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The purpose of this study was to depict the mental models high school students, ages 14-18, hold of zoos. This study also examined how students define conservation and the role of zoos in conservation. This study examined the differences in mental models of 84 students 1) 21 students who had visited a zoo with their teacher in the same semester in which the study was conducted, 2) 21 students who had visited a zoo during another school year with their teacher, 3) 21 students who had visited the zoo without a teacher, and 4) 21 students who had never visited a zoo. It also examined the mental models of students of different ethnicities and examined differences in mental models of young men and women.

This study was conducted and the data analyzed using a qualitative methodology research design. All 84 students completed a demographic questionnaire, a concept map, and a ranking concepts exercise. Twenty-four students were interviewed.

The findings indicated that: 1) students who had visited a zoo have a richer mental model of zoos than students who have never visited a zoo, 2) students who had visited a zoo with their teacher provided a deeper richer understanding of the roles of zoos in conservation and education, 3) students who have never visited a zoo do have mental models of zoos, 4) students do not mention conservation with respect to zoos unless specifically asked about the role of zoos in conservation, and 5) students did not mention the zoo's connection to species survival nor did they view zoos as a source of information for conservation-related topics.

The data indicated that the mental models student hold of zoos consist of seven themes: 1) organisms, 2) people, 3) amenities, 4) descriptive terms, 5) habitats, 6) education, and 7) conservation. The seven themes were defined and used to create the Zoo Acuity Model. The central constructs of the Zoo Acuity Model are the Observation Framework, the Interaction Framework, and the Information Framework. Most important to this study is the development of the Information Framework, which described the information students knew about zoos.

MENTAL MODELS STUDENTS HOLD OF ZOOS

by

Patricia Gail Patrick

A Dissertation Submitted to
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Approved by

_____
Committee Chair

To Momma and Daddy: Thank you for making education an important part of our lives. To Mike: Thank you for listening and listening and listening. To my sisters Tammy and Betsy, who share my love for Buffett. To Dr. Matthews: Thank you for never giving up on me, even when you thought I might not be worth all the headaches. To Lady Dr. Sue Dale Tunnicliffe: Thank you for trekking to the U.S. and for being a long distance mentor. To Mack: You are my dog—enough said.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

"Man looks at his world through transparent templates which he creates and then attempts to fit over the realities of which the world is composed" (Kelly, 1955, p. 8-9).

"Constructs are used for predictions of things to come, and the world keeps on rolling on and revealing these predictions to be either correct or misleading. This fact provides the basis for the revision of constructs and, eventually, of whole construct systems" (Kelly, 1955, p.14).

Zoos, by definition, are conservation organizations (AZA, 2004; IZE, 2004; WAZA, 2004; IUDZG/CBSG IUCN/SSC, 1993). For the purpose of this study any use of the following terms: *zoo* or *zoo community* throughout the paper allow for a more precise illustration of the diverse identities of zoos. Mazur & Clark (2001) state, "These terms allow for a more accurate representation of the zoo's multiple identities: traditional and persistent institution of western society, an industry pursuing professionally-defined goals, and a community of people striving to obtain greater relevance and meaning for their organizations" (p. 186).

As conservation organizations, zoos have an obligation to help human beings acknowledge their own influences on the natural world and, in turn, an opportunity to help direct human choices towards a healthier relationship with the natural world (Balmford et al., 2004; Gwynne, 2004; Reading & Miller, 2004; Sterling, Wood & Lee, 2004; Stevens, Sams & Ogden, 2004). Moreover zoos have an opportunity to become communicators of ecological wisdom and help us refocus our views of wild animals and wild places (Balmford et al., 2004; Gwynne, 2004; Reading & Miller, 2004). But are zoos effective in communicating this conservation message to zoo visitors?

Zoos claim to stress conservation in their educational messages, but currently there is little evidence to support any claims that visitors are affected by the messages (Ogden, et al., 2004; Swanagan, 2000; Tunnicliffe, 1996a; Tunnicliffe, 1996b). Members of the Multi-Institutional Research Project (MIRP) state in their literature review that a majority of zoo studies investigate the perceptions the public has of animals. Even though "many of these same studies cited the potential for zoos to positively influence their visitors' conservation knowledge, affect, attitude, and behavior, these claims were not substantiated or validated by actual research" (Dierking, Burtnyk, Buchner & Falk, p. 15, 2002).

I investigated the mental models that high school science students hold of zoos. The participants were high school science students between the ages of 14 and 18 years old. I was interested in the understandings high school science students have of the roles and purposes of zoological institutions, including the role of zoos in conservation. This study is important because zoological institutions see themselves as conservation organizations

(AZA, 2004; IZE, 2004; WAZA, 2004; IUDZG/CBSG IUCN/SSC, 1993); yet, researchers do not know how high school science students envision the roles and purposes of zoos. It is not clear what impact a zoo visit has on the understandings of students of the roles and purposes of zoos. Do high school science students see zoos as conservation organizations?

Zoos clearly have a conservation mission, and that mission is formally articulated in zoo mission statements (AZA, 2005). Conservation (stewardship, sustainable practices, ecosystems, and carrying capacity) is a subject of study in secondary school biology classes, social studies classes (environmental problems), and even literature classes (social, historical and cultural influences) (NCDPI, 2005). Yet, little research is available that documents the understandings high school science students have of conservation and the conservation mission of zoological institutions.

Importance and Rationale of the Study

Each year, North American zoos and aquariums draw more than 134 million visitors, nine million of whom are students (AZA, 2004). The popularity of zoos and aquariums, as providers of both recreational and educational opportunities, is well established (Chobot, 1989). Teachers take field trips to zoos because they provide an opportunity for exceptional educational experiences in a relatively non-threatening setting (Schroeder, 1970).

Visitors interpret the information they are given through their previous knowledge, understanding, experiences, and beliefs (Kolbert, 1995; Falk & Dierking, 1992; Falk & Dierking, 2000). Therefore, it is important for zoo educators to know what mental models

or mental representations students have of zoos and how these models are formed (Falk & Dierking, 1992). Once zoo educators have an understanding of the mental models students hold of zoos, they will have a theoretical basis upon which to build their educational programs.

Over the last thirty years, researchers have stressed the need for studies that document the impact of visits to zoos on conservation knowledge, awareness, and behavior (Churchman & Marcoulides, 1991; de White & Jacobson, 1994). In 1972, Sommer wrote an article discussing the educational role of zoos and addressing the need for more systematic inquiry into what visitors learn about environments during a zoo visit. Sommer called for research documenting the extent to which the zoo visit allows visitors to develop a proper environmental ethic. A decade ago, a study conducted by the Chicago Zoological Society and the Lincoln Park Zoological Society (IUDZG/CBSG (IUCN/SSC, 1993) concluded that zoo visitors do not think of zoos as conservation organizations. During a research study conducted at the turn of this century at Zoo Atlanta, Swanagan (2000) commented that research specifically documenting the impact of conservation messages in zoos is in its infancy. In 2002, a literature review conducted by the MIRP called for research documenting the educational impact of zoos and their conservation messages (Dierking et al., 2002). In addition, Tunnicliffe called for the work I carried out:

> The range of public beliefs and attitudes towards the role of zoos in conservation has not been fully investigated and needs to be better understood in order to determine to what degree zoos do play a vital

> role in conservation and whether they are successful in their attempts. The visiting public's attitudes and perceptions also serve as a barometer of success of the zoo's efforts to elevate the public consciousness regarding environmental issues. If the visitors are not aware of the zoo's conservation aims, then the zoo is not effectively conveying its message, hence not fulfilling its educative role. (Tunnicliffe, 1995, p. 24)

Clearly, the understandings young adults hold of zoos is of interest to zoo educators as well as classroom educators. For example, determining how much is known about zoos and the role of zoos in conservation may aid zoo educators and classroom educators when deciding upon the level of information that needs to be disseminated before, during, and after a zoo visit. In addition, determining an overall mental model that young adults have about zoos, may help zoo educators and classroom educators counteract misconceptions and may provide possible ways in which zoos might address the misconceptions.

Conducting this study was important for the following reasons: 1) we do not know how effective zoo conservation education has been (Dierking et al., 2002), 2) research is needed to document what people know about zoos and the role of zoos in conservation (Churchman & Marcoulides, 1991; Tunnicliffe, 1996a; Tunnicliffe, 1996b; de White & Jacobson, 1994; Swanagan, 2000; Ogden, et al., 2004), 3) a complete understanding of the knowledge zoo visitors bring to the zoo must be established (Ogden, et al., 2004), and 4) the studies regarding zoo visitors conducted in the past have addressed visitor demographics and motivations, visitor interactions with zoo programs and staff; the purposes of zoo education, and the educational components of zoos (Churchman, 1987).

This study adds to the literature in that it directly asked students what they knew about zoos, the role of zoos, and the role of zoos in conservation (Tunnicliffe & Reiss, 2000).

Conservation-based organizations should undertake the dissemination of information and the transformation of human action as it relates to the continuing decline of wildlife and wild places (Miller et al., 2004). Moreover, progress in conservation depends on reaching out to schools through educational opportunities and advancing public understanding of science issues and the role of humans in conservation (Carr, 2000). School programs developed by conservation-based organizations are growing and improving. Students and teachers are a core audience served by classes, tours, outreach programs, and special curricular materials. In other words, education is a powerful tool to be utilized by conservationists and conservation organizations (Graham, 2000).

Zoos are in a critical position to contribute to conservation education; therefore, they are being urged to reevaluate their conservation education efforts based on the knowledge visitors bring to the zoo (Balmford, et al., 2004; Gwynne, 2004; Reading & Miller, 2004; Sterling, Wood & Lee, 2004; Stevens, Sams & Ogden, 2004). Providing a model of the knowledge or understandings high school science students have regarding zoos was the niche this study sought to fill. Education programs in zoos might be more powerful if we have a better understanding of what the typical high school science student knows about and thinks about the roles and purposes of zoological institutions.

The impact of conservation messages in zoos and the impact zoo visits have on the conservation knowledge, awareness, and behavior of visitors requires more research (Swanagan, 2000; Churchman & Marcoulides, 1991; de White & Jacobson, 1994). A plea

for conservation-related knowledge research was set forth by Paul Boyle at the 2005, AZA National Conference. Boyle stated,

> We need to know our audience better…We need to do more research to understand our audience. We need to understand where our public is coming from. We need research which documents what people know and what they understand. We need research which gives a picture of how people understand conservation and the role of conservation organizations. What do they bring? What level is their understanding? How much information can we give them and not compromise their level of understanding? The only way to accomplish this is to understand our audiences. (Boyle, 2005)

Five percent of zoo visitors in the United States are teenagers (Wineman, Piper & Maple, 1996) and teenagers are the most neglected age group with respect to zoo planning and programming (Wineman et al., 1996). At first glance, teenagers may not appear to be a significant group for study. However, I provide six reasons why teenagers are an important population in zoo visitor research. First, teenagers are emerging adults and adults make up the largest population of zoo visitors. Between 55-70% of all zoo visitors are adults (Conway, 1982).

Second, according to Piaget's (1929) theory of development, teenagers have reached the formal operational stage of development and are capable of thinking logically and abstractly. While some researchers (Piaget, 1963; Case, 1985; Case, 1992; Berk, 1999, Wilber, 1999) have determined that many adults, and therefore teenagers, never reach the formal operational stage of development and have difficulty thinking logically and abstractly. Nevertheless, teenagers are more likely to approximate adult reasoning levels

than are younger children. Moreover, teenagers have progressed through the concrete operational stage, which allows them to engage in mental representations and think logically about the world around them. Teenagers are able to manipulate their mental representations to think and solve problems (Piaget, 1976).

Third, teenagers are concerned about the role of zoos in environmental affairs. When teenagers at the Indianapolis Children's Museum were asked to design an exhibit about their environmental concerns they asked for exhibits about environmental pollution and "expressed a desire to explore issues of habitat destruction, endangered species, zoo design, and environmental ethics. They confirmed they come to the zoo primarily for a social experience (Wineman, et al., 1996, p. 102)." Moreover, teenagers are future voters who will influence the nation's economics (Hall, Lindenberger, Kummel, Kroeger & Eichorn, 2001), politics (Chapin, 2000), and health issues (Brown, Gardner & Helweil, 1999).

Fourth, the major focus of 90% of informal institutions is elementary school programs. Fieldtrips for high school students are almost non-existent (Fido & Gayford, 1982). Zoo fieldtrips drop off after the seventh grade (personal communication, Fran Nolan, May 5th, 2001; Dimitrijeska, Snider, Stoop & Smith, 2005). However, it is well documented that fieldtrips are important and educationally effective when incorporated into a science curriculum (Sorrentiono & Bell, 1970; Muse, Chiarelott & Davidman, 1982; Fido & Gayford, 1982; Orion & Hofstein, 1991; Michie, 1998) and that teachers believe that fieldtrips provide otherwise unavailable experiences (Michie, 1998). Current research is being done to determine why this drop off in zoo visitation among teenagers

occurs (Dimitrijeska, Snider, Stoop & Smith, 2005). To combat the lack of zoo programs for high school students, some zoos are incorporating conservation education for high school students into their master plan. If zoos are aware of the understandings young adults bring to the zoo and know how to use this information to develop programs which reach young adults, they may also be able to bring about a change in the number of teenagers who visit the zoo.

Fifth, high school students are becoming disconnected from science education, nature, and organisms living in their natural environments (Ogden, Gentile & Revard, 2004). Sixth, currently, there are only 14 studies that apply to zoos and teenagers (Swan, 2005). More data is needed to determine if zoos, zoo programs, and zoo visits are successful in reaching teenagers.

Even though Wineman, et al. (1996) have shown that students are able to describe zoo exhibits in relation to their environmental concerns, they did not determine if students actually thought of zoos as conservation organizations. Students were not asked if they viewed zoos as conservation organizations nor were they asked about the role of zoos in conservation. In fact, students reiterated their beliefs that zoos are a place for socializing. This study begins to fill in the gaps in zoo research by determining the mental models high school science students hold of zoos and adding to the data concerning zoos and teenagers.

Research Questions

1. What are the understandings of high school science students of the roles and purposes of zoos? That is, what are the mental models students hold of zoos?
    A. What are the differences in mental models students hold of zoos who have visited the zoo with a teacher in the last year (WTSS), who have visited the zoo with a teacher prior to the school year the study was conducted (WTASY), who have visited the zoo with someone other than a teacher (WOT) and who have never visited a zoo (NVZ)?
    B. What are the differences in mental models males and females hold of zoos?
    C. What are the differences in mental models of students of different ethnicities: African American, White, and Hispanic?
2. How do students define conservation and the role of the zoo in conservation?

This study attempted to understand the mental models high school science students have of zoos and how students define the role of the zoo in conservation. Furthermore, this study looked at other factors, such as race and gender and with whom a student visited a zoo.

Defining Conservation

This study uses a biological definition of conservation, which is also recognized by the zoo community. According to the World Conservation Strategy (WCS) (IUDZG/CBSG, 1993), nature conservation must be the central theme of zoos and should

include the conservation of wildlife, wilderness, and people. The Strategy divides conservation into two types: *in situ* (in the wild) and *ex situ* (in the zoo).

In situ conservation endeavors to protect and restore biological communities and their associated ecosystem functions in the wild (Primack, 2002). Zoos' roles in *in situ* conservation are reestablishing naturally extinct species in the wild, halting the destruction of the capacity of the earth to support life, protecting and maintaining sufficient numbers of species and biological communities (IUDZG/CBSG, 1993), and identifying increasing threats to biodiversity (Sutherland & Gosling, 2000).

Ex situ conservation is a practical inner-institutional approach to preventing the extinction of species (Caro, 1998). Zoos play a role in *ex situ* conservation, by sustaining *ex situ* populations of animals, maintaining genetic variation within species, maintaining facilities for *ex situ* conservation of and research on plants, animals and microorganisms, rehabilitating and reintroducing threatened species, providing financial and other support for *ex situ* conservation, and providing an educational outlet through which the zoo may interact with the outside community (IUDZG/CBSG, 1993).

What is a Zoo?

There is much variation in zoos, aquariums, and zoological gardens. The definition of a zoo for this study met the criteria of a zoo as defined by the World Conservation Strategy (WCS),

1. Zoos possess and manage collections that primarily consist of wild (non-domesticated) animals, of one or more species, that are housed so that they are easier to see and to study than in nature.

2. Zoos display at least a portion of this collection to the public for at least a significant part of the year, if not throughout the year. (IUDZG/CBSG, 1993, p. 9)

and three criteria as defined by the Association for Zoos and Aquaria (AZA),

1. A zoo is a "permanent cultural institution which owns and maintains wildlife, under the direction of a professional staff".
2. A zoo "provides its collection with appropriate care and exhibits them in an aesthetic manner to the public on a regularly scheduled, predictable basis."
3. A zoo "shall…be defined as having as their primary business the exhibition, conservation and preservation of the earth's fauna in an educational and scientific manner" (AZA, 2004).

For the purpose of this study, a zoo was defined as an institution, which met the WCA and the AZA criteria.

Zoos as Conservation Organizations

Zoos define themselves as conservation organizations (IUDZG/CBSG IUCN/SSC, 1993; AZA, 2004; IZE, 2004; WAZA, 2004). Zoos are important educational institutions which can help human beings acknowledge their influence on the natural world and, in turn, direct human choices towards a healthier relationship with the natural world (Balmford, 2004; Gwynne, 2004; Reading & Miller, 2004; Sterling, Wood & Lee, 2004; Stevens, Sams & Ogden, 2004). Using effective communication skills, zoos have an opportunity to educate the public about the needs of saving animal species from extinction and preventing habitat destruction (Hutchins & Conway, 1995).

Education in Zoos

According to the World Conservation Strategy, zoo education is education that is conducted in the framework of the educational curriculum of educational institutions within or in relationship to the zoo (IUDZG/CBSG, 1993). Zoo education is the dissemination of knowledge by zoo employees and volunteers and is what people find out during a zoo. Zoo education may be as simple as reading exhibit information or as structured as listening to a zoo employee or volunteer speaking to visitors about a zoo animal. Zoos are conducive to first hand experiences, to direct and indirect contact with animals and plants, and to participant interaction and socialization (AZA, 2004; IZE, 2004; WAZA, 2004).

Conservation Education

The specific aim of conservation education is to develop lifelong knowledge and skills for conservation action. Conservation education recognizes the central role of people in all nature conservation efforts. Conservation education is designed to affect the awareness, attitudes, and behaviors of people toward natural resources. It promotes the public education and awareness of the conservation of biodiversity, by providing information about species and their natural habitats (IZE, 2004; AZA, 2004; WAZA, 2004). The zoos of the world have a unique role to play in the global efforts to make people conscious of the role of zoos in conservation (IZE, 2003; Hancocks, 2001; IUDZG/CBSG, 1993; Sommer, 1972). Therefore, it is not only important that zoos formally define their role in education, but it is imperative that they define their role in conservation education.

Conservation Education in Zoos

The World Conservation Strategy (IUDZG/CBSG, 1993) defines conservation education in zoos as,

> … explaining the irreplaceable value of the entire biological system of our planet and all of its constituent components…conservation education in zoos can make it clear that nature conservation affects everyone, and that everyone needs to be concerned with it. They should play an active role in increasing the public and political awareness of the connections between consumption and lifestyle and the survival of species and biological systems. Conservation education includes informing the public about the threatened status of the species of zoo animals, and other animals which are taxonomically and/or geographically related. Conservation education in zoos can make it clear that nature conservation affects everyone, and that everyone needs to be concerned with it. (p. 25)

As wildlife and wild places diminish, zoos have the opportunity to slow down the loss of wildlife and wild places through education, conservation, and reproduction of threatened species (Croke, 1997). In an attempt to aid zoos with their conservation education directives, The World Conservation Organization Strategy (IUDZG/CBSG, 1993) developed specific goals for zoo conservation education. The goals of interest for this research were: "1) make it clear that nature conservation affects everyone, 2) increase public awareness of the connections between consumption and lifestyle and the survival of species and biological systems, and 3) inform the public about the threatened status of animals (p. 25)."

The modern zoo is failing to realize its potential for conservation education (Zoological Society of Philadelphia, 1989). Zoos give visitors the opportunity to see

unique organisms, as well as an opportunity to learn more about familiar animals. During these close encounters zoos have the attention of individuals, which gives them an opportunity, be it short, to emphasize their importance and the importance of conservation (Falk & Dierking, 2000; Tunnicliffe, 1996b). Currently, conservation messages are shifting from endangerment and captive breeding to the importance of saving habitat (Mazur & Clark, 2001).

As zoo programs continue to grow and improve, students and teachers remain a core audience served by classes, tours, outreach programs, and special curricular materials. Progress in conservation depends on reaching out to schools through educational opportunities and advancing public understanding of science issues and human roles in conservation (Carr, 2000). Zoos are in a critical position to contribute to conservation education. Since zoos have been placed in this position of critical conservation educator, they are being urged to reevaluate their conservation education efforts based on the knowledge visitors bring to the zoo visit (Boyle, 2005; Balmford, et al., 2004; Gwynne, 2004; Reading & Miller, 2004; Sterling, et al., 2004; Stevens, et al., 2004). This study made a contribution to this effort by elucidating the knowledge or mental models that high school science students have of zoos.

Research on Conservation-Related Knowledge

Students, teachers, and the general public have a weak base of conservation-related knowledge, attitudes, and practices (Swanagan, 2000; Bowers, 1997; Price et al., 1994; Birney, 1991). There is a growing recognition that human understanding of the natural environment must be altered through conservation education. The manner in which zoos

choose to approach the task of conservation education must be taken seriously. The education staff (Chizar, Murphy, & Lliff, 1990), the exhibits (Boud, Keogh, & Walker, 1985), and the zoo experience and prior knowledge of the visitor (Chizar, et al., 1990; Gwynne, 2004) are ultimately responsible for creating the opportunities for learning that may arise from the zoo experience.

The outcome of a zoo visit is situated in the affective domain of learning, the domain concerned with feelings, emotions, beliefs, and attitudes (Jenner, 2003). In some instances attitudes towards the environment and animals are more negative after a visit to a zoo (Swanagan, 2000). In other cases, children who visit the zoo use positive emotional terms to describe their visit and the interactions they have with zoo personnel during their zoo visit (Zoological Society of Philadelphia, 1989), implying that the presence of live animals and their caretakers influences the tenor of their responses. Not only is learning affected by expectations and social influences, but by the physical environment as well (Birney, 1988).

Many researchers stress the need for research that documents the impact of visits to zoos on conservation knowledge, awareness, and behavior (Churchman & Marcoulides, 1991; de White & Jacobson, 1994). A study conducted by the Chicago Zoological Society and the Lincoln Park Zoological Society (1993) concluded that zoo visitors do not think of zoos as conservation organizations.

In 1992, the World Wildlife Fund conducted a survey of zoo and aquarium educators. The survey revealed that the majority of formal and nonformal educators felt that conservation education should be a priority in their institutions and that more research

was needed to understand how to effectively improve environmental literacy (Braus & Champeau, 1994). Many conservation studies have focused on conservation issues on topics such as ocean conservation, elephant conservation, bird conservation, and primate conservation (Price, Ashmore & McGivern, 1994; Birney, 1991). This purpose of this study was to obtain a view of the understandings secondary science students hold of zoos. Studies have shown that students do not understand what conservation means (Swanagan, 2000; Price et al., 1994; Birney, 1991), do not spontaneously talk about it while visiting a zoo (Tunnicliffe, 1995), and zoo educators do not know the effects of their efforts due to a lack of research on students' mental representations of zoos (Swanagan, 2000).

The field of visitor studies was initiated in the 1930's and has grown within the past 15 years. Birney (1995) places zoo visitor studies into three categories: 1) studies at the national level addressing the perceptions of the public who have attended museums and zoos, 2) studies conducted at museums and zoos examining the learning of adult visitors, and 3) studies examining the experiences children have in leisure settings. Based on the literature review completed for this study, there are clear cries for the very study that I completed. As determined by Birney (1995) and the literature review, zoo researchers have tended to conduct their research studies on site with zoo visitors. Dr. Lady Sue Dale Tunnicliffe said if you want to know what students think you need to ask the students (Tunnicliffe & Reiss, 2000). This study took Tunnicliffe's approach of examining mental models of secondary students by asking students what they know about zoos, including both students who had visited a zoo and those students who had never visited a zoo. High

school students are the focus of this study since they have been largely neglected by investigators and were certainly largely neglected by many zoo education efforts.

Research in the area of visitor studies included investigations that addressed issues of visitor demographics and motivations to visit zoos, and visitor interactions with zoo programs and staff (Falk & Dierking, 1995; Falk & Dierking, 2000). Many of the studies investigated the perception of animals by the public, with very little attention paid to the overall conservation messages conveyed in zoos and how those messages were interpreted by visitors (Churchman, 1987). The fields of interpretation and visitor studies are continually assessing the learning impact of the placement of kiosks, signs, interactives, and displays (Falk & Dierking, 1992; Falk & Dierking, 1995; Falk & Dierking, 2000).

Personal Construct Theory

The constructivist theory maintains that constructs or mental models are not fixed but can be altered by assimilating new information over time leading to new constructions or views of reality (Lincoln & Guba, 1985). Based on this theory, people construct their view of reality through interactions with others and through engaging in activities. Building on the constructivist theory is Kelly's (1955) personal construct theory (PCT). The PCT states that the world is perceived by a person in terms of whatever meaning that person applies to it and the person has the freedom to choose a different meaning. The person is capable of applying alternative constructions or meanings to any events in the past, present, or future. They are able to reconstruct,

reinterpret, or redefine events. The theory recommends that affect, cognition, and action be construed together for developing a fuller understanding of human behavior.

PCT seeks to provide a theoretical basis for understanding and predicting the interpretation of an individual of their environment and their reactions to it (Kelly, 1955). The PCT is important for this study, because when students visit zoos they bring with them their understandings of a zoo. This understanding may have been influenced by prior visits to a zoo, media, peers, or family. The interactions students have at the zoo with animals, zoo staff, exhibits, peers, teachers, and family all have the potential to change the students' interpretations and understandings of zoos; therefore, changing the mental models students hold of zoos.

Mental Models

The PCT states that people have the ability to understand and interpret their environment based on the interactions they have with that environment. The theory of mental models, or mental representations, takes PCT one-step further, in that mental models provide the framework in which the personal construct understandings take place. Functionally, mental models provide a framework for interpreting and predicting various phenomena (Vosniadou, 1994) and for determining appropriate responses to new situations, as well as for guiding the perceptions, decisions, and behaviors of an individual (Kearney & Kaplan, 1997). Kearney & Kaplan (1997) describe mental models as hypothesized knowledge structures symbolizing the misconceptions, assumptions, beliefs, and perceived facts a person holds about the world. Structurally, mental models

dynamically and instantaneously reflect emerging representations of complex and novel situations (Halford, 1993; Johnson-Laird, 1990; Wiser, 1995).

Mental models are constructed, cognitive representations of events and situations that may be based on real and personal experiences or on what a person obtains from a media source such as television (Josephson, 1987). Our mental models become what we abstract from our experiences through personal construct and store in memory as an example of some thing or some situation (Garnham, 1997). Once the model is constructed, it may be used to guide incoming information (Halford, 1993), to reason and problem solve (Greeno, 1984), and to assist in or direct recall (Zwaan & Radvansky, 1998). This study examines whether students who have visited a zoo hold different mental models of zoos than students who have never visited a zoo.

In a Piagetian sense, the use of personal construct theory and mental models theory encompasses assimilation as well as accommodation processes (Neimeyer, 1985). As a research framework, the two theories are associated with a constructivist approach to research, which share the goal of understanding the world of lived experience from the point of view of those who live it (Schwandt, 1994). Our construction of knowing takes the form of anticipation, in that we order our thoughts to make sense of what will happen. Moreover, our constructs change based on the assimilation of new information. PCT is bipolar in nature because we perceive differences and similarities between things, people, events, and ideas (Burr & Butt, 1992). Therefore, personal constructs of a zoo visit may be affected by factors prior to the zoo visit, during the zoo visit, and after the zoo visit.

Before visiting a zoo several factors may play a role in eliciting a construct of zoos. For example, students may be excited about the zoo, their teacher may have talked about the visit and what to expect at the zoo, students may have seen or read about zoos in the media, and their parents and/or peers may have told them about zoos. In addition, the excitement of a zoo visit itself may invoke an affective reaction which in turn affects the mental construct of a zoo.

During the zoo visit students' mental constructs of a zoo may be affected by the zoo itself and affective feelings the zoo visit elicits. Exhibits, information obtained during the visit, and the zoo staff may have an affect on the mental constructs of a student. In addition to the zoological institution, accompanying peers and chaperones may also cause adaptations in the mental constructs of a student. After a zoo visit students have personal observations, new information, affective reactions to the visit, and memories they need to process. They adjust their mental constructs based on this new information. If teachers or peers discuss the zoo visit, an students may adjust their mental constructs of a zoo. Additionally, after a zoo visit students may make plans for a future zoo visit evoking a recall of their mental constructs of a zoo.

Understanding the concepts and personal constructs of students is important because a zoo visit is a multidimensional experience. Many different experiences may affect an individual's zoo visit and may cause a change their personal constructs of meaning. It would be ill served to simplify any of these experiences. For example, a student is affected by a complex external system, such as the teacher, the previous knowledge of the student, information obtained prior to the zoo visit, the zoo visit itself, physical

interaction with peers, and information obtained while at the zoo. Included in personal constructs are the internal dimensions of the experience, such as behavioral reactions, perceptions and beliefs about zoos, the affective reaction to a zoo visit, and the social interaction with peers, chaperones, and zoo staff.

In personal construct theory and mental models theory each person predicts and controls their universe. The person represents their world by creating patterns or constructions and interpreting and comparing them to their own perceptions of what happens (Pope & Denicolo, 1993). Thus, a person anticipates events, and compares their anticipations to their view of the reality of the events and acts accordingly. Each person may construe the universe very differently, and in general people seek to improve the constructs of their models by altering them and by organizing or reorganizing them (Sendan & Roberts, 1998).

Research Design

Research design was selected to show how all of the major parts of the research project worked together to address the central research questions. The researcher determined the questions pertinent to this study, described the procedures to be followed, and then determined data collection techniques. The design of the study determined how data collection was done to examine the relationships investigated. Subsequently, the data were analyzed and conclusions were drawn to reflect the most appropriate interpretation of the data. Figure 1 illustrates the way in which Krathwohl's (1998) research design was adapted for this study.

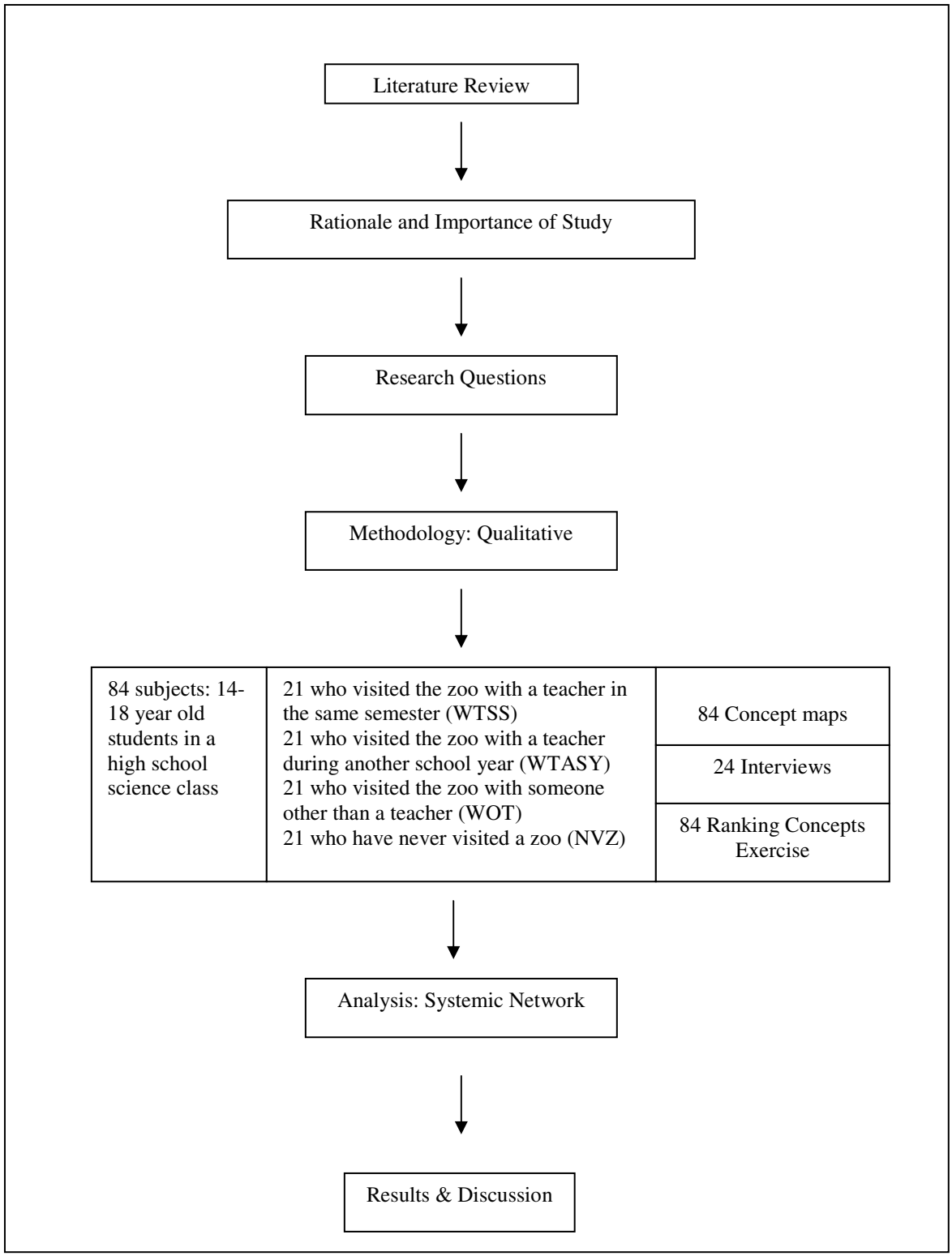


Figure 1. Krathwohl's (1998) Chain of Reasoning Mode.

This study began with a literature review of conservation education in zoos. Based on the literature review there were gaps in the research on the understandings students hold of zoos. In addition, very little research had been done with secondary school students, the population selected for this study. This research was situated in the Visitor Centered Evaluation Hierarchy (VCEH) (Wells & Butler, 2004). The VCEH is a diagnostic, research tool which aids in selecting the most appropriate approach for gathering data. The VCEH is a pyramid divided into the following tiers: benefits, long-term learning, short-term learning, psychographic data, and descriptive (demographic) data. Each tier of the pyramid describes the population to be studied and the tools best suited to the study (Figure 1).

Procedures for Collection of Data

This study employed a qualitative research-based diagnostic tool called a systemic network to analyze concept maps students created about zoos and the responses of a subset of students to an oral interview. The purpose of using concept maps and interviews was to determine the layers of the reality of students, as it related to zoos, in an attempt to develop knowledge about that reality. People develop hypotheses which initially make claims about events, processes, and behaviors in the world as experienced by individuals operating within the world (Gaines & Shaw, 1982). Prior research in personal construct theory and mental model theory suggests that people invent and re-invent their personal intellectual framework or personal construct system. Due to the ability people have to construct, deconstruct, and reconstruct their mental models, qualitative methodology may be a way to elicit an image of those constructs.

Population

The purpose of this study was to explore secondary students' mental models of zoos. The target population was 84 high school science students all enrolled in a science class. The high school was located in the same county as the zoo. Some of the students visited the zoo with their classes during the semester that the study was completed. The students of three teachers with a total of nine science classes participated in this study initially by completing a questionnaire. Teacher A took her students to the zoo prior to the investigation while Teacher B and Teacher C were asked to take their students to the zoo after the investigation. This allowed me to give a questionnaire to 90 students who had visited a zoo in the same semester as the investigation and 170 students who had not visited a zoo in the same semester. The questionnaires were used to determine which of the 170 students met the following criteria: visited the zoo with teacher prior to this school year, visited the zoo without teacher, and never visited the zoo. This provided four distinct groups of students who then completed a concept map and a ranking concepts exercise. A selected subset of each of the four groups was interviewed.

Data Collection

This study identified the understandings of high school science students of the roles and purposes of zoos. To determine the grouping of students a questionnaire was administered. The questionnaire consisted of demographic questions about gender, ethnicity, and whether or not the student had previously visited a zoo. Because of the difficulty in determining the mental models of students (Burr & Butt, 1992), this study gathered data via qualitative methods consisting of concept maps, open-ended interviews,

and ranking concepts exercises. The procedure for the concept mapping activity and the questions for the interview were grounded in the literature review and the research questions. Additionally, all students were asked to complete a ranking concepts exercise in which they were asked to number words in the order of which words best described zoos.

Concept Maps

Concept maps are a visual representation of the knowledge structure of a person and depict a person's understanding of a given topic (Novak & Gowan, 1984). This study collected data utilizing a concept map approach. Prior to students constructing a concept map about zoos, concept mapping was quickly taught to the students. Specific instruction on concept mapping procedures may be found in Appendix A. Prior to constructing a concept map, students were asked to write the word 'zoo' at the top of a sheet of paper and list 25 words or more that they associated with zoos and why zoos exist. Using this self-created word bank, students then constructed a concept map using each of their words in a map.

Semi-structured Interviews

Interviews were conducted in the school library and were taped using a digital recorder. Asking students questions directly is a natural and holistic approach to discovering their thoughts. For this study the questions were determined prior to the study. The interview questions were semi-structured, which means they were open-ended, but had a predetermined direction. The questions were pre-formulated, but the interviewees and the interviewer determined the direction of the interview after the

questions were asked. This was accomplished by the interviewer by using probes. For example, the interviewer restated specific words or phrases the interviewee used during the conversation and asked the student for clarification (Weller, 1988). The interview questions are located in Appendix B.

Data Analysis

Bliss, et al. (1983) developed a way of codifying data, a systemic network, which makes large amounts of qualitative data amenable to statistical testing. The concept maps and interviews were analyzed using a form of systemic analysis (Bliss et al., 1983; Tunnicliffe, 1996a; Tunnicliffe, 2000). The systemic network allowed the researcher to transform qualitative data into quantitative data while preserving the relationships between the categories (Tunnicliffe, 1995). The quantitative data gathered from the research was recorded in an Excel file, allowing an analysis of all data gathered from the demographic questionnaires, concept maps, interviews, and ranking concepts exercise.

Limitations of the Study

It is easy to ask students questions. If the students are interested in the questions their answers are likely to be detailed and rich. If they do not have to fit their answers into some predetermined scheme, they are more able to focus on their own thoughts and judgements. On the other hand, there are serious problems associated with such a method. For example, changing unstructured answers into usable constructs and scoring and synthesizing scores all pose a number of problems with regards to translation of meaning. Concept mapping of students' mental constructs can be used to determine the relationships that they believe exist between concepts (Bannister & Fransella, 1971) and

systemic networks aid in changing the qualitative data obtained into quantifiable data (Bliss et al., 1983).

The students interviewed for this study attended a high school, which was located in the same county as a large zoo, and all biology teachers took their students to the zoo each semester. Therefore, this study may not be generalizable to all high school science students. Students may have been embarrassed to admit that they had never been to a zoo, therefore some of the students identified as zoo visitors may not have been to a zoo. Students, who had not visited a zoo, may have been tempted to say they had visited a zoo, if they thought this was the correct answer or the answer for which the interviewer was looking. Therefore, some students who had never visited a zoo may not have been identified. To correct for misidentifying students who claimed to have visited a zoo, but had not, the questionnaire asked students what zoo they had visited.

Interviews and concept maps provide data about the expressed models of students. Mental models of individuals are unique to each observer and may be very difficult to uncover (Kelly, 1995; Sendan & Roberts, 1998). In fact, individuals may believe one thing but verbalize another. Their verbal answers may not be an indication of their underlying beliefs (Coll & Treagust, 2003). In order to counter this limitation, this study utilized a combination of data-gathering techniques.

Summary

Conway (2004) states that zoo education and communication programs have greatly expanded but rarely target the decision-makers that can make conservation happen. It is time for zoos to analyze and evaluate their educational role in helping zoo visitors

develop personal constructs about conservation. As humans become even more separated from nature, it will become increasingly necessary for zoos to challenge what people believe about the role of the zoo in conservation, the importance of conservation, and their personal role as conservationists (Balmford et al., 2004; Gwynne, 2004; Reading & Miller, 2004; Sterling et al., 2004; Stevens et al., 2004). Zoos need to obtain a clearer glimpse into the understanding the public has of zoos and their beliefs about how zoos function in relation to conservation. Understanding the mental models of zoos embraced by students and their beliefs about the roles and purposes of zoos can provide fundamental information.

Using concept maps, interviews, and ranking concepts exercises, I describe the predominant personal constructs held by both zoo visitors and non-zoo visitors, ages 14-18, and describe how these constructs might affect how zoos approach their educational programs. This research serves to add to the current visitor studies literature on a personal construct level, inform zoos of their impact on the personal constructs of students, and set a baseline for future research on conservation education in zoos. Careful consideration of the mental models students hold of zoos, may contribute to educating students about conservation. The identification of the patterns students form in the personal constructs of their mental models provides data which will begin a constructive dialogue about the educational choices zoos should make concerning the future of their programs and exhibits.

Organization of the Dissertation

Chapter I describes the purpose and rationale for studying the mental representations or expressed mental models of students. In addition it provides a brief overview of the research design.

Chapter II, the review of the literature, presents a foundation for this study by describing conservation education in zoos. Chapter II also provides an examination of education programs in zoos and the current challenges in the field. The literature review then moves to a discussion of personal construct theory and mental models theory, the research in regard to education, and the significance of the theories in explaining how people construct meaning of their environment.

The methodology used during this study is described further in Chapter III. This chapter describes the research paradigm and provides more detail about the Visitor Centered Evaluation Hierarchy (VCEH), including how this study is situated in zoo research. A detailed description of the participants for this study is provided. Moreover, the credibility, transferability, dependability, and confirmability of the study are addressed. This study utilized a variety of data sources: 1) a questionnaire, 2) a concept mapping activity, 3) interviewing and 4) a ranking concepts exercise. The concept map and the interview elicited a variety of descriptive data, which were analyzed using a systemic network.

Chapter IV presents the analysis of the data and the findings of the study. The concept map and interview data from this study were analyzed using a systemic network (Bliss et al., 1983; Tunnicliffe, 1996a; Tunnicliffe, 2000). The analysis and the findings

for each research question are provided and described. The counts produced by the systemic network are provided for the concept maps and interviews. The rankings for the ranking concepts exercise are also presented.

Chapter V includes a discussion and interpretation of the findings and salient themes. The Zoo Acuity Model is presented and includes generalizations and conclusions about the mental models of students of zoos. The research supports Conway's (2004) claim that zoo education and communication rarely reach the people they target. The dissertation ends with a discussion of implications that the findings may have on zoo policy and zoo education. Suggestions for further research are also included.

CHAPTER II

REVIEW OF LITERATURE

"Teaching about a living nature, that demands saving, is a compelling mission. Teaching about a world that no longer exists is much less so." (Nichols, 1996)

Of central importance to this study is the review of literature. Although, there is a significant body of research about zoos and zoo conservation, there is little literature on zoo conservation education. Additionally, there is sparse literature on students' understandings of the roles and purposes of zoos including zoo conservation education. As previously stated in Chapter I there are specific gaps in the literature concerning the understandings students hold of zoos.

This chapter provides a brief history of the literature that is available on zoo conservation education and students' understandings of zoo conservation education. Furthermore, in order to situate this investigation within the current literature a condensed review of the development of zoological institutions from menageries to conservation centers is included. A foundation for the study is built by introducing the roles of zoos and the educational experiences at zoos, including school visits and

exhibitry. Once the foundation for the study is ascertained through the literature, an explanation of mental models creates the study's framework.

Research on the Impact of Zoos

Research specifically documenting the impact of conservation messages in zoos is in its infancy (Swanagan, 2000). Studies which focus on the public understanding of wildlife and wildlife conservation fall into broad categories. First, public perceptions at the national level have been documented with specific analyses of those respondents who visit museums and zoos. Second, studies conducted at museums and zoos examine visitor learning at the adult level. Third, some studies examine the experience of children in leisure settings (Birney, 1995).

Studies of zoo visitors have addressed issues of audience, in terms of visitor demographics and motivations, visitor interactions with zoo programs and staff, the ever-changing purposes of zoo education and the educational components of zoos (libraries, animals, plants, signage) (Churchman, 1987). However a majority of the studies investigate public perception of animals, and pay little attention to the overall conservation messages conveyed in most zoos (Dierking, Burtnyk Bucherner & Falk, 2002). Though many of these same studies cited the potential for zoos to positively influence their visitors' conservation knowledge, affect, attitude, and behavior, these claims are not substantiated nor validated by actual research (Dierking et al., 2002). Little to no systematic research regarding the impact of visits to individual zoos and aquariums on visitor conservation knowledge, awareness, affect, or behavior has been conducted and presented at conferences and/or subsequently published. Very few studies have

investigated the overall impact of a visit or visits to an individual institution and across institutions (Dierking, et al., 2002).

There is a need for research that documents the impact of visits to zoos and aquariums on visitors' conservation knowledge, attitudes, awareness, affect, and behavior (Churchman & Marcoulides, 1991; de White & Jacobson, 1994). The best way to address the challenges of zoos is to evaluate the conservation impacts of zoos and visitor education (Hatchwell, Lattis, West & Zimmerman, 2004). Current trends in research often overlook the divergent and non-scientific ways children construct their understanding of animals, ecology, and conservation (Palmer, 1997; Myers, Saunders & Garrett, 2003).

Perceptions of Nature

Piaget (1929) suggested that children progress through four stages of understanding the concept of living organisms. Children in Stage I (up to age 6) attribute life to everything that performs a function or is active, including people, other animals, vehicles, the sun, and ovens, but not trees and other plants. In Stage II (ages 6-8), a child defines objects that have life as only things that move, for example, humans, other animals, vehicles, and the sun. However, at this level, ovens, trees, and other plants are not considered alive. Children in Stage III (ages 8-12) regard as living, only things that move on their own, for example, humans, other animals, and the sun. Finally Stage IV children (age 12 and older) either believe people and other animals are living or people, other animals, and plants are living. Children as young as five years recognize that inanimate entities, even ones that move and have functions, are not alive (Dolgin & Behrend, 1984;

Gelman, 1990; Richards & Siegler, 1984). In a study, carried out in three countries (Japan, Israel, U.S.), five to nine year olds who were interviewed knew that people, other animals, plants, and inanimate things were different types of entities with different properties (Hatano, et al., 1993).

According to E. O. Wilson's Biophilia hypothesis, humans have an innate desire to catalog, understand, and spend time with other life-forms (Kellert & Wilson, 1993). The Biophilia hypothesis states that all people are characteristically drawn to nature. They need to have an affiliation with nature in order to succeed and obtain the optimal level of self-value. Wild animals inspire our innate caring about species and nature because of their dependence on ecosystems, their beauty, and because we relate to them as sensing, perceiving creatures (Kellert & Wilson, 1993).

For most children, animals form a significant part of the world around them, whether as wildlife or pets (Tunnicliffe & Reiss, 1999a). Students have an understanding of pets and organisms with which they have daily contact such as squirrels, trees, grasses, birds, and ants, and have a grasp of these organisms' ecological relationships (Boulter, Tunnicliffe & Reiss, 2003). Industrialization and urbanization are reducing students' direct interactions with non-urban nature (Kellert & Wilson, 1993; Balmford, 1999). Due to the reduced contact with non-urban nature, interest in the variety of living things is perhaps becoming redirected toward human artifacts (Kellert & Wilson, 1993; Balmford, 1999). As the world becomes more urbanized, our personal experiences with animals become more isolated, in many cases limited to domesticated pets and urban species. However, owning a pet provides people with a limited knowledge of organisms (Kellert,

1980; Ascione, 1992). The omnipresent attitudes towards animals have been described by researchers as humanistic, showing little appreciation for non-urban wildlife in general. Lacking firsthand experiences with non-urban wildlife, much of the urban-American population has come to depend upon wildlife organizations, publications, and television programs for education, and to provide education for future generations (Wilkinson, 1997).

Research links loss of knowledge about the non-urban natural world to growing isolation from it (Habhan & Trimble, 1994; Kellert & Wilson, 1993). Ewart and McAvoy (1994) believe that many environmental, social, and educational problems are rooted in the lack of public knowledge about natural resources. Some psychologists believe that as humans separate themselves farther from non-urban nature the healing forces of nature and the animal kingdom are being left behind (Levinson, 1969) and that the distance is causing a psychological hindrance in humans (Shepard, 1982). For that reason, conservationists need to reestablish children's links with non-urban nature if they are to bridge the gap between children and their desire to conserve (Balmford, et al., 2002).

To quantify the knowledge children have of nature and the effects of human-made creatures on their innate interest in diversity, students in the United Kingdom were shown pictures of organisms and Pokémon flashcards and asked their names. Pokémon is a cartoon for children in which a variety of faux organisms interact with a young boy. At age 8 students could identify nearly 80% of a sample drawn from 150 synthetic Pokémon species. However when asked to name the real organisms, they named less than 50%. It appears that the creators of Pokémon are doing much better than conservationists at

inspiring interest in students (Balmford, et al., 2002). Educating children about the needs of all wildlife, instead of learning facts about animals, may be an approach that leads children to have an interest, appreciation, affection, and respect for non-urban species (Wilkinson, 1997).

Children (8-9 years old) in Urban Chicago were asked about their perceptions of their urban environment. Their perceptions of the urban environment were positive, but they perceived nature outside the urban environment as harmful or dangerous (Simmons, 1994). Despite this fear of the non-urban world some research shows that students believe the non-urban natural world is important. For example, students interviewed in an impoverished community in Houston, Texas, said that animals (84%), plants (87%), and parks/open spaces (70%) were an important part of their lives. Results also showed that it would matter to these children if polluting the bayou harmed birds (94%), water (91%), insects (77%), and the view (93%) (Kahn & Friedman, 1995).

People who belong to wildlife and/or environmental organizations, watch animal-related television programs, read books, or use a CD-Rom have a higher base of nature related knowledge than those who do not (LaHart, 1978; Westervelt & Llewellyn, 1985; Eagles & Muffitt, 1990; Tunnicliffe & Reiss, 2000; Boulter, Tunnicliffe & Reiss, 2003). Research shows that school plays a very small role in pupils' recollections of their sources of learning. Instead home is predominantly the source of knowledge, coupled with pupils' direct observations out of school (Tunnicliffe & Reiss, 2000; Boulter et al., 2003). Therefore, out of classroom visits and activities appear important in the development of knowledge. It may be that learning about wildlife in their natural habitat,

a responsibility towards these animals and a preservation of their habitats are closely linked (Wilkinson, 1997).

People have inaccurate attitudes and perceptions regarding animals (Bitgood et al., 1993; Tunnicliffe, 1994; Tunnicliffe, 1996; Tunnicliffe, 2000; Tunnicliffe & Reiss, 2000). In a national study of the American public, Kellert (1980) suggested that zoo visitors have a humanistic orientation to animals rather than a scientific one and score low on formal tests of animal knowledge. In a separate study, Kellert and Westervelt (1983) found that ecological and scientific knowledge of wildlife is low in children. Correcting such attitudes and perceptions is not automatic, nor is altering an individual's behavior in such a way as to change their destructive effect on the environment (Walker, 1991).

The Evolution of Zoos

Throughout the history of animal collections, people have placed great importance on the collection of both fauna and flora (Gray, 1991; Croke, 1997; Hancocks, 2001). During the times of early human the first wolf ancestor of the dog scavenged for food scraps and humans began an association which led to the first domesticated animal, triggering a fundamental shift in the human-wild animal relationship (Croke, 1997; Hancocks, 2001). Humans quickly discovered that dog ownership provided many benefits, such as security, amusement, devoted companionship and greater hunting success. However, it is suggested that the ultimate reason for wild dog ownership became prestige and power. Eventually, the idea of power and ownership became the reason for owning large collections of wild and domesticated organisms (Hancocks, 2001).

Historians believe the true start of animal collections, now called zoological gardens or zoos, but originally referred to as menageries, began in ancient Egypt (Dembeck, 1965; Hoage & Deiss, 1996). The animal collections consisted of lions, baboons, bulls, snakes, hippopotami, antelope, gazelles, cattle, and crocodiles. Many of the early collections of animals included both domesticated and exotic animals and were used for hunting, personal satisfaction and entertaining guests (Hoage & Deiss, 1996).

Crowds were allowed to watch lions being fed live prey at local temples. Horsemen and gladiators were sent into battle against hundreds of bears and lions and occasionally, the coliseum would be flooded to accommodate fights against hippos, seals, and crocodiles (Croke, 1997). Due to the increase in trade between nations, animals became a political pawn. The gift of an animal was seen as powerful for both the gift giver and the receiver (Baratay & Hardouin-Fugier, 2002). Ownership of such animals was considered proof of wealth and stature (1997).

The first zoo to open to the public was the Vienna Zoo (Schönbrunn) in 1752 (Vienna Zoo, 2004). The Paris Botanical Garden was opened in 1635 and opened its menagerie in 1793 (Paris Botanical Garden, 2004). The London Zoo opened in 1828, as the first scientific zoo, housing organisms being studied by scientists. In 1847, the London Zoo was opened to the public (London Zoo, 2004).

Even though people were curious about the collections of fine animals owned by others, public access to zoos emerged slowly (Koebner, 1994; Baratay & Hourdouin-Fugier, 2002; Croke, 2002). During the sixteenth century, menagerie access was mostly restricted to friends of the owners or honored guests. During the seventeenth and

eighteenth centuries gardens and menageries were opened to the public (Baratay & Hardouin-Fugier, 2002). Upon entering the nineteenth century, private collections were opened to the public (Croke, 1997; Baratay & Hardouin-Fugier, 2002).

In the second half of the seventeenth century, places where animals were kept as collections were called menageries (Baratay & Hardouin-Fugier, 2002). The term menagerie was first used, in 1664, to describe a collection of animals at Versailles (Baratay & Hardouin-Fugier, 2002). Zoo design was limited primarily to the construction of individual enclosures, or cages, for animals with safety for humans as the main concern. The ability to see the animals was secondary. The relationship between the organism and its natural environment was not considered in menagerie design (Koebner, 1994; Croke, 1997).

During the eighteenth century many people were exposed to exotic animals at local fairs. Traveling showmen gave the public the chance to see wild animals. The animals in traveling shows were often taught entertaining tricks. The first traveling animals were an elephant, a rhinoceros, monkeys, and lions. In the United States, traveling shows and menageries were flourishing by 1813 (Baratay & Hardouin-Fugier, 2002).

The Philadelphia Zoo is considered to be the oldest zoo in the US, because its charter was approved in 1859, but the Civil War delayed its opening until 1874. While the Philadelphia Zoo was awaiting its opening two other zoos opened; the Central Park Zoo in 1861 and the Lincoln Park Zoo in 1868 (Croke, 1997).

During the mid-eighteenth century, zoos were designed around taxonomy or the physical characteristics and relationships of the animals (Rabb, 1994; Hoage & Deiss,

1996; Harrison, 1991; Karkaria & Karkaria, 1998). Interpretation was restricted to the name of the animal and comparative anatomy and physiology (Karkaria & Karkaria, 1998). Little was done to promote the understanding of ecological relationships and the importance of habitats.

As zoos became a public institution in the nineteenth century, it became imperative that zoos spend time deciding how to best share the zoo's collections with visitors (Koebner, 1994; Croke, 1997). The need to provide visitors a place for public viewing gave rise to exhibits. Zoo exhibits are defined as a space in which one or more animal specimens form the focal point (Tunnicliffe, 1996). Toward the end of the nineteenth century scientific study of the animal species found in zoos became more popular (Harrison, 1991).

The 20th Century Zoological Park or Living Museum was designed to show the natural habitat of the animal in an enclosure. Ecological themes were introduced and the information conveyed concerned the habitats of animals and their behavioral biology. The exhibits were often moated enclosures designed to be similar to the animal's natural habitat (Koebner, 1994; Hoage & Deiss, 1996; Croke, 1997; Harrison, 1991; Baratay & Hardouin-Fugier, 2002). The exhibit enclosures consisted of artificial rockwork of varying quality, sparse vegetation, and larger areas for the animal. The view of the visitor became more important. Moreover, animals were arranged zoogeographically into regional settings (Koebner, 1994; Hoage & Deiss, 1996; Croke, 1997; Harrison, 1991; Baratay & Hardouin-Fugier, 2002). However the emphasis was on the exhibit itself not science or education (Karkaria & Karkaria, 1998).

The Modernism Era followed the zoogeographic arrangement era. The issue of health and sanitation became important and animal enclosures were converted to glass-fronted, laboratory-like enclosures. The rockwork of the previous era was changed to plain walls of concrete and masonry. Interpretive messages of this era tended to be expanded labels with information presented in lists or outline and were placed outside the reach of the visitor. Signs were placed within the enclosures (Koebner, 1994; Hoage & Deiss, 1996; Croke, 1997; Harrison, 1991; Baratay & Hardouin-Fugier, 2002).

In the Post Modern Era the architectural style was sleek and futuristic and so are the graphics. Computer graphic style signage competes with the live exhibits for attention. Animal shows are also part of the post-modern zoo (Koebner, 1994, Hoage & Deiss, 1996). In the post-modern era interpretive messages are restricted to animal behavior and other fascinating or entertaining facts (Croke, 1997; Harrison, 1991; Baratay & Hardouin-Fugier, 2002).

Zoos in the 21st Century are still evolving. The exhibit style associated with the future zoo is habitat immersion, which surrounds visitors with artifacts and educational stimuli directed towards a particular subject. In an immersion exhibit, there is a central theme, such as an ecosystem, region or country and everything in the exhibit is oriented to that theme. Thematic elements contribute to an integrated picture of the organism's habitat (Karkaria & Karkaria, 1998). An immersion exhibit is an enclosure design in which the visitor feels like they are a part of the enclosure. The enclosure is landscaped with the use of both real and artificial material, giving the visitor an impression of the animals' real habitat. This is important as the first goal of interpretation is to present an

animal in relation to its habitat. The interpretive design at such exhibits is unobtrusive (Koebner, 1994; Hoage & Deiss, 1996; Croke, 1997; Harrison, 1991; Baratay & Hardouin-Fugier, 2002).

The Role of Zoos

The role of the zoo in society has changed greatly over the last fifty years. Zoos emerged in the early era of human as a place of pleasure and curiosity, but have evolved into scientific facilities which serve to discover, educate, entertain, and conserve. The original pedagogical approach of zoos was to display animals in rows of enclosures so that people could see strange creatures and make comparative observations of the physical form of different species. Due to the deteriorating link between humans and the non-urban natural world, zoos are coming under pressure to impart information, and educate people. Zoos have evolved to include education as a priority along with conservation and research (Karkaria & Karkaria, 1998).

As zoos developed during the 1960s they saw themselves as having four functions: recreation, education, research, and conservation (Nichols, 1996). In the 1970s, as ecological concerns began to emerge, zoos could no longer justify themselves as primarily entertainment facilities and started to consider making conservation their central role. Conservation, and education about conservation, became their focus (Hancocks, 2001). During the 1970s, zoo professionals began conservation programs and the American Zoo Association maintained that conservation had become its highest priority (Hancocks, 2001). Today, zoos work to bring conservation to the forefront of their educational programs. Zoos have the potential to shape public opinion, to encourage

empathetic attitudes toward wildlife, and to educate the public about ecology, evolution, and wild animals. Zoos offer an educational opportunity to come in contact with Nature (Hancocks, 2001).

The Evolution of Zoo Education

The Bronx Zoo in New York opened its education department in 1929 (Schwammer, 2001) and the idea that the public could be educated in zoos spread in the 1930s (Baratay & Hardouin-Fugier, 2002). A greater interest in natural history education also emerged as contact with non-urban nature began to dwindle. In Europe the first major European zoos to develop educational programs were the London Zoo in 1958 and Frankfurt Zoo in 1960 (Schwammer, 2001).

Post and Herk (2002) outlined four phases of education in zoos: Phase I: The Prehistoric Period, Phase II: The Island Educator, Phase III: The Recognized Educator, and Phase IV: The Utilized Educator. During the Prehistoric Period zoos did not have education departments or an educational influence. Curators were expected to design the primary educational feature, signage. From 1960 to 1980 the Island Educator was identified was a misfit, but was tolerated by colleagues and isolated from the rest of the zoo. Education departments developed to educate school children and design informative educational signage. In the 1980's the Recognized Educator was not involved in zoo design but was expected to implement the nature conservation message. Education was evolving into an important part of the mission of the zoo. Today the Utilized Educator is recognized as important and has an active voice in the design of new exhibits. The

educational role of the zoo is recognized as important in the mission statements of the zoo (Post & Van Herk, 2002).

Today, zoos are in a position to share their message with the world. The future of zoos and environmental change may be closely linked. Zoos and aquariums will be caretakers of life in an ongoing extinction crisis (Kellert & Wilson, 1997). E. O. Wilson (1993) stated that zoos must do three things to protect biodiversity: 1) educate, 2) argue, and 3) explain. It is the zoo's task to explain how nature works and how we are all directly tied to the intricate web of biological diversity. In their explanation, zoos should include extensive details of the fundamental nature of the animal-plant interdependency (Nichols, 1996). The effects of diminishing human/non-urban relationships have affected humans psychologically. Humans are losing touch with non-urban nature and the consequences of the decline of nature. Now is the time for zoos to motivate members, visitors, and the public to become involved in preserving nature (Nichols, 1996). The mission of the zoo should embrace species survival and education about the environment and should take into account how the zoo will reach visitors with its conservation message (Kellert & Wilson, 1993; Koebner, 1994).

Zoo Education

Zoo education programs are moving away from strictly taxonomic and natural history themes toward ecological interpretation and conservation implications (Hunt, 1993). Zoos are becoming more aggressive in their conservation education efforts (Thurston, 1995). Nearly all zoos, including small zoos, in the U.S., Europe and Australia have Education Departments (Walker, 1991; Heimlich, 1996). A living animal collection

is the attraction of zoos and is potentially educational, but education is not automatic (Walker, 1991). Zoo professionals are focusing on finding ways to develop the knowledge and feelings that motivate visitors to conservation action (Anderson, 2001). Supporting the message of the importance of conservation education is more than adding an attractive sign or designing a nice enclosure (Walker, 1991; Croke, 1997). Educational opportunities in zoos arise out of the human reaction to the wonders of the zoo (Resnicow, 1994).

One in ten people on the planet visits a zoo or aquarium (Beirlein, 2003), thereby coming in contact with exhibits. The exhibit is the area in which a visitor may view an organism, therefore, becoming the interface between the zoo and the visitor. Indeed, exhibits are believed to be the outward manifestation of the zoo's soul (C. Vernon, personal communication, December 12, 2004). Thus, the design and operation of an exhibit should demonstrate a dedication to the zoo's values and should convey a conservation message (Beirlein, 2003).

Zoos spend millions of dollars, each year, to build exhibits that educate visitors through creative, interactive technology, and graphics (Swanagan, 2000). Often, exhibits provide knowledge-based information. Even though people tend not read graphics, many exhibits have graphics with natural history facts, but information does not equal education (Bitgood, Formwalt, Zimmerman & Patterson, 1993). It is difficult to deliver informational or inspiring messages at an exhibit without the use of interpretation (Martin, 2000). Thus, the goal of zoo education should include working toward a new way of perceiving and living in our environment (Kolbert, 1995). More recently, exhibits

have focused on naturalistic designs which spotlight conservation issues. In the exhibit the public is encouraged to support the conservation issue by giving donations, practicing wise consumerism, signing petitions, writing support letters, or making phone calls to legislators (Swanagan, 2000). An example of this type of exhibit is the Congo Gorilla Forest at the Bronx Zoo, New York. The Congo exhibit includes two troops of lowland gorillas, a forest, and treetop lookouts. The exhibit involves zoo visitors in making conservation choices by asking them to contribute their exhibit admission fee to conservation projects in Africa (Bronx Zoo Congo Gorilla Forest, 2004). Visitors report increased interest in conservation after visiting such exhibits (Piper & Derwin, 1988; Ogden & Lindburg, 1991). The interest exhibits cultivate is important since zoos frequently cite the value of their exhibits in terms of influence on visitor behavior (Zucker, 1995).

The animal collection, the exhibit design, and the tone of the exhibits are all part of the educational opportunities visitors encounter while visiting an exhibit (Croke, 1997). Therefore, exhibit design is an important part of the zoo's educational message (Vernon, personal communication, December 12, 2004). An exhibit provides zoo educators with only an instant to capture, hold, and engage attention (Roberts, 1994). Increasingly, institutions are using interpretive layering, which provides information in small, layered levels so that visitors can choose to absorb the essence of the exhibit without filtering through complex descriptions or discussions. A trend in exhibit interpretation is in simplifying information to reduce the cognitive difference between the scholarly viewer and the lay person (Watkins, 1994).

In general, zoo professionals believe that naturalistic exhibits, such as the Congo Gorilla Forest, increase the affective impact on visitors by offering a view of the animal in the context of its natural environment (Coe, 1985; Finlay, Patterson & Maple, 1988). In 1992, Doering compared the general public's familiarity with the issues of tropical rain forest conservation before and after experiencing the Smithsonian Institution's traveling Tropical Rain Forest exhibit and explored whether prior knowledge about rain-forest issues differed measurably between those groups. The results of that study suggested that the exhibit was valuable both in reinforcing awareness in individuals with prior exposure to a topic and in introducing the same issues to visitors who had no such prior exposure. In addition these large exhibits, with better viewing opportunities and active species in close proximity have been shown to attract more visitors for longer periods of time (Lessow, 1990).

Exhibits cannot say everything by themselves, thus they need to be designed with conservation messages in mind. Zoos are not ‘meaning makers’ and visitors are not ‘meaning takers’ (Beirlein, 2003). Visitors construct their own meanings from what they already know and see (Craik, 1943). The physical contexts zoos offer, or exhibitry, are just one of many factors involved in the construction of these meanings. If during the course of a visit, people communicate with others and develop an aesthetic connection with animals and the concept of habitat, zoos can be deemed as making some progress (Dioum, 1968). Zoo educators should consider the extent to which viewing animals enables visitors to better understand conservation, and whether the messages explicit within the exhibits reach the visitors (Tunnicliffe, 2001). As zoos continue to use exhibits

as an educational tool the exhibits should engage, inspire, and empower zoo audiences toward specific conservation goals (Martin, 2000).

No matter how zoos choose to get their message to visitors, education is the zoo's most important conservation function (Walker, 1991). However, even though people recognize zoos as educational institutions, few people visit zoos to be educated; they want to be entertained (Martin, 2000). Adults who recognize the educational importance of zoos do not visit the zoo intending to learn, but rather encourage their children to learn (Lessow, 1990).

Zoo education should go beyond information about animals because knowledge about animals and attitudes about them have a low correlation (Kellert & Westervelt, 1983). Merely providing information about an animal increases knowledge but does not promote more positive attitudes (Morgan & Gramann, 1989, LaHart, 1978). Providing information about animals without giving students direct encounters with animals in their habitats can result in only a basic understanding of how the organism depends on its environment (Kellert & Westervelt, 1983).

In a report to the Zoological Society of Philadelphia (1989), Dunlap and Kellert looked at the impact of nonformal education on shifts in factual knowledge, basic attitudes, ethical concerns, and conservation awareness of zoo visitors. Visitors failed to gain any appreciable knowledge of conservation. Knowledge was largely restricted to basic issues of animal appearance or behavior. Visitor interest in and awareness of wildlife conservation does not increase after a single visit to the zoo (Sims, 2004; Zoological Society of Philadelphia, 1989).

> The range of public beliefs and attitudes towards the role of zoos in conservation has not been fully investigated and needs to be better understood in order to determine to what degree zoos do play a vital role in conservation and whether they are successful in their attempts. The visiting public's attitudes and perceptions also serve as a barometer of success of the zoo's efforts to elevate the public consciousness regarding environmental issues. If the visitors are not aware of the zoo's conservation aims, then the zoo is not effectively conveying its message, hence not fulfilling its educative role. (Tunnicliffe, 1995, p. 24)

School Visits

School visits to zoos are arranged with educational and, occasionally, declared social objectives in mind (Tunnicliffe, 2001). The zoo provides a safe place in which students can practice their social skills (Tunnicliffe, 1994). Although people often visit zoos for social reasons (Tunnicliffe, 2001), parents (Rosenfeld, 1980), and schools (Tunnicliffe, 1994) cite education as one of the objectives of zoo visits. Many times school parties come to the zoo with defined educational objectives (Tunnicliffe, 1994). Teachers cite conservation as a part of their objectives. An international survey (Tunnicliffe, 1994) conducted in 1992 among school teachers who arranged a field trip to a zoo revealed that of 147 respondents, 110 (75%) said that they considered conservation an important aspect of their visit, but only 65 (44%) cited this as a focus topic, and 85 (51%) said conservation was not a theme they would study. Those teachers who affirmed the topic's importance in their pupils' education also said that they brought the children to the zoo to study conservation (Tunnicliffe, 2001). Despite the conservation objectives of teachers and zoos, students do not talk about conservation issues to any great extent during a zoo visit. Data (Tunnicliffe, 1995) have shown that school groups in zoos talked about

conservation significantly more ($p < 0.005$) than did the family groups, albeit infrequently and to a very slight extent. There were few conversations about the natural habitat of the animals, despite a significant number of teachers having indicated in the world-wide survey that learning about conservation was one of the reasons for taking their pupils to the zoo (Tunnicliffe, 1994). However, the increased mention of conservation among the school visitors suggests that either the teachers had heightened the children's awareness of this topic or that the zoos involved had presented the conservation message more successfully for school groups than they had for families (Tunnicliffe, 2001). Present research will seek to get a clearer view of the relationship between the mental models students hold of the purpose of a zoo and the role of the zoo in conservation.

Five percent of zoo visitors in the United States are teenagers (Wineman, Piper & Maple, 1996). However, teenagers are the most neglected age group during zoo planning (Wineman et al., 1996).

To reach teenagers, zoos are developing collaborative relationships with schools. As early as 1973, the Jr. Zoo Crew at the Atlanta Zoo provided at-risk teens an opportunity to volunteer to participate in animal care, conservation research, food service, and warehouse work. The Atlanta Zoo also allowed the student volunteers to participate in workshops and discussion sessions concerning conservation policy (Brown, 1973). The Trevor Zoo, in Millbrook, NY, allows students to participate in the daily care and management of organisms and conduct extended research studies (Wineman et al., 1996). Students, who live near the Bronx Zoo and are having academic difficulty, are given on

the job training in husbandry by zoo staff (Wineman et al., 1996). The Durrell Conservation Organization, on Jersey Island in the Channel Islands off the coast of France, provides a program for students 12 and older in which students go behind the scenes to work with animal staff. During each visit to the zoo, students develop food packets which they feed to animals (personal observation, 2003). To utilize students as educators of other young people, the San Francisco Zoo employs teenagers as interpreters. The teenagers are stationed along a trail with live animals where they do educational demonstrations (Wineman, et al., 1996). Staff members of the Minnesota Zoo and teachers and administrators from Independent School District 196 created an optional high school founded on a professional partnership. The school district wanted to create a small, optional high school as a solution for overcrowding; the teachers were looking for a way to incorporate integrated learning into an experiential setting; and staff members from the zoo wanted to create an outreach program to enhance the zoo's connection to the community. As a result of the zoo-school partnership, students do research in a zoo and present their findings (Tunseth & Nowicki, 2003). These innovative partnerships offer a foundation upon which to build future programs between students, schools, and zoos.

In addition to the programs between zoos and schools, ex-situ zoo education programs are being designed. For example, conservation action stations in zoos, malls, parks, and other public areas could engage people in educational interactives, give them information about the zoo and conservation action, and encourage them to write letters to governmental representatives (Wineman et al., 1996). Moreover, zoo education specialists are designing summer camps, overnight stays, zoomobiles, lab sessions, and

workshops (Wineman, et al., 1996). The next step in developing effective educational programs is to evaluate existing programs and the knowledge of zoo visitors and non-visitors.

The Goal of Zoo Conservation Education

Children have an inherent desire to run after butterflies, love beautiful birds and wild places, and want to make friends with elephants and tigers. (Pandey, 2003, r2)

The ultimate goal of conservation education concentrates on generating knowledge and developing and raising awareness and concern about nature (Bogner, 1999). People care about what they know (Habhan & Trimble, 1994; Kellert & Wilson, 1993). Many educators and instructors automatically assume that conservation education brings an individual closer to nature, which, in turn, positively affects her/his environmental ethics (Bogner, 1999). However, as previously stated, humans are losing their awareness of the importance of interdependence or sharing the planet with other species (Hancocks, 2001). A vital part of conservation education should assist people in realizing that they share a world with other beings who have needs similar but not identical to the needs of human beings (Naherniak, 1995). By developing the awareness children have of nature, the children will, in turn, develop confidence, empathy, and respect for others (Naherniak, 1995). Zoos have the opportunity to fill the gap between education and awareness and assist in refocusing our views of wild animals and places (Wilkinson, 1997).

In effect, the primary reason cited for visiting a zoo is for the educational benefit of children (Kellert, 1980). However, zoos have to be aware of their educational limitations. The knowledge scores of those who visit a zoo are not significantly different from those of non-visitors (Kellert, 1980). Through good communication skills, zoos have the opportunity to educate the public on the needs of saving animal species from extinction and preventing habitat destruction (Hutchins & Conway, 1995).

What Visitors Bring to a Zoo Visit

The zoo education staff is ultimately responsible for creating the opportunities for learning that may arise from the experience of the visit (Kellert & Westervelt, 1983). However, visitors come to the zoo with an array of experiences and lifelong constructed knowledge. Often, zoos need to correct misinformation before new or desired learning can occur (Borun, Massey & Lutter, 1992). Attractions themselves present experiences and it is the nature of an experience to be determined and interpreted largely by the individual (Boud, Keough & Walker, 1985).

Perceptions influence the way individuals evaluate the external world (LaHart, 1978). A person can tell you about him or herself thus helping you to get to know this person. This is a different kind of knowing and it suggests that getting to know a broad range of people provides an educator with exemplars of what people in general are like (Coburn, 1995). Interpretive researchers do not expect that the procedures of experimental natural science can ever be used to produce general laws of education. Rather one must come to a greater understanding of what meaning is and how it is created (Coburn, 1993). As educators gain knowledge of what students bring to a

situation, educators gain insight on how learning environments can be more effectively designed. The more educators know about the mental models of students, that which students believe, the better educators will be able to teach (Coburn, 1995).

Mental Models

The emergence of the cognitive sciences in the 1960's instigated new ideas, orientations and terms in the research field. Some of the various terms that are used by researchers in order to describe the mental models of students are: representations, social representations, ideas, alternative frameworks, intuitive notions/ideas, conceptions, alternative conceptions, misconceptions, preconceptions, and obstacles (Craik, 1943; Driver, Guesne & Tiberghien, 1985; Johnson-Laird, 1990; Munson, 1994; Tunnicliffe, 1995; Leach, Driver, Scott & Wood-Robinson, 1996; Mangas, Martinez & Pedauye, 1997; Maskill, Cachapuz & Suarez, 1993; Vosniadu, 1998).

I will first describe physical representations and mental representations, a generic term inclusive of mental models. Then I will discuss schemata, mental structures, and conceptual models and their significance for my proposed study. Mental representations have been described and revisited in cognitive education for decades (Craik, 1943; Gentner & Stevens, 1983; Johnson-Laird, 1983; Paivio, 1986; Brewer & Samarapungavan, 1991; Vosniadou, S., & Brewer, W. F. 1994; Garnham, 1997; Glynn, 1997; Tunnicliffe & Reiss, 1999; Tunnicliffe & Reiss, 2000; Seel, 2001; Gilbert, Treagust & Gobert, 2003; Krcmar & Curtis, 2003). Theories of mental representations in general and mental models in particular, deal with form and function of individual knowledge. The idea of mental representations and how that information is used to

interact with the world is approached in three general theories: 1) Paivio's (1986) classification of mental representations, 2) the theory of mental models (Johnson-Laird, 1983; Bucciarelli & Johnson-Laird, 2005), and 3) mental models of natural phenomena (Gentner & Stevens, 1983).

Paivio (1986) applied physical representations to mental representations. Physical representations can be picture-like or language-like. Mental representations are descriptions and classifications devised for physical representations (Paivio, 1986). Picture-like representations may be photographs or drawings, whereas language-like representations are verbal descriptions of objects. Picture-like representations may be more useful in aiding in identification. For example, if a person has seen a picture of the Statue of Liberty they are more likely to recognize it during a visit. If a person has seen the statue during a visit they are more likely to recognize the statue in a picture. However, if a person has only heard a description or read a description of the statue, they may not recognize it in a picture or during a visit. Since this study does not take into account physical representations of zoos, it is necessary to go back to the foundation upon which Paivio built his theory, mental models.

Mental models are individual interpretations, rather than an objective analysis of the real world (Day, 1999), reflecting a person's representation of an idea, an object, an event, a process, a concept or a system (Kyllonen & Shute, 1989; Gilbert & Boulter, 1998; Jewell, 2002). Mental models may also include procedural knowledge, such as rules and skills, or assumptions (Kyllonen & Shute, 1989).

Mental models, although resistant to major changes (Vosniadou, 1998), are naturally evolving. Mental models do not have to be technically accurate, but they must by functional. People use mental models to interpret events and then the interpretations, the new mental models created become the lens through which to view new events. Forrester (1971) suggests that although decisions are made on the basis of mental models, the models may be vague, incomplete, and imprecise. Mental models will be constrained by such things as the user's technical background and previous experiences (Gentner & Stevens, 1983).

Cognitive science is the study of how we think and how we make sense of our world. Cognition means coming to know through internal processes such as learning, perception, comprehension, thinking, memory, and attention (West, Farmer & Wolff, 1991). The internal processes of cognition and knowledge representations form mental models (Kim, 1993b). Examining and explaining schemata, concepts, conceptual models, and expressed models will help better explain the idea of mental models.

Mental models play an active role in the learning process defined as the acquiring of knowledge or skill. We generate knowledge when we give meaning to information or experience (DiBella & Nevis, 1998). Mental models affect what we experience by interpreting and giving meaning to what we experience. Mental models provide the context in which to view and interpret new material, and they determine how stored information is relevant to a given situation (Kim, 1993). Mental models are data structures constructed to make sense of events (Senge, 1990; Stata, 1994) and to

represent a person's view of the world, including explicit and implicit understandings (Kim, 1993).

Are we defining schemata or mental models? Schemata are the building blocks of mental models. Mental models are creations of the moment (Brewer, 1987). Schemata are hierarchal data structures consisting of the information and the rules for organizing the information. (Neisser, 1979; Rumelhart, Smolensky, McClelland & Hinton, 1986). Mandl, Friedrich & Hron (1988) define schemata as cognitive structures in which general knowledge is represented in memory. A schema of an action is defined as the structured totality of the characteristics which allow one to repeat an action and apply it to new circumstances (Piaget, 1950). In modern cognitive psychology schemata are understood as generic data structures which play a central role in the interpretation of perceptions, the regulation of behavior, and the storage of knowledge in memory. In Piaget's theory of equilibration a schema mainly serves to assimilate new information into existing knowledge structures. A schema is activated (Rumelhart et al., 1986) when there is a match between what is occurring and the essential variables in a schema. When schemata are activated they allow certain information to be assumed that has not actually occurred. For example, when someone walks into a restaurant they may not see the cook but they presume there is one. Schema may be preconceptions or expectations that guide perception and action. Flawed, incomplete and missing schema, therefore, result in inaccurate perceptions (Neumann, 1990).

Cognitive psychology is concerned with the construction of symbolic models of information processing understood generally as the capacity of the human mind to

construct knowledge, to interpret the world and to reason in a deductive or inductive manner (Seel, 2001). Schemata form the basis of the construction of models (Seel, 1995). According to Piaget, the fundamental basis for the development of mental representations is based on the development and gradual refinement of assimilative schemata (Piaget, 1985). Cognition and learning take place in the use of mental representations in which individuals organize symbols of their experience or thought in such a way that they effect a systematic representation of this experience or thought, as a means of understanding it, or of explaining it to others (Seel, 1995). Cognitive learning occurs when people actively construct meaningful representations, such as coherent mental models, that represent and communicate subjective experiences, ideas, thoughts, and feelings (Mayer, Moreno, Boire & Vagge, 1999). Mental models allow one to perform actions entirely internally and to judge the consequences of actions, interpret them, and draw conclusions based on them (Rumelhart, et al., 1986). By means of mental representations an individual is capable of simulating real actions in the imagination (Seel, 2001).

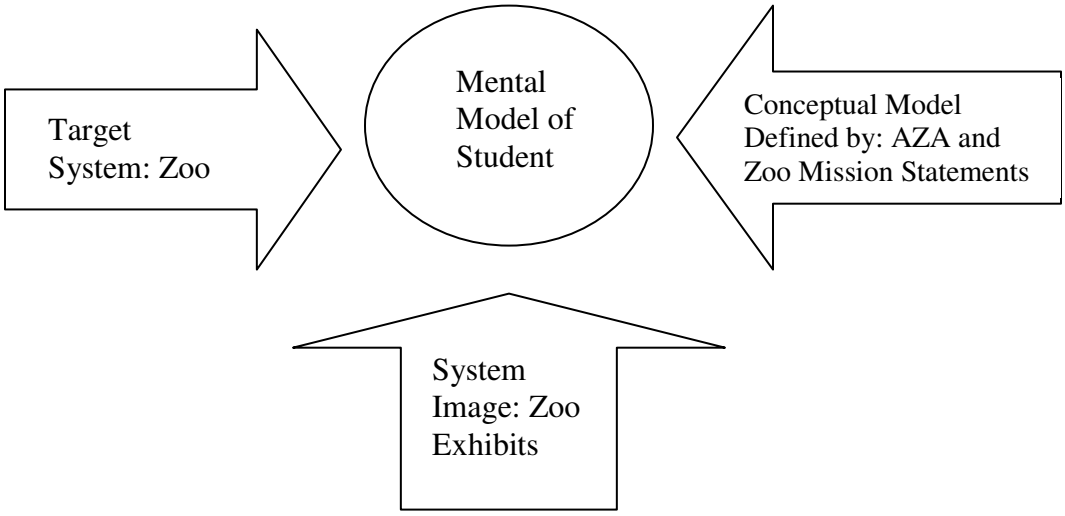
Concepts are the mental structures by which we represent meaningful categories (Bruning, Schraw & Ronning, 1999). Objects or events with perceived similarities are grouped together and are examples or instances of the concept. For example, *bird* is a concept, and robin, cardinal, and blue jay are instances of this concept (Markman, 1999). Similar features across examples of a concept are called attributes and essential features of a concept are called defining attributes. The internal knowledge representation of a concept includes the defining attributes and the rules that relate the attributes to one another. Mental models, however, unlike isolated concepts, are situated, contextualized,

and perhaps richer than individual concepts. That is, when a mental model is activated, an entire event or situation may have been called to mind. If we assume this richer context in the model, we are better able to account for a longer effect (Krcmar & Curtis, 2003).

People form internal, mental models of themselves and of the things with which they are interacting. The mental models provide an opportunity to understand, predict, and explain the interaction. Mental models have four aspects: the target system, the conceptual model of the target system, the user's mental model of the target system, and the scientist's conceptualization of that mental model. The system the person is using or learning is the target system. A conceptual model is invented to provide an appropriate representation of the target system, appropriate in the sense of being accurate, consistent, and complete. Conceptual models are fashioned by teachers, designers, scientists, and engineers (Genter & Stevens, 1983).

Conceptual models are devised as tools for the understanding or teaching of physical systems. The conceptual model is used to design the target system. The conceptual model governs the human interface with the system, so that the image of that system seen by the user is consistent, cohesive, and intelligible. The image formed by the system is called the system image. All operations and educational information should be consistent with the system image (Genter & Stevens, 1983). For this study, the target system is the zoo, the conceptual model is defined by AZA and the zoo's mission statement, the system image is the zoo's exhibits, and the mental model is what the student's have in their heads. See Figure 2.

Figure 2. Target System, Mental Model, Conceptual Model and System Image



Based on constructivist theory, the initial role of the researcher or teacher is to assess students' prior knowledge. By linking new concepts to previous ones or by causing students' dissatisfaction with their current schema the process of conceptual change begins. If a constructivist learning theory is to be followed in zoo education, then uncovering students' current knowledge structures is the first step. When teachers or researchers ask subjects about their understandings of a topic, subjects respond by presenting representations through words, mathematical symbols, drawings, physical constructions, or gestures (Bruner, 1964). Students' representations that have been placed in the public domain may be viewed as the expressed models (Buckley, Boulter & Gilbert, 1997; Gilbert & Boulter, 2000). These expressed models are assumed to be generated from mental models. The only way for a researcher to understand a subject's mental model of a particular phenomenon is by eliciting one or more of their expressed

models of that phenomenon. Expressed models are external representations of the target system generated from one's mental models and expressed through action, speech, written description, and other material depictions (Gobert & Buckley, 2000).

Mental models are occasionally classified into two co-existing kinds: espoused theories, and theories-in-use. The espoused theory is the mental model which people will say they hold if asked to explain or justify a given pattern of activity. This may differ from the theory-in-use, which is the mental model that is implicit in the performance of that pattern of activity. You cannot ask someone to describe their theory-in-use, you can only hypothesize and test it by observing their actions. (Argyris & Schon, 1996). In addition to two kinds of theories, mental models research also has two goals. First, mental models research can be characterized by the way people understand some domain of knowledge and applying this understanding to better teach and test for this knowledge. Second, the fundamental goal of mental models research is to understand human knowledge about the world (Genter & Stevens, 1983).

The theory of mental models provides a basic theory for understanding how people think about the world. As such, it provides a foundation for understanding Kelly's Theory of Personal Constructs. Kelly's Personal Construct Theory is based on the fundamental postulate that a person's processes are psychologically channeled by the way in which she/he anticipates events (Kelly, 1955; Kelly, 1970; Kenny, 1984). Kelly stated that people differ in their construction of events in that they evolve for their convenience a system embracing ordinal relationships between constructs. People may employ construct systems that are incompatible with one another. Kelly also believed that a person's ability

to interact in social processes is determined by the level of similarity in their construct systems (Kenny, 1984). An additional point raised by Kelly was that in order to understand what someone means by a construct or concept, it is necessary to know against what the person contrasts that concept. In other words, understanding something which is, also implies understanding what is not (Kenny, 1984). According to Kelly, each individual is living in a world of his or her own construction. The processes of sense-making or world-making are the processes by which we integrate our experiences into the process of constructing such worlds.

From a cognitive perspective, learning involves information processing activities such as storing, retrieving, transforming, and using information. Learning is the process of acquiring new operational and conceptual knowledge and memory is commonly thought of as "a storage device where everything we perceive and experience is filed away" (Kim, 1993, p. 39). However memory is not simply a static storage device. Mental models, a part of active memory, are an important concept in cognitive learning theory and are the focus of this study. Mental models "provide the context in which to view and interpret new material" (Kim, 1993, p. 39). Mental models are part of the process of acquiring new knowledge which is then stored in and retrieved from static memory. Craik (1943) advocated that we form the basis for which we reason and predict the outcome of events. Within this framework, mental models are considered internal constructions of some aspect of the external world that can be manipulated enabling predictions and inferences to be made (Rogers, Rutherford & Bibby, 1992).

This study is based on the following assumptions concerning mental models:

1. Mental models are internal representations shared with others through expressed models via interviews.
2. Language is the key to understanding mental models.
3. Mental models can be represented as networks of concepts.
4. The meanings for the concepts are embedded in their relationships to other concepts.
5. The social meaning of concepts is derived from the intersection of different individuals' mental models (Carley & Palmquist, 1992).

Johnson-Laird's (1983) theory of mental models asserts that humans represent the world they are interacting with through mental models. Mental models are a way of describing the process which humans go through to solve deductive reasoning problems (Johnson-Laird, 1983). In order to understand models for real-world phenomena, a person has to hold what Johnson-Laird (1983) describes as a working model, or perceptual model, of the phenomenon in his or her mind. For example, if a person is told or sees that there is a table in front of a stove and the table has four chairs, one on each side, the person will judge the remark or the view of the table being in front of the stove as true, if it corresponds to their perception of the world or their perceptual model (Johnson-Laird, 1983). Perceptual models allow a person to preserve properties from one model to another. In turn, when a person judges an assertion to be true, the person has related a model based on that representation to a model of the world (Kamp, 1981). Mental models are the attempts of a person to form an understanding of an unknown phenomenon by transferring inferences from an existing mental model to a new phenomenon (Johnson-

Laird, 1983; Van der Henst, Yang, & Johnson-Laird, 2002; Cherubini & Johnson-Laird, 2004, Johnson-Laird, Legrenzi, & Girotto, 2004).

Gentner & Stevens (1983) focus on the transfer from one internalized model to another and suggest that mental models are constructed through analogical reasoning. Gentner & Stevens' (1983) mental models theory specifically addresses the understanding people have of physical phenomena. This approach to mental models may be used to explain the understandings that individuals have of the behavior of objects according to the laws of physics. Gentner & Stevens offer mental models as analogies as an example of how people develop an understanding of physical phenomena such as heating and boiling and tools used to measure heat (e.g. a thermometer and a thermostat).

In Johnson-Laird's (1983) and Gentner & Stevens' (1983) mental models theories existing or prior knowledge has a considerable influence on reasoning about a new problem or phenomenon. There is a large body of research showing that prior experience plays a crucial role in the recall of information. The knowledge structures that have been invoked to explain these results include constructs such as frames (Minsky, 1975), schemata (Rumelhart & Norman, 1988), scripts (Schank & Abelson, 1977) and mental models (Gentner & Stevens, 1983; Johnson-Laird, 1983)

Mental models have been used in visitor studies to give a baseline of the understandings of visitors. For example, Tunnicliffe & Reiss (1999) used mental models to investigate what children know about animals. They gathered data by listening to conversations in exhibits and interviewing children as they reacted to preserved specimens in a school setting. Kiesler & Goetz (2004) wanted to determine the mental

models people hold of robotics. The researchers placed talking robots in a science museum. The robots asked people questions and asked them to take a survey. Since *A Private Universe* (Schneps & Sadler 1989), a video depicting the mental models students hold of basic astronomical concepts, was recorded, similar research has been done in planetariums to determine current astronomical mental models (Dussault, 1999).

A mental model is an individual's personal knowledge of a phenomenon (Duit & Glynn, 1996), in this case, of zoos. The personal knowledge of the viewer faced with questioning about zoos and their role in conservation will have both similarities to and differences from what zoos believe about themselves. The mental models students hold of a zoo may include organisms, reasons to visit, the role of the zoo in conservation, the role of the zoo in education, and social interactions. Viewers use their existing mental models as referents, and learning is about extending an existing mental model by utilizing new information (Johnson-Laird, 1983).

The purpose of this study was to begin to investigate the mental models high school students hold of zoos. Formulating clear and operational representations of the mental models students hold of zoos will aid zoos in developing conservation education programs. Chapter III describes the methodology employed to gather and analyze the data from student questionnaires, concept maps, interviews, and ranking concepts exercise.

CHAPTER III

METHODOLOGY

"Why does the sun set in the west? And why does my heart keep beating in my chest?...I got a PBS mind in an MTV world"

(Buffett & Mayer, 1999).

"And the end of all our exploring, will be to arrive where we started and to know the place for the first time" (Elliot, 1943).

The review of literature in the previous chapter revealed that there is little evidence that zoos, zoo visits, and educational programs at zoos affect the conservation-related knowledge of visitors. Moreover, the existing literature does not appear to be utilized by the zoo community when designing educational programs or exhibits. In *Visitor Learning in Zoos and Aquariums*, Sydney Butler wrote in his introductory letter,

> Inherent in most zoo and aquarium missions is a desire to change visitor behavior and attitudes, with the aim of creating a more environmentally aware and responsive population. Our institutions hope to increase awareness of conservation and conservation actions and that visitors will become better stewards of the environment, yet we lack the data to determine the extent to which we are successful. We're convinced of the value of our exhibits and programs, yet we are hard pressed to cite specific research when questioned. (Dierking et al., 2002, p. i)

In addition, Dierking et al. (2002) elaborate that since 1972,

> the presentation and treatment of animals by zoos and aquariums has greatly improved, but there is still a tremendous need for visitor research that truly documents the role that zoos and aquariums play in facilitating public understanding of conservation. (p. v)

Even when current research is available many zoos do not use the research to make changes in their approach to education. In the preface to *Learning from Museums* (2000) Spock states that:

> There seems to be a stubborn streak running through our profession that treats museum exhibitry and programming as a mysterious art, entirely dependent on the instincts and skills of the exhibitor and programmer, rather than being built on a growing common body of knowledge. There is abundant evidence that few of us seem to be paying attention to what we already collectively know…Especially disturbing are our colleagues who would not think of presenting information in exhibitions and programs that was not thoroughly grounded in the current research literature of their fields but who remain the most stubbornly inoculated from the influences of the learning theory and visitor studies literature. They just don't—or won't—get it. (Falk & Dierking, 2000, p. ix)

Since the inception of the Philadelphia Zoo in 1859, zoos have become a part of American culture. One hundred thirty-four million Americans visit zoological institutions annually (AZA, 2004). The American Zoo and Aquarium Association (AZA) describe the typical zoo visitor as "a married woman under thirty, who is accompanied by her child or children" (Croke, 1997, p.96). Older school children, ages 14-18, may be taken

to the zoo to study the behaviors of a particular animal (Croke, 1997). Most non-school group zoo visitors, however, visit zoos to witness the diversity of exotic species (Hoage & Deiss, 1996).

The purpose of this study is to bring to light the mental models students have of zoos. High school science students will each complete a questionnaire, a concept map, an interview, and a ranking concepts exercise in order to provide the investigator with some insights into their mental models of zoos.

The purpose of Chapter III is to describe the methodology used to investigate and evaluate the expressed mental models secondary science students hold of zoos. First, the questions for the study are provided. Second, a rationale for using a qualitative methodology is outlined and the issues of credibility, transferability, dependability, and confirmability are addressed. Third, Chapter III provides information that situates this study in the visitor studies literature. Fourth, data sources are reviewed. Fifth, the qualitative data gathering tools (concept map, interview, and ranking concepts exercise) used to explore mental models are explained. Sixth, is an explanation of how the qualitative data was analyzed using a systemic network.

Research Questions

Since the focal point of this dissertation was the mental models high school science students hold of zoos, this research focused on issues that were particularly relevant to zoos. The purpose of this study was to determine the mental models that high school science students hold of zoos by examining the individual realities of high school science students and their comprehensive explanations of the roles and purposes of zoos. The

approach embodied in this inquiry into the mental models students hold of zoos did not consider the validity of the world external to the perceptions students hold of the zoo, but did acknowledge the student as an individual being giving meaning to his/her reality, and did consider the expressed perceptions a student has of the zoo only a portion of their individual, total meaning of zoos, and the role of zoos in conservation. The method used to elicit the pertinent mental models is a qualitative approach based on a semi-structured, interactive interview, a zoo concept map, and a ranking concepts exercise. If zoos want to know what meaning students attach to a zoo and the role of a zoo in conservation, it is crucial to elicit this information from students.

The data sources for the investigation were a questionnaire, a concept map of a zoo, an interview, and a ranking concepts exercise. To collect this data nine intact secondary science classes were visited by the researcher. First, the investigator administered a questionnaire (Appendix C). Second, the investigator instructed intact classes on how to create a concept map and the class as a whole constructed a concept map of a 'mall' on the board. Then, all students in the class completed, without assistance, their own concept map of 'zoos'. Third, following an analysis of the questionnaires, students were selected and interviewed by the investigator. Fourth, students individually completed a ranking concepts exercise.

The previously mentioned data gathering tools were employed in order to answer the following study questions:

1. What are the understandings of high school science students of the roles and purposes of zoos? That is, what are the mental models students hold of zoos?

A. What are the differences in mental models students who have visited the zoo with a teacher in the last year (WTSS), who have visited the zoo with a teacher prior to this school year (WTASY), who have visited the zoo with someone other than a teacher (WOT) and who have never visited a zoo (NVZ) hold of zoos?

B. B. What are the differences in mental models males and females hold of zoos?

C. What are the differences in mental models of students of different ethnicities: African American, White, and Hispanic?

2. How do students define conservation and the role of the zoo in conservation?

Qualitative Research Paradigm

Many researchers agree that the research question should guide the choice of research methods and techniques (Hemingway, 2001; Hoepfl, 1997; Lee et al., 1999). Educational research currently features two paradigms or worldviews. Each paradigm represents a way of considering ourselves as researchers in relationship to the people or events we study. Additionally, paradigms become the underpinning upon which we set our beliefs about the nature of the world and how to inquire into those beliefs (Guba & Lincoln, 1989).

One perspective, or paradigm, is referred to as qualitative, naturalistic, or phenomenological. The other is known as quantitative, positivistic, or experimental (Bogdan & Biklen, 1982; Lincoln, 1990). Both research orientations embody certain

epistemological and ontological assumptions as well as beliefs about the role of the researcher, the research process and method, and convictions about the participants in the research process. In this study a qualitative approach was used to gather data.

Qualitative inquiry represents a sharp contrast to the mainstream of traditional scientific culture and its quantitative study of human phenomena (Taylor, 1977). Qualitative research has its origins in the behavioral and sociological sciences and measurement is primarily concerned with verbal and written descriptions and interpretations (Gall, Borg & Gall, 1996).

If cultural research is done without the consideration of the human experience the research will consist of a disjointed mass of processes, in effect losing the reality the researcher hopes to construct. By adding a human cultural perspective, qualitative inquiry becomes concerned with the inner person as s/he derives and constructs meaning. Qualitative inquiry begins to attribute the element of human consciousness that sets humans apart as a unique entity, hoping to understand people from their own frame of reference (Znaniecki, 1968).

Qualitative inquiry is a process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The qualitative research paradigm allows the investigator to obtain information from a variety of sources using various methods to understand the perceptions and perspectives of participants in the research setting. Investigators using the naturalistic method want to discover the nature of reality and believe that "reality construction cannot be separated from the world in which they are experienced" (Lincoln & Guba, 1985, p. 189). The naturalistic investigator

acknowledges that reality is constructed according to the experiences of the participant in the inquiry (Guba & Lincoln, 1989). Naturalists, for example, refer to the person engaged in the research process as the investigator and the participant is the focus of inquiry. The emphasis is on the subjective quality of the experience. Naturalists embrace and acknowledge the influence of participants and, in fact, assume that participants have not only multiple realities, but infinite adaptability as Lincoln and Guba (1985) phrase it. When it is decided to participate in this form of research, Mooney (1975) refers to researchers as producers in relation to their research. They are inquirers engaging in the process of examination with a full sense of their involvement as themselves in the process (Mooney, 1975).

Qualitative research is usually concerned with non-statistical methods of inquiry and analysis of social phenomena. It is a process in which themes and categories emerge through analysis of data collected by such techniques as interviews, observations, videotapes, and case studies. The investigator seeks to understand human experience by analyzing words, reporting detailed views of informants, building a complex holistic picture, and conducting the study in a natural setting (Creswell, 1998). Qualitative investigators believe the most important part of research is to "reveal both the processes by which people construct meaning about their worlds and to report what those meanings are" (Hull, 1997, p. 14). Qualitative research uses detailed descriptions from the perspective of the research participants themselves as a means of examining specific issues and problems under study (Haworth, 1984).

Quantitative and qualitative methodologies have different strengths and weaknesses and the reason for choosing a qualitative methodology revolves primarily around the type of question or problem to be explored (Lee, Mitchell & Sablynski, 1999). Garrison and Shale (1994) conclude that both types of research require rigor in developing knowledge, defining knowledge as the construction of information, and provide meaning for others in similar situations. The method and standard of establishing credibility are relative to the purpose and context of the research.

Qualitative research is used primarily for the purposes of description, interpretation, and explanation (Lee et al., 1999; Hoepfl, 1997; Nassar, 2001). Questions that begin with 'how' or 'what' lend themselves to qualitative study (Creswell, 1998; Lee et al., 1999). This study was interested in what students think and their constructed realities (Lincoln, 1990); therefore, qualitative approaches were used to gather data in the form of concept mapping, open-ended interviewing and a ranking concepts exercise. Selected participants engaged in an interview with the investigator in an effort to assist the investigator in understanding the meaning students make of zoos. However, the qualitative data were analyzed using a systemic network which allowed qualitative data to be analyzed quantitatively (Tunnicliffe, 1995).

The quality of the research is paramount if the findings are to be credible and usable. Each piece of research must be judged within the context of the community of scholars it represents (Garman, 1996). No matter the type of research used, it should conform to certain rules that serve as criteria by which to judge the soundness and trustworthiness of the research study (Marshall & Rossman, 1995). Engaging in qualitative research

demands an understanding of some of the criteria associated with doing this type of research. Qualitative research is based on a sound rationale—a logic that can defend the proposed study. Four alternatives to the criteria in a conventional paradigm have been proposed: 1) credibility, 2) transferability, 3) dependability, and 4) confirmability (Lincoln & Guba, 1985; Koch, 1994). The following sections define credibility, transferability, dependability, and confirmability.

Credibility

Credibility is the strength or the ability of the study to explore a problem or describe a setting, a process, a social group, or a pattern of interaction (Marshall & Rossman, 1995). The credibility, or trustworthiness, of a constructivist investigation aims to address the idea that the findings are worth paying attention to, that is, the results are really the results. Among the most cited criticisms of qualitative research are the presumed lack of reliability and validity of its findings. Critics question the ability of qualitative research to obtain correct answers or correct impressions of the phenomenon under study (Kirk & Miller, 1986). An inquiry should reflect the accurate depiction of the subject studied. Other criticisms concern the reactive effects of the presence of the observer or interviewer on the situation being studied and selective perception or bias on the part of the researcher. Also of concern has been the inability of the researcher to observe all factors that might influence the situation under study (McCall & Simmons, 1969; Schaffir & Stebbins, 1991). Qualitative research is more likely to address validity throughout the data collection and analysis process.

Credibility, during this study, was achieved by recording the interviews done with students, taking notes of words or topics students used during the interview and by only questioning students about topics they introduced to the interview. The investigator was careful not to lead students during the interview. The questionnaire, concept map, and ranking concepts exercise were done with all students in the classroom; therefore, insuring each student had a similar experience.

Transferability

Transferability is connected to the notion that the interpretations of the research can fit into contexts outside the study situation. Additionally, transferability is heightened when the audience under study views the research findings as meaningful and applicable in terms of their own experiences. In a strict sense, transferability is impossible because the investigation is defined by its time and context. Qualitative inquiry accepts that transferability is a fallacy because context is critical. In other words, qualitative inquiry is context-dependent. Not only does perspective differ from person to person, but each situation has different meaning for each participant (Habermas, 1971). Like fingerprints each person has their own view of the world and within these collective world views investigators look for similarities (Habermas, 1971). Generalization from setting to setting becomes conditional.

To gain transferability the investigator can use concepts and models to guide data collection and analysis (Marshall & Rossman, 1995). Then, subsequent research can occur within these same parameters. Detailed, rich descriptions provide sufficient information to enable readers to judge the applicability of findings to other settings that

they know (Seale, 2002). Hull (1997) and James and Mulcahy (1999) add that the description must also include convincing analysis or interpretation. The issue of transferability may be addressed by using the technique of thick description, wherein the investigator accumulates as much data as possible from multiple sources to form a data base for interpretation (Geertz, 1973). Dependability lies in the exact documentation of the process of inquiry in such a way that demonstrates how the investigator arrives at the interpretations.

Another strategy that can be used to address the issue of generalizability is triangulation. Triangulation is the use of different data collection methods to approach the same topic of investigation (Hull, 1997; Merriam, 2002a; Seale, 2002). For the purpose of this study the triangulation strategies were a concept map, an interview, and a ranking concepts exercise. These data collection tools were used to help the investigator fully understand as much as possible, the mental models high school students hold of zoos.

Dependability

Dependability accounts for answering the following questions: Are the results consistent with the data collected? Are there sufficient accounts of the data and the analysis? The replicability of research is a quandary for qualitative investigators. Qualitative investigators work on the assumption that the social world is ever changing and replication should not take place. Although replicability of findings may be impossible, if researchers study the same community of research participants at a similar time, the data sets obtained by these researchers and their interpretation should be largely comparable (James & Mulcahy, 1999). Observations of multiple comparison groups,

cross-site analyses, and acquisition of multiple viewpoints of the sample phenomena are all techniques used to improve the reliability of findings (Jick, 1983). By documenting the methods, procedures, and the sample selection and explaining the data categories the investigator acknowledges the question of dependability (Hull, 1997; Merriam, 2002a). Dependability is increased when the following steps are taken: 1) the description of the process of how data is reduced into themes is meticulous, 2) information related to the selection of interview participants, consistency of interviews, interview questions, interview journals, and interviewees is replete, 3) details are given about place and time of interviews, 4) the study is elucidated in such detail as to be easily replicated either figuratively or literally, and 5) the research and the basis upon which inferences have been made are explicit (Lee et al., 1999). These five considerations were all employed in my data gathering and data analysis efforts.

Confirmability

Confirmability refers to the degree to which the results could be confirmed or corroborated by others. The confirmability of findings is based on the ability of the researcher to critically reflect on his or her assumptions, world views, biases, theoretical orientations, values, and epistemological stances (Merriam, 2002a). This reflection should also include acknowledgment of dilemmas encountered in the process, including ethical issues (Hull, 1997). The data helps confirm the general findings and lead to the implications (Marshall & Rossman, 1995).

Investigators allow themselves to have particular feelings, such as closeness with participants, and try to deny or get rid of emotions they deem inappropriate. Since

qualitative investigators are interested in understanding multiple constructions and fluctuating interpretations of reality (Merriam, 2002b, p. 4), individuals engaging in qualitative research must be open to multiple ways of viewing what they are studying and comfortable with the assumptions of the qualitative approach (Nassar, 2001). They must also be willing to present findings from the participants' point of view (Creswell, 1998).

When I began this research I had personal biases. I taught high school biology and environmental science and during my work as a teacher I worked with the local zoo to develop zoo curriculum. My students visited the zoo every school year. Based on my personal accounts of students' visits to the zoo, I believed that students were not aware of the role zoos play in conservation and the reasons why zoos are important.

There are strategies that may be employed to enhance confirmability. I documented the procedures for checking and rechecking the data throughout the study. I actively searched for any negative instances that contradicted prior observations. I kept an audit trail consisting of: 1) raw data, 2) analysis notes, 3) personal notes, and 4) preliminary developmental information (Lincoln & Guba, 1985).

Credibility, transferability, dependability, and confirmability are important considerations when facilitating qualitative research. I considered how and when data were collected and used similar analysis procedures to insure credibility. Transferability was addressed through triangulation, by collecting information using three data gathering techniques. Detailed record keeping concerning place and time of interviews, how participants were selected for interviews and interview questions were employed to

increase dependability. By keeping a personal journal during the interview process and a complete record of the raw data, confirmability of the study was addressed.

I identified the questions for my study and determined the best research paradigm to be used. Moreover, I chose the best methods to answer the questions I had posed by using the Visitor Centered Evaluation Hierarchy (VCEH) (Wells & Butler, 2004) (Figure 3) to align my research with current research principles in informal learning settings.

Visitor Centered Evaluation Hierarchy

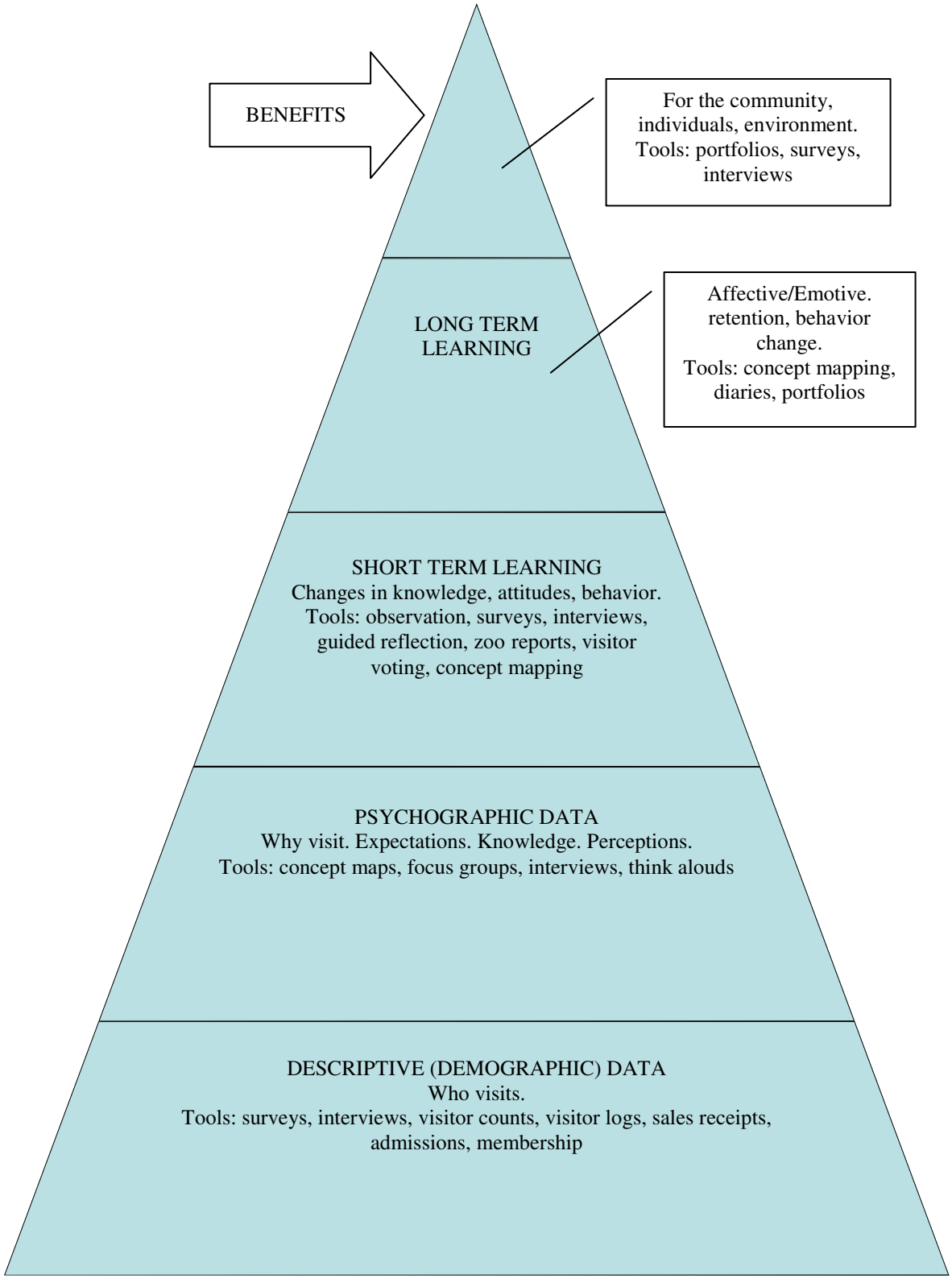
To situate this study in visitor studies research I used the Visitor Centered Evaluation Hierarchy (VCEH). The Hierarchy is an aid in "understanding the range of questions that can be addressed and the methods that can be used to understand the effects of informal learning (Wells & Butler, p. 11, 2004)." The VCEH represents a culmination of research in informal learning and was developed to identify the areas of research in informal learning settings where more research is needed. The VCEH also identifies the evaluation tools best suited for each level or type of research. Each tier on the VCEH describes the type of information gathered, the audience from which the information is gathered and the diagnostic tools used to gather data. The VCEH provided me with a way to focus my study.

The bottom tier describes how to gather demographic data about visitors by surveying, interviewing and counting visitors. Moreover, demographic data is gathered through admissions to institutions and institutional memberships. The second tier involves gathering psychographic data about why people visit informal learning settings and their expectations and perceptions during the visit.

Suggested tools for gathering psychographic data are concept maps, focus groups, interviews, and think-alouds. An evaluation of learning is divided into two tiers: long term learning and short term learning. Short term learning is defined as measuring a change in knowledge, attitude or behavior, and may be measured using observations, surveys, interviews, guided reflections, zoo reports, visitor voting, and concept mapping. Long term learning is deemed an affective or emotive domain and measures retention and/or behavior change. Tools for measuring long term learning are identified as concept mapping, diaries, and portfolios. The last tier accounts for the benefits gained by the community, individuals, and for the environment. Benefits are assessed through portfolios, surveys, and interviews.

My research is clearly situated in the psychographic tier. The psychographic tier attempts to understand the perceptions/misperceptions, knowledge, and expectations of visitors. This study attempted to gain an understanding of the knowledge and perceptions high school science students have of zoos. This study sought to identify the mental models students hold of zoos, because mental models divulge the knowledge people hold in their long term memory (Senge, Kleiner Roberts, Ross, & Smith, 1994) and the perceptions which people build as part of their everyday reasoning processes (Kearney & Kaplan, 1997). Kearney & Kaplan (1997) suggest that mental models are knowledge structures embodying the assumptions, beliefs, perceptions, and misconceptions people hold about the world and guide their decisions and behavior. This study is focused on the knowledge structures high school science students hold of zoos.

Figure 3. Visitor Centered Evaluation Hierarchy
(Wells & Butler, 2004)



By situating my research in the psychographic tier and using psychographic data gathering tools, specifically concept maps and interviews, I investigated the mental models of the understandings secondary students have of zoos by determining their expressed models. Identifying the understandings students have of zoos may uncover information that will be helpful to zoo personnel in planning more effective programs and signage, and developing more effective communication strategies with secondary school visitors. Effective programs, signage, and communication with teachers and students will enhance the understandings students hold of the roles and purposes of zoos with respect to conservation. As mentioned above, the literature review states that more attention is needed in the area of conservation education programs for high school students, a currently neglected age group. Additionally, for classroom teachers, my study provides information which teachers might use to design a field trip and field activities and encourage student participation during a field trip to the zoo.

This study identified the mental models students hold of zoos by analyzing their expressed models. The expressed models of students were accessed by having students draw concept maps about zoos, through interviews and by ranking concepts associated with zoos. The following sections explain in detail the concept map, student interview, ranking concepts exercise, and the systemic network which was used to analyze data.

Participants

The number of students needed in a qualitative study is dependent on the situation being studied, and the questions being asked. The target population for this study were high school science students in nine science classes at the same school. The school is also

located in the same county as the zoo the students visit. The nine classes, taught by three teachers, were made up of 260 students. Teacher A was asked to take her science students to the zoo prior to the study. Teacher B and Teacher C were asked to take their students to the zoo after the investigation. This provided two distinct groups, one group that had been to the zoo with their teacher in the same semester as the study and one group that had not been to the zoo with their teacher in the same semester.

Prior to visiting the zoo, Teacher A assigned students specific ecosystems found at the zoo. Students were expected to find information about their ecosystems and the organisms they would see at the zoo. During their visit to the zoo, students recorded information about organisms and ecosystems and used probes to collect data, such as light intensity and temperature, about their ecosystem. After the zoo visit, students designed presentations about the information they gathered prior to and during their zoo visit. During the school's Parents Night Out, students presented their data for parents.

Once demographic data were collected and analyzed four distinct groups were easily identified: 1) science students who had visited the zoo with their teacher the same semester (WTSS), 2) students who had visited the zoo with their teacher during another school year (WTASY), 3) students who had visited the zoo without a teacher (WOT), and 4) students who had never visited a zoo (NVZ). Of the 260 students who were given the questionnaire, there were only 21 who had never visited a zoo; therefore, it was decided that the data for 21 students in each group would be analyzed. The students were chosen by a volunteer who randomly selected randomly 21 questionnaires from each of the

student groups (WTSS, WTASY, & WOT). The remaining 176 students who completed a questionnaire were not used for this study.

One of the questions asked by this study was if there were differences in the mental models of students of different ethnicities and genders. I identified and interviewed one male and one female from each of the of the following ethnicities: White, African American and Hispanic within each identified group (WTSS, WTASY, WOT, NVZ) This provided me with 24 students to interview. The remaining 60 students were White.

Design of the Study

Based on the literature review not only have high school students (ages 14-18) been ignored by some zoo educators, but zoos have failed to determine the mental models teenage students have about zoos and the role of zoos in conservation, and whether or not these mental models can be altered by visiting a zoo. Therefore, I analyzed a concept map and a ranking concepts exercise done by all students and interviewed selected students, both those who have visited a zoo and those who have never visited zoos. I chose students to interview based on ethnicity and gender.

Prior to the investigation the school and school system, granted permission for the school and selected teachers to participate in this study. An Institutional Review Board (IRB) ethical protocol is on file with the University of North Carolina at Greensboro. Before the data collection, the high school students were told by their teacher that they had been asked to participate in a research project. The students were assured that participation was voluntary and they were allowed to choose whether to participate or not. The names of students were not documented to assure anonymity, but students were

assigned numbers by the teachers so the responses of students to the questionnaire, the concept map, the interview, and the ranking concepts exercise could be matched. All material collected from students will be held securely for five years after the research is completed and will then be disposed of by destroying all electronic files and shredding all paper files.

Depicting Mental Models

Several methods and instruments may be utilized to depict student mental models, including asking students to think aloud while performing a task (Kelly, 1995), reassembling a set of cards with concepts written on them (Rowe & Cooke, 1995), entering thoughts in a journal (Harel & Papert, 1993; Yager, 1995), filling in a blank template or structure (Naveh-Benjamine & Lin, 1991), and drawing concept maps of understanding (Novak & Gowin, 1984; Glynn, 1997). Other methods include oral interviewing of students (Osborne & Gilbert, 1980; Tunnicliffe & Reiss, 1999a), gathering the written responses of students using, for example, a drawing or photograph as a probe (Leach, Driver, Scott & Wood-Robinson, 1995; Tunnicliffe & Reiss, 1999b), recording the spontaneous conversations of students (Tunnicliffe, 1995; Tunnicliffe & Reiss, 1999c), and interviewing students about instances (Osborne & Freyberg, 1985). Another approach has been to ask subjects to draw certain objects (Guichard, 1995; Tunnicliffe & Reiss, 1999b). This study utilized a questionnaire, a concept map, an interview, and a ranking concepts exercise to elicit the mental models students hold of the roles and purposes of zoos.

Data Collection—Questionnaires

First, students were asked to complete a Student Questionnaire (Appendix C). The form asked the participants to provide information about themselves in twelve areas: (1) grade level, (2) age, (3) gender, (4) race/ethnicity, (5) if they had visited a zoo, (6) how they learned about zoos, (7) names and places of zoos visited, (8) number of zoo visitations, (9) date of their most recent zoo visit, (10) with whom they visited the zoo, (11) description of family involvement with zoos, and (12) a brief written description of the experience students had had with zoos.

Data Collection—Concept Maps

Concept mapping is based on Ausubel's (1968) cognitive psychology and constructivist epistemology (Novak, 1990). Meaningful learning is the establishment of non-arbitrary relations among concepts in the mind of the learner, with the learner assimilating new concepts and schema into their existing frameworks (Ausubel, 1968). If the learner has relevant prior knowledge, meaningful learning material and the learner is willing to understand and apply the effort needed to attain meaningful understanding of the topic, meaningful learning should occur. Moreover meaningful learning would only be achieved if the learner chooses to link new information to currently held concepts (Novak, 1998).

The concepts students hold may be acquired through a diagrammatic mode of expression called concept mapping (Kinchin, 2000). Concept maps are tools for representing knowledge organized into a visual diagram of constructed knowledge. As students create the concept map they begin with a broad concept such as, tree, and link

the broad concept to more specific subconcepts, such as leaves, soil, and water. Novak (1977, 1991) believes that knowledge construction is a level of meaningful learning. Concept mapping represents knowledge construction in that it represents the conceptual structure of a subject.

Concept maps have been used as a learning tool (Cliburn, 1990; Novak, 1990), an instructional tool (Martin, 1994), and as a tool for developing curriculum (Starr & Krajcik, 1990). However, they are also effective in identifying both valid and invalid schema held by students, therefore becoming an evaluation tool (Mintzes, Wandersee & Novak, 2000). Concept maps as a data collecting tool can be as effective as interviews (Edwards & Fraser, 1983).

In a concept map, the concepts are arranged as a hierarchy with the general concept at the top of the map and the more explicit concepts arranged below, with connecting words illustrating the relationships between concepts in the form of propositions (Novak, 1990). A concept is a perceived regularity in objects or events designated by a specific label. When two or more concepts are connected using linking words, such as a verb, a meaningful statement or unit is created (Novak, 1990).

Concept maps should be constructed in reference to some particular question, situation or event. A concept map places a general topic in a circle or box. Words or ideas related to the topic concept are enclosed in circles or boxes and relationships between the ideas are indicated by a connecting line and linking word. Linking words are placed on the line between concepts specifying the relationship between the two concepts (Novak & Gowin, 1984; Novak, 1990). For example, the word ‘tree’ may be the general topic with

the words soil and roots below. The words tree, soil, and roots are circled. The words 'soil' and 'roots' are both connected to the word 'tree' with a connecting link containing the words 'needs for growth'. The words soil and roots are connected with a connecting link containing the word 'are in'.

Concept maps are believed to be a visual representation of the knowledge structure or understanding a person has of a given topic (Novak & Gowan, 1984). The use of concept maps as an evaluation tool may vary from very formal assessment to informal teacher assessment (Novak & Gowan, 1984). This study collected data utilizing a concept map and analyzed the concept maps designed by students using a systemic network.

A protocol for teaching or reviewing concept maps with students was developed (Appendix A). The investigator used the protocol while teaching students how to design a concept map. The investigator played a word game by asking students to picture a dog, an elephant and a movie theater. After students practiced picturing words they were asked to picture a shopping mall and make a list of all the words they thought of that they associated with a shopping mall. The students picked two words and linked them with a verb or describing word. The investigator wrote the word 'mall' at the top of the blackboard or overhead. Students were asked to think of ways they could connect those words to the word mall and to each other. The investigator wrote the connecting words on the lines between the circled words as students related the words to each other. For example, mall----fun to see---friends. Following this activity the investigator asked the students to do the same with the word zoo. Each student was given a Zoo Word List Sheet (Appendix D) and a Concept Map sheet (Appendix E). Students were given ten

minutes to generate a list of descriptive words about zoos. When students finished with their word list, they were given twenty-five minutes to construct a concept map. Students were not given instruction or help during the construction of the concept map so that their answers would not be influenced by the investigator.

Data Collection—Interviews

An interview, for the purpose of this research, was defined as the exchange of information which begins when the interviewer asks the interviewee the interview questions and ends when the interviewee has stopped answering the questions. A semi-structured interview guide was developed to assist in collecting data during the interviews (Appendix B). The semi-structured interview guide addressed the following areas: describing a zoo, defining the word zoo, listing reasons zoos exist, explaining the role of the zoo in conservation and describing how the zoo participates in conservation. The interview guide was developed from the literature review and with help from the dissertation committee. An initial interview guide was designed, and subsequently reviewed and critiqued by the dissertation committee.

Students were asked the questions from the interview guide. Every question was asked of every student. However, students were asked to define or explain words or phrases they used to answer questions. For example, if the students used the word "endangered", they were asked to define the word "endangered" and explain how the word related to zoos. The interviews were conducted during the science class period in the school library. Interviews were digitally recorded and transcribed verbatim before analysis was begun. Recordings have the advantage of capturing data more faithfully than

written notes, and can deter interviewers from subconsciously selecting specific items to record (Patton, 1990; Marlow, 1993).

At the most basic level, interviews are conversations (Kvale, 1996) and require that both parties be agreeable to such a relationship (Marlow, 1993). Qualitative interviews may be used either as the primary strategy for data collection, or in conjunction with observation, document analysis, or other techniques (Bogdan & Biklen, 1982). Qualitative research interviews are "attempts to understand the world from the subjects' point of view, to unfold the meaning of peoples' experiences, to uncover their lived world prior to scientific explanations" (Kvale, 1996, p. 25). Interviews for research or evaluation purposes promote change and the emphasis is on intellectual understanding (Kvale, 1996). Interviews provide the evaluator with raw data which,

> reveal the respondents' levels of emotion, the way in which they have organized the world, their thoughts about what is happening, their experiences, and their basic perceptions. The task for the qualitative evaluator is to provide a framework within which people can respond in a way that represents accurately and thoroughly their point of view about the program. (Patton, 1987, p. 35)

Qualitative interviewing utilizes open-ended questions that allow for individual variations and can be: 1) informal, conversational interviews; 2) semi-structured interviews; or 3) standardized, open-ended interviews (Patton, 1990). This study followed a semi-structured interview, or guided interview protocol. An interview guide made up of questions to be explored during the interview was developed prior to the interview

(Appendix B). Piaget (1926, 1950) used semi-structured interviews to capture how people think of a particular domain. Semi-structured interviews were chosen because they are "reasonably objective while still permitting a thorough understanding of the respondent's opinions and the reasons behind them" (Gall et al., 1996, p. 452). Using a semi-structured interview technique, "provides a desirable combination of objectivity and depth and often permits gathering valuable data that could not be successfully obtained by any other approach" (Gall et al., 1996, p. 452). Semi-structured interviews allowed me to probe into the replies given by participants and to pursue additional issues interviewees mentioned that were not included in the interview guide.

Data Collection—Ranking Concepts Exercise

The words used in the ranking concepts exercise (Appendix F) were taken from the word lists students generated during the Zoo Concept Map activity (Appendix E). The twenty most commonly used words or phrases were listed and students were asked to put the words or phrases in the order in which they best described zoos. The number '1' meant that that word best described zoos. The number '20' meant that that word least described zoos. Every word was numbered and the numbers were used only once.

Data collected for this study were analyzed using a systemic network. The systemic network used in this study was used to code every word in the concept map and every word in the interview (Bliss et al., 1987). A systemic network is a hierarchical system in which words are given rank orders based on how many students used the word(s). In addition to the concept map and interview, students were also asked to complete a ranking concepts exercise (Appendix F). These three data sources provided opportunities

for triangulating the data collected to increase transferability. By including three data sources and keeping discrete, meticulous records, credibility, dependability, and confirmability were also addressed.

Ethical Issues

Due to the subjective nature of qualitative research, there may be more ethical dilemmas and concerns with confidentiality associated with a qualitative method than with quantitative research (Hoepfl, 1997). Ethics, in a research context, are the principles of right and wrong that a particular group accepts (Bogdan & Biklen, 1982). Ethics has to do with how one treats those individuals with whom one interacts. At a commonsense level, caring, fairness, openness, and truth are important values that provide a foundation for building relationships and the activity of inquiring (Smith, 1990). Guba and Lincoln (1989) outline five specific concerns that relate to consent and freedom from harm. 1) face to face contact with participants should build trust, 2) participants should have privacy and participants should be assured of confidentiality, i.e. participant anonymity, 3) the trust of the participant should not be violated, 4) participants should have knowledge of the procedures and the investigation and their role in the investigation, 5) investigators should be aware of the ethical issues of how to tell the participants' stories. These five concerns were noted and taken into account during this study. An IRB is on file with the University of North Carolina Greensboro.

Analyzing the Data Using Systemic Networks

Qualitative data of the volume produced in the present study can appear to be unwieldy in the sense that a large amount of information is obtained. Therefore, I used a systemic network to codify the data (Bliss, Monk & Ogborn, 1983). A systemic network allows qualitative data to be converted into quantitative data by categorizing or grouping items and preserving the relationship between the categories (Tunnicliffe, 1995). Systemic networks are used so that researchers can identify and classify the concepts students express (Bliss et al., 1987). By using a systemic network to analyze data, I defined the general mental model of zoos by labeling units of the expressed models of many individuals (Spiliotopoulou, 2004).

The systemic network is the perfect data analysis tool to use in this study, because the systemic network functions like a true connectional database. The systemic network relates whole to whole, whole to all parts, all parts to the whole, whole to each & every individual part, all parts to each & every individual part, each & every individual part to the whole, each & every individual part to each & every other individual part, and arranges it all in a hierarchical framework. This then provides a myriad of tools and functions, perhaps the most important of which are: 1) it allows you to see relationships, and 2) it allows for more efficient and effective information storage, retrieval, and manipulation.

I utilized a system of categorizing responses naturally appearing in the data (Monk, 1983; Bliss, Monk & Ogborn, 1983). The data were first categorized into themes which discriminated only among the responses according to membership in a particular theme.

The themes were then broken down into more discrete categories, continuing this procedure until a set of terminal categories for each theme was reached. The description of responses became more specific from the themes to the terminal categories. For example, the theme *organisms* indicates that a response referred to the organisms seen at the zoo. Following the systemic network to a particular terminal category, for example, the word 'exhibits' discriminates between responses at a finer level; this indicates that the response identifies zoos as a place for animals which are kept in exhibits.

Choices within the systemic network were determined by a bar '[' or a bracket '{'. One selection was made from the choices in a system following a bar '['. Selections were made from all choices within the system following a bracket '{'. The categories used in the present research are discussed in more detail in Chapter IV (Bliss et al., 1983; Tunnicliffe, 1995; Tunnicliffe & Reiss, 1999). For this study, once a student mentioned the topic it was recorded and was not recorded again. For example, a student may have used the word *animal* five times during the interview but the word was only recorded once. For the purposes of this study, I was interested in the presence of the word or concept not the frequency of occurance.

Data analysis, reported in Chapter IV, incorporated frequencies and inferences as well as content analysis of the questionnaire, student concept map, interview, and ranking concepts exercise. The analysis of the data from the concept map and interview was completed at a descriptive level using a systemic network. The themes were recorded and frequencies were computed. The frequencies found in the questionnaire and ranking

concepts exercise were analyzed. Examples of students' descriptions are provided as further evidence.

CHAPTER IV

FINDINGS

The purpose of this study was to depict the mental models high school students hold of zoos. This study also examined how students define conservation and the role of zoos in conservation. This study examined differences in mental models of students 1) who visited a zoo with their teacher in the same semester in which the study was conducted (WTSS), 2) students who visited a zoo during another school year with their teacher (WTASY), 3) students who have visited the zoo without a teacher (WOT), and 4) students who have never visited a zoo (NVZ). It also examined the mental models of students of different ethnicities and examined differences in mental models of young men and women. This study was conducted and the data analyzed using a qualitative methodology research design which included a demographic questionnaire, a concept map, an interview and a ranking concepts exercise.

The demographic questionnaire was designed to determine the target population for the study. After evaluating the questionnaires the aforementioned four groups were revealed. This chapter details the findings of the study and is organized around the data gathering tools: 1) the questionnaire, 2) the concept map, 3) the interview, and 4) the ranking concepts exercise. The high school at which the study was conducted was located

in the same county as the state's zoo. The total number of students enrolled at the high school was 1,126; 581 males, 545 females. The rural school had a 13% minority population including: American Indians <1%, Asian American <1%, African American 5%, and Hispanic 7%. Whites made up 87% of the student body (Great Schools, 2006).

The author-designed demographic questionnaire, Student Questionnaire: Visiting Zoos, found in Appendix C, was given to 270 high school science students. Due to the low minority rate of the school (13% total from various groups), the questionnaire was administered to 270 students in order to locate students targeted for the study. Since the high school was located in the same county as the state's zoo, it proved difficult to find students who had never visited a zoo. After evaluating the 270 questionnaires, I verified that 21 students had never visited a zoo; therefore, it was decided that 21 students would be chosen to represent each group of students identified for the study: 21 science students who had visited a zoo with their teacher in the same semester the questionnaire was given (WTSS), 21 students who had visited a zoo with a teacher during a previous school year (WTASY), 21 students who had visited a zoo without a teacher (WOT), and 21 students who had never visited a zoo (NVZ). Therefore, the total number of students participating in this study was 84. The demographic data gathered from the other 176 students were not analyzed.

Demographic Profile of High School Science Students

The demographic survey was utilized to create profiles for each of the 84 students in this study. The first four questions provided information detailing 1) grade level, 2) age, 3) gender, and 4) race. Table 1 provides a comprehensive profile summarizing the results

of the data gathered from the demographic survey. Fifty-four (64.3%) of the students were sophomores (second year of high school) and 42 (50%) were 15 years old. Forty (47.6%) students were males and 44 (52.4%) students were females. Eighty-one percent of the students were White, 9.5% were African American, and 9.5% were Hispanic.

Table 1
Demographic Data for Students in the Study
N=84

GRADE	**FREQUENCY**	**%**
Freshman	18	21
Sophomore	54	64
Junior	6	7
Senior	6	7
AGE	**FREQUENCY**	**%**
15	42	50
16	27	32
17	12	14
18	3	3
GENDER	**FREQUENCY**	**%**
Male	40	47
Female	44	52
ETHNICITY	**FREQUENCY**	**%**
White	68	81
African American	8	9
Hispanic	8	9

Questions five through twelve on the questionnaire were used to determine where students obtained their information about zoos, to establish the amount of interaction students had had with zoos, and with whom they had visited a zoo. These questions asked the following: 5) if the student had visited a zoo; 6) where the student had acquired their information about zoos (teacher or other) (Table 2); 7) the name of the last zoo visited; 8) how many times they had visited a zoo (Table 3); 9) when they had last visited a zoo (Table 4); 10) with whom they had visited a zoo (Table 5); 11) if they had any involvement with zoos other than visiting (e.g. employment, zoo membership, attendance and zoo programs); and 12) to describe any experiences they had had with zoos. Due to the small number (4) of students who indicated other additional involvement with zoos no data table is included for this variable.

Sixty-three (75%) students had visited a zoo and 21 (25%) students had never visited a zoo. Students were asked to name sources from which they attained information about zoos (Table 3). Sixty-six (78.6%) students named at least one source, while 18 (21.4%) students did not name a source for the ideas they had concerning zoos. Students provided multiple sources (not mutually exclusive) of information about zoos. Zoo visitation (36.9%), family (33.3%), and teacher (32.1%) were named as frequent sources for information about zoos. Television (19%) and friends (19%) were also named as sources of information about zoos.

Table 2
Sources From Which Students Acquired Zoo Information
N=84

SOURCE	FREQUENCY	%
Zoo Visitation	31	36.9%
Family	28	33.3%
Teacher	27	32.1%
No Source	18	21.4%
Friends	16	19%
TV	16	19%
Books	13	15.5%
Zoo Signs	8	9.5%
Commercials	5	6%
Magazines	4	4.8%
Internet	4	4.8%

Fifty-five (87.3%) students who had visited a zoo prior to this study had visited a zoo ten times or less (Table 4). Five (7.9%) students had visited a zoo more than 20 times. Fifty-three (84.1%) students who had visited a zoo prior to this study had visited a zoo in the last three years (Table 3). The last visit for one student had been more than ten years prior to this study (Table 4). Students who had visited a zoo were asked who their companions were during their zoo visit (Table 5). Family (61.9%) and friends (45.2%) were cited most often as persons with whom students have visited a zoo. Table 3

Table 3
How Many Times Student Visited a Zoo
N=84

NUMBER OF VISITS	FREQUENCY	%
0	21	25%
1-5	39	46.4%
6-10	16	19%
11-15	2	2.4%
16-20	1	1.2%
20+	5	6%

Table 4
Time Elapsed Since Students Last Visited a Zoo
N=84

YEARS	FREQUENCY	%
0	21	25%
0<1	32	38.1%
1-3	21	25%
4-6	7	8.3%
7-9	1	2.4%
10+	1	1.2%

Table 5
Person(s) With Whom Students Visited a Zoo
N=84

SOURCE	FREQUENCY	%
Family	52	61.9%
Friend	38	45.2%
Boy/Girlfriend	10	11.9%
Church	4	4.8%
Daycare	2	2.4%

Four of the students had had additional involvement with zoos other than visitation. Three of the students had family members (one aunt, one brother, one sister) who had worked at the zoo. None of these three students had ever visited a zoo. One student, a zoo visitor himself, also volunteered at the zoo once a year for the zoo's Halloween Haunted Trail.

Mental Models Students Hold of Zoos

This study was carried out to determine the understandings students hold of zoos by asking them what they know about zoos. By analyzing the concept maps and interviews I found that there are common themes in the understandings students hold about zoos. This section gives an overview of what students say about zoos, including: 1) *descriptive terms*, 2) *organisms*, 3) *people*, 4) *zoo amenities*, 5) *education*, 6) *habitats*, and 7) *conservation*.

Not only do students describe zoos as physically large, a place for enjoyment, and fun, dirty, loud, and crowded; they also described zoos as a place to visit with family and friends and as a place to see animals. Moreover, students are concerned with where they will eat and how they will move around in the zoo. During the study I found it very interesting that students did not mention the theme *conservation* unless they were specifically asked about conservation and the role of zoos in conservation.

Predictably, students mentioned animals more often than any other theme. Not only did students say the word plant and/or animal they also named types of animals and/or plants such as gorilla, alligator, polar bear, grass, and/or tree. However, not so predictable were their descriptions of animal enclosures and animal care. Students named animal

enclosures as exhibits and/or cages. During their explanation of zoos, students felt that it was important for animals to get food, water, and exercise and it was also important that their enclosures be kept clean.

The students in this study identified *people* as an important part of their understandings of zoos. Not only did they identify the *people* with whom they visited the zoo, including *children*, *parents*, *boyfriend*, and/or *girlfriend*, they also mentioned the zoo staff. Students believed zoo security and zookeepers were an important part of their zoo visit. Zoo security provided a safe environment and the zookeepers were available to provide information about the zoo.

Students also described the *amenities* at the zoo. The most important zoo *amenities*, as described by the students, were how they would move around the zoo, where they would eat, and what they found in the gift shop. In addition to walking around the zoo, students mentioned trams/trains, strollers for children, and wheelchairs as sources of transportation. I found students were concerned with where they ate, what they ate while they were at the zoo, and the cost of the food. Gift shops were also an important part of the understandings students have of zoos. Even if students had not visited zoos they mentioned items they could purchase in the gift shop.

I found that students mentioned *education* and *habitats* less than the other topics. None of the students specifically stated they went to the zoo to learn. Instead students mentioned specific information they discovered and/or gave examples of information they obtained during their visit. WTSS students were asked to locate specific information while they were visiting the zoo; therefore, some of their data related to information their

teacher wanted them to find during their visit. For example, students stated that they were supposed to find out about the habitat in which their organism lived and any adaptations their organisms had. The following is an example from a student interview:

> My teacher made us answer questions like uh…questionnaire about the animals. We had to read every sign in front of the animal's habitat and then we had to do research on the ecosystem. I had the arctic ecosystem. We had to take light probes and we had to take temp probes and do research on the animals and things like that.

However, *habitats* were not only mentioned in relation to a school visit, in which teachers asked for specific information; *habitats* were also described and named. Students described *habitats* by stating what was found in there such as *soil*, *water*, *rocks*, and/or *plants*. Students also named *rainforests*, *grasslands*, and/or *deserts* as specific examples of *habitats*. When students used the word *habitat* in their description of zoos, they were asked to explain what the word habitat meant. Students replied that *habitats* are "an organism's surroundings" or "where it lives".

Surprisingly, the theme *conservation* was not mentioned by students in the concept map. Based on prior research, in which Tunnicliffe (1995) found that students did not spontaneously talk about conservation during a zoo visit, I decided to ask students conservation-related questions. I asked students to define conservation and to provide examples of how zoos are involved in conservation. If students were not able to define conservation, I continued to probe by asking if they knew what conserve meant. *Conservation* was mentioned by one student prior to being prompted. This student stated

that zoos exist, “to save animals”. Students who described *conservation* after being prompted also stated, “it is to save animals”. However, students saw zoos as a place where animals were being “saved from extinction” because they were saving “endangered animals”. Students believed that zoos took animals out of the wild to save them from being hunted and to breed them. Students who mentioned breeding believed that all the zoo-born animals were kept at the zoo.

Concept Mapping—Mental Models of Zoos

The concept mapping activity was completed in the classroom. Students were asked to design a concept map about zoos. Students were first taught how to complete a concept map prior to constructing a concept map about zoos. Specific instruction on concept mapping procedures may be found in Appendix A. Prior to constructing a concept map, students were asked to write the word ‘zoo’ at the top of a sheet of paper and list 25 words or more that they associated with zoos and why zoos exist. Students then constructed a concept map using each of their words in a map.

When students began to list the words they associated with zoos they were only able to list about ten words and most of those were names of animals. I told students to begin to design their concept maps and as words came to them they could add them to their word list. When I began to analyze the data from the concept maps I realized that not all students had followed the instructions about how to complete a concept map. I contacted the teachers about the way students had designed their concept maps. The teachers told me they do concept maps with their students. However, the process involved having one main word and requiring the students to place the remaining words underneath that relate.

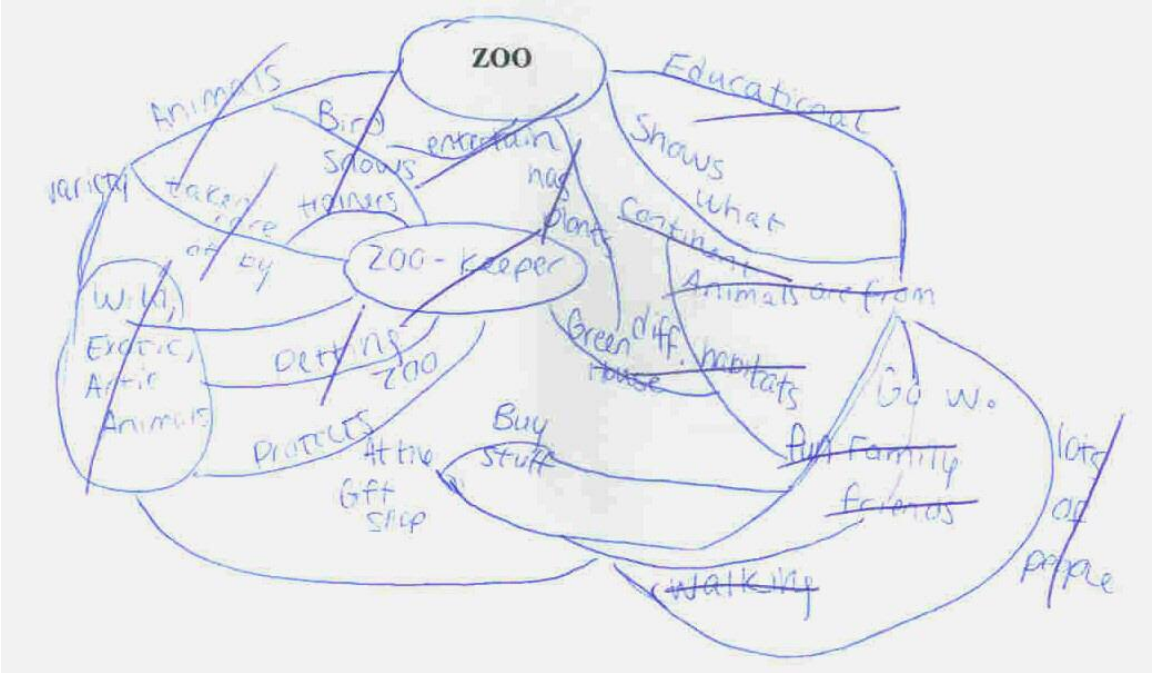
Figure 4 is an example of a concept map done by a student who listed words under a main topic and Figure 5 is an example of a concept map of a zoo completed with more detail. However, all concept maps were analyzed in the same way.

Figure 4.

Concept Map Done by a Student Who Only Listed Words

Figure 5.

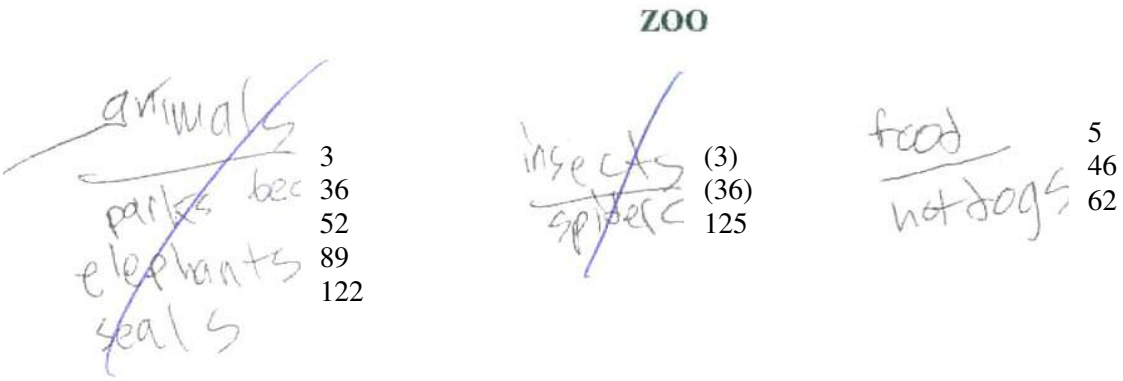
Concept Map Completed With More Detail



A systemic network was developed to quantitatively analyze the concept maps. Appendix G is the systemic network used to analyze the concept maps (and the interviews). A systemic network allows for all words in the data to be counted and for all themes to be analyzed. A systemic network provides a snapshot of the data collected by assimilating all the data into an easy to follow diagram. Choices within the systemic network are determined by a bar '[' or a bracket '{'. As you read across the systemic network from left to right you get themes, sub-themes, and terminal words. The description a student has given of a mental model becomes more apparent as you move

across to the terminal word. A word followed by a bar '[' means that a student only used one of the choices. In this study a bar '[' is followed by two choices: 1) described the word and 2) used only the word. For example, if a student used the word *habitats* and did not provide further information concerning a habitat the word was coded as *used only the word*. A word in the systemic network followed by a bracket '{' means that a student may have described the word using one or more of the choices. For example, students may have named only one type of animal or they may have named several types of animals, such as mammals, reptiles, birds, insects, and/or fishes. The systemic network not only provides a representation of the words students used to describe zoos, it also provides a count of how many students used those words.

In order to analyze these data all the themes, sub-themes, and terminal words of the network were numbered sequentially across the network (Appendix G). Hence, when analyzing the words of the concept maps and interviews, words were numbered and entered into an Excel file, from which counts could be ascertained. Qualitative data were changed into quantitative data. The concept map below and the following excerpt from the interviews would be numbered in the following way. Note: Once a word was coded it was coded again, but not recounted. Codes that were previously counted in the statement are placed in parentheses.



3, 36, 52, 93, 134
They take really good care of their animals at that zoo. They were

(3, 36, 52) 90, 127
cleaning a lot of the cages when we were there. They had at least

6, 13, 77, 112, 114 (3, 36, 52, 93, 134)
4 people in there…and they were washing the windows.

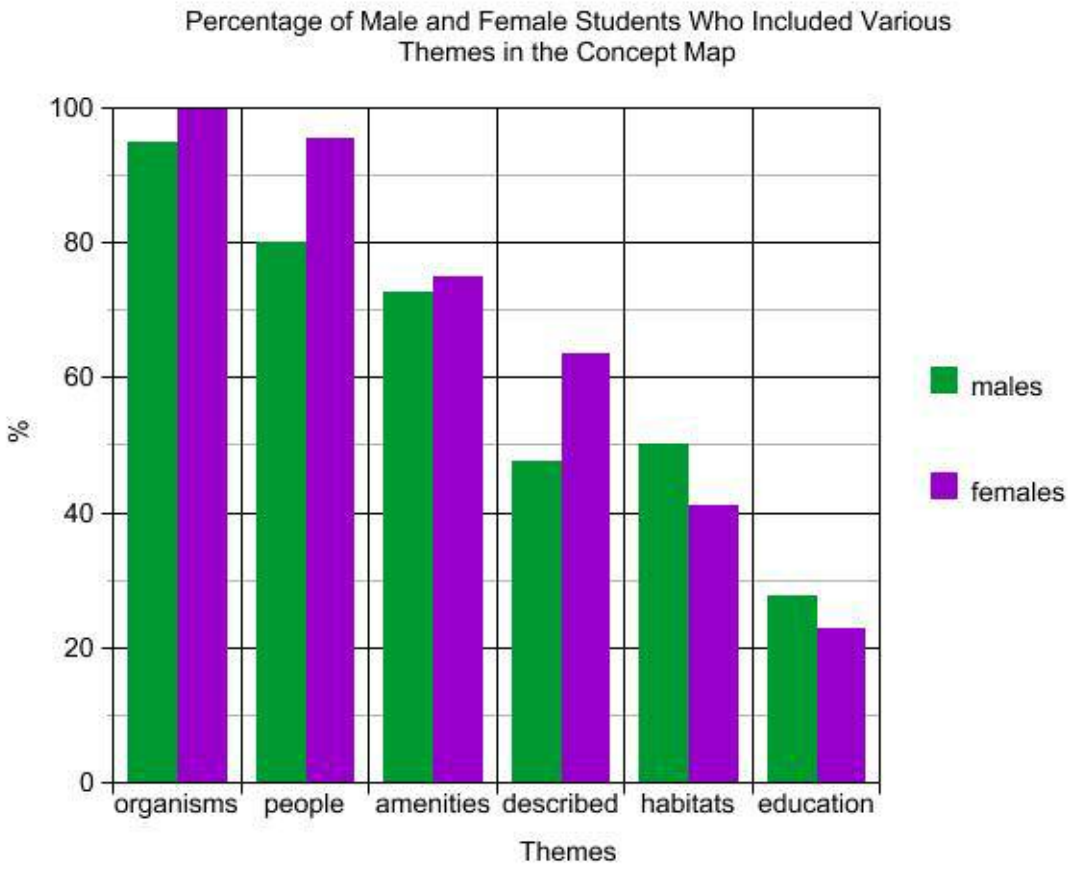
The results of the systemic network are presented using the students' words which are italicized, followed by the number of students who mentioned each word. For example, *organisms* (82) included *animals* (82) and *plants* (29). Six major themes were discerned from the concept maps completed by students. The six themes in order of prominence were: 1) *organisms* (82), 2) *people* (74), 3) *amenities* (65), 4) *descriptive terms* (47), 5) *habitats* (38), and 6) *education* (21).

The six major themes were originally identified in the concept maps and later confirmed in the student interviews. The theme, *organisms* (82), was delineated by any mention of the words *animal* and/or *plant* and/or names of specific *organisms*. When

students gave specific names of *people* such as *family*, *zookeeper*, and/or *children* and/or identified what *people* do at zoos, these were coded as *people* (74). *Amenities* (65) were identified as any mention of transportation, shops, and/or food. When students used adjectives to illustrate or depict the zoo, these words were coded as *descriptive terms* (47). For example: fun, crowded, and/or loud were coded as *descriptive terms*. *Habitats* (38) were coded when students gave examples of *habitats* such as *grasslands* and/or when students identified characteristics of *habitats* such as *water*. *Education* (21) included any references to field trips and/or information obtained from signs at the zoo.

Appendix H depicts the themes students identified in their concept maps. The appendix provides data separated by gender, ethnicity, and type of zoo visitation. Figure 6 depicts the differences in percentages of males and females who included various themes in the concept map. Sixty-four percent of females and 48% of males described zoos. Moreover, females mentioned or named *people* (95.5%) more often than males (80.0%).

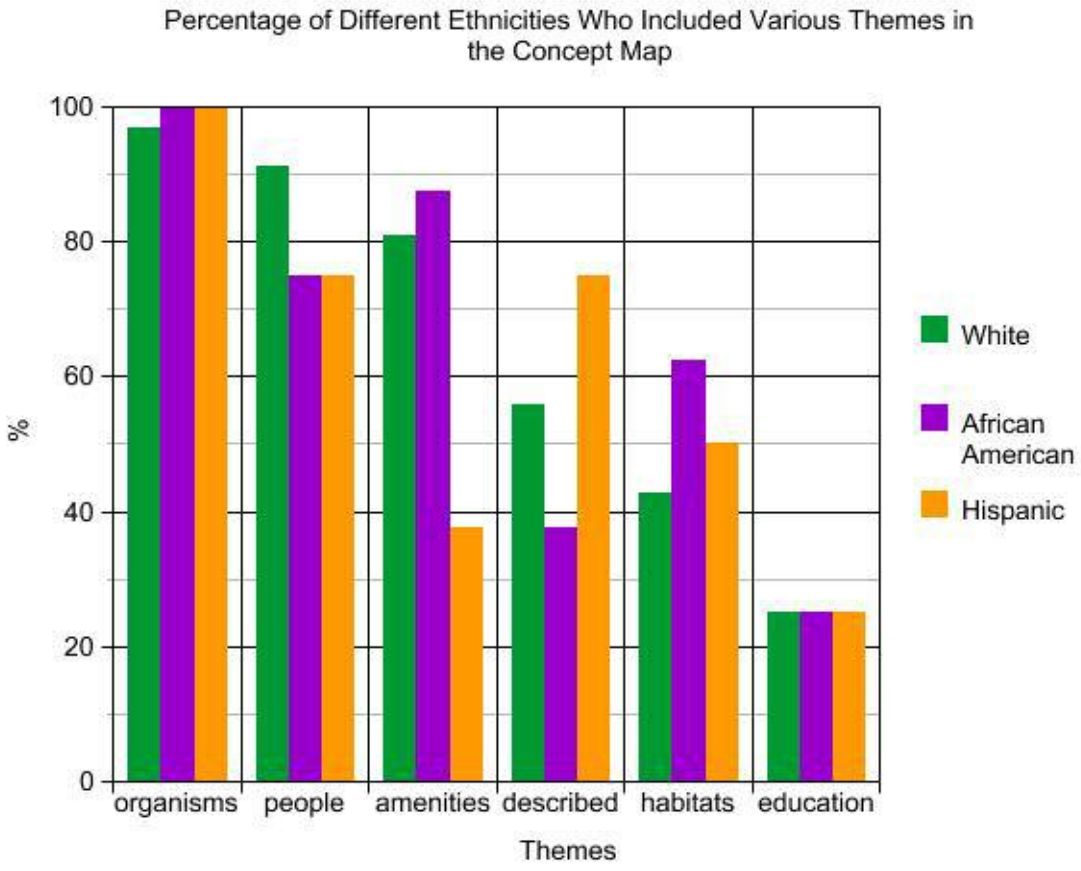
Figure 6



The most prominent differences among the various ethnicities were evident in the following themes: *amenities* (65), *descriptive terms* (47), *habitats* (38) (Figure 7). African Americans (87.5%) and Whites (80.8%) mentioned the *amenities* at the zoo more often than Hispanics (37.5%). In contrast, Hispanics (75%) used *descriptive terms* more often when divulging their knowledge of zoos than did Whites (55.8%) and African Americans (37.5%). When students were prompted to tell what they know about zoos, there was a

difference in the number of students who mentioned *habitats*. African Americans (87.5%) mentioned *habitats* more often than Hispanics (50%) and Whites (42.6%).

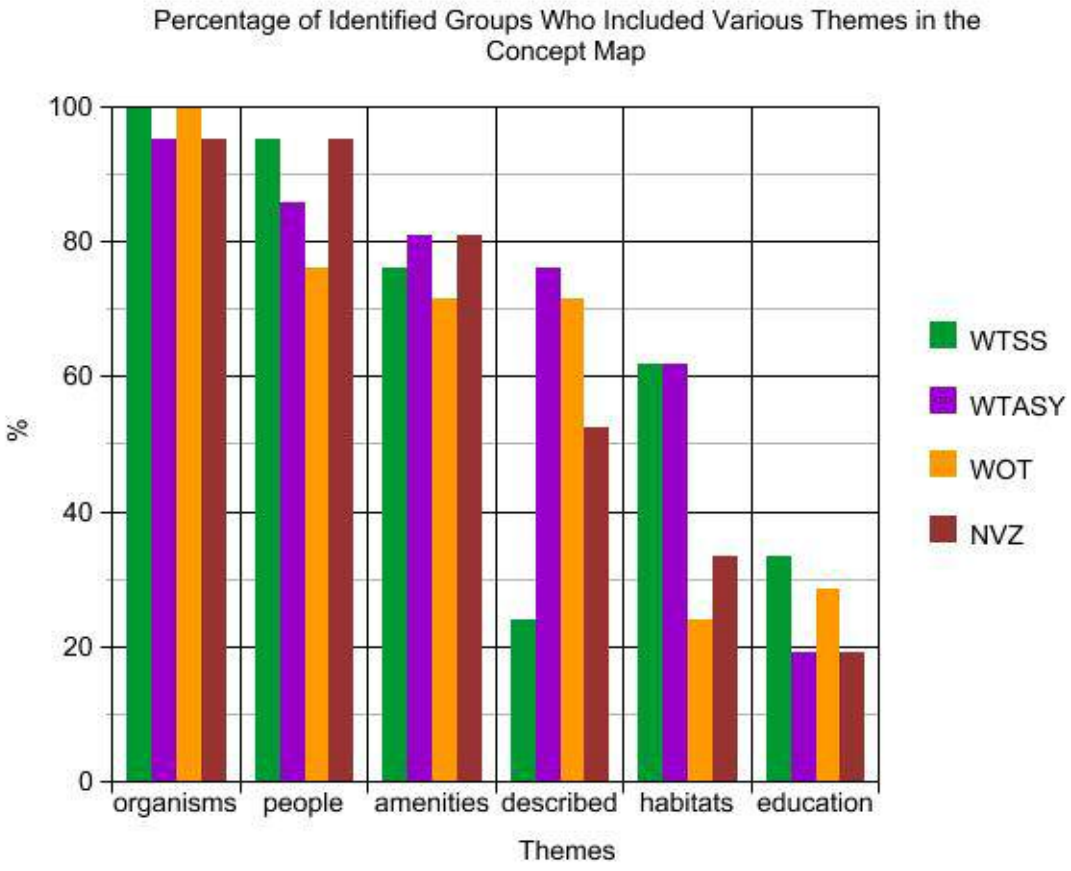
Figure 7.



Differences were apparent between the four identified groups of students (WTSS, WTASY, WOT, NVZ) (Figure 8) in the following themes: *descriptive terms* (47) and *habitats* (38). The WTSS group (23.8%) used *descriptive terms* less than the WTASY group (76.1%), the WOT group (71.4%), and the NVZ group (52.5%). *Habitats* were

mentioned most often by the WTSS group (13, 61.9%) and the WTASY group (13, 61.9%).

Figure 8.



In addition to the information concerning the six major themes previously identified, the systemic network provides an opportunity for deeper analysis by identifying the words students used to depict each of the themes. Appendix I provides an overview of the six themes identified in the concept map and the understandings students have of zoos.

One hundred percent of the students who mentioned *organisms* (82) referenced *animals* (82). Twenty-nine students referenced *plants* (29). Four of the students who cited *animals* used only the word *animal* with no further description. Seventy-eight students pointed out specifics about *animals*. For example, students specifically *named* types of animals such as *mammals* (46), *reptiles* (27), *birds* (27), *fishes* (17), and/or *insects* (10). When referring to *animals* students indicated that they were kept in *cages* (17) and/or *exhibits* (10). In addition to naming where animals were kept students were also concerned with *animal care* (32). When diagramming *plants* (29) students named *trees* (13), *grass* (8), and/or *flowers* (6) as well as identifying the plants as a *food source* (7).

Seventy-four students included *people* in their concept maps. Sixty-four of these students named the *people* they associate with zoos and/or what *people* do when they are at the zoo. Ten students used only the word *people* with no further information. Fifty-two students *named* the following *people* they associate with zoos: *staff* (30), *children* (25), *friends* (20), *family* (17), and/or *boy/girlfriend* (9). Students who named *staff* (30) specifically pointed out *zookeepers* (16), *security* (7), and/or *tour guides* (6). The concept map also revealed that students believe *people eat food* (21), *become tired* (9), *take pictures* (8), and/or *spend money* (8) while they are visiting the zoo.

Sixty-five students used terms identifying the *amenities* (65) at the zoo. *Transportation* (43), *gift shop* (42), and *food* (40) were mentioned most often. *Tram/trains* (27) and *walking* (31) were named most often in reference to *transportation* (43). The cost in the *gift shop* (42) was mentioned by 20 students and the cost of *food* (40) was mentioned by 11 students.

Forty-seven students used descriptive terms to illustrate zoos: *crowded* (14), *big* (13), *smelly* (13), *fun* (10), *noisy* (7), and/or *colorful* (7). Twelve students described the *weather* (12) at the zoo.

Thirty-eight students mentioned *habitats*. Two students *used only the word habitat* and 21 students named components of *habitats* such as *water* (11), *plants* (10), and/or *rocks* (5). Sixteen students of the 38 students who mentioned *habitats* named specific *habitats*: the *desert* (11), the *arctic* (7), and the *grasslands* (6).

Education (21) was mentioned the least in the concept mapping activity. Of the 21 students who mentioned *education*, ten used the words *education* and/or *learning*. Nine students stated they went on *fieldtrips* to find out about zoos and four students said they got *information from signs*.

In addition to a qualitative analysis of the concept maps, I also completed a statistical analysis. To determine whether or not there were correlations between the demographic data and themes, a Spearman's rho (p=.05) (SPSS, 2006) was performed.

In the concept mapping data a statistically significant correlation (rho= -.327, p=.032) was found in the female group among the *descriptive terms* girls used to describe zoos and the theme *amenities*. Females who did not use *descriptive terms* tended to describe the *amenities* at the zoo. Within the male group, a statistically significant correlation (rho= -.375, p=.017) was determined between the themes *amenities* and *habitats*. Males who did not tend to describe the *amenities* at the zoo tended to describe *habitats*.

Significant correlations were also found among the ethnic groups, Whites and Hispanics. White students who did not tend to mention *habitats* tended to mention *people* (rho=-.268, p=.027). Hispanic students who did not tend to mention *habitats* tended to mention *amenities*.

To determine relationships between the four student visitation groups and the themes a Spearman's rho (p=.05) was done using SPSS (2006). A correlation (rho=.636, p=.002) was also determined in the WOT group of students and the themes *descriptive terms* and *people*. Students who had visited the zoo without their teacher tended to use *descriptive terms* and to describe the *people* they associated with the zoo.

Interviews—Mental Models of Zoos

The systemic network developed to analyze the concept maps was also used to analyze the interviews. This section provides the results discerned from the interviews.

The interviews were conducted in the school library during the students' science classes. Six students were chosen from each of the four groups (WTSS, WTASY, WOT, NVZ) as follows: one male and one female White, one male and one female African American, one male and one female Hispanic. Twenty-four students were interviewed. Interviews ranged in length from five minutes to 11 minutes. The specific questions asked of all students may be found in Appendix B. All students were asked all of the questions in the Oral Interview Guide. During the interview students were asked to clarify words such as endangered and extinct. The following is an excerpt from an interview in which a student was asked to clarify the word endangered.

Student (S): They save endangered animals. Like from the wild probably.

Interviewer (I): What does endangered mean?

S: Like are harmed or hurt or like people eat too much of or something.

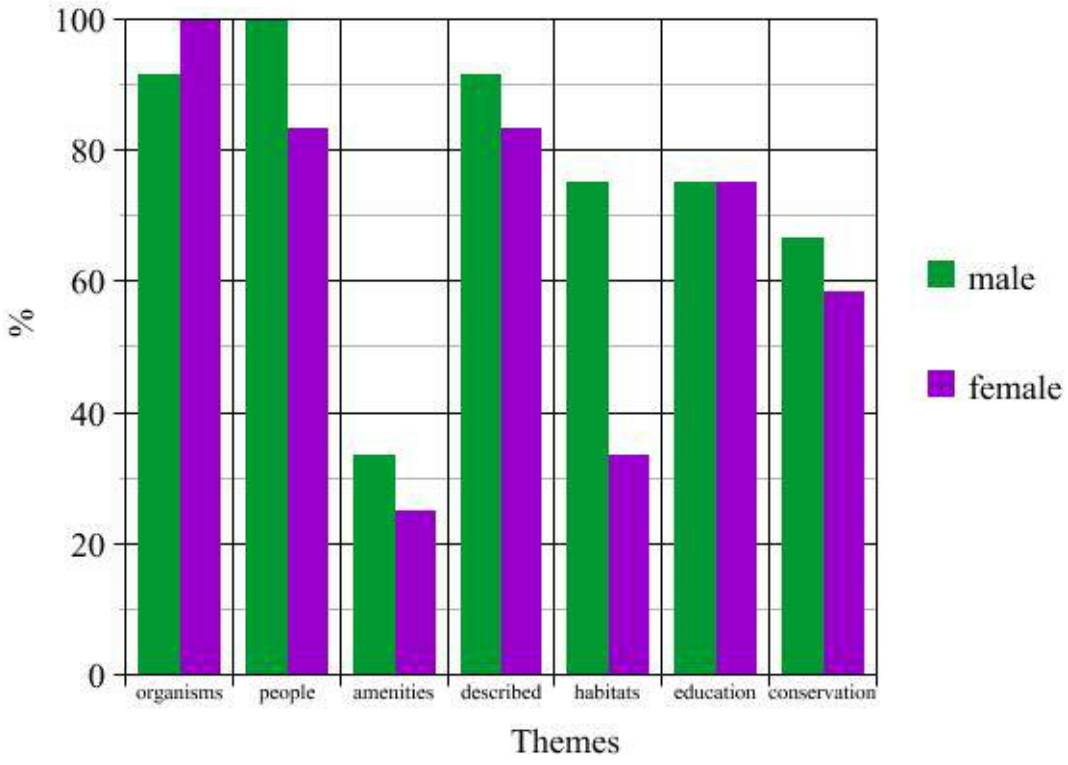
Appendix G is the systemic network used to analyze the concept maps and the interview. *Conservation* was not mentioned in the concept mapping activity; therefore, the systemic network was adjusted to accommodate the theme *conservation*. The new theme (*conservation*) and describing words identified from the interview are darker and in bold on the systemic network. The seven major themes that emerged from the interview data in order of prominence, followed by the number of students, in parentheses, who mentioned that theme were: 1) *organisms* (23), 2) *people* (22), 3) *descriptive terms* (21), 4) *education* (18), 5) *conservation* (15), 6) *habitats* (13), and 7) *amenities* (7). *Conservation* (or related terms) was not included at all by any students on their concept maps. Since a purpose of this dissertation was to determine students' conservation awareness and the role of zoos in conservation, the interview explicitly asked students about their knowledge of zoo-related conservation. Therefore conservation became a theme for the systemic network used to analyze the interviews.

Appendix J is a breakdown of the themes students detailed in the interviews. The table separates the results by gender, ethnicity, and type of zoo visitation. One student did not mention *organisms*. Two students did not mention *people*. Three students did not use *descriptive words* in the interview. Nine (75%) males and four (33.3%) females depicted *habitats* or used the word *habitat* (Figure 9). Seventy-five percent of males and females mentioned *education*. *Conservation* was defined by eight males (66.6%) and seven

females (58.3%). *Amenities* were mentioned by four males (33.3%) and three females (25.0%).

Figure 9.

Percentage of Male and Female Students Who Included Various Themes During the Interview

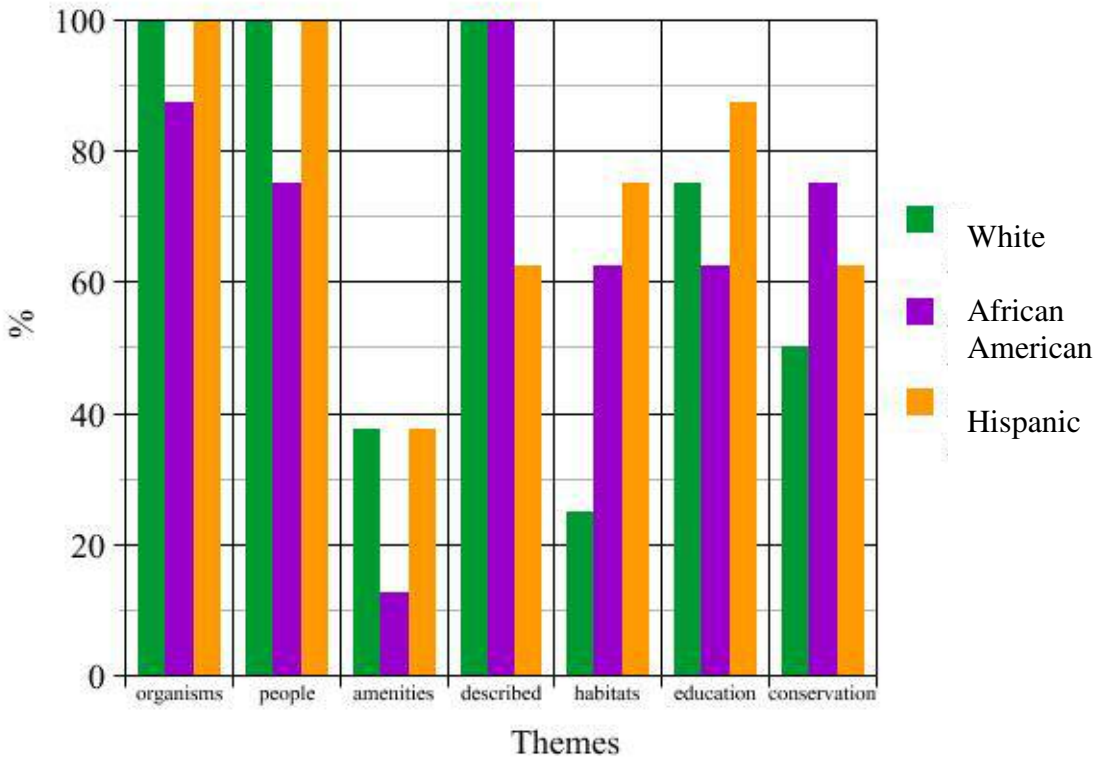


Ethnic differences were most evident in the following themes: *descriptive terms* (22), *education* (18), *conservation* (15), *habitats* (13), and *amenities* (7) (Figure 10). African Americans (100%) and White (100%) used *descriptive terms* more often than Hispanics (62.5%). During the interviews *education* was mentioned more often by Hispanics (87.5%) and Whites (75%) and less often by African Americans (62.5%). Seventy-five

percent of Hispanics and 62% of African Americans mentioned *conservation*, while 50% of Whites mentioned *conservation*.

Figure 10.

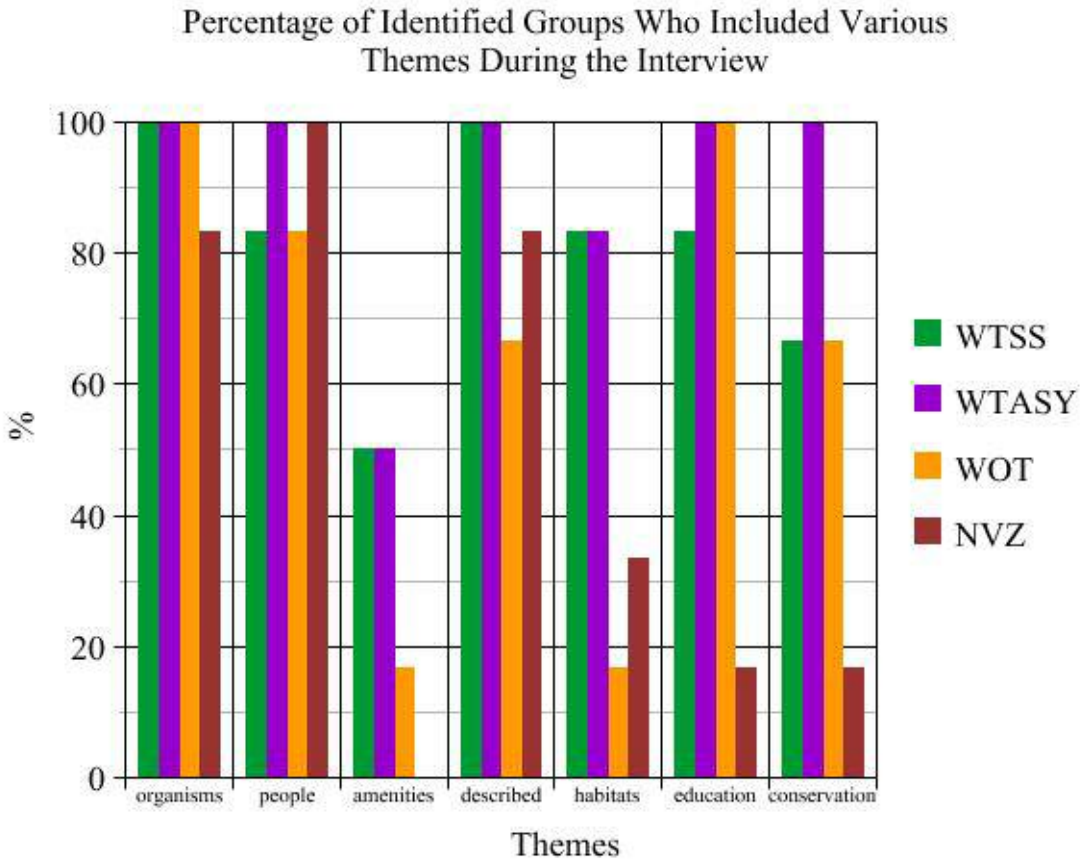
Percentage of Different Ethnicities Who Included Various Themes During the Interview



There was a noticeable difference in the number of students who mentioned *habitats* (13) (Figure 11). Whites (25.0%) did not mention *habitats* (13) as often as Hispanics (75%) and African Americans (62.5%). Hispanics (37.5%) and Whites (37.5%) mentioned the *amenities* at the zoo more often than African Americans (12.5%).

Differences were apparent between the four identified groups of students in the following themes: *education* (18), *conservation* (15), *habitats* (13), and *amenities* (7) (Figure 11). All groups of students (WTASY 100%, WOT students 100%, and WTSS students 83.8%) who had visited the zoo mentioned *education* (18) more than NVZ students (16.6%). WTSS students (66.6%), WTASY students (100%), and WOT students (66.6%) mentioned *conservation* most often. Only one NVZ student mentioned *conservation*. *Habitats* were mentioned most often by WTSS students and WTASY students (83.3%).

Figure 11.



Appendix K provides an overview of the seven themes identified in the interview and the understandings students have of zoos. Each theme is listed, and the words students used to depict each of the themes are presented.

Twenty-three students named *organisms* or where they are housed. Twenty-two students identified *animals* and eight students identified *plants*. Students who mentioned where *organisms* were housed named *exhibits* (5) and/or *cages* (3). Eleven students

named different types of *organisms* such as *mammals* (7), *reptiles* (3), *birds* (2), and/or *insects* (1).

Twenty-one students mentioned *people*. Students named zoo personnel such as *zookeepers* (5) and/or *tour guides* (2). *Family* (7), *children* (6), and/or *friends* (5) were also mentioned. In addition to naming the *people* students associate with zoos, students also used *descriptive terms* to depict zoos. *Descriptive terms* used to explain zoos were as *fun* (9), *natural* (5), *big* (3), *entertaining* (3), *enjoyable* (2), and/or *smell* (2).

Education was mentioned by 18 students. However, the theme *education* was given a wide definition to capture all elements students might identify as *education*. Students stated that they learned about *organisms* (13), *habitats* (7), *ecosystems* (4), *adaptations* (4), and *behavior* (3). Twelve students specifically stated information/facts about *organisms*. For example they said they learned about what animals eat (9), where animals live (6), and the color of the animal (5). Ten students stated that they got their information from signs. Two students stated that they went on a fieldtrip with a teacher.

During the interview, students were specifically asked to define conservation and to explain the role of zoos in conservation. I decided to include these questions in the interview because the mental models people have of the role of zoos in conservation is not well understood (Swanagan, 2000; Dierking et al., 2002; Tunnicliffe, 1995). When students were asked to define conservation, ten students defined it as to *protect/save*. Other words students associated with *conservation* were *breeding* (10), *extinct* (9), *endangered* (9), and *hunting* (5).

Students named examples of *habitats* (11) such as *grasslands* (3), *arctic* (2), *desert* (2), and *rainforest* (2). Five students defined *habitats* as *where organisms live*. One student used the word *habitat* with no further explanation.

Four students mentioned *amenities* during the interview. *Amenities* included *food* (4) and the *gift shop* (3).

In addition to the qualitative analysis, a Spearman's rho (p=.05) was completed for the interviews using SPSS (2006). The statistical analysis showed a strong positive correlation in the male group between education and conservation (r=.816, p=.001). Males who mentioned the theme education also tended to mention the theme conservation. Females also showed a positive correlation between education and conservation (r=.474, p=.001). The correlations for males and females may indicate a statistically significant relationship between the themes education and conservation.

A statistical correlation was not determined for the student groups (WTSS, WTASY, WOT, NVZ) and the ethnic groups in the interview. To perform a statistically significant correlation, 10 data points are need for each variable. Since the student groups and ethnic groups among the students chosen for the study were so small I was not able to determine a correlation coefficient.

Ranking Concepts Exercise

After students completed the concept mapping activity, a master word list of all the words students used in the concept map was compiled to determine which words were used most frequently. The top 20 words from the word list were used to design a ranking concepts exercise. The words were put in random order and students were asked to rank

them 1 to 20 based on how well the word depicted zoos, one meaning that the word most depicted zoos and 20 meaning that the word least depicted zoos.

Students listed the 20 words from the ranking concepts exercise in the following order:

1. animals
2. exhibit
3. plants
4. family
5. walking
6. children
7. fieldtrip
8. learning
9. friends
10. fun
11. water
12. food
13. tram
14. gift shop
15. playground
16. weather
17. rocks
18. money
19. smell
20. employees

Table 6 shows the top five choices of the four groups of students.

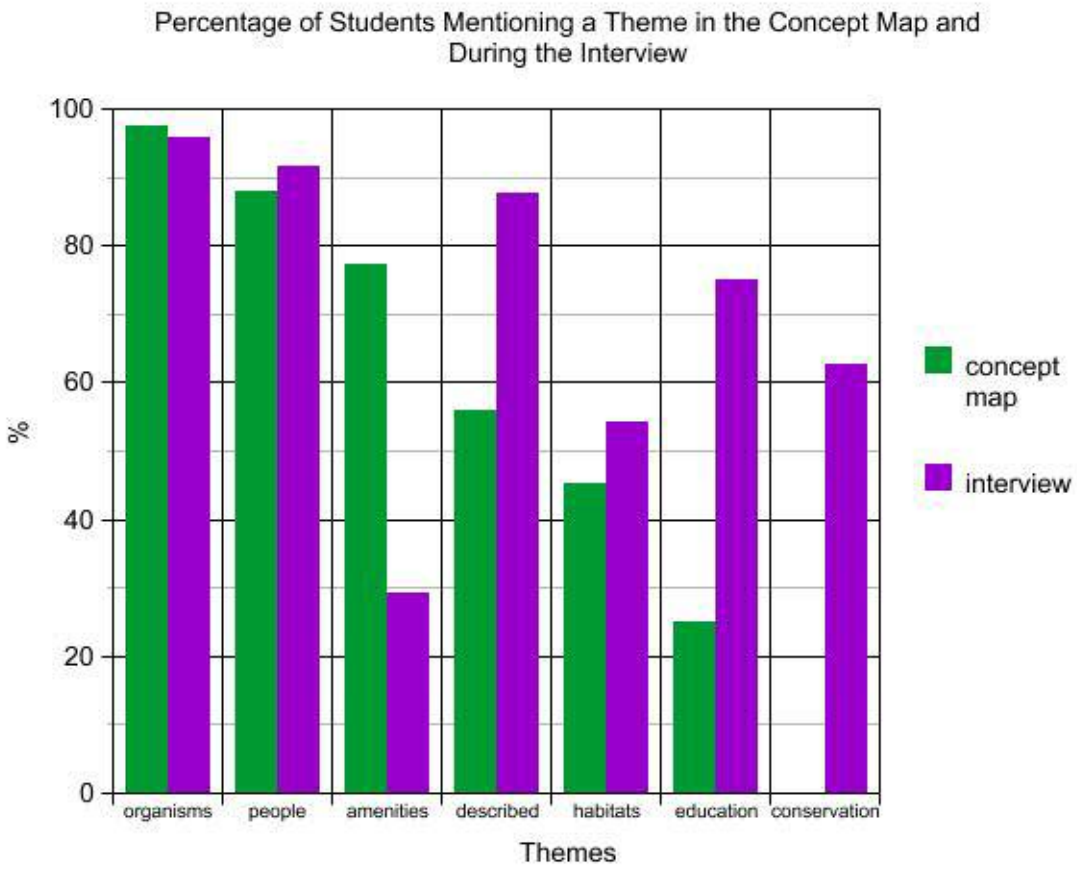
Table 6.
Top Five Words Identified in the Ranking Concepts Exercise

With Teacher This Semester	**With Teacher Other Semester**	**Without Teacher**	**Never Visited a Zoo**
Animals	Animals	Animals	Animals
Exhibits	Exhibits	Plants	Exhibits
Plants	Plants	Exhibits	Children
Walking	Walking	Walking	Family
Fieldtrip	family	family	Learning

Triangulation

Three different data collecting tools were used during this study. A concept map activity, an interview, and a ranking concepts exercise were completed to allow me to triangulate the data in order to develop an understanding of the mental models students hold of zoos. Figure 12 shows the percentage of students who mentioned each theme in the concept map and during the interview.

Figure 12.



The theme *descriptive terms* was the fourth most mentioned theme in the concept map and the third most mentioned theme in the interview. The theme *amenities* was the third most mentioned theme in the concept map. In the systemic network walking was included in the theme *amenities*. In the ranking concepts exercise students ranked walking as the fifth word that most defines zoos.

Conservation and *conservation* related words were only found in the interview. No student mentioned *conservation* in the concept map; therefore, none of these words were listed in the ranking concepts exercise.

Summary

Findings from the concept map, interview, and ranking concepts exercise provide information that allows a clearer insight into the mental models students hold of zoos. Students identify zoos as places to see *organisms*. Students also name the *people* with whom they visit the zoo and the *people* with whom they have contact at the zoo. *Education* and *conservation* are not primary concepts identified by students. However, when students are prompted with specific questions concerning their knowledge of zoos, *education* and *conservation* are recognized as the responsibility of zoos. This became clear during the interview when students were asked why zoos exist and how zoos are involved in *conservation*. In fact, students mentioned *education* three times more often during the interview than they did in the concept map and *conservation* was mentioned only during the interview.

Chapter V includes a discussion and interpretation of the results of this study and identifies the mental models students hold of zoos. Chapter V also offers a discussion of

the implications of the findings from the study for classroom educators and zoo educators.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Research Overview

The purpose of this dissertation was to implement a study designed to profile the mental models high school students hold of zoos. Specifically, the present study investigated the students perceptions of why zoos exist and their knowledge of the role of zoos in conservation.

I used the Visitor Centered Evaluation Hierarchy (VCEH) (Wells & Butler, 2004) to identify the types of questions and the evaluation tools best suited for my study. The VCEH allowed me to focus my study on the understandings students hold of zoos, both students who have visited a zoo and those students who have never visited a zoo. As suggested by the VCEH, I situated my research in the psychographic tier and I used a concept map and interviews, as well as a ranking concepts exercise for my data gathering tools. By using the data gathering tools suggested in the psychographic tier, this study elicited the understandings students have of zoos.

I determined the mental models secondary students have of zoos through their expressed models. The expressed models of students are the written or verbal comments of what students understand about zoos. In order to elicit the expressed models students

have of zoos, I had eighty-four high school science students design concept maps to describe zoos. I had these same students rank a list of 20 words according to how descriptive these terms were of zoos. Additionally, 24 of the 84 students were interviewed.

As indicated in a review of the literature, zoos are considered conservation organizations (AZA, 2004; IZE, 2004; WAZA, 2004; IUDZG/CBSG IUCN/SSC, 1993), but there was little research to support or define the understandings high school science students have of the roles and purposes of zoos and the role of zoos in conservation (Ogden, et al., 2004; Dierking, Burtnyk, Buchner & Falk, 2002; Swanagan, 2000; Tunnicliffe, 1996a; Tunnicliffe, 1996b). Additionally, this study addressed the call for research on zoo-related knowledge and conservation related knowledge (Boyle, 2005) by identifying the mental models students hold of zoos. In this chapter, I discuss, interpret, and draw conclusions about the findings described in Chapter IV. I also include the implications of this study for zoo educators, classroom educators, and provide suggestions for further study.

Research Questions

The research questions that guided this study were:

1. What are the understandings of high school science students of the roles and purposes of zoos? That is, what are the mental models students hold of zoos?
    A. What are the differences in mental models students hold of zoos who have visited the zoo with a teacher in the last year, who have visited the zoo with a teacher prior to this school year, who have

visited the zoo with someone other than a teacher and who have never visited a zoo?

B. What are the differences in mental models males and females hold of zoos?

C. What are the differences in mental models of students of different ethnicities: African American, White, & Hispanic?

2. How do students define conservation and the role of the zoo in conservation?

Discussion & Interpretations

This section provides a discussion and interpretations of the major findings from Chapter IV. The findings from the concept map, interview, and ranking concepts exercise are interpreted to provide a model of the understandings students hold of zoos. The discussion and interpretations are organized in the following sections: 1) demographics, 2) students' mental models of zoos, 3) distinctions in the mental models of students based on type of zoo visitation, 4) distinctions in the mental models held by students of different genders and ethnicities, 5) students' definitions of conservation and the roles zoo have in conservation, 6) implications and suggestions for further research, and 7) summary.

Demographics

Since visitors interpret the information they are given through their previous knowledge and understandings (Kolber, 1995; Falk & Dierking, 1992; Falk & Dierking, 2000), it is important to know the mental representations students hold of zoos. Therefore, this study identifies what students know about zoos by diagramming their mental models of zoos.

The data showed that the demographic profile for the typical high school science student in this study, who had visited a zoo, had visited one to five times (46.4%), had visited in the last year (38.1%), and had visited most often with family (61.9%). This finding supports previous studies in that, proportionately, families make up the largest group of visitors to zoos (Falk & Dierking, 2000).

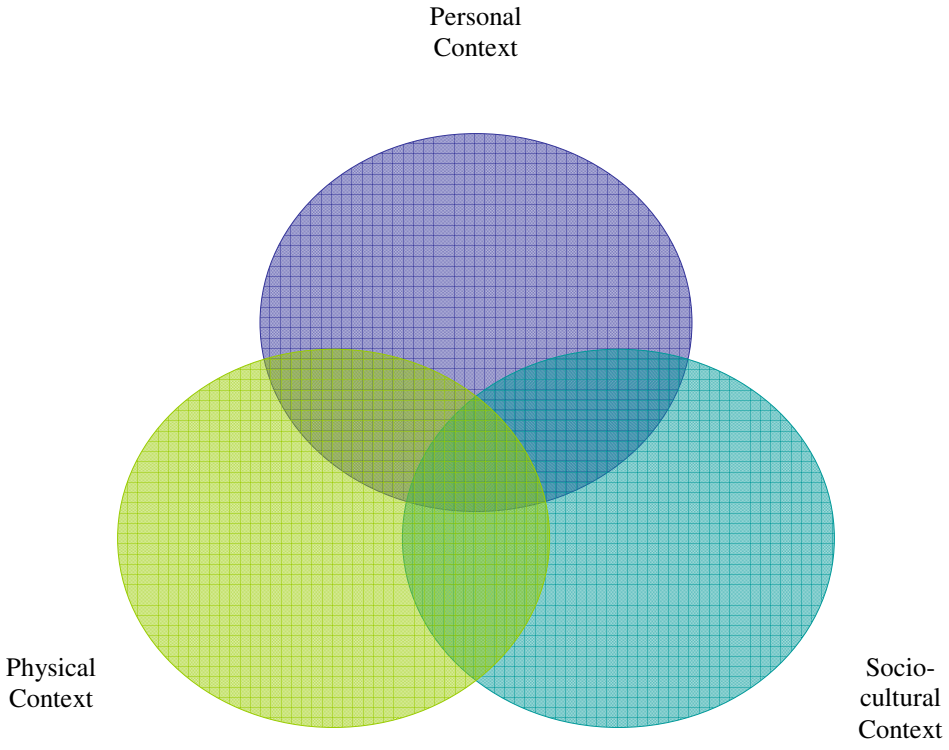
Students' Mental Models of Zoos

The field of visitor studies has focused on the experiences children have had in leisure settings and studies conducted at the museum or zoo (Birney, 1995). The research in zoos includes visitor demographics, motivations to visit zoos, and visitor interactions with exhibits, programs, and staff (Falk & Dierking, 1992; Falk & Dierking, 1995; Falk & Dierking, 2000). In *Learning from Museums*, Falk & Dierking (2000) described how visitors make meaning of a museum visit and they developed the Contextual Model of Learning (Figure 13). The Contextual Model of Learning involves three overlapping contexts: Personal, Sociocultural, and Physical. Visitors learn through the interactions of all three of the contexts over a period of time. The model does not attempt to reduce the

the complexity of learning but becomes a comprehensible organization of learning. To explain the mental models students hold of zoos and to show how the themes identified by the systemic network overlap, I adapted Falk and Dierking's Contextual Learning Model to create the Zoo Acuity Model.

Figure 13.

Contextual Learning Model (Falk & Dierking, 2000)



Falk & Dierking's Personal Context describes the motivation people have for learning when they visit a museum as intrinsic. Learning is self-motivated, satisfying, and personally rewarding. People are more willing to learn when they come in contact with supportive environments and when they have control over their learning. Learning in the Personal Context requires prior knowledge and cues from the outside world. For example, students may hear a story, while visiting the zoo, about red wolves being bred and released into their natural habitat. This information may be stored until they are confronted with questions concerning red wolves or questions concerning how zoos are involved in conservation.

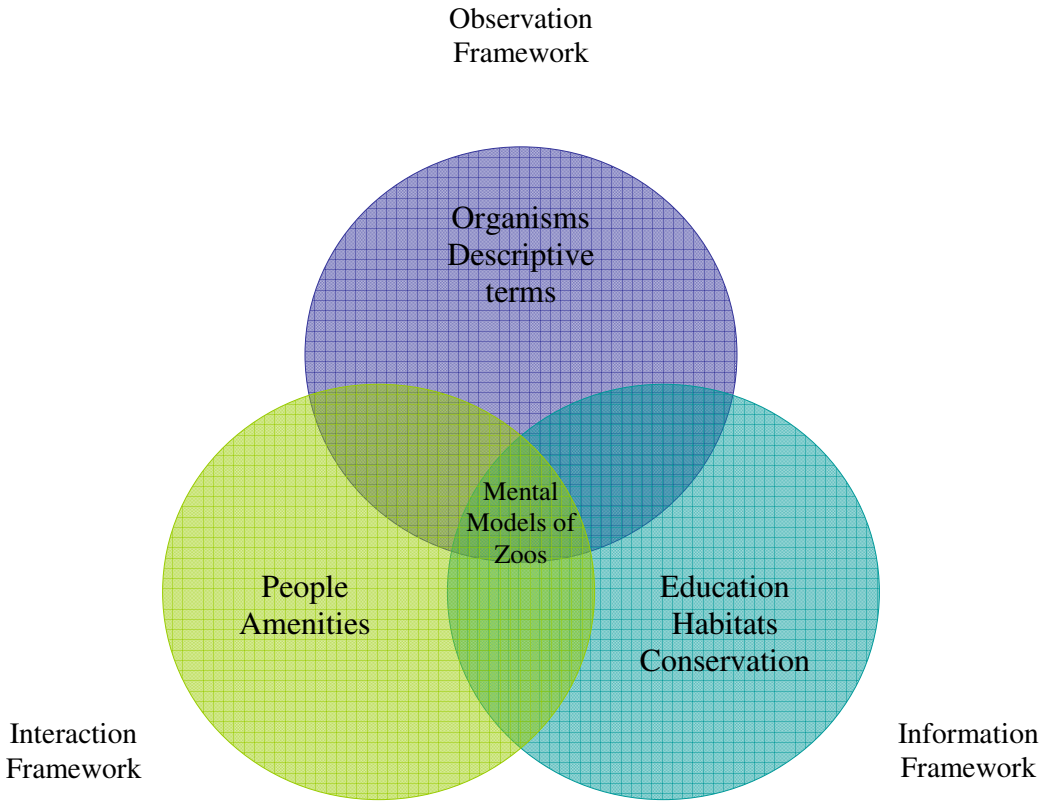
The Sociocultural Context was founded on Vygotsky's approach to cognition. Vygotsky believed that cognition developed as a result of social interaction. Additionally museum visitors are seen as a community of learners who socially share their knowledge before, during, and after a museum visit. Learning in the Sociocultural Context happens during group play, storytelling, modeling, and narration.

The Physical Context situates learning in the physical environment. People have a need to make sense of their environment by trying to recognize elements of an old context in the new context. The emotions, which are evoked during an experience, will forever form the memories we have of that experience. The physical environment including smells, sounds, experiences, and feelings that the zoo visit evokes all foster memories of an experience and the learning that takes place in that environment. To explain the mental models students hold of zoos and to show how the themes identified

by the systemic network overlap, I adapted Falk & Dierking's Contextual Learning Model and derived the Zoo Acuity Model (Figure 14).

Figure 14.

Zoo Acuity Model



The above schema based on Falk & Dierking, shows three interlinking areas. The intersection of these three Frameworks denotes the mental models held by students of zoos. These themes were derived from the analysis of the concept maps and the interviews. The analysis used the systemic networks developed for understanding the data collected. From the analysis, I identified seven main themes of the mental models of the students. The themes are: 1) *organisms*, 2) *people*, 3) *amenities*, 4) *descriptive terms*, 5) *habitats*, 6) *education*, and 7) *conservation*. These themes are subsumed into the three zoo understanding frameworks: 1) the Observation Framework, 2) the Interaction Framework, and 3) the Information Framework. These three frameworks are the basis for the Zoo Acuity Model.

I chose to name my model the Zoo Acuity model because acuity means the sharpness or keenness of perception or perceptiveness. The term acuity is used most often in terms of visual acuity, therefore, to me, the Zoo Acuity model means, "How do you see a zoo?" So, in relation to the mental models of zoos, it is, "How do you see zoos in your mind?" or "How do you think about zoos?" Acuity is related to "acumen" (both from the same Latin origin) sharpness of mind, so acuity means the sharpness of your mental vision. Acumen refers to understanding or perception, not just a collection of information or facts, but how well you understand those facts (Wikipedia, 2006). Or, as I indicated above, how sharply do you see it in your mind.

The Observation Framework includes students naming organisms they saw during a zoo visit or might see during a zoo visit and naming the location of the organism (exhibit, cage, cave). This framework also incorporates words students use to describe animal care

and animal behavior that they saw at the zoo or thought they might see at the zoo. In the Observation Framework students also use descriptive terms to depict how they view zoos, for example, fun, big, and smelly.

The following are excerpts from student interviews which show examples of the Observation Framework:

> They [zoos] have animals.
>
> [I go there to] Observe the animals.
>
> It [the zoo] is fun and has animals.
>
> Sometimes there's an animal, like the polar bears, that don't come out in the summer. They're only out in the winter and fall. And some of them die and they replace them or their environments.
>
> They have animals there so people can come there and see different animals from different parts of the world. So they can experience and look at the animals so they know about different animals. And different plants in different areas so they can get to know the different animals in the different areas so if they want to go visit that place in the world they will know what kind of animals are there and the kind of plants.
>
> It [zoo] is a tourist entrapment.
>
> A small park with animals in containment for other people's pleasure.
>
> They take really good care of their animals at that zoo. They were cleaning a lot of the cages when we were there. They had at least 4 people in there…and they were washing the windows.

The Information Framework includes the themes education, habitats and conservation. Students believe zoos to be educational and their descriptions include

information and/or facts they discover while visiting zoos, including colors of organisms, the food preferences of the organism, adaptations, ecosystems, and where organisms would be found in their natural environment. As shown in the Zoo Acuity Model, it is very hard to fully exclude habitats from the other frameworks, because habitats may be observed during the zoo visit. However, habitats were included in the Information Framework because students state that you may obtain information about habitats more often than they describe habitats as something they see while at the zoo.

The following are examples of the statements students used to acknowledge what they learned during a zoo visit and comments they made concerning habitats:

> To learn about you know how all the animals live and what kind of environment they live in.
>
> [I learned] About the habits of the animal, what size, the heights, different lengths, also different kinds of plant.
>
> [I learned] how they live, things they do, their jobs.
>
> Each exhibit had signs that told you about everything.
>
> [Zoos exist] To help people learn about different ecosystems and what's involved in them.
>
> I learn about different habitats and stuff and how animals live, what they eat.
>
> They [people] can learn how other living things live. How they survive and stuff.
>
> We went there on a field trip to study animals, their habitats and all their adaptations.
>
> We had to study like polar bears. They live in the cold and we had to study the habitat about the cold so we could learn about the adaptations

and how they get used to the cold.

> They [zoos] try to make it [exhibits] as true as possible. The plants they even try to make the real plants like they live in like the habitats. They try to make them as real as possible. The exact plants that are in their habitat and the exact temperature and sunlight and all that.

Conservation is included in the Information Framework because zoos identify themselves as a place where people learn about conservation (AZA, 2004; IZE, 2004; WAZA, 2004; IUDZG/CBSG IUCN/SSC, 1993). Moreover, conservation is not something students stated they observed nor had interaction with during the visit. Conservation was mentioned by students only during the interview when they were prompted by questions that the interviewer asked. Students mentioned conservation only after being asked why zoos exist and/or how zoos are involved in conservation. Fifteen out of 24 students mentioned conservation during the interview. Students were asked why zoos exist before they were asked to explain how zoos are involved in conservation. When asked why zoos exist, seven of the 15 students mentioned conservation. However, three of these seven students were not able to explain how zoos are involved in conservation. The other eight students did not cite conservation as a reason for why zoos exist but they were able to explain how zoos are involved in conservation when asked by the interviewer.

The Interaction Framework includes the themes *people* and *amenities*. People are included in the Interaction Framework because students interact with the people with whom they visit the zoo and with zoo employees. Students also interact with the amenities found at the zoo such as gift shops, food, and sources of transportation.

The following are excerpts from the student interviews in which students mention people and/or amenities.

> You can get food at the zoo and it's expensive.
>
> Children can go see the animals.
>
> Over the summer I went to the zoo with my aunt and some friends, my mom, my sister and my stepdad. We went to the zoo. We looked at the animals and we walked around. The little kids that were with us said they were enjoying the animals too. With family you have a little bit more freedom. With school you have to answer a whole bunch of questions and stuff and you have to try and be faster to try to look at everything.
>
> It was when I went back to Mexico and my Aunt was like do you want to go? It was like a treat and it was fun. We went with friends and family. We had a lot of fun.
>
> Walk around. Look at the different sites…gift shops and all that.
>
> They [zoos] are a little boring if you go alone. Cool gift shops.
>
> Well it was on a date. My first date. We just walked around and fed all the animals. My boyfriend's nephew came with us so he was all excited about the animals and jumping around and said look at that look at that. It was so fun. It was cool.

The mental models students hold of zoos consist mainly of the Observation Framework and the Interaction Framework as identified by the concept maps and interviews. Conversely, through their mission statements, zoos identify education and conservation as their main goals (Patrick, Matthews, Tunnicliffe, & Ayers, 2006). Clearly, there is a discrepancy between what zoos say they do and the understandings students have concerning zoos.

The Zoo Acuity Model, like the Contextual Learning Model, takes into consideration the situations in which learning occurs. For example, the Observation Framework and Interaction Framework incorporate all of the concepts from the Contextual Learning Model: Physical Context, Personal Context, and Socio-cultural Context. The main difference between the Contextual Learning Model and the Zoo Acuity Model is the addition of the Information Framework. The Information Framework completes the mental models students have of zoos. As stated in this study, the mental models students hold of zoos are influenced by the people with whom they visit, the people they encounter during their visit (family, zoo staff, friends), the physical attributes of the zoo (exhibits, transportation, food, and gift shops), and the emotive aspects of the zoo (smells, noises, colors). This study supports the idea that a zoo visit is situated in the affective domain of learning (Jenner, 2003). Much of what students talked about when asked about zoos was: 1) what animals they saw or might see during a zoo visit, 2) who they visited the zoo with, and 3) how the zoo looked.

Based on the results of this study, the Observation Framework and the Interaction Framework are where the mental models students hold of zoos are anchored and well defined. It is now imperative to utilize the Observation and Interaction frameworks to begin building a stronger interrelationship between all three of the frameworks; therefore, strengthening the mental models students have of zoos.

For example, when students were probed during the interview for a deeper understanding of the role of zoos in conservation, some were not able to identify how zoos are involved in conservation. Moreover, none of the students used conservation

topics or words in the concept mapping activity. Therefore, I surmise that students do not fully understand conservation and students are not able to explain how zoos are involved in conservation. My research supports claims made by the Chicago Zoological Society and the Lincoln Park Zoological Society (1993) that zoo visitors do not think of zoos as conservation organizations and reinforces previous studies that show students do not understand what conservation means (Swanagan, 2000; Price et al., 1994; Birney, 1991).

Distinctions in the Mental Models of Students Based on Type of Zoo Visitation

This study identified the mental models students hold of zoos. Four groups of students were categorized with respect to type of zoo visit: 1) students who visited a zoo with their teacher in the same semester the study was conducted (WTSS), 2) students who visited a zoo during another school year with their teacher (WTASY), 3) students who have visited the zoo without their teacher (WOT), and 4) students who have never visited a zoo (NVZ).

There were differences among the descriptions students gave of zoos in their concept maps and interviews. As might be expected, NVZ students did not have as rich a mental model of zoos as WTSS. A student who had never visited a zoo was not able to elaborate when asked questions about zoos. A look at the example below confirms that students' answers were limited to "I don't know.", "Yes.", and "No." When the student attempted to answer the questions they were only able to provide a few words without further explanation. The following is an excerpt from an interview with a student who had never visited a zoo:

Interviewer (I): Tell me what you know about zoos?
Student (S): I don't know I never been there.
I: OK. If you were to define the word and to tell someone what a zoo is, what would you say? Do you have any ideas at all about zoos? What would you tell people about them?
S: They have animals and that's all I know.
I: OK. Why do they have animals?
S: Ahm. Study them.
I: OK. Any other ideas why they have animals?
S: To entertain people.
I: To entertain people. OK. Alright. If someone asked you what is the job of the zoo? Why do we have them? Why do they exist? What would you say?
S: To take care of them.
I: To take care of what?
S: Animals.
I: OK. How do they take care of them?
S: I don't know.
I: Why do you think they keep the animals there?
S: To keep them healthy.
I: Ok. Is that important? To keep them healthy?
S: Yes.
I: Why is that important?
S: Because…I don't know.
I: So why do we have zoos? Why do they exist? Why do we have them?
S: I don't know.
I: OK. Have you ever heard the word conservation?
S: No.
I: Have you ever heard the word conserve?
S: Unuh
I: OK. Do you think zoos are involved in conservation?
S: I don't know what conservation is.
I: Do you know examples of how zoos are involved in conservation?
S: No.

For comparison, the following is an excerpt from an interview with a student who had visited a zoo with a teacher in the same semester that this study was conducted. This student was able to provide detailed information about words such as habitat and

endangered. Additionally, this student was able to provide a deeper explanation of conservation and how zoos are involved in conservation.

Interviewer (I): Tell me about your trip to the zoo.
(S): We more or less…we looked at what type of animals were in their habitat and we saw what the habitats looked like. We done a study a guide sheet. We went through there and answered questions about different animals and different habitats and then we done…we checked cuticle thickness on plants. We checked light intensity and temperature which I done on the lab in the classroom. Then we tested all that and we measured the plants and we took pictures of the plants. Our habitat was the cypress swamp. Which we described the alligators and I think we did the box turtles.
I: What does the word habitat mean?
S: Habitats is like if you look at like…we're sitting across from woods and they're tearing down the woods on deep river and that's destroying different habitats for salamanders and newts and things like that. It's destroying things like that where they live and their habitat and what they live in. Like dead logs would be like where salamanders live in.
I: What do habitats have to do with zoos?
S: Zoos try to build the animal's habitat. Like the lions have like a prairie habitat with high rocks and where they can more or less roam like they do in the wild.
I: What is your experience with zoos? Do you know someone who works at the zoo? Are you a member? Are your parents members? Do you have any interaction outside the school?
S: My cousin works at the zoos but she's just volunteering with 4-H and my aunt used to work at the zoo.
I: What did she do there?
S: I don't remember.
I: How do you think that people working at the zoo has influenced what you know about zoos?
S: Like if you go to the zoo you can talk to them and they can tell you about what happens around the zoo and how the zoo…when you're working at the zoo how things run and they keep everything straight and neat the way it needs to be and they keep the animals. Like if the animal is sick they take care of it and I think it is just wonderful that they do that.
I: What is a zoo? Can you define that word for me?
S: A zoo is a place where we hold animals in captivity to be seen in almost their real life settings and they're safe and if they're endangered they're safe. They can't be hunted and its like a national wildlife park.

I: What does endangered mean?
S: Endangered means that the bald eagle is endangered. It means that there is not many of that species left.
I: Why do we have zoos?
S: To keep animals safe. Like I said endangered animals and different animals and it keeps animals from being hunted by poachers and people that want them for different things.
I: What does conservation mean? Have you ever heard the word conservation in relation to zoos?
S: A little bit. Like the big prairies at the NC Zoo they are keeping the land from being torn down and shopping malls and stuff like that there.
I: Do you know what the word conservation means?
S: Conservation to me means keeping the land and the animals from dying and not tearing down everything and keeping life with the land.
I: What do zoos do about conservation? What is their role in conservation? Can you give me some examples?
S: They plant different types…they take plants from…like whenever somebody's doing something and taking stuff down they can take the plants from there without killing them and put them in a conservation or wildlife habitat so the animals still have their habitat so they can live there. And they keep things up like that and they make sure that all the land… that all their animals are all in the land that they have is not tore down or messed with to preserve life so people will know what it looked like before any of these shopping malls or Walmarts got here.
I: When you talk about these animals and plants, where do you think they came from?
S: From different places, I don't know. They take cactuses from the Sonora Desert and try to bring them here, but our climate is different and they can't really keep those cactuses up but we have regular cactuses here in NC that are used to this climate and can stay alive. And the animals eat cactus and they…different animals eat the tops of trees. Like the giraffes will eat the tops of the trees and eat the trees they put in the habitat and they try to get it as close to their natural habitat as they can.
I: How do you know what you know about zoos? Where did you get your information from?
S: Visiting zoos, going with my family, going with the school, doing research projects on habitats and different life and just different ways.
I: What did you do your research on?
S: I did it online. Whenever we went to the zoo I did my own research there. I checked the…I had…we done the swamp. I looked at all the signs. I jotted down all the information I thought I could use in my conclusion on my paper and used that and the research here in the library and computers and different books that you can find about different animals in the swamp.

The presence of a teacher did make a difference in whether or not students mentioned habitats. WTSS and WTASY students remembered more about habitats and conservation and discussed what they learned at the zoo more often than other student groups. The WTSS group was responsible for recording data while at the zoo and presenting this data to parents at the school on parents' night. These findings support Falk & Dierking's (2000) claims that when children have an agenda during a zoo visit and an opportunity to explain their learning to others they are more likely to remember their discoveries.

Over half of the WOT students visited in a family group. The fact that most of the students in the WOT group visited with family may be the reason why they mentioned people, amenities, education and conservation most often in the concept map and interview. Students who visited with family mentioned the people they visited with more often than students who visited with a teacher. These findings are also consistent with family groups because they are more social, interact with the exhibits and share information in the exhibits more often, and share prior knowledge. Family groups are also more likely to view zoos as places for learning (Falk & Dierking, 2000).

Most non-school group zoo visitors attend zoos to witness the diversity of exotic species (Hoage & Deiss, 1996). This study supports that claim because all groups of students (WTSS, WTASY, WOT) who had visited a zoo described zoos as places to see

animals. Additionally, this study found that even students who have never visited described zoos as places to see animals.

Swanagan (2000) stated that a zoo visit may negatively affect the attitudes people have about animals. This study does not support Swanagan's assessment of the affects of a zoo visit. Students who had visited a zoo and students who had not visited a zoo mentioned animals the same and only three students mentioned animals in a negative way: 1) animals in containment for other people's pleasure, 2) animals are kept in cages, and 3) a tourist entrapment.

Based on the Personal Construct Theory (PCT) students who visited a zoo should have a different mental model of zoos than students who have never visited the zoo. Additionally, the PCT also suggests that the people with whom students visit the zoo will influence the students' mental models. My study confirms that students who have never visited a zoo also have mental models of zoos, which are not as rich as students who have visited a zoo. Predictably, the concept maps and interviews of students who had never visited a zoo were not as rich in detail as students who had visited a zoo prior to the study.

Moreover, this study shows that students have understandings of zoos that may be influenced by the people with whom they visited a zoo. For example, if the student visited with someone other than a teacher they have different understandings of zoos than students who have visited with a teacher. This has important implications for classroom educators and zoo educators. Educators must take into consideration the prior knowledge students have of zoos. Prior to a zoo visit classroom educators should prepare students by

describing zoos, the role of zoos, and the role of zoos in conservation. Zoo educators need to address the misconceptions students have of zoos by providing students with opportunities to observe how zoos are involved in conservation, if conservation is the mission of zoos.

Distinctions in the Mental Models Held by Students of Different Genders & Ethnicities

The main priority of this study was to identify the mental models students hold of zoos and determine if whether any differences existed between the mental models of students of different genders and ethnicities. However, the number of minority students at the school chosen for this study was low. Eighty-seven percent of the student body consisted of Whites, while 13% of the students were Hispanic (7%), African American (5%) and other (1%) (Great Schools, 2006). Therefore, determining differences between ethnicities for this study was difficult and did not provide large amounts of data. The population for this study consisted of 81% White, 9.5% African American, and 9.5% Hispanic.

While no large differences existed between males and females, one dissimilarity was apparent. Males mentioned habitats more often than females in the concept map and in the interview.

Students' Definitions of Conservation and the Zoo's Role in Conservation

As previously expressed, conservation was only mentioned by students during the interview. When asked about zoos, most students did not spontaneously talk about conservation. This supports Tunnicliffe's (1995) dissertation research which stated that students do not spontaneously talk about conservation at an exhibit during a school visit.

During the interview students were asked to explain why zoos exist. Seven students mentioned conservation or a conservation related topic. The following are excerpts from students' interviews in which they were answering why zoos exist:

> Sometimes they help some of the animals there…like…endangered animals. To keep animals safe. From hunters. From people who want to kill them because they…have like stuff. Like animals, like elephants or rhinos. They kill them to get their horns.

> To keep animals that are getting extinct and to reproduce things. So they can be more of that species.

> One reason is so we can learn about the animals but I think another reason is like they may have some endangered species in there so they can help them reproduce and mate so they are not being killed. If they have the animals there and in the wild and they are being helped taking care of. If they have babies they can keep them there and take care of them too.

To determine if students understood the idea of conservation and how zoos are involved in conservation students were asked to define conservation. Students had a difficult time explaining conservation so I immediately asked if they knew what "conserve" meant. If students were able to explain conserving I asked them to relate that to zoos and describe how zoos conserved or were involved in conservation. Some students were able to explain how zoos are involved in conservation. The following are statements students made when describing conservation and how zoos are involved in conservation.

> It is like you know I said you know if an animal is endangered they might bring them in or if they are injured or something they might bring them to the zoo and take care of them.

> It [zoos] might take animals that are almost extinct or endangered and give them a home and help breed them until they can become unendangered.
>
> They [zoos] might take an animal that is hurt or something and put it in a habitat that they are more comfortable in so like they put a male or a female in there so they can produce more. They can put them out when they are endangered.
>
> Zoos do conservation so that some animals that are dying off that are about to fall off the list, but are still alive they will put them in zoos which will help out their population because they can have babies there at the zoo. Then they can take them to where they really belong…to where they came from. Then they will bring the population up.
>
> Zoos like take in…they take in…like in Japan or something like that and they rescued a little panda bear and they kept it there and now she's doing really good. So I think zoos care for the animals really well.
>
> Let's say that the jungle was been disappearing because of humans or buildings or houses or something, so they take animals and they put them in places similar to where they are used to living so they can keep growing.
>
> If an animal is on the endangered species list they will get 2. They will like breed them and introduce the children into the wild. They are getting the red wolf off the endangered species list. They will….they breed…they like breed the 2 red wolves and when the pups do come out they'll let them live with their mom for a little while. Then they will reintroduce them out into the wild so they can live in the wild.

The National Aquarium in Baltimore (McKelvey, et al., 1999) conducted a study in which they asked adult visitors about conservation before and after they entered the aquarium. The Baltimore study found that people did understand conservation, were able to articulate examples of conservation, and their descriptions and understandings of

conservation were much richer as they exited the aquarium. This study does not support these findings in that no student group spontaneously included conservation on their concept map. Students only mentioned conservation when they were prompted with conservation questions. Fifty percent of the students who mentioned conservation were able to articulate their knowledge of how zoos are active in conservation. Additionally, students who had never visited a zoo were not able to explain conservation nor were they able to give examples of how zoos are involved in conservation. This study does support the National Aquarium's study in that it shows that students who have visited a zoo, whether with a teacher, family, or friends, were more likely to describe conservation in relation to zoos and, in some cases, give limited examples of conservation and how zoos are involved in conservation.

Implications

Implications for Zoo Educators

Since it has been determined that zoo visitors interpret the information they are given through their previous knowledge and understanding (Kolbert, 1995; Falk & Dierking, 1992; Falk & Dierking 2000) it is important for zoo educators to know that visitors see zoos as places for organisms. Students are also interested in the people with whom they visit the zoo and the people with whom they come in contact while visiting the zoo. This study does support prior studies (Zoological Society of Philadelphia, 1989), which implied that the presence of a caretaker influenced a student's visit. In this study students mentioned the zookeeper as an important part of their visit and when asked about their interaction with zookeepers students stated they got information from the zookeepers.

Based on the results of the Zoo Acuity Model the people with whom students visit, the zoo personnel with whom they have contact and the organisms, themselves, may be an approach to increasing students' knowledge of conservation.

As Carr (2000) stated zoos need to reach out to schools and the public by providing educational opportunities in which people may grasp a better understanding of the role of humans in conservation. This study supports Carr's statements in that it provides an overview of the understandings students have zoos. Even if students have never visited a zoo they do have some ideas about zoos and what a zoo visit would be like. Therefore classroom teachers and zoo educators need to be aware of the knowledge students take to the zoo.

The World Conservation Organization (WCO) Strategy (IUDZG/CBSG, 1993) stated specific goals for zoo conservation education. The goals of zoo conservation education are to make people aware that conservation affects everyone, to increase the public's awareness of the connection between species survival and biological systems and the affects of human consumption, and to increase public knowledge of the status of endangered organisms. My study shows the WCO's goals of zoo conservation have not been obtained with respect to students and zoos. Many of the students in this study were not aware of conservation nor were they aware of how zoos are involved in conservation. Moreover, students did not mention their connection to species survival nor did they mention that zoos were a source of information for conservation related topics. However some students did state that zoos aided in saving threatened or endangered species.

Since many of the people who visit zoos are adults with children (AZA, 2004), it is important for zoo educators to provide educational material for this group. Educational material might include interactive information cards on which children and/or adults record conservation related information as they visit the zoo. In order to increase the involvement of parents and students zoos could sell data books in which the data could be recorded. For example, questions might include: 1) How big is the elephant? 2) How much food does the elephant eat? 3) How much space does an elephant need in the wild?, 4) Why are elephants hunted? 5) What can you do to help protect elephants? Zoo interactive information bags could be an option for parents or teachers who bring students to the zoo. Zoos could charge for the bags. For example, the zoo bag might have pieces of fake fur that feel like the lion, polar bear, or zebra. Another artifact might be a large dot that is the size of an elephants foot which could be placed on the ground while visiting the elephants so children could see up close the size of elephant's foot. Additionally different colors of material could be included that children could match with the organism they were viewing. By getting parents, teachers, and students involved zoo educators would have a better chance of getting across the zoo's conservation message.

Implications for Classroom Educators

Birney (1988) stated that students are affected by the physical environment as well as their expectations. This study supports Birney because in this study students were concerned with how they would travel around the zoo, whether walking or riding and what they would buy at the gift shop. Educators must address these concerns before they attempt to add to the mental models students have of zoos. Classroom educators need to

prepare students for the zoo visit by addressing transportation at the zoo, time that will be allowed in the gift shop, and preparing students for what they will see during a zoo visit. Furthermore, classroom educators need to prepare students for what they will see at the zoo, including details of why zoos are important and their roles in conservation. Classroom educators may ask students to identify examples, during a zoo visit, of how zoos are involved in conservation.

This study confirms previous research which states that students predominantly identify home and direct observation as their main sources of information (Tunnicliffe & Reiss, 2000; Boulter et al., 2003). In this study students named visiting a zoo and family as their primary sources of information about zoos. However, students also named teachers as their third source of information concerning zoos. This may be due to the fact that half of the students in the study had visited the zoo with their teacher. Therefore, the understandings students have of zoos are affected by both out of classroom visits and the people with whom they visit.

Since students are constantly reorganizing and altering their understandings of zoos based on the information they obtain from people outside the zoo, zoo personnel, zoo visits, teachers, and media, it is imperative for zoo educators and classroom educators to provide students with accurate information concerning zoos.

Conservation messages may be shifting from species decline and breeding to the importance of saving habitat (Mazur & Clark, 2001), but students are not getting this message. This study is in line with other research (Swanagan, 2000; Price et al., 1994; Birney, 1991) in that it shows that students do not understand what conservation means.

In reality, students see zoos as a place to see animals, engage with other people, and at the least a place for animals to be kept for breeding and to be released back into nature. In the case of this study, students did not mention saving habitat. Instead, students who did mention conservation stated zoos save animals. However, students who have visited a zoo prior to this study were more likely to mention habitat in relation to zoos than students who had never visited zoo. This may show that a zoo visit makes students more aware of an organism's habitat, which according to the Zoo Acuity model would provide zoo educators and classroom educators an educational bridge to link habitats and conservation.

Moreover, an interesting finding for zoo educators and classroom educators was uncovered during the interview. Both male and female students who mentioned education in relation to zoos were more likely to identify zoos as conservation organizations. This may have implications for zoo educators and classroom educators. If students, who believe that zoos are places where learning occurs, are more likely to identify zoos as conservation organizations, then zoo educators and classroom educators may be able to incorporate conservation education programs.

Suggestions for Further Research

This study did not compare students' knowledge of zoos before a zoo visit and after a zoo visit, so I am not able to determine if a zoo visit changes the understandings students have of zoos. However, I was able to determine that students who have never visited a zoo do have different understandings of zoos than students who have visited a zoo. Students who have never visited a zoo designed concept maps similar to the concept

maps of students who have visited zoos. Differences were more apparent during the interview. Students who have never visited a zoo did not mention zoo amenities. Moreover, only one student, who had never visited a zoo, mentioned zoos as educational or as conservation organizations.

Another dilemma encountered in this study was the concept mapping procedure. Students were given specific directions concerning how to complete a concept map. However, in the example they were asked to come up with words they associated with a mall. All classes used similar words when describing a mall, such as, friends, family, shopping, and food. The use of these words may have influenced the concept maps they developed concerning zoos. If this study were repeated another concept may be used they would not be related to zoos, for example, the word cell would not evoke words associated with zoos.

Students did not use the word conservation or any conservation related terms in the concept map. However, some students were able to describe conservation and the role of zoos in conservation during the interviews when specifically asked conservation related questions. This may indicate that conservation related terms may need to be included in the ranking concepts exercise. By including conservation terms in the ranking concepts exercise they investigator may be able to determine the level at which students identify the importance of zoos as conservation organizations.

This study is important because it provides insight into why students believe zoos exist and how students' view the role of zoos in conservation. However, this study may by expanded by having students draw pictures of zoos. Additionally, zoo educators may

be interviewed to determine what messages they believe their programs are conveying to students. Other zoo personnel may be asked if they believe zoos are responsible for conveying a conservation message. Since this research showed that students tend not to identify zoos as conservation organizations, the next study may ask students if they would be willing to financially support zoos in the future.

Summary

Even though zoos identify themselves as conservation organizations, which utilize education as a catalyst for ecological change, many of the students in this study did not view zoos as conservation organizations. Now it is the responsibility of zoos and classroom educators to form a link between the understandings students have of zoos and saving habitats. This study may be used as a guide for making that connection. Since students are aware of zoos as a place where habitats are recreated, a connection needs to be made between what students know about habitats (places where organisms live) and what zoo educators and classroom educators want students to know about conservation.

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APPENDIX A

HIGH SCHOOL STUDENT CONCEPT MAP PROTOCOL

HIGH SCHOOL STUDENT CONCEPT MAP PROTOCOL

Introduction
This protocol provides step-by-step instructions and background information for constructing a concept map of zoos with high school students.

Introduce Concepts:
A concept is a word for something you can picture in your mind. Concept words are connected by linking words.

1. I want to start with a word game. I am going to say a word and I want you to form a picture of it in your mind. I will do this with a few words.

2. Picture the following word in your mind: dog. Now picture an: elephant. Now let us try something more difficult, picture: a movie theater. These are specific concept words. Now think about the word 'mall'. This is a general concept word. If I asked you to make a list of words you associate with mall what would they be?

3. Are the words you listed verbs or nouns? Are they describing words? Pick 2 of the words on the list and link them with a verb or describing word. Linking words together to form a picture of what you are saying is called concept mapping. We will use the words we listed to create a concept map about the mall. Write the word 'mall' at the top of the board or overhead and circle the word. Ask students for words they associate with the word 'mall'. Write these words below the word 'mall' on the board or overhead. Now ask students to think of ways they can connect those words to the word mall and to each other. Write the connecting words on the lines between the circled words as students relate the words to each other. For example, mall----fun to see---friends.

4. Now we're going to do a concept map of the word zoo. A concept map of a zoo will be a word map of what is in your mind when you think about zoos.

5. Each student will be given a Zoo Word List Sheet (Appendix H) and a Concept Map sheet (Appendix I).

6. The word "zoo" has been written at the top of the Zoo Word List for you. Using the blanks write as many concept words as you can think of that you associate with the word "zoo" or with the role of zoos. You will have 5 minutes to complete this task. You have been asked to write 25 words; however, you may write more than 25 words.

7. When you finish with your concept word list, then, construct your concept map. Concept words go in circles and linking words go on lines connecting the circles. You will be given 20 minutes to complete your zoo concept map.

APPENDIX B

ZOO ORAL INTERVIEW GUIDE

ZOO ORAL INTERVIEW GUIDE
This oral interview will take approximately 15-20 minutes.

FIRST NAME/NUMBER:_____
Time Start: _____
Time End: _____

1. Have you ever visited a zoo?

If a student has visited a zoo ask questions #2 and #3. If not, go to question #4.
2. When was your last visit to a zoo?

3. Which zoo did you visit?

4. Tell me about your trip to the zoo.

5. What is your experience with zoos? Do you know someone who works at the zoo? Are your parents members at the zoo?

6. Tell me what you know about zoos.

7. Define a zoo? What is a zoo?
During this question ask them to clarify words they use, such as conservation. Use: What do you mean by….?

8. What is the role or job of zoos?
During this question ask them to clarify words they use, such as recycle. Use: What do you mean by…?

9. What is conservation?

10. What is the role of the zoo in conservation? What do zoos do that are examples of conservation?

11. How do you know this information? Where did you learn about zoos?

APPENDIX C

STUDENT QUESTIONNAIRE: VISITING ZOOS

FIRST NAME: _____

STUDENT QUESTIONNAIRE: VISITING ZOOS

1. Grade Level (circle one): Freshman Sophomore Junior Senior
2. Age: _____
3. Gender (circle one): Male Female
4. Race (circle one): Caucasian (white) African American Hispanic Other
5. Have you ever visited a zoo (circle one)? Yes No
6. How did you learn about zoos?

_____

_____

_____

7. If you have visited zoos, what was the name of the zoo(s) or where was the zoo(s) located?

_____

_____

8. If you have visited a zoo, approximately how many times have you been to a zoo? _____
9. If you have visited a zoo, approximately how long has it been since you last visited a zoo? _____
10. If you have visited a zoo, you visited a zoo with (circle all that apply and/or fill in blank for other): family friends girlfriend/boyfriend teacher

Other _____

PLEASE TURN OVER FOR ADDITIONAL QUESTIONS

11. Describe your involvement with zoos. For example, is your family a member of the zoo or do one of your parents work at the zoo?

_____

_____

_____

12. Write one paragraph that tells about your experience with zoos.

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX D

ZOO WORD LIST

ZOO WORD LIST

LIST BELOW ALL OF THE WORDS THAT YOU ASSOCIATE WITH ZOOS AND THE ROLE OF ZOOS.

ZOO

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____
23. _____
24. _____
25. _____

APPENDIX E

ZOO CONCEPT MAP

ZOO CONCEPT MAP

CONSTRUCTED USING THE WORDS LISTED ON YOUR ZOO WORD LIST

ZOO

APPENDIX F

RANKING CONCEPTS EXERCISE

FIRST NAME: _____

CONCEPTS RANKING EXERCISE

Look at the following words. Place these words or phrases in the order in which you think they best describe zoos. The number 1 means that word best describes zoos. The number 20 means that word least describes zoos. Each word must be numbered and numbers can only be used once.

_____ water

_____ gift shop

_____ playground

_____ walking

_____ weather

_____ food

_____ money

_____ smell

_____ friends

_____ fieldtrip

_____ learning

_____ plants

_____ children

_____ family

_____ tram

_____ animals

_____ employees

_____ rocks

_____ fun

_____ exhibit

Explain how you decided to rank your answers.

_____

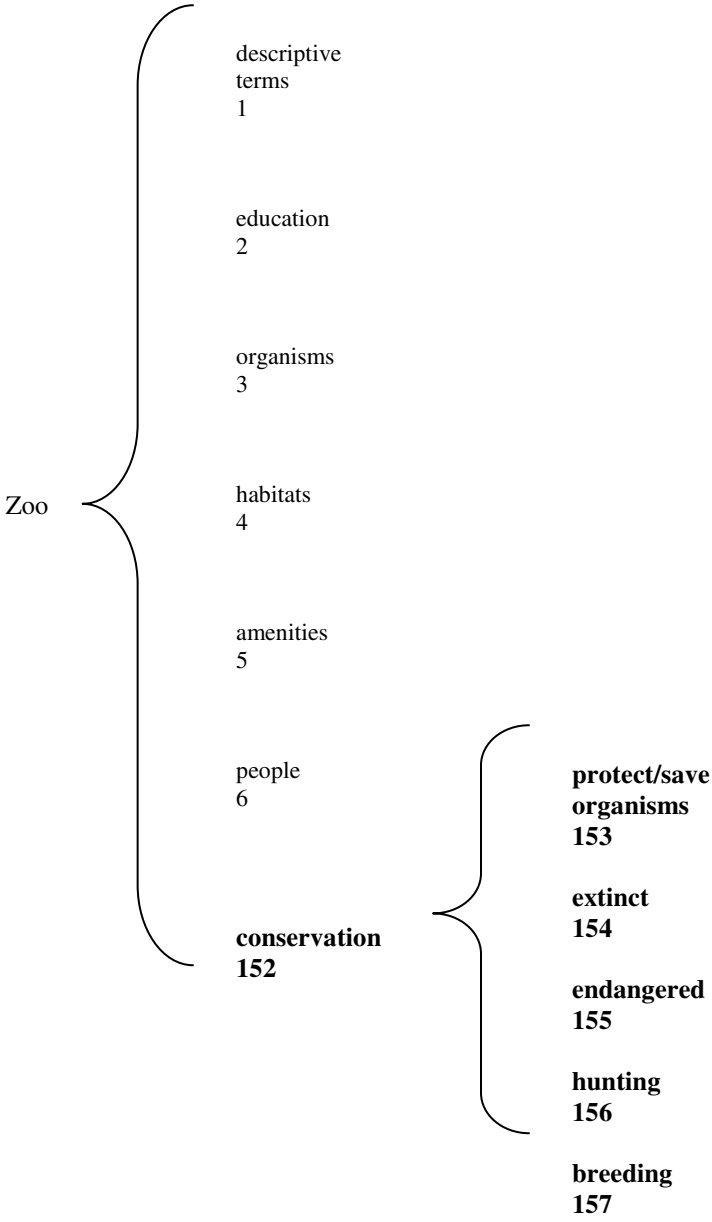
_____

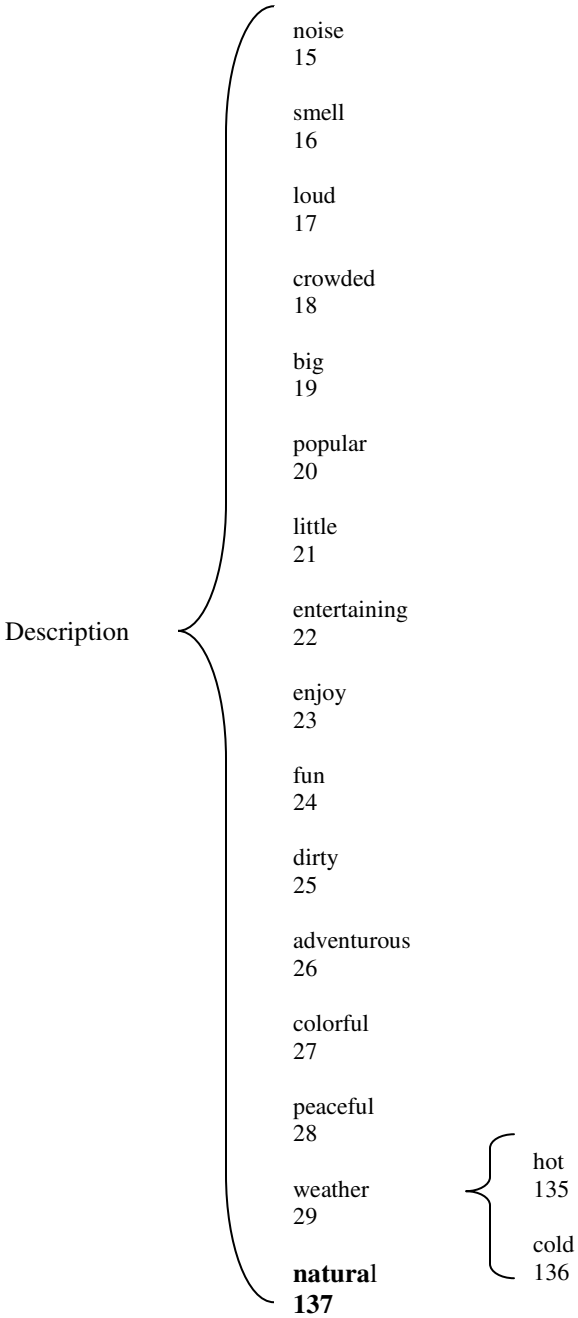
_____

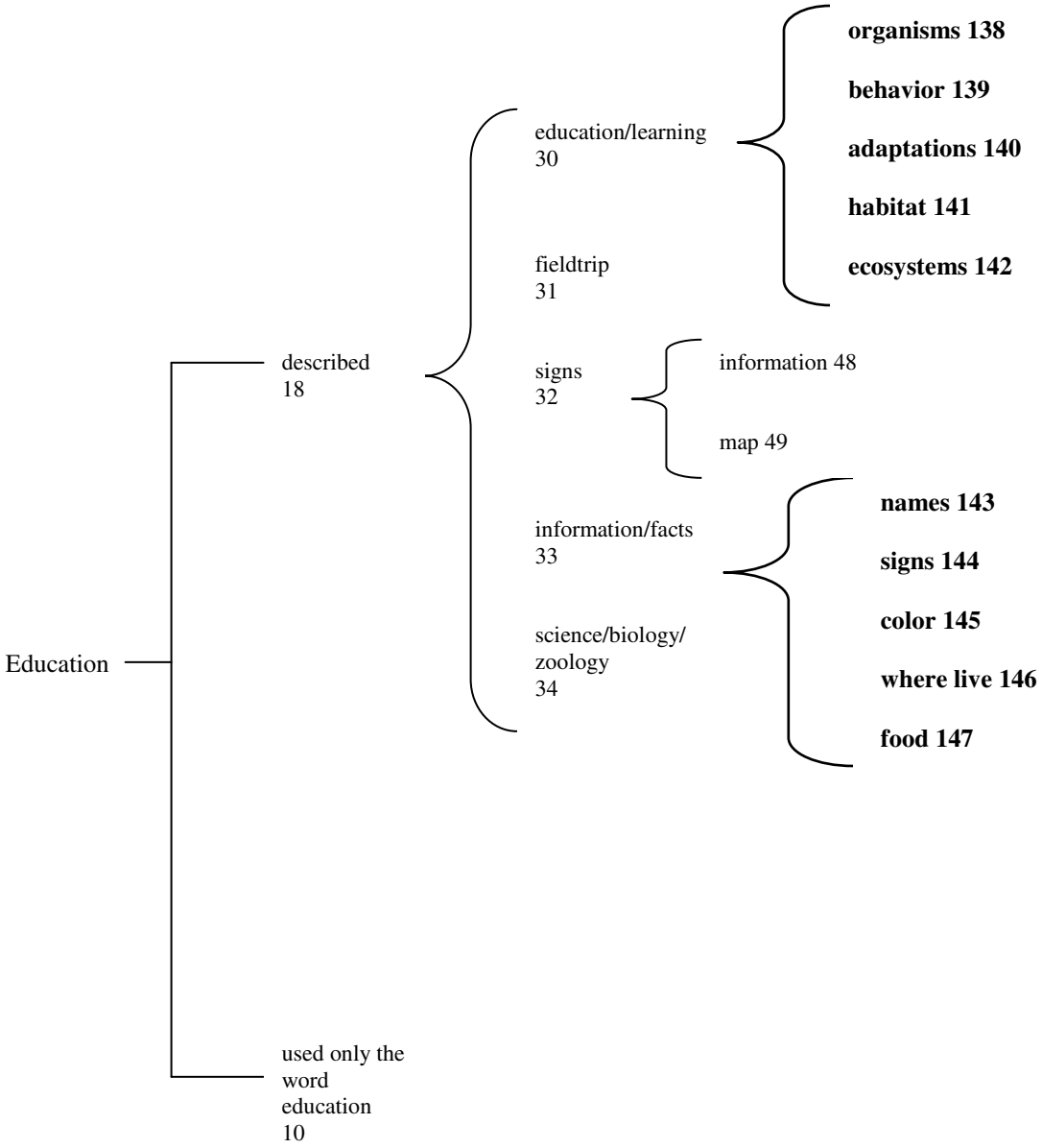
APPENDIX G

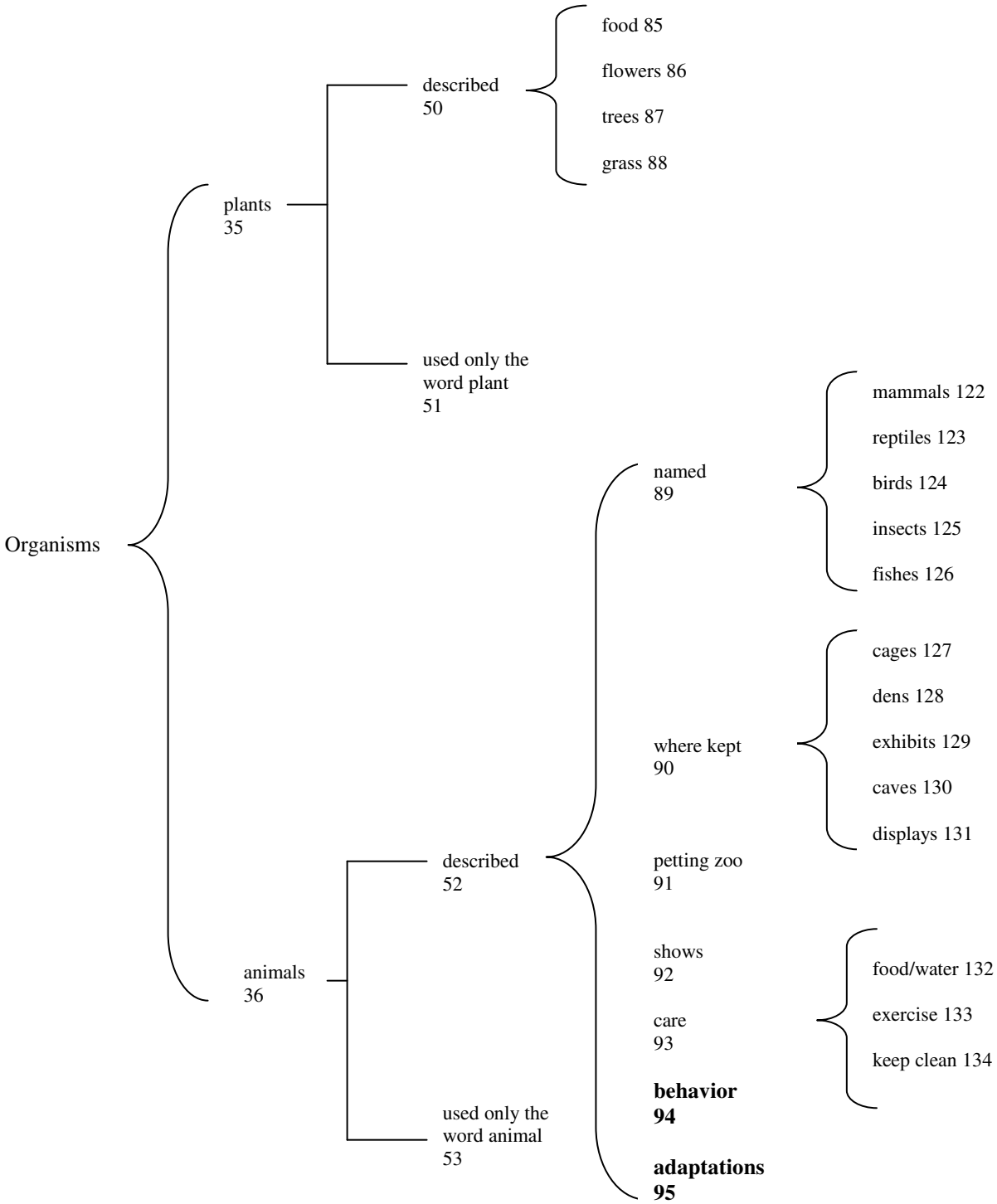
SYSTEMIC NETWORK

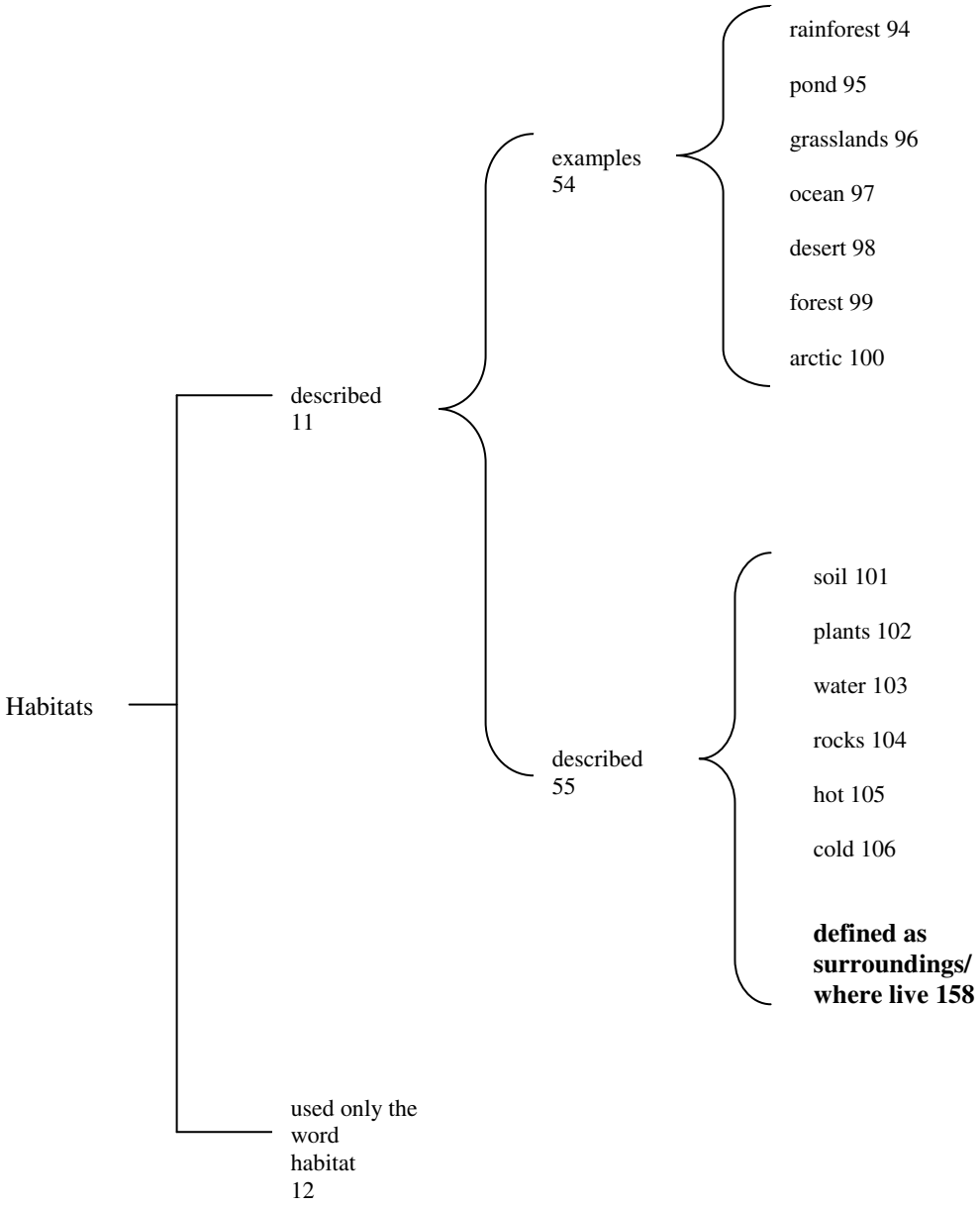
Systemic Network

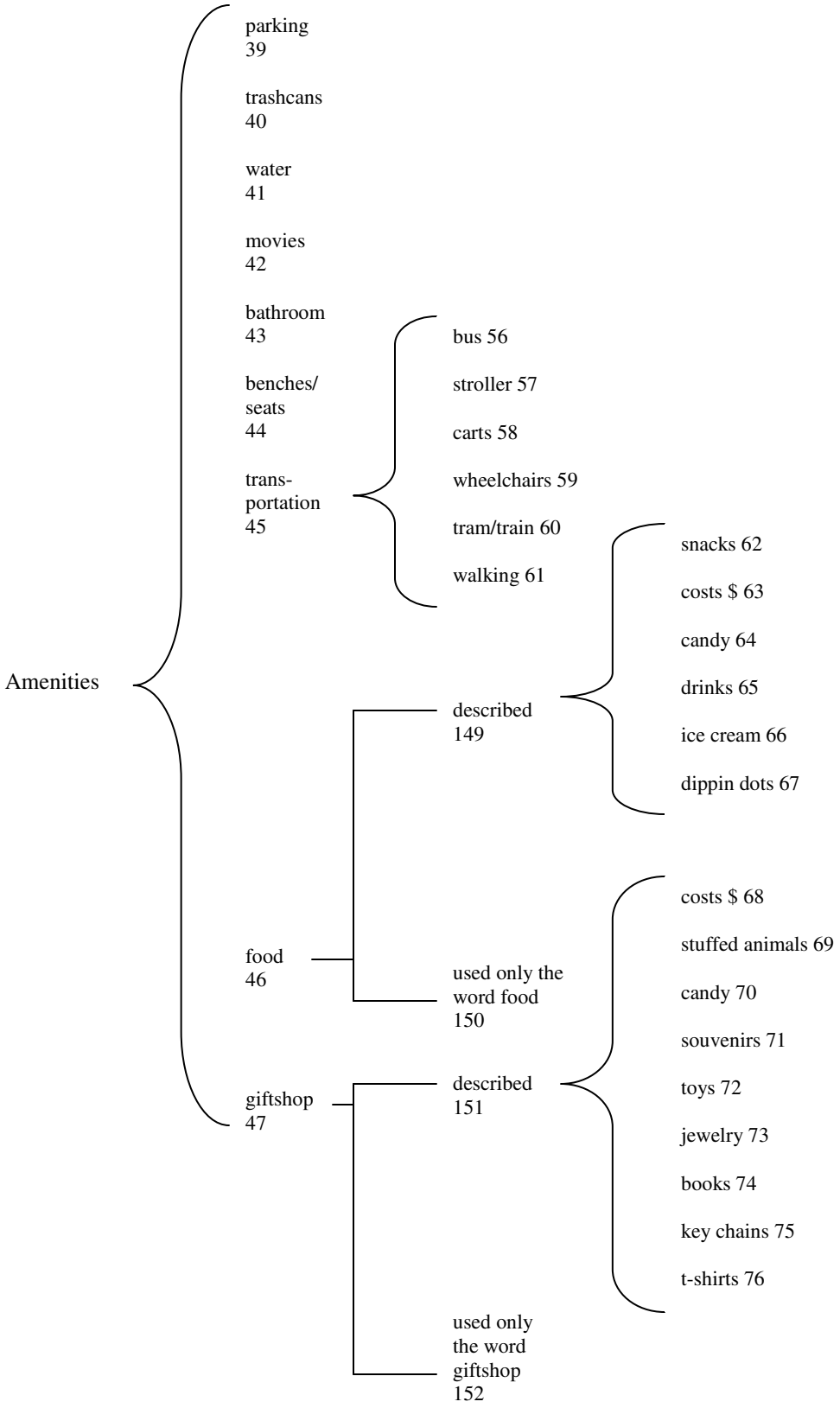


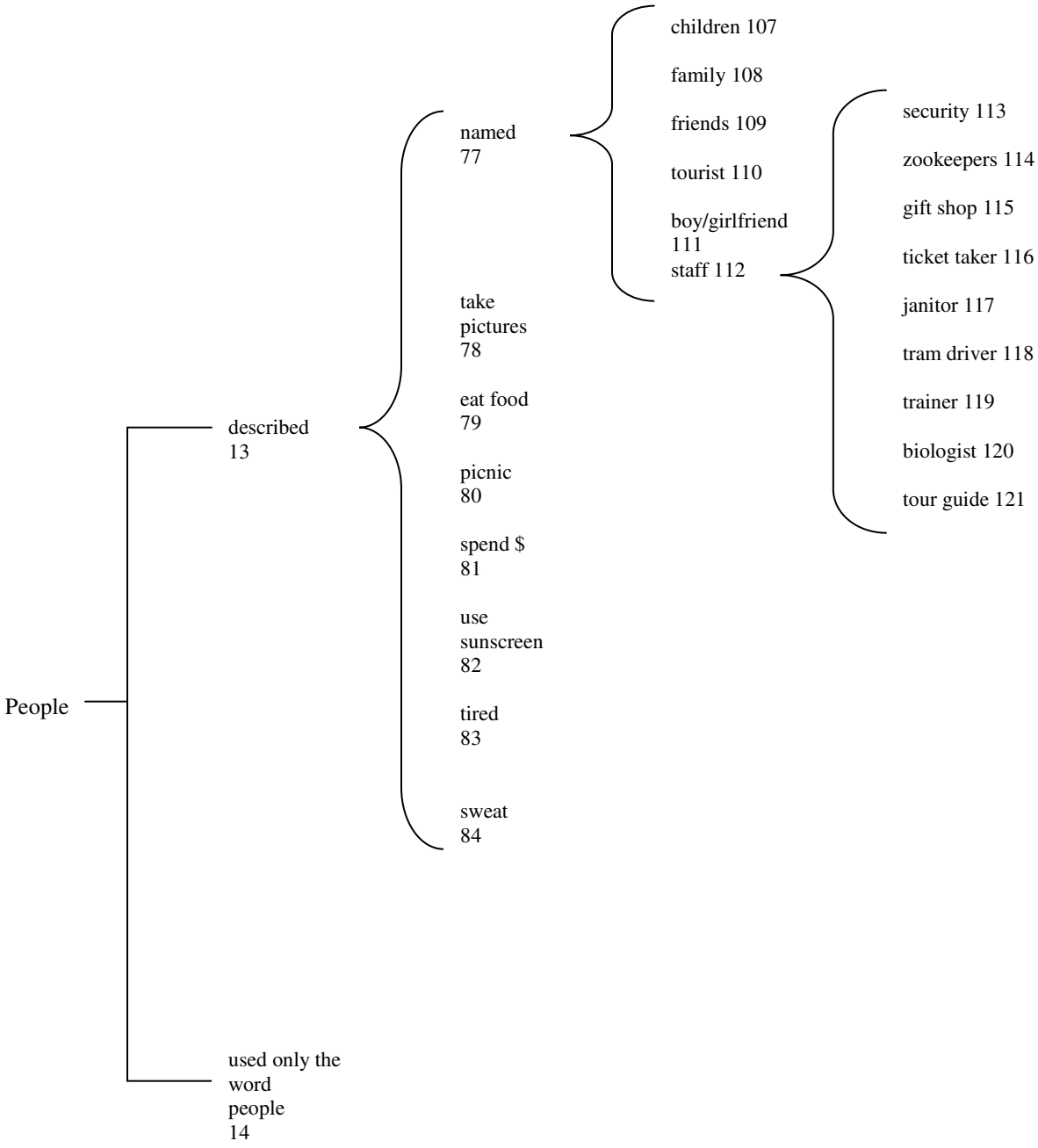

Description
noise
15
smell
16
loud
17
crowded
18
big
19
popular
20
little
21
entertaining
22
enjoy
23
fun
24
dirty
25
adventurous
26
colorful
27
peaceful
28
weather
29
hot
135
cold
136
natural
137


Education
described
18
used only the
word
education
10
education/learning
30
fieldtrip
31
signs
32
information/facts
33
science/biology/
zoology
34
organisms 138
behavior 139
adaptations 140
habitat 141
ecosystems 142
information 48
map 49
names 143
signs 144
color 145
where live 146
food 147


Organisms
plants
35
described
50
food 85
flowers 86
trees 87
grass 88
used only the
word plant
51
animals
36
described
52
named
89
mammals 122
reptiles 123
birds 124
insects 125
fishes 126
where kept
90
cages 127
dens 128
exhibits 129
caves 130
displays 131
petting zoo
91
shows
92
care
93
food/water 132
exercise 133
keep clean 134
behavior
94
adaptations
95
used only the
word animal
53


Habitats
described 11
examples 54
rainforest 94
pond 95
grasslands 96
ocean 97
desert 98
forest 99
arctic 100
described 55
soil 101
plants 102
water 103
rocks 104
hot 105
cold 106
defined as surroundings/ where live 158
used only the word habitat 12


Amenities
parking 39
trashcans 40
water 41
movies 42
bathroom 43
benches/ seats 44
trans- portation 45
bus 56
stroller 57
carts 58
wheelchairs 59
tram/train 60
walking 61
food 46
described 149
snacks 62
costs $ 63
candy 64
drinks 65
ice cream 66
dippin dots 67
used only the word food 150
giftshop 47
described 151
costs $ 68
stuffed animals 69
candy 70
souvenirs 71
toys 72
jewelry 73
books 74
key chains 75
t-shirts 76
used only the word giftshop 152


People
described 13
named 77
children 107
family 108
friends 109
tourist 110
boy/girlfriend 111
staff 112
security 113
zookeepers 114
gift shop 115
ticket taker 116
janitor 117
tram driver 118
trainer 119
biologist 120
tour guide 121
take pictures 78
eat food 79
picnic 80
spend $ 81
use sunscreen 82
tired 83
sweat 84
used only the word people 14

APPENDIX H

CONCEPT MAPPING—CROSSTABULATIONS

Concept Mapping—Crosstabulations

GENDER	Described		Education		Organisms		Habitats		Amenities		People	
	F	%	F	%	F	%	F	%	F	%	F	%
Male n=12	19	47.5	11	27.5	38	95.0	20	50.0	32	72.7	32	80.0
Female n=12	28	63.6	10	22.7	44	100	18	40.9	33	75.0	42	95.5
ETHNICITY	F	%	F	%	F	%	F	%	F	%	F	%
Latino American n=8	6	75.0	2	25.0	8	100	4	50.0	3	37.5	6	75.0
African American n=8	3	37.5	2	25.0	8	100	5	62.5	7	87.5	6	75.0
European American n=68	38	55.8	17	25.0	66	97.0	29	42.6	55	80.8	62	91.1
ZOO VISITATION	F	%	F	%	F	%	F	%	F	%	F	%
Visited Teacher This Semester n=21	5	23.8	7	33.3	21	100	13	61.9	16	76.1	20	95.2
Visited Teacher Another Year n=21	16	76.1	4	19.9	20	95.2	13	61.9	17	80.9	18	85.7
Visited w/o Teacher n=21	15	71.4	6	28.5	21	100	5	23.8	15	71.4	16	76.1
Never Visited n=21	11	52.3	4	19.0	20	95.2	7	33.3	17	80.9	20	95.2

APPENDIX I

CONCEPT MAPPING—WORDS USED

Concept Mapping—Words Used

Theme	Subordinate Words from Concept Maps
Organisms (82)	*animals* (82) *illustrated* (78) *named* (52) *care* (32) *kept in cages* (17) *kept in exhibits* (10) *used only the word animal* (4) *plants* (29) *named type of* (27) *used as food* (7)
People (74)	*named* (77) *staff* (30) *zookeepers* (16) *security* (7) *tour guide*(6) *children* (25) *friends* (20) *boy/girlfriend* (9) *do at zoo* (57) *eat food* (21) *become tired* (9) *take pictures* (8) *spend money* (8) *used only the word people* (10)
Amenities (65)	*transportation* (43) *walking* (31) *tram/train* (27) *gift shop* (38) *costs money* (20) *stuffed animals* (7) *food* (40) *snacks* (15) *drinks* (12) *costs money* (11) *candy* (5)
Described (47)	*crowded* (14) *big* (13) *smells* (13) *weather* (12) *fun* (10) *noisy* (7) *colorful* (7)
Habitats (38)	*examples of* (16) *desert* (11) *arctic* (7) *grasslands* (6) *depicted* (21) *water* (11) *plants* (10) *rocks* (5) *used only the word habitat* (2)
Education (21)	*education/learning* (10) *fieldtrip* (9) *information from signs* (4)

APPENDIX J

INTERVIEWS—CROSSTABULATIONS

Interviews—Crosstabulations

GENDER	Described		Education		Organisms		Habitats		Amenities		People		Conservation	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Male n=12	11	91.6	9	75	11	91.6	9	75	4	33.3	12	100	8	66.6
Female n=12	10	83.3	9	75	12	100	4	33.3	3	25.0	10	83.3	7	58.3
ETHNICITY	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Latino American n=8	5	62.5	7	87.5	8	100	6	75.0	3	37.5	8	100	5	62.5
African American n=8	8	100	5	62.5	7	87.5	5	62.5	1	12.5	6	75.0	6	75.0
European American n=8	8	100	6	75.0	8	100	2	25.0	3	37.5	8	100	4	50.0
ZOO VISITATION	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Visited Teacher This Semester n=6	6	100	5	83.3	6	100	5	83.3	3	50.0	5	83.3	4	66.6
Visited Teacher Another Year n=6	6	100	6	100	6	100	5	83.3	3	50.0	6	100	6	100
Visited w/o Teacher n=6	4	66.6	6	100	6	100	1	16.6	1	16.6	5	83.3	4	66.6
Never Visited n=6	5	83.3	1	16.6	5	83.3	2	33.3	0	0	6	100	1	16.6

APPENDIX K

INTERVIEWS—WORDS USED

Interviews—Words Used

Theme	Subordinate Words from Interviews
Organisms (23)	*animals* (22) *illustrated* (20) *named* (11) *care* (11) *kept in exhibits* (5) *kept in cages* (3) *used only the word animal* (3) *plants* (8)
People (21)	*named* (16) *staff* (7) *zookeepers* (5) *tour guide* (2) *family* (7) *children* (6) *friends* (5) *used only the word people* (5)
Described (19)	*fun* (9) *natural* (5) *big* (3) *entertaining* (3) *enjoy* (2) *smell* (2)
Education (18)	*education/learning* (16) *organisms* (13) *habitats* (7) *ecosystems* (4) *adaptations* (4) *behavior* (3) *information from signs* (10) *information/facts about organisms* (12) *food* (9) *where live* (6) *color* (5) *fieldtrip* (2)
Conservation (15)	*breeding* (10) *protect/save* (10) *extinct* (9) *endangered* (9) *no hunting* (5)
Habitats (11)	*examples of* (6) *grasslands* (3) *arctic* (2) *desert* (2) *rainforest* (2) *depicted* (7) *defined as where they live* (5) *plants* (3) *used only the word habitat* (1)
Amenities (4)	*food* (4) *snacks* (3) *costs money* (2) *gift shop* (3) *souvenirs* (3) *souvenirs* (1)

APPENDIX L

PARENTAL CONSENT FORM

Parental Consent Form

My name is Ms. Patricia Patrick. I am a doctoral candidate at the University of North Carolina at Greensboro. I am conducting research that focuses on what high school students know about zoos. Your child was selected as a possible participant because she/he is in the age range I am interested in studying.

The purpose of this study is to determine what high school students know about zoos. It also explores the differences between students who have and students who have never visited zoos. If you agree that your child may participate in this study, she/he will be asked to complete a questionnaire (15 minutes) and a concept map (30 minutes) about zoos. He/she may also be interviewed (15 minutes) to further explore their ideas about zoos. Additionally, students will also complete a brief (15 minute) word bank exercise about zoos. All data gathering will take place at the school.

There are no risks to participants. There will be no direct benefit of this research to participants, but society will benefit from the programs developed by zoos and biology teachers, who take their students to the zoo. The records of this study will be kept private and data will be reported using pseudonyms. Instead of using students' names on data collection forms, students will be assigned identifying numbers. Consent forms will be kept securely along with results for 7 years after completion of this study.

By signing this consent form, you agree that you understand the procedures and any risks and benefits involved in this research. You are free to refuse to participate or to withdraw your consent to participate in this research at any time without penalty or prejudice; your participation is entirely voluntary. Your privacy will be protected because you will not be identified by name as a participant in this project.

The University of North Carolina at Greensboro Institutional Review Board, which insures that research involving people follows federal regulations, has approved the research and this consent form. Questions regarding your rights as a participant in this project can be answered by calling Mr. Eric Allen at (336) 256-1482. Questions regarding the research itself will be answered by Patricia Patrick, by calling 336-471-1185. Any new information that develops during the project will be provided to you if the information might affect your willingness to continue participation in the project.

By signing this form, you are agreeing to participate in the project described to you by Patricia Patrick.

Signature of Participant _____ Date _____

Signature of Investigator _____ Date _____

APPENDIX M

TEACHER CONSENT FORM

Teacher Consent Form

My name is Patricia Patrick. I am a doctoral candidate at the University of North Carolina at Greensboro. I am doing a study to try to learn about what high school students know about zoos. Your students are invited to participate in a research study focusing on what students think about/know about zoos. Your students have been selected as participants because your students are in the age range I am interested in studying. I ask that you read this form and contact me with any questions you may have about this study at 336-471-1185

The purpose of this study is to determine what high school students know about zoos. It also explores the differences between students who have and students who have never visited zoos. If you agree that your student may participate in this study, she/he will be asked to complete a questionnaire and a concept map about zoos. He/she may also be interviewed to further explore their ideas about zoos. Additionally, for students who are interviewed, they will also complete a brief (15 minute) word bank exercise about zoos. The questionnaire will take approximately 15 minutes to complete and the concept map will take about 20 minutes. These activities will both be completed in your student's biology classroom under the guidance of their regular classroom teacher and me. Students selected for follow-up interviews and a word bank exercise will spend an additional 15 minutes with me. Both interviews and the word bank exercise will be conducted at the high school.

The records of this study will be kept private and data will be reported using pseudonyms. Only first names will be recorded on data collection instruments. Consent forms will be kept securely along with results for 7 years after completion of this study.

Your decision about whether or not to participate in this study will not affect your current or future relations with the University of North Carolina at Greensboro or your school personnel. If you decide to allow your students to participate, you are free to withdraw your students at any time. Your students may also discontinue participation at any time. If you have any questions, you may contact Ms. Patricia Patrick at 336-471-1185.

Signature of Participant _____ Date _____

Signature of Investigator _____ Date _____

APPENDIX N

PRINCIPAL CONSENT FORM

Principal Consent Form

RANDLEMAN HIGH SCHOOL
Randleman, NC

School of Education
Department of
Curriculum & Instruction

To the UNC-Greensboro IRB Committee

Patricia Patrick has explained her study about zoos and why she would like to use my school.

I understand the purpose of this study is to determine what high school students know about zoos. I agree that students may participate in this study. I am aware students will be asked to complete a questionnaire (15 minutes), a concept map (30 minutes) about zoos and to rank order words (15 minutes) about zoos. Patricia may also interview (15 minutes) selected students to further explore their ideas about zoos.

Patricia has assured me that the records of this study will be kept private and a pseudonym will used to identify the school in her dissertation and future publications. I have also been given Patricia's contact information as well as a contact at UNCG concerning IRB protocols.

By signing below I give my full permission for Patricia Patrick to gather data at Randleman High School.

Signature of Participant _____

Date _____

Signature of Investigator _____

Date _____

APPENDIX O

STUDENT ASSENT FORM

Student Assent Form

My name is Ms. Patricia Patrick. I am a doctoral candidate at the University of North Carolina at Greensboro. I am conducting research that focuses on what high school students know about zoos. You have been selected as a possible participant because you are in the age range I am interested in studying.

The purpose of this study is to determine what high school students know about zoos. It also explores the differences between students who have and students who have never visited zoos. If you agree to participate in this study, you will be asked to complete a questionnaire (15 minutes) and a concept map (30 minutes) about zoos. You may also be interviewed (15 minutes) to further explore your ideas about zoos. Additionally, you will also complete a brief (15 minute) word bank exercise about zoos. All data gathering will take place at the school.

There are no risks to participants. There will be no direct benefit of this research to participants, but society will benefit from the programs developed by zoos and biology teachers, who take their students to the zoo. The records of this study will be kept private and data will be reported using pseudonyms. Instead of using your name on data collection forms, you will be assigned an identifying number. Consent forms will be kept securely along with results for 7 years after completion of this study.

By signing this consent form, you agree that you understand the procedures and any risks and benefits involved in this research. You are free to refuse to participate or to withdraw your consent to participate in this research at any time without penalty or prejudice; your participation is entirely voluntary. Your privacy will be protected because you will not be identified by name as a participant in this project.

The University of North Carolina at Greensboro Institutional Review Board, which insures that research involving people follows federal regulations, has approved the research and this consent form. Questions regarding your rights as a participant in this project can be answered by calling Mr. Eric Allen at (336) 256-1482. Questions regarding the research itself will be answered by Patricia Patrick, by calling 336-471-1185. Any new information that develops during the project will be provided to you if the information might affect your willingness to continue participation in the project.

By signing this form, you are agreeing to participate in the project described to you by Patricia Patrick.

Signature of Participant _____ Date _____

Signature of Investigator _____ Date _____