Survey	
Mean	4.00
Mode	4
Median	4
Maximum	4
Minimum	4
Count	6
SD	0.00

Analysis	
Mean Difference	0.00
Count Difference	2

Question 1.3 - Animal Well-being

How important is each objective in the zoo exhibit design process?



	Mean	SD
Pre-survey	4.00	0.00
Post-survey	4.00	0.00

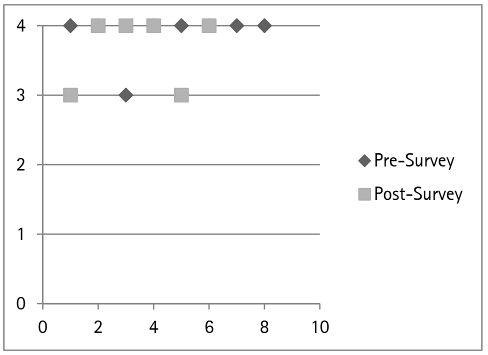
Question 1.4 - Conservation

Pre-Survey	
Mean	3.88
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.35

Post-Survey	
Mean	3.67
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.52

Analysis	
Mean Difference	0.21
Count Difference	2

How important is each objective in the zoo exhibit design process?



	Mean	SD
Pre-survey	3.88	0.35
Post-survey	3.67	0.52

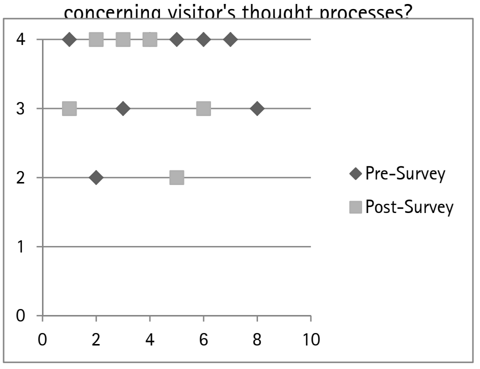
Question 2.1 - Zoo Mission

Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.33
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.82

Analysis	
Mean Difference	0.17
Count Difference	2

To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitor's thought processes?



	Mean	SD
Pre-survey	3.50	0.76
Post-survey	3.33	0.82

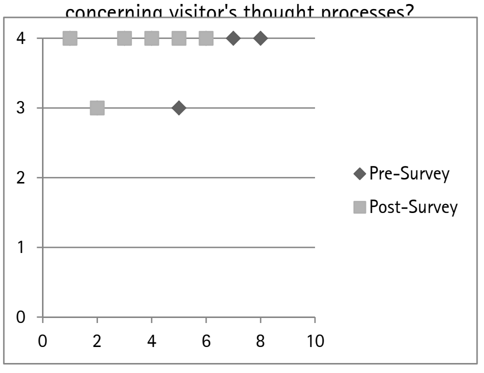
Question 2.2 - Zoo exhibit proposed objectives

Pre-Survey	
Mean	3.75
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.46

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.08
Count Difference	2

To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitor's thought processes?



	Mean	SD
Pre-survey	3.75	0.46
Post-survey	3.83	0.41

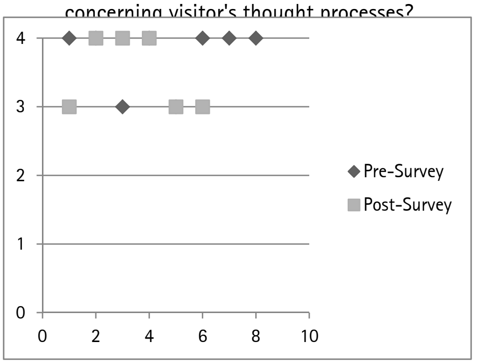
Pre-Survey	
Mean	3.75
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.46

Post-Survey	
Mean	3.50
Mode	3
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.55

Analysis	
Mean Difference	0.25
Count Difference	2

Question 2.3 - Zoo exhibit proposed message

To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitor's thought processes?



	Mean	SD
Pre-survey	3.75	0.46
Post-survey	3.50	0.55

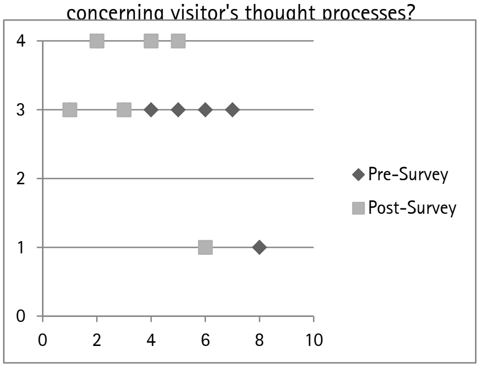
Pre-Survey	
Mean	2.88
Mode	3
Median	3
Maximum	4
Minimum	1
Count	8
SD	0.83

Post-Survey	
Mean	3.17
Mode	4
Median	4
Maximum	4
Minimum	1
Count	6
SD	1.17

Analysis	
Mean Difference	0.29
Count Difference	2

Question 2.4 - Personal design goals for the zoo exhibit

To what degree does each of the following zoo exhibit design goals guide design decisions concerning visitor's thought processes?



	Mean	SD
Pre-survey	2.88	0.83
Post-survey	3.17	1.17

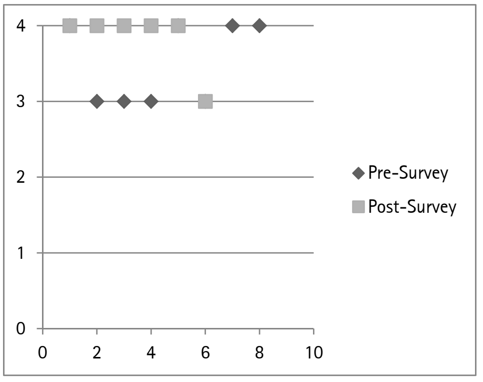
Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.53

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.33
Count Difference	2

Question 3

Visitors learn from zoo exhibit designs.



	Mean	SD
Pre-survey	3.50	0.53
Post-survey	3.83	0.41

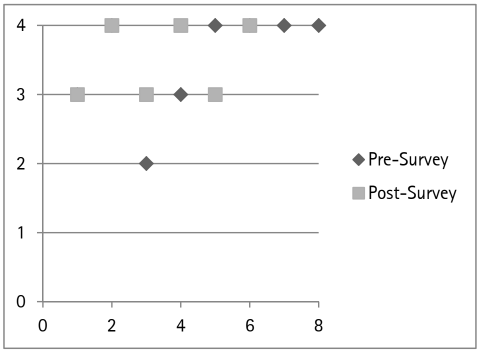
Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.50
Mode	3
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.55

Analysis	
Mean Difference	0.00
Count Difference	2

Question 4

Zoo exhibits encourage visitor learning.



	Mean	SD
Pre-survey	3.50	0.76
Post-survey	3.50	0.55

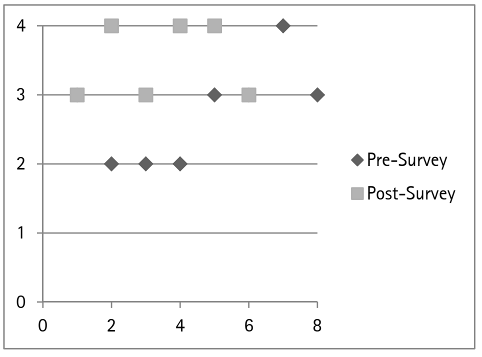
Pre-Survey	
Mean	2.75
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.71

Post-Survey	
Mean	3.50
Mode	3
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.55

Analysis	
Mean Difference	0.75
Count Difference	2

Question 5

Zoo exhibits facilitate visitor's learning by encouraging their thought processes.



	Mean	SD
Pre-survey	2.75	0.71
Post-survey	3.50	0.55

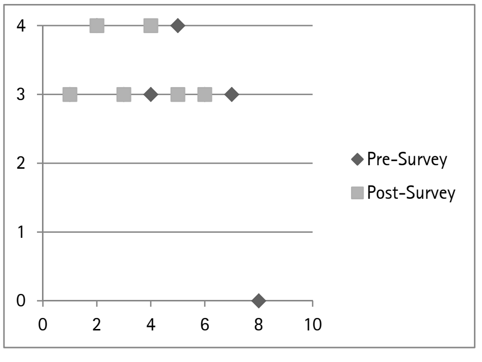
Pre-Survey	
Mean	3.29
Mode	3
Median	3
Maximum	4
Minimum	3
Count	7
SD	1.25

Post-Survey	
Mean	3.33
Mode	3
Median	3
Maximum	4
Minimum	3
Count	6
SD	0.52

Analysis	
Mean Difference	0.05
Count Difference	1

Question 5

Zoo exhibit designs facilitate visitor's motivation for learning.



	Mean	SD
Pre-survey	3.29	1.25
Post-survey	3.33	0.52

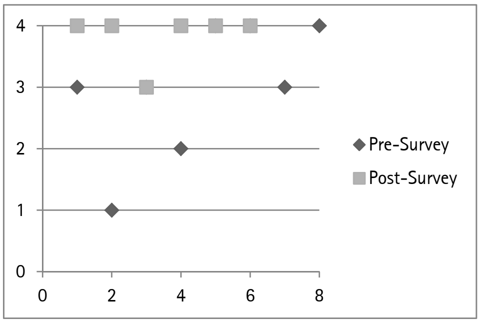
Pre-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	1
Count	8
SD	1.07

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.83
Count Difference	2

Question 7

Zoo exhibits guide visitor's learning by directing their attention to the most important learning



	Mean	SD
Pre-survey	3.00	1.07
Post-survey	3.83	0.41

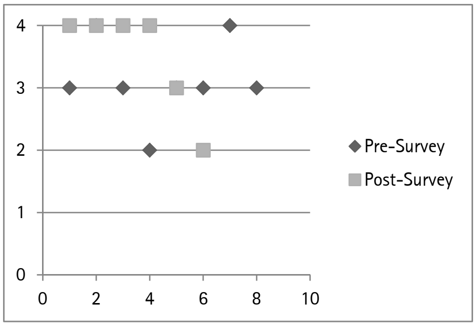
Pre-Survey	
Mean	3.13
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.64

Post-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.84

Analysis	
Mean Difference	0.38
Count Difference	2

Question 7

Zoo exhibits prompt visitors to recall prior knowledge.



	Mean	SD
Pre-survey	3.13	0.64
Post-survey	3.50	0.84

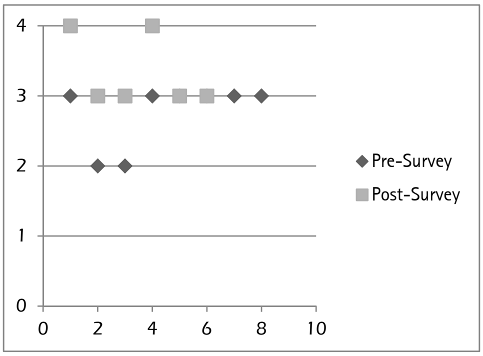
Pre-Survey	
Mean	2.75
Mode	3
Median	3
Maximum	3
Minimum	2
Count	8
SD	0.46

Post-Survey	
Mean	3.33
Mode	3
Median	3
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.58
Count Difference	2

Question 9

Zoo exhibits engage visitors in the most important learning content.



	Mean	SD
Pre-survey	2.75	0.46
Post-survey	3.33	0.41

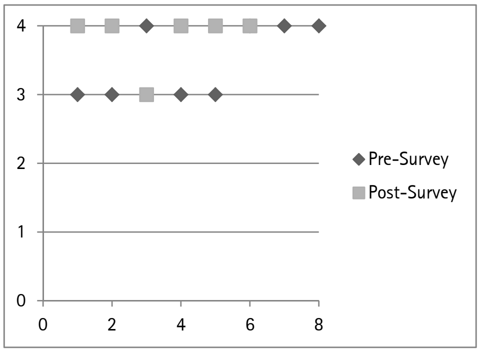
Pre-Survey	
Mean	3.50
Mode	3
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.53

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.33
Count Difference	2

Question 10

Zoo exhibits assist visitors in creating meaning from the exhibit experience.



	Mean	SD
Pre-survey	3.50	0.53
Post-survey	3.83	0.41

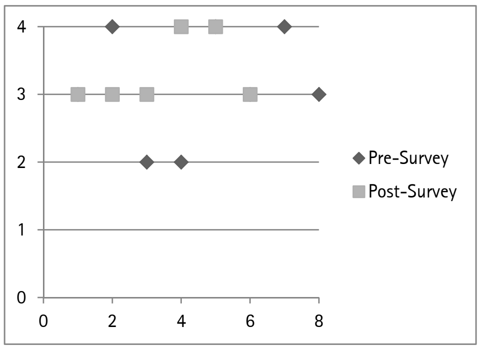
Pre-Survey	
Mean	3.13
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.83

Post-Survey	
Mean	3.33
Mode	3
Median	3
Maximum	4
Minimum	3
Count	6
SD	0.52

Analysis	
Mean Difference	0.21
Count Difference	2

Question 11

Zoo exhibits reinforce visitor learning by encouraging visitors to apply their knowledge.



	Mean	SD
Pre-survey	3.13	0.83
Post-survey	3.33	0.52

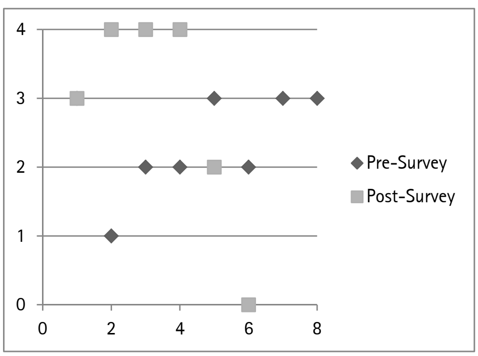
Pre-Survey	
Mean	2.38
Mode	3
Median	3
Maximum	3
Minimum	1
Count	8
SD	0.74

Post-Survey	
Mean	3.40
Mode	4
Median	4
Maximum	4
Minimum	2
Count	5
SD	1.60

Analysis	
Mean Difference	1.03
Count Difference	3

Question 12

Zoo exhibits provide visitors with feedback on their learning.



	Mean	SD
Pre-survey	2.38	0.74
Post-survey	3.40	1.60

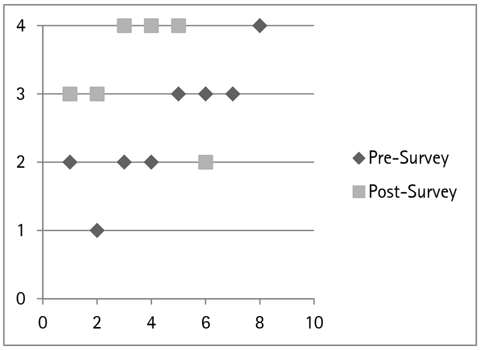
Pre-Survey	
Mean	2.50
Mode	2
Median	3
Maximum	4
Minimum	1
Count	8
SD	0.93

Post-Survey	
Mean	3.33
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.82

Analysis	
Mean Difference	0.83
Count Difference	2

Question 12

The visitor experience in a zoo exhibit is designed to engage a sequence of thought processes.



	Mean	SD
Pre-survey	2.50	0.93
Post-survey	3.33	0.82

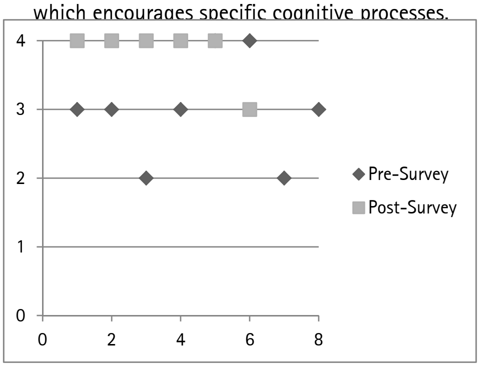
Pre-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.83
Count Difference	2

Question 14

The zoo exhibit landscape, design elements and theming are designed to create an environment which encourages specific cognitive processes.



	Mean	SD
Pre-survey	3.00	0.76
Post-survey	3.83	0.41

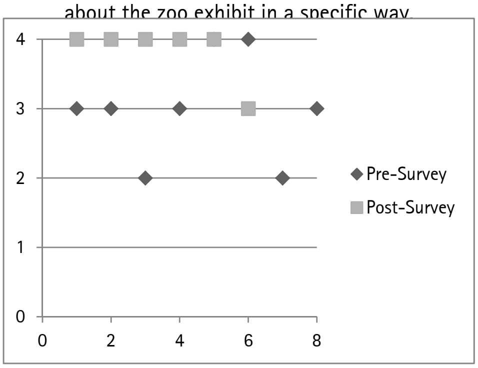
Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.55

Analysis	
Mean Difference	0.00
Count Difference	2

Question 15

The spatial relationships between a visitor and animal are designed to encourage visitor's to think about the zoo exhibit in a specific way.



	Mean	SD
Pre-survey	3.50	0.76
Post-survey	3.50	0.55

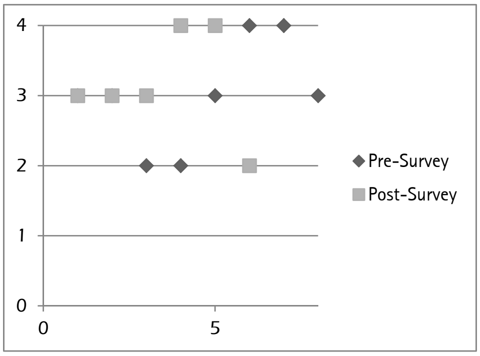
Pre-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.17
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.75

Analysis	
Mean Difference	0.17
Count Difference	2

Question 16

Zoo exhibit circulation organization is designed for visitor learning.



	Mean	SD
Pre-survey	3.00	0.76
Post-survey	3.17	0.75

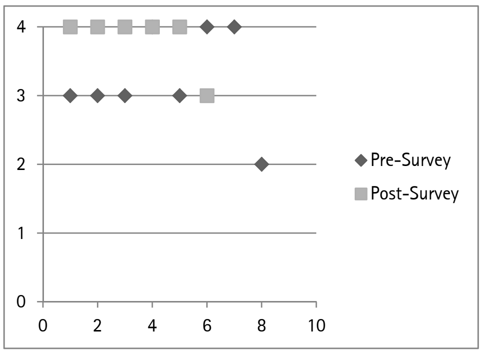
Pre-Survey	
Mean	3.25
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.71

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.58
Count Difference	2

Question 17

Learning is the transformation of information into knowledge.



	Mean	SD
Pre-survey	3.25	0.71
Post-survey	3.83	0.41

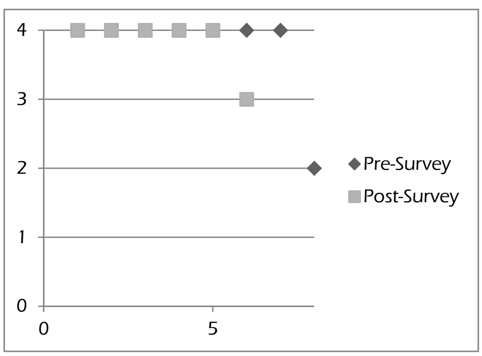
Post-Survey	
Mean	3.75
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.71

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.08
Count Difference	2

Question 18

People think about and learn the same information differently.



	Mean	SD
Pre-survey	3.75	0.71
Post-survey	3.83	0.41

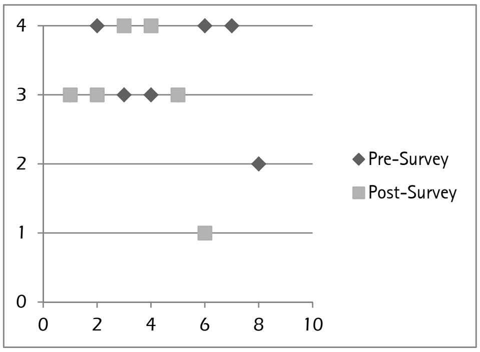
Pre-Survey	
Mean	3.25
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.71

Post-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	1
Count	6
SD	1.10

Analysis	
Mean Difference	0.25
Count Difference	2

Question 19

Engaging visitor's thought processes is a personal goal when designing zoo exhibits.



	Mean	SD
Pre-survey	3.25	0.71
Post-survey	3.00	1.10

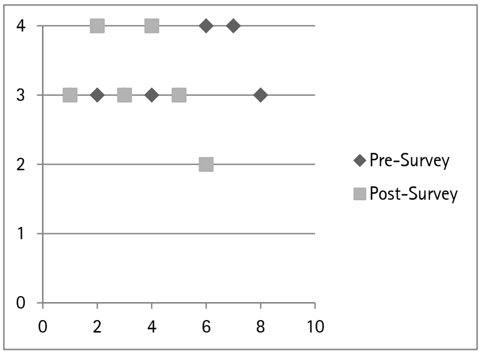
Pre-Survey	
Mean	3.25
Mode	3
Median	3
Maximum	4
Minimum	3
Count	8
SD	0.46

Post-Survey	
Mean	3.17
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.75

Analysis	
Mean Difference	0.08
Count Difference	2

Question 20

Zoo exhibit learning objectives help guide design decisions.



	Mean	SD
Pre-survey	3.25	0.46
Post-survey	3.17	0.75

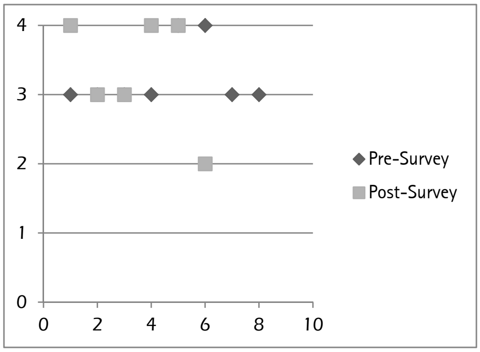
Pre-Survey	
Mean	3.25
Mode	3
Median	3
Maximum	4
Minimum	3
Count	8
SD	0.46

Post-Survey	
Mean	3.33
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.82

Analysis	
Mean Difference	0.08
Count Difference	2

Question 21

Information about visitor learning is recalled and employed during the zoo exhibit design process.



	Mean	SD
Pre-survey	3.25	0.46
Post-survey	3.33	0.82

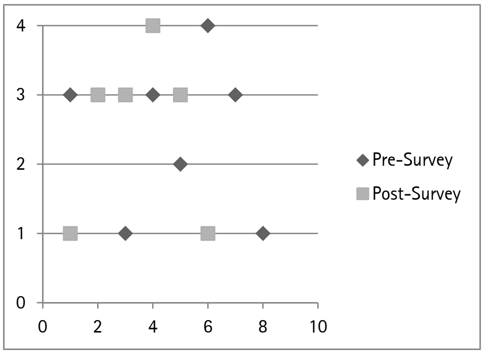
Pre-Survey	
Mean	2.50
Mode	3
Median	3
Maximum	4
Minimum	1
Count	8
SD	1.07

Post-Survey	
Mean	2.50
Mode	3
Median	3
Maximum	4
Minimum	1
Count	6
SD	1.22

Analysis	
Mean Difference	0.00
Count Difference	2

Question 22

Methods and literature pertaining to design for visitor learning are adequate.



	Mean	SD
Pre-survey	2.50	1.07
Post-survey	2.50	1.22

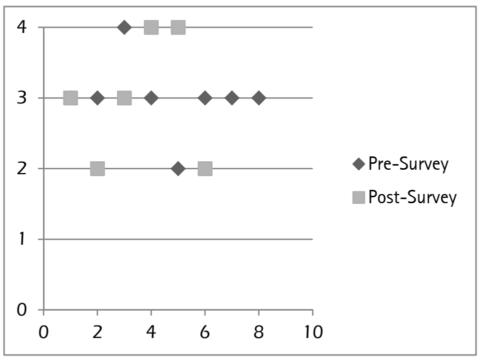
Pre-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.53

Post-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.89

Analysis	
Mean Difference	0.00
Count Difference	2

Question 22

Visitors apply and recall information learned in zoo exhibits outside of zoos.



	Mean	SD
Pre-survey	3.00	0.53
Post-survey	3.00	0.89

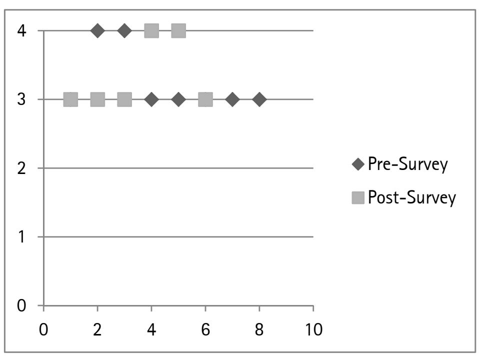
Pre-Survey	
Mean	3.25
Mode	3
Median	3
Maximum	4
Minimum	3
Count	8
SD	0.46

Post-Survey	
Mean	3.33
Mode	3
Median	3
Maximum	4
Minimum	3
Count	6
SD	0.52

Analysis	
Mean Difference	0.08
Count Difference	2

Question 24

Visitors apply and recall information learned outside of zoos as they experience zoo exhibits.



	Mean	SD
Pre-survey	3.25	0.46
Post-survey	3.33	0.52

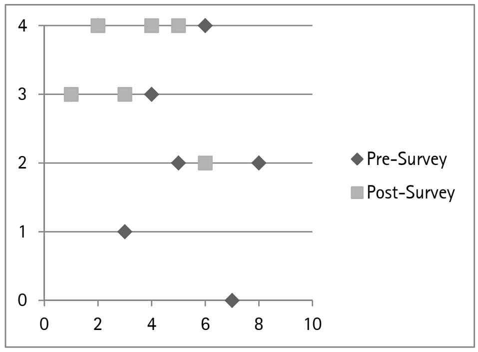
Pre-Survey	
Mean	2.71
Mode	3
Median	3
Maximum	4
Minimum	1
Count	7
SD	1.41

Post-Survey	
Mean	3.33
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.82

Analysis	
Mean Difference	0.62
Count Difference	1

Question 25.1 - Research

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	2.71	1.41
Post-survey	3.33	0.82

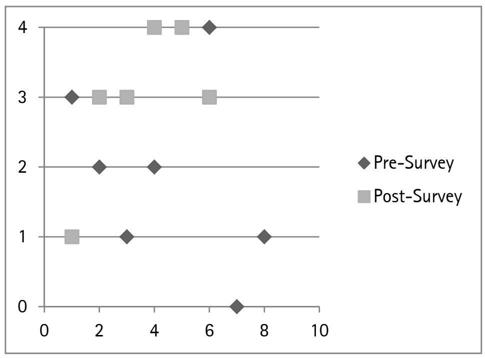
Pre-Survey	
Mean	2.43
Mode	2
Median	2
Maximum	4
Minimum	1
Count	7
SD	0.83

Post-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	1
Count	6
SD	0.52

Analysis	
Mean Difference	0.57
Count Difference	1

Question 25.2 - Site Analysis

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	2.43	0.83
Post-survey	3.00	0.52

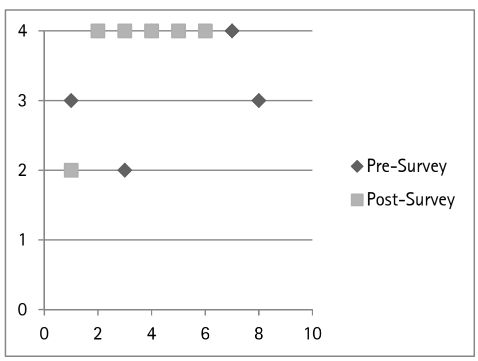
Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	3.67
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.82

Analysis	
Mean Difference	0.17
Count Difference	2

Question 25.3 - Programming

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	3.50	0.76
Post-survey	3.67	0.82

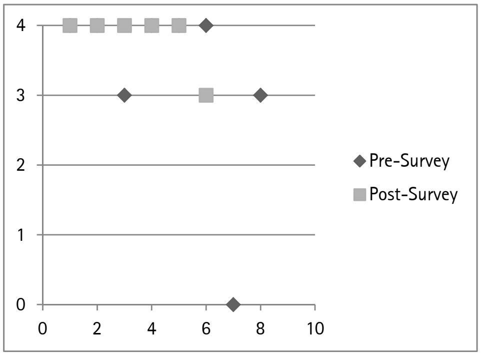
Pre-Survey	
Mean	3.71
Mode	4
Median	4
Maximum	4
Minimum	3
Count	7
SD	1.39

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.12
Count Difference	1

Question 25.4 - Concept Development

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	3.71	1.39
Post-survey	3.83	0.41

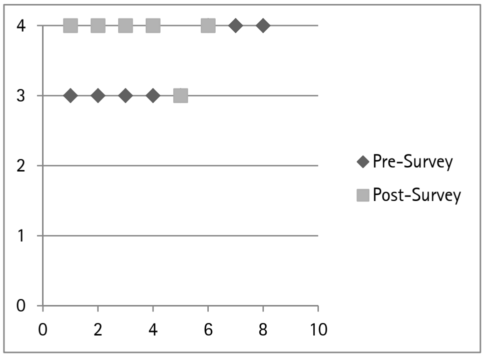
Pre-Survey	
Mean	3.38
Mode	3
Median	3
Maximum	4
Minimum	3
Count	8
SD	0.52

Post-Survey	
Mean	3.83
Mode	4
Median	4
Maximum	4
Minimum	3
Count	6
SD	0.41

Analysis	
Mean Difference	0.46
Count Difference	2

Question 25.5 - Design Development

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	3.38	0.52
Post-survey	3.83	0.41

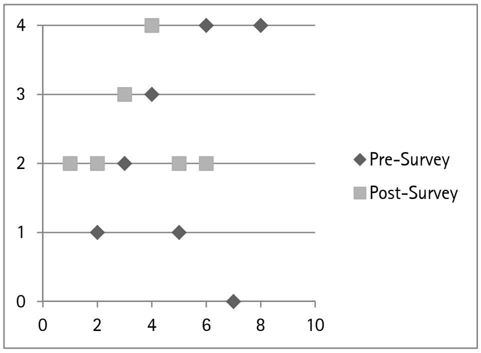
Pre-Survey	
Mean	2.43
Mode	2
Median	2
Maximum	4
Minimum	1
Count	7
SD	1.46

Post-Survey	
Mean	2.50
Mode	2
Median	2
Maximum	4
Minimum	2
Count	6
SD	0.84

Analysis	
Mean Difference	0.07
Count Difference	1

Question 25.6 - Construction Documentation

To what degree does visitor learning influence the following design stages?



	Mean	SD
Pre-survey	2.43	1.46
Post-survey	2.50	0.84

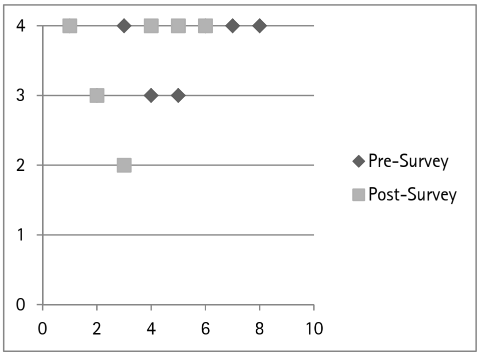
Question 25.7 - Post-Occupancy Evaluation

To what degree does visitor learning influence the following design stages?

Pre-Survey	
Mean	3.63
Mode	4
Median	4
Maximum	4
Minimum	3
Count	8
SD	0.52

Post-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.84

Analysis	
Mean Difference	0.13
Count Difference	2



	Mean	SD
Pre-survey	3.63	0.52
Post-survey	3.50	0.84

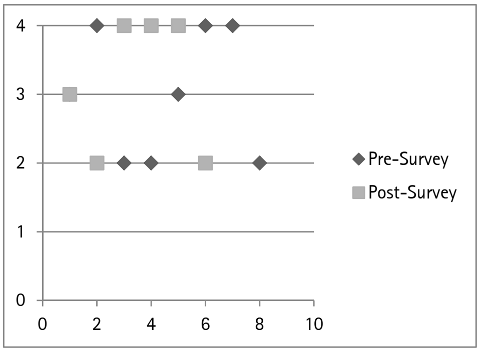
Question 26

Visitor's existing knowledge and interest is considered in the zoo exhibit design process.

Pre-Survey	
Mean	3.00
Mode	4
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.93

Post-Survey	
Mean	3.17
Mode	4
Median	4
Maximum	4
Minimum	2
Count	6
SD	0.98

Analysis	
Mean Difference	0.17
Count Difference	2



	Mean	SD
Pre-survey	3.00	0.93
Post-survey	3.17	0.98

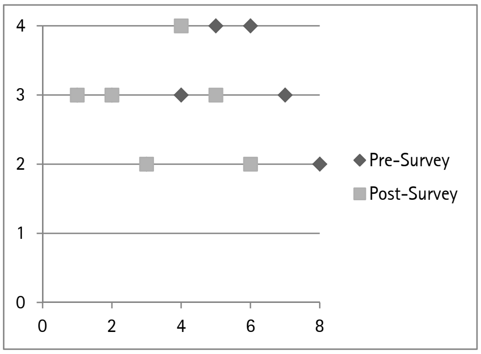
Question 27

How visitors learn guides conceptual design.

Pre-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	2.83
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.75

Analysis	
Mean Difference	0.17
Count Difference	2



	Mean	SD
Pre-survey	3.00	0.76
Post-survey	2.83	0.75

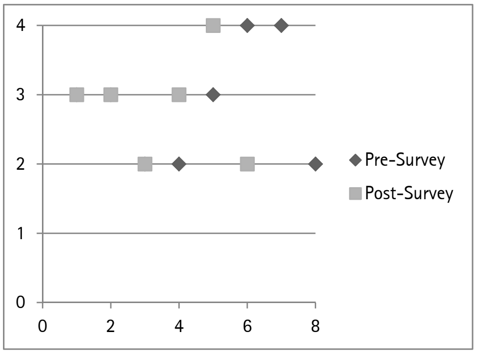
Pre-Survey	
Mean	2.88
Mode	3
Median	3
Maximum	4
Minimum	2
Count	8
SD	0.83

Post-Survey	
Mean	2.83
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.75

Analysis	
Mean Difference	0.04
Count Difference	2

Question 28

Strategies for how visitors learn change for different design alternatives.



	Mean	SD
Pre-survey	2.88	0.83
Post-survey	2.83	0.75

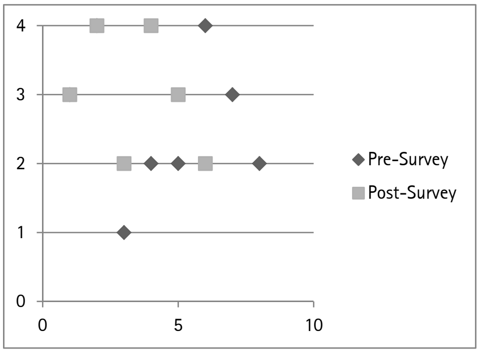
Pre-Survey	
Mean	2.63
Mode	2
Median	3
Maximum	4
Minimum	1
Count	8
SD	1.06

Post-Survey	
Mean	3.00
Mode	3
Median	3
Maximum	4
Minimum	2
Count	6
SD	0.89

Analysis	
Mean Difference	0.38
Count Difference	2

Question 29

Selection of a zoo exhibit design concepts is based to some degree on how visitors learn.



	Mean	SD
Pre-survey	2.63	1.06
Post-survey	3.00	0.89

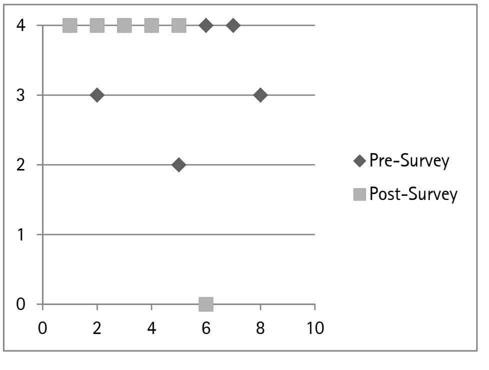
Pre-Survey	
Mean	3.50
Mode	4
Median	4
Maximum	4
Minimum	2
Count	8
SD	0.76

Post-Survey	
Mean	4.00
Mode	4
Median	4
Maximum	4
Minimum	4
Count	5
SD	1.63

Analysis	
Mean Difference	0.50
Count Difference	3

Question 30

How willing are you to employ additional information about how people learn in zoo exhibit



	Mean	SD
Pre-survey	3.50	0.76
Post-survey	4.00	1.63

Appendix G - Design Guidelines Document

Appendix G contains the design guidelines document. The document is intended to be used digitally enabling the hyperlinked functionality. A digital copy of the design guidelines can be found at ___________.