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I Hear, and I Forget; I See, and I Remember; I Do, and I Understand: An Exploration of Children's Museums as Successful Learning Environments for Students with and without Disabilities

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Doctoral degree in Special Education

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"I HEAR, AND I FORGET; I SEE, AND I REMEMBER; I DO, AND I UNDERSTAND": AN EXPLORATION OF CHILDREN'S MUSEUMS AS SUCCESSFUL LEARNING ENVIRONMENTS FOR STUDENTS WITH AND WITHOUT DISABILITIES

By

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ABSTRACT

"I HEAR, AND I FORGET; I SEE, AND I REMEMBER; I DO, AND I UNDERSTAND": AN EXPLORATION OF CHILDREN'S MUSEUMS AS SUCCESSFUL LEARNING ENVIRONMENTS FOR STUDENTS WITH AND WITHOUT DISABILITIES

By

Whitney Hosmer Rapp

One of the quests of educational researchers has been to find successful learning environments for all students, with or without disabilities. This study explored several components of a children's museum in order to investigate its potential as a successful learning environment.

The factors explored were: (a) scaffolding of learning in the students' zone of proximal development; (b) meaningful and contextualized activities and exhibits; (c) opportunities for students to make their own choices and become self-regulating learners; (d) activities that are responsive to individual learning styles, learning rates, and ability levels; (e) establishment of learning communities; (f) opportunities for dialogue and the social construction of knowledge; (g) parental involvement in their children's learning; and (h) opportunities for the students to engage in play. Also studied was the classroom environment to determine the extent to which students and teachers generalized their experiences in the children's museum to another educational setting. The methodology of the study was qualitative.

Data collection procedures included videotaped observations in the museum and classroom; a series of four audiotaped formal interviews with each participant; informal interviews during observation periods; and written questionnaires by participants following each visit to the museum.

Videotapes and audiotapes were transcribed and studied for evidence of the aforementioned factors. Data was analyzed with the aid of QSR NUD-IST Qualitative Data Analysis Software.

Major findings revealed that all students, regardless of disability classification, demonstrated differences in learning behavior in the museum setting. Also, there was evidence of all of the factors investigated in the children's museum setting. Finally, there was little generalization of differences from the museum to the classroom setting.

Implications for further research include recognition of obstacles to generalization across settings and more significant differences in learning by the students. A potentially successful school-museum program is proposed.

To my dear family.
Most especially, to my husband, Steve, my parents and my grandparents, whose infinite love and support make it possible for me to aim high and achieve even higher.

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Chapter One: Introduction

Every year, teachers are required to do more and more for their students in the same amount of time. As children are failing to learn culturally-sanctioned values at home, value education has become part of the elementary school curriculum. As children of younger and younger ages are becoming involved in drug use and sexual activity, drug awareness and sex education are being added to the roster. Teachers who believe in the benefits of inclusion take on even more responsibilities as they work to successfully include students with disabilities in general education classrooms. To top it off, preparation for standardized testing often looms over the teachers' heads. These responsibilities are in addition to the pressure on teachers to individualize all lessons to meet the specific needs of each and every student.

Basically, there comes a time when all of this cannot be accomplished in one setting by one or even two teachers. Teachers need support in accomplishing all there is to accomplish with today's youth. Branching out beyond the school to incorporate other learning environments and to "re-incorporate" the home environment is one answer. One setting that can help teachers enrich the education of their students, including those with disabilities is that of a children's museum.

For the past two years, I have been volunteering my time at various children's museums. I have come to regard children's museums as one of the most powerful resources that educators and parents can offer their children. In the children's museum, I have informally observed shy children becoming confident leaders; hesitant children taking initiative; children whose parents describe them as "high-strung" and " short of attention" concentrating on one activity or exhibit for extended periods of time. I have heard children explaining scientific principles to other children and to their parents. I have observed their questions grow in complexity over the course of one museum visit. I have been told by parents that their children beg to do science experiments and math puzzles at home after visiting children's museums. Children have come up to me to tell me that they used to hate science until they came to the children's museum.

All of this has led me to step back and consider the potential for a children's museum to provide all learners with a fun, exciting, comfortable, nurturing learning environment. The study I describe here was an opportunity for me to turn my informal observations into a formal, systematic study. The fields of museum study and education alike would benefit from studies that explore the potential of children's museums to constitute successful learning environments and educational supplements for all students, and especially students with disabilities who may learn differently and with more difficulty than others.

Purpose of the Study

The purpose of this study is to take a closer, more systematic look at children's museums in order to determine the presence of factors that characterize successful learning environments.

The factors can be grouped into two themes. The first theme is cognitive learning. This study examined the presence of scaffolded learning, meaningful and contextualized activities, self-regulated learning, and learning styles to determine whether children's museums are settings that foster cognitive development in students. The second theme is social learning. While distinguishable from cognitive learning, it is yet intertwined with and as important as cognitive learning. This study will explore the establishment of a learning community, dialogue and social construction of knowledge, parent involvement, and the role of play in order to determine whether children's museums foster social development in students.

To restate, the main purpose of this study was to explore the possibility of children's museums as successful learning environments for students with and without disabilities and to provide a rich description of that environment. A secondary purpose to study the children's museum setting as a model to promote inclusion.

Research Questions

The study was conducted to answer the following research questions:

1. In what ways and to what extent do children's museums foster cognitive learning over time for students with and without disabilities?

   a) In what ways and to what extent is children's learning scaffolded?

   b) In what ways and to what extent are activities meaningful and contextualized for the learners?

c) In what ways and to what extent do children regulate their own learning?

d) In what ways and to what extent do activities and exhibits support individual learning styles and rates?

e) In what ways and to what extent do children's museums foster the learning of lifelong learning skills (e.g. confidence, curiosity, problem-solving, creativity, divergent thinking, systematic investigation, and scientific inquiry)?

2. In what ways and to what extent do children's museums foster social development over time in students with and without disabilities?

a) In what ways and to what extent is a learning community established?

b) In what ways and to what extent is the social construction of knowledge facilitated?

c) In what ways and to what extent are parents involved with their children and in their children's learning?

d) What role does play serve in the setting of the children's museum?

3. In what ways and to what extent is learning in children's museums generalized to other settings over time?

Rationale

A study that seeks to answer these questions is greatly needed. Very little to none of the literature on children's museums speaks to studies on the learning that occurs in these settings.

A second point is that scholars have mentioned the need for schools to branch out and work with community resources to better educate children (Nicolopoulou & Cole, 1993).

Gardner (1991) calls for more potent educational approaches and goes on to say, "I find clues for these efforts in highly contrasting institutions: the ancient institution of the apprenticeship and the new institution of the *children's museum*" (p. 13, emphasis added). Other researchers speak to the potential benefits for schools in working with museums (AAM, 1992; Bloom & Mintz, 1990; Brandt, 1993; Danilov, 1986; Hein, 1990; Hooper-Greenhill, 1991; Maiga, 1995; O'Donnell, 1995; Pitman-Gelles, 1981; Sykes, 1994; Wall, 1986; Waterfall & Grusin, 1989; Winstanley, 1967). This study proposes to show how viable a learning resource children's museums can be. This study will enhance not only the museum study literature, but also literature on successful learning environments for all students, including those students with learning and other disabilities. The study will bring to awareness the potential of children's museums as one of these successful learning environments where these learners can develop cognitively and socially over time.

Third, this study provides an opportunity for teachers to establish relationships with university researchers, museum educators, and parents. It expands their resources, giving them information about instructional principles and activities that they can use in their classrooms for the benefit of all students, with or without disabilities. This study shows how these interdisciplinary relationships should be established and supported over time.

Fourth, this study provides museum educators with information about the needs of teachers and students. Using this information, museum educators can better accommodate all learners in all ways - cognitively, socially, physically, and emotionally.

Fifth, this study expands the learning repertoire of students. It adds another environment and source for learning. As the African proverb states, it takes a whole village to raise a child. This study adds one more resource, the children's museum, to the village.

Sixth, this study expands on the work of the Early Literacy Project. The underlying principles of the project are applied here to academic areas other than literacy and to settings other than the classroom.

Finally, participants include both general education and special education students. Thus, the potential of children's museums as successful inclusion environments can be explored here.

Chapter Two: Relevant Literature

Chapter Introduction

This chapter begins with a review of the literature relevant to learning. Following a discussion of the social constructivist and holistic framework are discussions of eight factors that have been found to be important components in successful learning environments for students with learning disabilities. These factors are: (1) scaffolded instruction; (2) meaningful and contextualized activities; (3) self-regulated learning; (4) activities that are responsive to learning styles, rates and ability levels; (5) learning communities; (6) the social construction of knowledge; (7) parental involvement; and (8) play. From there ensues a discussion of the history, definition, and characteristics of children's museum. Lastly, each of the above factors are discussed again in the context of children's museums.

Theoretical Framework

The present study is based on the theories of social constructivism and holism. These theories were chosen because they best fit the nature of today's classrooms and children's museums. The atmosphere and events of a classroom, and perhaps even more so of a children's museum, are very unique, dynamic, and complex. Events in these settings can be defined as many different things lasting various lengths of time. Events in the classroom might be lessons, verbal interactions among students and/or teachers, class discussions, or acts of discipline. Events in the children's museum might be interaction with exhibits, verbal interactions among students and/or adults, demonstrations, activities, or acts of discipline.

Events in these settings do not occur in a linear fashion, with one event occurring and ending before the next begins. Neither do events in these settings occur in parallel lines, with one sequence of events occurring alongside another sequence. The events are not separate entities. Rather, what happens in today's classrooms and children's museums is a "web" of events. The events overlap. Several occur at one time, with each player involved in more than one event at a time. They are simultaneous but not synchronized. Events are interdependent; the outcome of one event is dependent on the outcome of another event, making the web all the more intricate. Events cannot be isolated from one another, added up, and still represent what happens in the classroom, just as the strings of a web cannot be isolated from one another and still keep the web together and strong.

Also, these two settings are highly social. Even in a classroom where there is a rule of no talking, a social web exists. The very fact that teachers and students come together in school to form a classroom setting makes it a public, social setting. Each person's perceptions of the events and role in the events is in relation to others. These perceptions and roles interact to form a unique social setting. There is an idea that every child, even a sibling, is born into a "different" family. The social structure and context is altered with every new member, and the perceptions of each member are different from those of any other member.

In the same vein, every teacher and student is in a "different" classroom, and every visitor is in a "different" museum.

For these reasons, the settings of the classroom and of the children's museum are best supported by the tenets of social constructivism and holism.

Social Constructivism

Social constructivism, as put forth by Lev Vygotsky, is the theory that learning and the advancement of knowledge occurs through social interaction with more knowledgeable others (Davydov, 1995; Kozulin, 1990; Vygotsky, 1978, 1986; Wertsch & Sohmer, 1995). Via social mediation, learners integrate new knowledge with existing concepts. Lower level concepts are transformed into higher level concepts (Vygotsky, 1986). Also, as learners interact with others to integrate new knowledge, public actions of communication become private thoughts, labeled inner speech by Vygotsky (Kozulin, 1990; Perlmutter & Burrell, 1995).

One of the most important notions of Vygotskian theory regarding socially mediated learning is that of the "zone of proximal development" (Paris & Winograd, 1990, p. 11). This zone of proximal development (ZPD) is the difference between what the child knows or can do independently and what he can do or know with the guidance of a more knowledgeable peer or adult (Roegholt, 1993). As Dixon-Krauss (1995) explains, "learning occurs as the child gradually internalizes higher level thought processes that are activated through social interaction with an adult or in collaboration with capable peers" (p. 46). Scaffolding learning within the ZPD encourages the child to develop further within an ability range that is cognitively comfortable. Since there are multiple entry points for the construction of new knowledge, based on what the child already knows and his present ability level, the child is not introduced to frustrating or confusing concepts too soon (Brandt, 1993; Gardner, 1991). Guiding children within their zones of proximal development, basing instruction on their advancing abilities, helps them to become successful, confident learners (Sykes, 1994).

In his writings, Vygotsky argued that these same ideas be applied to learners with cognitive disabilities, which he referred to as handicapped learners (Kozulin, 1990). Handicapped learners must learn "scientifically," through practice and instruction what their non-handicapped peers learn "spontaneously," through everyday actions (Kozulin, 1990, p. 202). In respect to the zone of proximal development, the transfer from adult-with-child to child-alone occurs with handicapped learners, but the process is more drawn out. Vygotsky felt that the same meanings could be internalized by handicapped learners, but the symbolic or mediational systems through which the internalization occurred must be modified. He wrote, "Meaning rather than a sign is important. Let us change the signs and retain meaning" (Kozulin, 1990, p. 201).

<u>Holism</u>

Many terms have been used to describe the holistic paradigm. It has been aligned with structuralism, constructivism, and even holistic constructivism (Poplin, 1988b). Moreover, holism has been connected with confluent education which links the cognitive with the affective and Waldorf education which integrates activities around the arts (Miller, 1986). Finally, in discussing holistic principles, words such as "context," "meaning," "subjective," and "personal experience" are often used (Heshusius, 1989b, p. 595). These descriptors reflect the values inherent in the holistic paradigm.

Holism focuses on two central themes. First is the idea of wholeness. In holism, the whole is greater and different than the sum of the parts. The parts interact, resulting in a complex, integrated whole (Heshusius, 1989a). Holism considers the complete or whole person, including strengths, weaknesses, motivations, interests, needs, values, and goals (Hammill, 1993). It considers the social, emotional, cognitive, and physical aspects of each person. All of these parts are intertwined with all the others to create a whole being.

In this vein, each whole being must also be considered within a context. While recognizing independent behaviors, skills, and cognitive processes, holists stress the context within which these occur, and thus the underlying unity among them (Miller, 1986). In fact, Kavale and Forness (1994) assert that "understanding is not possible without reference to the context within which it occurs" (p. 29).

In education, a holistic curriculum is one where concepts and areas of study are interdependent (Kimball & Heron, 1988). The teacher of such a curriculum is a potential source of relatedness and wholeness as he or she recognizes the whole child and facilitates each child's

relatedness within the learning community (Miller, 1986). As well, the holistic teacher creates a meaningful context for the children by integrating concepts and connecting new knowledge with past experiences.

The second central theme of holism pertains to the individual. In holism, individual differences are a most important consideration. People have unique past experiences that shape who they are and give value to what they have come to know, feel, and lend to their learning and interactions. New experiences and knowledge are viewed from the unique perspectives that have evolved from past experiences. In holism, experiences then are "perspectival" (Kavale & Forness, 1994, p. 29), having different meanings when seen from perspectives of different individuals.

Since individuals view new knowledge from such unique perspectives, meaning cannot be imposed on them. Individuals must create, or generate, their own meaning that makes sense within the context of their current knowledge (Poplin, 1988a; Warner, 1993). In the holistic paradigm, learning is not designed by stimulus-response control mechanisms (Heshusius, 1989b), but is instead is thought to be reflective of purposeful and active actions on the part of the learner. "The inherently active and self-regulating organism is the pivotal cornerstone of the shift from reductionist [to]... holistic paradigm" (Reid, 1988, p. 417).

Therefore, holistic educators stress the role of active individual interests and self-concepts in learning, while striving to understand their students' experiences and what they know in order to provide them with new experiences in interesting ways through patience, perceptiveness, and ingenuity (Poplin, 1988b). "Holistic-constructivist teachers focus on getting students excited about learning and trust that their processing will follow their interests and needs in due developmental time" (Poplin, 1988b, p. 411).

In terms of research in education, holism is viewed as a type of interpretive research that demands researchers to apply common sense and good judgment. In doing so, they can yield acute and powerful analyses and interpretations (Kavale & Forness, 1994). Heshusius (1989b) defends holistic research as enhancing and useful and as "a personal and artistic way of knowing" (p. 598).

Summary

Classrooms and children's museums have many elements that make them unique settings. They are complex, intricate, and active environments full of social interaction and interdependent events. Social constructivism and holism best support these elements.

Factors of Successful Learning Environments

My knowledge of Vygotskian social constructivism and holism and the way in which these theories are enacted in in the classroom was reinforced through my experiences on the Early Literacy Project. This project involved the development of several literacy activities for students with learning disabilities that were based on five principles of learning and instruction and stemmed from the theories of social constructivism and holism. These five principles were: (1) scaffolded instruction; (2) meaningful and contextualized activities; (3) self-regulated learning; (4)

responsive instruction; and (5) the establishment of a learning community. The Early Literacy Project is described in detail in Englert, Raphael, and Mariage (1994).

The five principles of the Early Literacy Project became five of the factors in this study. By incorporating my experience in children's museums as well as knowledge gained from my studies, I have built on these five principles in two ways. First, I extended their application to academic areas other than literacy. Second, I added opportunities for dialogue, parental involvement, and play as three additional factors.

Dialogue and the social construction of knowledge actually underlied the five principles of the Early Literacy Project. However, I wanted this notion to be emphasized, so I added it as a factor in successful learning environments. Parental involvement was added because it includes yet another facet to the experiences of learners. It brings in the perspective of the home environment. Play was added as a factor because it is emphasized in the literature as an important component in learning environments and in the cognitive development of children (Casey & Lippman, 1991; Karrby, 1990; Goldhaber, 1994; Nicolopoulou & Cole, 1993; Perlmutter & Burrell, 1995; Sykes, 1994; Vygotsky, 1978).

Cognitive Factors

Scaffolded instruction. One cognitive factor that makes learning environments successful is the extent to which they scaffold the learning of developing children. Scaffolding is the process by which a child is guided to further learning by a more knowledgeable person. An adult or 'expert' gives new knowledge or loans their consciousness (Roegholt, 1993) to the developing child, directing the child's attention to important features. This interaction between the adult and child guides the child and gives him a way of making sense of new information (Metz, 1995; Nicolopoulou & Cole, 1993; Smagorinsky, 1995). Scaffolding occurs in the zone of proximal development described by Vygotsky (Beed, Hawkins, & Roller, 1991; Winn, 1994).

There are two distinguishing features of effective scaffolding. The first is the learner's retention of control over his or her own learning. Through scaffolding, learners advance their knowledge with help from others, but still maintain their own interests and ideas. True scaffolding is not an imposition of a preset structure on a learner (Searle, 1995). The child does not trade his own ideas for the expert's; rather he integrates new information with existing information to further his own thinking and learning (Garner, 1992; Massey, 1990; Resnick, 1991). The second distinguishing feature is dialogue between the teacher and the learner (Paris & Winograd, 1990). Dialogue establishes a shared understanding between teacher and learner and provides an avenue for ongoing, individualized, dynamic guidance (Paris & Winograd, 1990; Winn, 1990).

An example of scaffolded instruction is reciprocal teaching, studied by Palincsar and Brown (Beed, Hawkins, & Roller, 1991; Garner, 1992; Paris & Winograd, 1990). This method incorporates modeling, guided practice, independent practice and careful attention to teacher-learner dialogue. Reciprocal teaching is described in detail in Palincsar &

Brown (1984) and Palincsar (1986).

Meaningful and contextualized activities. Meaningful and contextualized activities are a second important cognitive factor in successful learning environments. Embedding activities in meaningful contexts orients children to new learning via their own personal experiences and background knowledge (Gardner, 1991; Hooper-Greenhill, 1987). The more meaningful and related to personal experience a new concept is, the easier a child is able to integrate it with existing knowledge (Massey, 1990; Resnick, 1987; Sykes, 1994).

Presenting new concepts to a child in a way that is removed or decontextualized from their daily experiences is less meaningful and conducive to learning, because the child has trouble grounding it to existing cognitive structures. Children learn about themselves via interaction with the world around them, thus learning contexts at home, school and in the community send them strong messages about who they are (Cohen & Trostle, 1990). To embed activities in familiar and meaningful contexts is to reinforce children's learning not to contradict it (Palincsar, 1993; Roberts, 1989).

Self-regulated learning. Successful learning environments provide children with the opportunity to make their own choices and regulate their own learning (Hooper-Greenhill, 1987; Nicolopoulou & Cole, 1993). Butler and Winne (1995) offer the following definition of self-regulated learning:

> self-regulation is a style of engaging with tasks in which students exercise a suite of powerful skills:

> setting goals for upgrading knowledge; deliberating about strategies to select those that balance progress toward goals against unwanted costs; and as steps are taken and the task evolves, monitoring the accumulating effects of their engagement....It may become necessary for self-regulating learners to adjust or even abandon goals, to manage motivation, and to adapt and occasionally invent tactics for making progress. Self-regulated learners are thus aware of qualities of their own knowledge, beliefs, motivation and cognitive processing (p. 245).

Students who set their own goals, strategies, and criteria for mastery are more likely to achieve than peers who are dependent on the teacher for these skills (Risemberg & Zimmerman, 1992). The ability to be self-regulating begins when learners actively choose the activities in which they engage. Choice based on interest fosters empowerment in children. Empowerment, in turn, fosters comfort and confidence in making choices about activities and goals to accomplish for those activities. This cycle of choice and empowerment is important to a child's cognitive development (Gardner, 1991; Nicolopoulou & Cole, 1993; Vygotsky, 1978). Ames and Gahagan (1995) feel settings are supportive environments for self-regulation if learners have ownership of ideas, are encouraged to evaluate their learning reflectively, are encouraged to take risks, and are allowed enough time to develop these skills slowly but surely.

Children can be self-regulating and thus successful learners regardless of their present ability level, style, or rate of learning (Griffin, 1994). Learners with learning disabilities especially can benefit from an awareness of their own progress and learning characteristics (Garner, 1992; Paris & Winograd, 1990). A method found helpful in providing these skills to learners with learning disabilities is peer tutoring. Because peer tutoring is less intimidating, the learners' self esteem is increased, empowering them to take more control (Byrd, 1990) and interact with each other more. This increased interaction gives them increased opportunity to use language related to thought and action, which leads to self-regulation.

Instruction responsive to all learning styles, rates, and ability levels. Children bring varied learning styles and abilities with them to any environment (Sykes, 1994). Activities must cater to all learning styles, learning rates, and all ability levels in order to support successful learning for all.

Children do not all learn in the same ways. Gardner (1991) agrees by saying, "Students possess different kinds of minds and therefore learn, remember, perform and understand in different ways" (p. 11). Gardner's (1991) theory of multiple intelligences describes seven different types of intelligence: (1) linguistic; (2) logical-mathematical; (3) spatial; (4) musical; (5) bodily/kinesthetic; (6) interpersonal; and (7) intrapersonal. Children possess strengths in many different combinations of these intelligences.

Therefore, activities should be inherently flexible to meet the needs of *all* learners. They should be attractive to visual, auditory, and kinesthetic learners. They should be attractive to readers and nonreaders. They should be attractive to learners with sensory, physical, emotional and cognitive impairments without isolating them to a different context or a different activity altogether.

Even when learners come to a learning environment with misconceptions, it is important to understand how their misconceptions were formed. First, individual misconceptions must be unpacked. Then, each learner can be taught the correct concepts according his or her own style, rate, and ability (Borun, 1990; Lumpe & Oliver, 1991; Massey, 1990).

Social Factors

Learning communities. An important social factor is the learning community. A community begins as a group of people with a common interest or goal. This interest or goal is the center of social roles and relationships among the members of the community (Lin et al., 1995; Nicolopoulou & Cole, 1993). Members of a community interact to share knowledge and provide feedback. The range of experts and novices make a community dynamic (Resnick, 1991). There is always new knowledge to be shared, experience to gain, and fresh ideas to be heard (Swales, 1990). Everyone brings their own wealth of background knowledge to the community. Every member is respected for the perspective he brings and shares with others. Because each member possesses different knowledge to different degrees, everyone in the group takes on the roles of both expert and novice. There is not one person who assumes the leadership role, but all members may, at some point, be the leader (Lin et al., 1995; Wells, Chang, &

Maher, 1990). This interaction can motivate students to build on each other's knowledge in order to advance each other's learning (Pitman-Gelles, 1981).

A learning community is an environment of collaboration rather than competition (Patrick, 1995, July 21). When children feel they are part of a community, they feel more comfortable in the setting. When children feel more comfortable, they are more likely to be successful learners (Hooper-Greenhill, 1987). Finally, learning communities encourage lifelong learning, because the shared goal is to learn continually, rather than to master skills and reach an endpoint in learning (Lin et al., 1995).

Dialogue and social construction of knowledge. The opportunity to engage in dialogic interactions about learning is another important social factor of successful learning environments. When children have the opportunity to discuss their explorations, trials, errors, successes, new ideas and questions with both peers and adults, they gain a better understanding of the knowledge to be learned (Gelman, Massey, & McManus, 1991). They also come to better understand the ways in which they learn best. Through extensive discussion of new learning, children form metacognitive knowledge about themselves, their learning styles, and their interests (Garner, 1992; Gardner, 1991; Hooper-Greenhill, 1987; Metz, 1995). Dialogue that occurs during peer tutoring promotes positive interactions between learners and their peers. This is also true for peer tutoring experiences involving learners with disabilities and their non-disabled peers (Byrd, 1990; Martella et al., 1995)

Through dialogue, children engage in the social construction of knowledge, an important process in cognitive development (Gardner, 1991; Hooper-Greenhill, 1987; Nicolopoulou & Cole, 1993; Roegholt, 1993). Children learn by socializing with other people and interacting with their environment (Palincsar, 1993). Davydov (1995) quotes Vygotsky by saying, " 'Every function in the cultural development of the child appears on the stage twice, on two planes. First on the social plane and then on the psychological; first, between people, and then, inside the child' (1987,vol.3, p. 145)" (p. 16). Through the use of cultural mediators, such as language and symbols, learners incorporate new knowledge into their own existing meaning systems (Gelman, Massey, & McManus, 1991; Resnick, 1991; Smagorinsky, 1995). Learners must share knowledge to make sense of it.

Parental involvement and family learning. Parental involvement is a third social factor that is important to successful learning environments. Even though children spend much of their time in formal schooling with teachers, they also spend a great deal of their lives at home and in the community with their families. Parents and other family members play a large role in the education and socialization of children. Researchers have noted that children learn more effectively when their parents are involved in their learning experiences (Cohen, 1989). Therefore, parents need to have opportunities to become involved in settings where their children learn. They should have the opportunity to guide their children's learning within the context of family values and traditions, and to reinforce ideas and concepts in different settings. This will help children to generalize new knowledge and incorporate it into their daily lives (Gelman, Massey, & McManus, 1991). Also, by participating in settings where their children are learning, parents can learn more about their children, how they learn and what they like to learn (Cohen, 1989; Smithsonian Institution, 1991; Thomas, 1992).

Play. Play is a fourth important social factor in successful learning environments. Contrary to what many teachers and parents believe, play is not mutually exclusive to learning. In fact, play is very important in cognitive development and construction of knowledge (Karrby, 1990; Goldhaber, 1994; Vygotsky, 1978). For children, play is associated with comfort, freedom to follow interests, and release from failure. Play allows children to act and interact in ways that more structured learning does not. Role-playing, pretending, drama, games, sports and other play activities provide many opportunities for growth and development (Nicolopoulou & Cole, 1993). Play can enhance divergent thinking and problem-solving abilities; free children to explore their natural curiosities; develop willingness to consider various possibilities; motivate children to learn; help children assume responsibility for their actions; help children enhance and defend their competence; develop language and symbol systems (Sykes, 1994), and enhance planning abilities (Casey & Lippman, 1991).

Play integrates many of the factors discussed above.

Play (a) allows adults to scaffold children's learning based on what the children are playing; (b) allows children to create meaningful activities based on scenarios from their own sociocultural backgrounds; (c) builds children's self confidence and self awareness regarding what they are and are not yet able to do on their own; and (d) provides an excellent opportunity for dialogue (Perlmutter & Burrell, 1995).

Goldhaber (1994) comments:

> Trumbull (1990) describes scientists as people who play with ideas in order to change the complex in to the simple. They explore phenomena with intensity and fearlessness, develop explanations of observed phenomena, and share observations, hypotheses, and conclusions with others. She also notes the similarity between the scientist and the child when she writes, "The playfulness of the scientist, like the playfulness of a child, is intense, but permits the freedom to explore and try out a wide range of ideas with no fear of being wrong" (p. 8) (p.26).

Children's Museums

History

The first children's museum in the world, The Brooklyn Children's Museum, opened in 1899. Since then and especially in the past twenty-five years, numerous other children's museums around the world have been opened. In 1901, the Children's Room was opened at the Smithsonian to spark in youngsters an interest that would keep them exploring museums as they grew older. Between this time and about 1925, a few more children’s museums popped up in Boston, Detroit and Indianapolis. These first few museums introduced the radical notions of designing museums for children and displaying exhibits for touching (Cleaver, 1992).

In the 1960’s, a revolution took place, inspired by Jean Piaget’s philosophy that, in order for children to know an object, they must act upon it. In 1961, Michael Spock, son of the acclaimed “baby doctor”, Dr. Benjamin Spock, took over the Boston Children’s Museum to further its hands-on, interactive approaches. In 1969, Frank Oppenheimer opened the The Exploratorium in San Francisco. These events were only the beginning. Through the 1970’s, 80’s, and 90’s, a myriad of children’s museums opened all over the country. Today, nearly every large or mid-sized city boasts a children’s museum (Cleaver, 1992).

Definition and Characteristics

A children's museum is one setting designed and developed to incorporate the factors discussed, among others, in a successful informal learning environment (American Association of Museums [AAM], 1992; Gardner, 1991; Hein, 1990; Pitman-Gelles, 1981; Smithsonian Institution, 1991; Sykes, 1994; Thomas, 1992; Wall, 1986; Winstanley, 1967). Children's museums are very unique, differing from traditional museums and schools in many ways (Smithsonian Institution, 1991; Sykes, 1994). Children's museums are designed for children. They are not adult museums scaled down in size or modified to attract children. They are created for children, their growing needs, their ability and interest levels, as well as their size (Cohen, 1989; Danilov,

1986; Thomas, 1992). They are designed to help children learn about themselves and the world around them. Children's museums are less about collections and displays and more about interactions and hands-on exploration. Rather than preserving artifacts, they preserve comfort and curiosity in children (Waterfall and Grusin, 1989). They introduce children to nature, science, history, technology, and other areas through comfortable, colorful, and playful means. They enhance cultural and educational experiences while promoting a lifelong love of learning (Boisvert & Slez, 1994; Farmer, 1995).

Children are aware that the setting is for them upon entering. They are free to choose their own activities, in any order they wish, with whomever they wish (Waterfall & Grusin, 1989). They are free to watch others, listen to explanations, read the directions, or dive right in and manipulate the exhibits and engage in the activities.

In the field of museum education, there are different types of children's museums, distinguished from each other by their titles. Some are science museums, concentrating primarily on the concepts of the field of science. Some are discovery rooms, focusing on the realm of nature. Some are museums about children and childhood, displaying collections of toys, objects, and clothing for children throughout history. In this study, the term "children's museums' refers to museums that are devoted to help children learn about their world through interactive means. Interactive means are exhibits or activities that are hands-on, experiential, participatory, playful, and about which children can learn through all five senses. The term does not refer to museums where exhibits are primarily displays of collections not available for interaction or hands-on exploration. According to Lumpe and Oliver (1991), hands-on activities are those that allow learners to handle, manipulate, or directly observe a process or concept.

As Successful Learning Environments

Children's museums and scaffolded learning. Exhibits in children's museums are developed to scaffold children in response to their ever-growing needs and abilities (Hooper-Greenhill; 1987, Pitman-Gelles, 1981; Smithsonian Institution, 1991; Suina, 1990). Each exhibit can scaffold children's learning, because there are many different aspects to each exhibit: manipulative pieces and controls; text or recordings explaining the activities and the underlying concepts; various levels of involvement with the activity or exhibit; order of "attack"; levels of complexity of knowledge presented by each exhibit or activity; and satiation of interest or understanding that cues children to move on.

A child may not be able to master all aspects of an exhibit at first, but through guidance from adults and more experienced peers, and through repeat visits to the exhibit over time, the child can develop skills needed to understand more and more about the exhibit (Maiga, 1995). In essence, the child grows with the exhibit and the exhibit grows with the child.

Children's museums and meaningful, contextualized activities. Activities in children's museums are meaningful, contextualized experiences. In these settings, objects from

children's everyday lives and experiences are used to illustrate concepts about physics, biology, chemistry, geometry, nature, history, cognition, health, medicine, language, culture, art, and music. Objects such as mirrors, pins, balloons, bubbles, building blocks, plastic tubes, sand, plastic toys in tanks of water, toilets, birds' nests, seashells, beehives, and rocks illustrate concepts such as optical illusion, reflection, refraction, resistance, force, friction, the Bernoulli principle, viscosity, geometry, balance, cantenary arch, sound frequency and tone, Lissajous figures, Pascal's law, Boyle's law, Archimedes' principle, siphoning, natural wonders, erosion and geology (Crane, 1991).

Since these concepts are brought to life using objects seen by children everyday, they can help children carry new learning over to familiar settings such as home, playground, and school (Cleaver, 1992; Hein, 1990; Maiga, 1995; Metz, 1995; Pitman-Gelles, 1981; Smithsonian Institution, 1991; Sykes, 1994; Thomas, 1992; Waterfall & Grusin, 1989). When concepts are presented in decontextualized, abstract ways, children do not incorporate them as easily into their existing cognitive structures. There is nothing to relate them to in their knowledge banks.

Often, the work of exhibit designers and program developers in children's museums is influenced by their own sociocultural backgrounds. It is important for them to conscientiously incorporate a variety of perspectives into exhibits and programs. The meaning of an object lies in its context of values, experiences, and language (Roberts, 1989).

Exhibits must be designed so a myriad of personal meanings can be connected to the objects.

Children's museums and self-regulated learning. In children's museums, exhibits and activities can provide children with opportunities for self-directed, self-regulated learning (AAM, 1992; Day, 1995, October 12; Hooper-Greenhill, 1987; Pitman-Gelles, 1981; Smithsonian Institution, 1991; Waterfall & Grusin, 1989; Winstanley, 1967). Howard Gardner attributes children's museums with having the potential to help learners assume responsibility for their own learning (Hannapel, 1990).

Children can set their own goals when they approach an exhibit. At first, the goal may be to push all the buttons; later it may be to figure out what happens when the buttons are pushed; still later it may be to understand what the exhibit has to teach via pushing the buttons. Whatever the goal, the child sets it. Towards achieving the goal, children can take over the responsibility of evaluating their own performance. They can decide whether or not each step taken has furthered or hindered their progress towards the goal. They can correct their actions or proceed as they were based on their evaluations. Lastly, children can decide at which point they have achieved the preset goal; whether or not they should abandon or modify the goal; and when it is time to move on and set an even higher goal.

Self-regulating learners are active learners, self-motivated learners, and independent learners (Hooper-Greenhill, 1987; Griffin, 1994). Empowerment lies in the ability to be such a learner (Roberts, 1989), and museums are empowering institutions (Farmer, 1995; Madden, 1985).

Children's museums, learning styles, learning rates, and ability levels. Exhibits and activities in children's museum are not meant for just one learning style or the most popular learning style. They are intended for all learning styles and all learning rates (AAM, 1992; Cleaver, 1992; Hooper-Greenhill, 1987; Pitman-Gelles, 1981; Smithsonian, Institution, 1991). As Roberts (1989) says, “learning begins on the visitors’ turf, with their interests and needs” (p. 155). Mayer (1992) points out that most children, but only 4% of teachers, are the types of learners who need action, physical involvement, and hands-on experience to learn more successfully. Children’s museums offer these activities.

At each exhibit, there is text for children who understand best through reading. There are pictures for children who understand best through symbols. There are recordings for children who understand best through listening. There are objects to handle for children who learn best through manipulation.

In children's museums, children do not compete against each other, and they do not compete against the clock. There are no preset standards indicating which children should understand which concepts by a certain age. There are no "norms" imposed upon learners. Children set their own norms, merely by being the types of learners they are. Children bring so many different styles of learning with them. Children's museums are settings that can cater to each and every one of them, so that each and every one of them can be successful. As Frank Oppenheimer, founder of The Exploratorium in San Francisco, California, once said, "No one flunks museum" (Gardner, 1991, p. 201).

Children's museums as learning communities. Children's museums are settings that can foster the development of rich learning communities (Maiga, 1995). In a children's museum community, children and adults share the common interest and goal of exploring new and different ways of learning about themselves and the world around them. This goal builds social relationships and rule systems among children and their parents or teachers, among children and their siblings or classmates, and among parents, teachers and museum educators (Nicolopoulou & Cole, 1993). Children take on different roles in the context of these relationships and rule systems. They are novices at some exhibits and activities, but experts at others. They teach each other (Gelman, Massey, & McManus, 1991; Roegholt, 1993) and they teach adults (Waterfall & Grusin, 1989). They are constantly growing with the community and its other members.

Children can feel comfortable in the children's museum community. They can feel as though they have a role, a purpose. They can feel freedom to explore and contribute their findings to the community of collaboration (Pitman-Gelles, 1981). Many children's museums, such as The Children's Museum, Indianapolis, involve children in planning exhibits by requesting their feedback and/or observing them in action (Farmer, 1995). They can be confident that these contributions are valued by others. This confidence is important for them to become strong, independent learners.

Children's museums, dialogue, and the social construction of knowledge. Dialogue and interaction among children and adults can be fostered to a great extent at children's museums (AAM, 1992; Hooper-Greenhill, 1987; Sykes, 1994). There are many ways that children can interact in a social context to construct new knowledge as they explore the exhibits and participate in the activities (Driver et al., 1994; LaVilla-Havelin, 1990; Metz, 1995; Resnick, 1987; Smithsonian Institution, 1991; Sykes, 1994). They might explain to less knowledgeable peers how exhibits work. They might describe what they like and what they don't like about exhibits and activities. They might share what they did last time or what they hope to do next time. They might make observations while participating in an activity or watching others participate. They might ask questions to clarify procedures or concepts they do not fully understand. The more opportunities for dialogue and discussion, the more the children can learn.

Children's museums and parental involvement. There are extensive opportunities for parents to become involved with their children in the setting of a children's museum (Day, 1995, October 12; Hooper-Greenhill, 1987, 1991; Sykes, 1994; Waterfall & Grusin, 1989). Some parents may chaperone field trips from their children's schools. Also, children's museums are open in evenings and on weekends to give parents more opportunities to come learn with their children. During these times, more one-to-one interaction may take place between parents and children, and the pace of the visit may be more relaxed than on a school field trip.

In children's museums, parents can facilitate the cognitive, social, and cultural development of their children. This might occur through explorations and explanation of new phenomenon in the context of their personal and familial values, traditions and experiences (Gelman, Massey, & McManus, 1991; Resnick, 1991). Hands-on activities that families can do together are an important aspect of all museums (Farmer, 1995; Hood, 1990). Families visiting museums are social groups with a vast diversity of learning styles, knowledge levels and attention levels (Dierking, 1989). Children's museums are able to provide rewarding, socially interactive experiences to all family types.

By observing their children at the exhibits, parents can come to learn more about how their children learn (Thomas, 1992). They may see that their children prefer to read the directions, or watch another child or themselves as parents complete the task first. They may like to approach the exhibit, handle the objects, push the buttons, work the levers, and then systematically engage in the intended activity. They may be slower learners or faster learners; they may be visual learners or auditory learners. In children's museums parents can discover this for themselves. With this knowledge about their children's learning styles, parents can guide their children in carrying successful learning over into the home and other community settings.

Children might not always be the learners during parent-child interactions in children's museums. Children might often be the teachers, teaching their parents new knowledge or enlightening their parents to new perspectives. Waterfall and Grusin (1989) point out that "a child's ability to renew an adult's sense of awe is one of the true wonders of the world" (p. 14).

Parents with young children are not the only visitors to children's museums who find meaningful, motivating experiences. Although children's museums are geared towards the developing child, teenagers, grandparents, and adults without children can also find much to interest them and much to learn in these settings (Hein, 1990).

Children's museums and play. Children's museums are all about playing. They are about touching, resting, talking, giggling, pretending, watching, trying, feeling, listening, asking, sharing, and doing. There are necessary rules for safety and fairness, but there are no constraints. There is freedom to try, and there is also freedom from failure. There is comfort and fun and fascination. There is also boredom and satiation, but with that comes the freedom to change activities or to rest or to share in what someone else is doing.

Playing also means learning (Sykes, 1994). While children play, they can learn about themselves, about the world around them, and about the nature of children's museums and their exhibits.

All Learners Can Learn in a Children's Museum

One very important thing to point out here is the idea that *all* children can learn at children's museums, and they can learn together (AAM, 1992; Hein, 1990; Hill, 1992). Children with different abilities do not need to be segregated from each other. Inclusion is a moot point in children's museums, because there is no exclusion in the first place (Hooper-Greenhill, 1991). There is no modification needed. The exhibits are inherently modified to meet the growing and changing needs of all visitors, children and adults. Since they cater to different learning styles, all exhibits are appropriate for all children. Everyone can get something out of a visit to a children's museum.

What do children actually learn from or get out of a visit to a children's museum? Again, this question is not easily answered by referring to the literature, because there is very little research in this area (Sykes, 1994). The present study proposes to look deeper into activity at children's museums to focus on the types of learning that occurs, and ways in which this learning can be facilitated. This study proposes to determine how successful children's museums are as informal learning environments.

To begin, it is important to talk about two categories of learning. It is acknowledged that learning cannot fairly be broken down into two distinct categories. However, for the purpose of this study, two general types of learning are mentioned. The first type is the learning of facts. This refers to learning pieces of static knowledge to store until needed at another time. Much of this knowledge is not applicable to other settings or learning. This type of knowledge consists of isolated, abstract bits of information, such as dates in history, spellings of words, mathematical equations, and chemical formulas.

The learning of some facts are important. That cannot be negated. However, a second type of learning may be more important. This is the learning of learning skills, so to speak. Without acquiring skills that will help children be lifelong learners, they will not reach their full potential and will not be able to put their knowledge of facts to use (Gardner, 1991; Roegholt, 1993). Lifelong learning skills include confidence, competence, and curiosity (Waterfall & Grusin, 1989), problem-solving (Hooper-Greenhill, 1987), creativity and divergent thinking (Gartenhaus, 1993), systematic investigation (O'Donnell, 1995), and scientific inquiry (AAM, 1992). These skills will help children be independent learners, to find out information and facts on their own, rather than leave them to be dependent learners who rely on teachers and parents for new information (Hein, 1990).

Children's museums may or may not directly teach youngsters specific facts about science, such as the boiling point of water, or about history, such as the date Christopher Columbus sailed to America. But this study proposes that children's museums *will* foster skills, and a lifelong love of learning and exploring (Hill, 1992; Hooper-Greenhill, 1987; Maiga, 1995; O'Donnell, 1995; Pitman-Gelles, 1981; Smithsonian Institution, 1991; Sykes, 1994).

The chances for deep learning and understanding increase with repeated visits and long-term programs (Blythe & Gardner, 1990; Cleaver, 1992; Gardner, 1991; Hein, 1990; Hooper-Greenhill, 1987; Pitman-Gelles, 1981; Sykes, 1994;

Waterfall & Grusin, 1989; Winstanley, 1967). On initial visits, one of the main goals of visitors is to familiarize themselves with the physical aspects of the museum setting. In order to feel comfortable enough to concentrate on exhibits and activities, adult and child visitors like to know certain things, such as where to start, which way to proceed, where the bathrooms and drinking fountains are, and whether or not there is a gift shop to visit. Once familiar with these aspects, subsequent visits are spent learning more about the exhibits (Falk & Dierking, 1992). The exhibits do not have to change in order for the visitors to learn more every time they return. The same exhibits can reveal new information each time. As Cleaver (1992) puts it, "To a growing child, the world is a totally different place from week to week, and reexploring a museum can reveal very different things from the previous visit" (p. 31).

Children can experience children's museums in meaningful ways through on-going school museum programs. Schools need to work with museums so that the students receive the best of both worlds: a structured environment where they learn important factual information and a less structured, informal environment where they can learn ideas and self-regulation, empowerment and lifelong learning skills (Gelman, Massey, & McManus, 1991).

This has already been illustrated by programs and research projects (Gardner, 1991). One program, the Center for Exploration at the Indianapolis Children's Museum, offers middle school children an apprenticeship lasting several months. During this apprenticeship, the students engage in

such activities as animation, shipbuilding, journalism, and meteorology.

A research project, called Project Spectrum, has been conducted by Howard Gardner and Mary Krechevsky of Harvard University and David Feldman of Tufts University (Gardner, 1991). Project Spectrum is a strong example of combining the strengths of both school and children's museums to offer students a successful learning environment. Students from preschool through the early primary grades are surrounded by activities that evoke the use of the seven intelligences outlined by Gardner (1991). These activities include a naturalist's corner, a storytelling area, and a building corner. The students are encouraged to choose their own activities based on their interests and abilities. Personal profiles are written about each student and the progression of activities he/she followed throughout the school year. This has proved effective in building on students' strengths while bolstering areas of weakness. Students in Project Spectrum have exhibited increased confidence and control over their own learning. The study here has been proposed to build on the findings of Project Spectrum and to emphasize that these findings also apply to students with disabilities.

Successful School-Museum Partnerships

Children’s museums are indeed different from school and other educational institutions (Farmer, 1995). Rather than replacements to schools, however, children’s museums can be valuable supplements or reinforcements (Farmer, 1995). Teachers and museum educators can work collaboratively to establish successful school-museum partnerships (Institute of

Museum Services, 1996).

The Institute of Museum Services (1996) names twelve conditions required to form lasting and effective partnerships. These are: (1) obtain an early commitment from appropriate school and museum administrators; (2) establish early and direct involvement of both school and museum personnel so both feel ownership from the beginning; (3) establish and understanding of the school's needs regarding state and local curriculum requirements; (4) create a shared vision for the partnership; (5) recognize and accommodate the different cultures of schools and museums; (6) set concrete goals to be evaluated and revised continually, if needed; (7) allocate enough human and financial resources; (8) define roles and responsibilities clearly; (9) promote dialogue and open communication; (10) provide benefits that teachers can use; (11) encourage flexibility, creativity, and experimentation; and (12) seek parent and community involvement.

Class field trips to children's museums have been found to be more successful when the novelty of the new environment is reduced through advance preparation or repeat visits (Kubota & Olstad, 1991). In addition, field trips can be more effective as educational tools if: (a) the learners' knowledge, interests, and experiences are evaluated in advance; (b) pre-visit activities are used in the classroom; (c) there is a variety of activities planned for the visit; and (d) post-visit activities are used in the classroom as follow-up (Bitgood, 1990)

Chapter Summary

The theoretical framework of this study is social constructivism, the idea that knowledge is constructed upon a base of prior experiences through social interaction with more knowledgeable others. Also a theoretical basis to this study is the holistic paradigm which centers on the themes of the whole equaling more than the sum of the parts and the importance of the individuality of each learner.

Eight factors reflecting this theoretical framework have been identified as being components of successful learning environments for students with learning disabilities. These are: (1) scaffolded instruction; (2) meaningful and contextualized activities; (3) self-regulated learning; (4) activities that are responsive to learning styles, rates and ability levels; (5) learning communities; (6) the social construction of knowledge; (7) parental involvement; and (8) play. All of these factors are applicable to the context of children's museums.

Chapter Three: Methodology

Chapter Introduction

This chapter describes the research approach and how it applies to research in children's museum. Also described are: the children's museum and classroom setting; the student, teacher, parent and museum staff participants; the design of the study; the methods of data collection; the procedures; and the methods of data analysis.

Qualitative Research Approach

Characteristics and Axioms

This study is qualitative in nature. The methods and measures employed were used for their ability to provide a rich description of the participants, their actions and interactions, and the setting in which they occur. Accounts of the performances studied here are more meaningful when described through rich, descriptive, holistic accounts. Miles and Huberman (1994) remark that, "Words, especially organized into incidents or stories, have a concrete, vivid, meaningful flavor that often proves far more convincing to a reader -- another researcher, a policy maker, a practitioner -- than pages of summarized numbers" (p. 1).

The strengths of qualitative research are many (Miles & Huberman, 1994). First, data in qualitative studies are collected in a context. Underlying issues salient to the context are better understood when they are described in context. Second, qualitative data are rich and holistic. They reveal the complexity and interactivity of real-life situations. Third, data are collected over time, revealing a dynamic process in which the participants are involved, rather than an isolated, static product. Fourth, qualitative research recognizes the social world in which we live. This brings to light the meanings people place on events and relationships via their interactions with others. To ignore the participants' perspectives, values, and constructed meanings is to ignore a large part of the picture. Qualitative research pays close attention to this aspect, completing the picture of what is occurring in the setting. Finally, qualitative data collection is flexible. It does not have to adhere to regiment. This flexibility allows more attention to be paid to more complex issues.

Qualitative research is deeply embedded in the naturalistic paradigm. Lincoln and Guba (1985) identify five axioms of inquiry under this paradigm:

The first axiom is that there are multiple realities rather than one tangible reality to every situation. Multiple realities can only be understood when studied holistically, taking all aspects of the situation into account. Prediction and control of the situation are highly unlikely.

The second axiom is that the inquirer and the inquiree cannot be separated. They interact during the entire process of inquiry. This interaction allows for the inquirer to gain a complete or holistic account of the situation. Without interaction, only one perspective, only a fragment of the picture, is captured.

The third axiom is that generalization is possible only through a "working hypothesis" (p. 38). There cannot be one fixed hypothesis that applies to all situations. Results of

naturalistic inquiry cannot always be generalized to other situations. Rather, an ideographic body of knowledge is used to interpret the aspects of each individual situation.

The fourth axiom is that cause-and-effect relationships cannot be distinctly determined through naturalistic inquiry. There are so many variables to consider within the holistic context, that one variable cannot be said unequivocally to result in another.

The fifth axiom is that naturalistic inquiry is value-bound rather than value-free. The naturalistic inquirer, the inquiree, the context, and the underlying theories involved all lend values to the situation. These values provide information needed to understand the situation.

Qualitative Research in Children's Museums

Smith (1990) contends that qualitative or ethnographic research methods lend themselves well to the museum setting. These methods emphasize the uniqueness of the setting rather than try to control it for the purpose of generalizability. Madden (1985) agrees that the act of controlling for the many variables of a museum setting detracts from the true understanding of the learning that occurs there.

Feher and Diamond (1990) describe science centers as excellent research laboratories. They have large audiences, as well as many opportunities for free choice and interaction. They feel that research in science museums: (a) is basic, open research aiming to advance our knowledge about human cognition and learning behavior; (b) provides basic research results that can enhance a given field and be generalized to environments other than the museum; and (c)

should be encouraged because it fosters the cross-fertilization of ideas and enhances the intellectual stature of science museums.

Study Characteristics

Settings

The settings in this study are natural settings. It was necessary for the phenomena studied to take place in its natural setting because of its dependency on context (Lincoln & Guba, 1985). There are two separate settings for this study - the children's museum setting and the general education classroom setting.

The children's museum. The children's museum setting is the Ann Arbor Hands-On Museum (AAHOM) in Ann Arbor, Michigan. AAHOM was established in 1979, and is housed in a historic landmark building, the former central firehouse of Ann Arbor. AAHOM is primarily a science museum with the philosophy that children learn best by doing - touching, handling, assembling, dissembling, and using. In a type of laboratory setting, abstract concepts become clearer as the children experience them firsthand, with their hands. Exhibits bring concepts in science, technology, natural history, mathematics, history, art, and world cultures to life.

This museum was chosen for two main reasons. First, the researcher is familiar with the setting, having been a volunteer Explainer Guide for nearly a year at the time the study began. Second, the museum staff showed a sincere interest in providing a setting for a study that may shed light on the nature of learning in science museums.

The museum currently has four floors for their 140 exhibits. The first floor, entitled "The Subject is You," contains exhibits related to the human body. For example, there is an X-ray table displaying the skeletal X-ray of a mummy; a scale; an instrument that measures voice waves; a device that demonstrates the mechanics of the human voice box; and a video recording of a fetal ultrasound. The layout and names of the first floor exhibits can be seen in Figure 1.

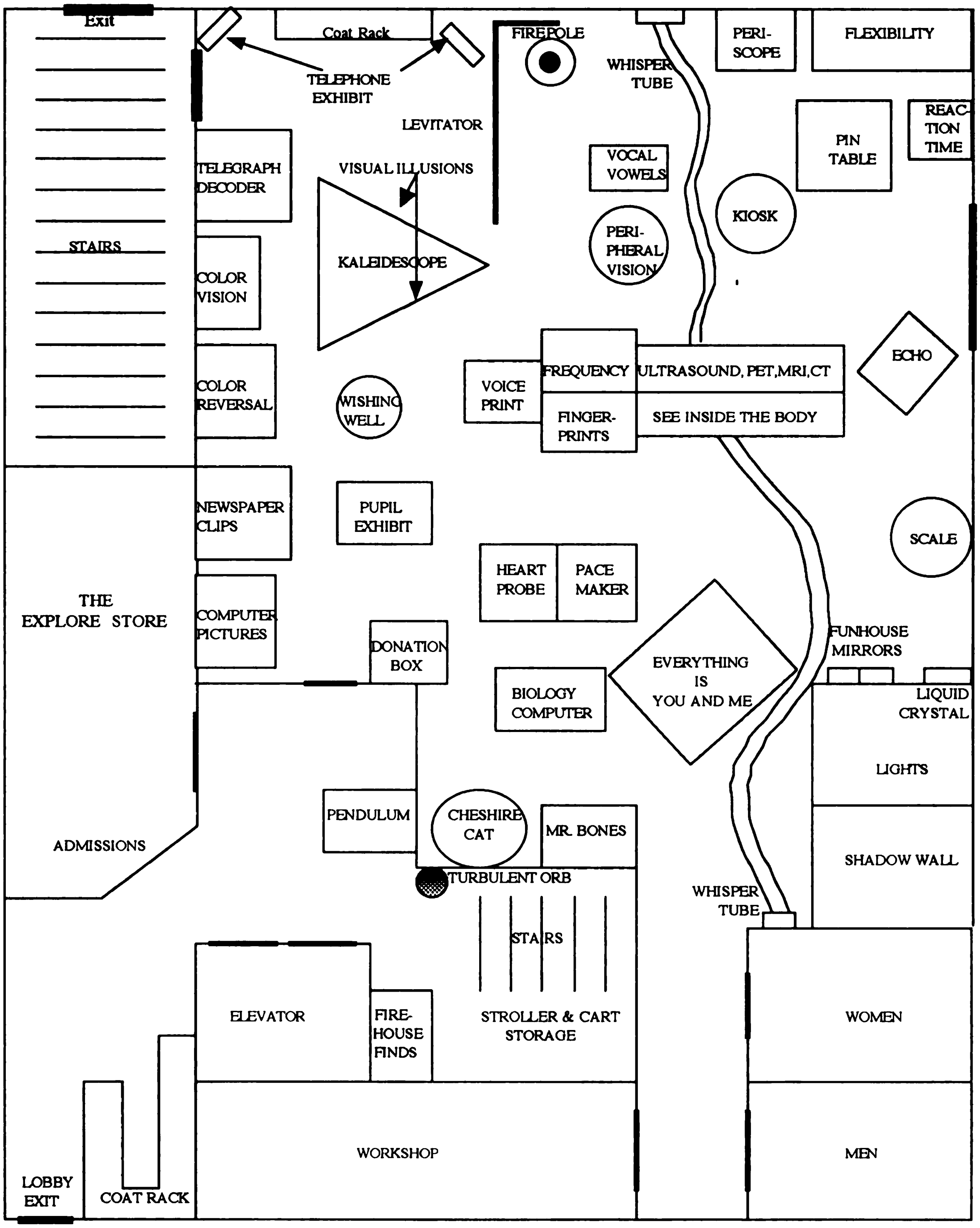


Figure 1: First Floor ("The Subject is You")

The second floor, entitled "The World Around You," contains exhibits depicting phenomena from our everyday surroundings. For example, there is a bubble capsule where visitors can surround themselves with a giant bubble; whisper dishes that allow visitors to whisper to each other across a large, crowded room; a hot air balloon that floats to the ceiling when filled with air heated by two toasters; and the Discovery Room filled with fossils, beehives, sea shells, aquaria, and terraria. The layout and names of the second floor exhibits can be seen in Figure 2.

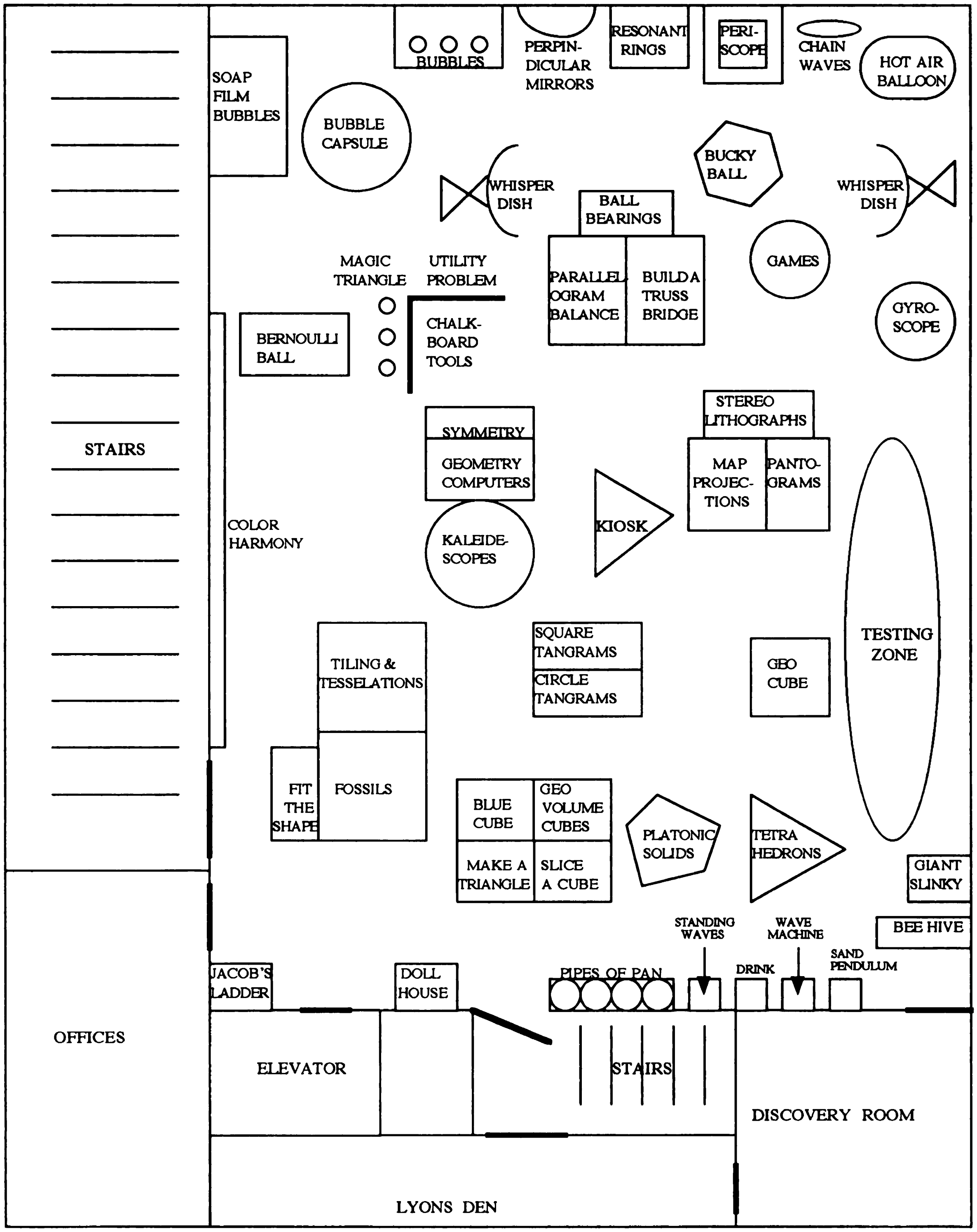


Figure 2: Second Floor ("The World Around You")

The third floor, entitled "Light and Optics," contains exhibits that use light. Some of the exhibits perform optical illusions. There is an engine that runs on light; several hologram displays; a light island that reflects and refracts light rays through different prisms; and a stroboscope. The layout and names of the third floor exhibits can be seen in Figure 3.

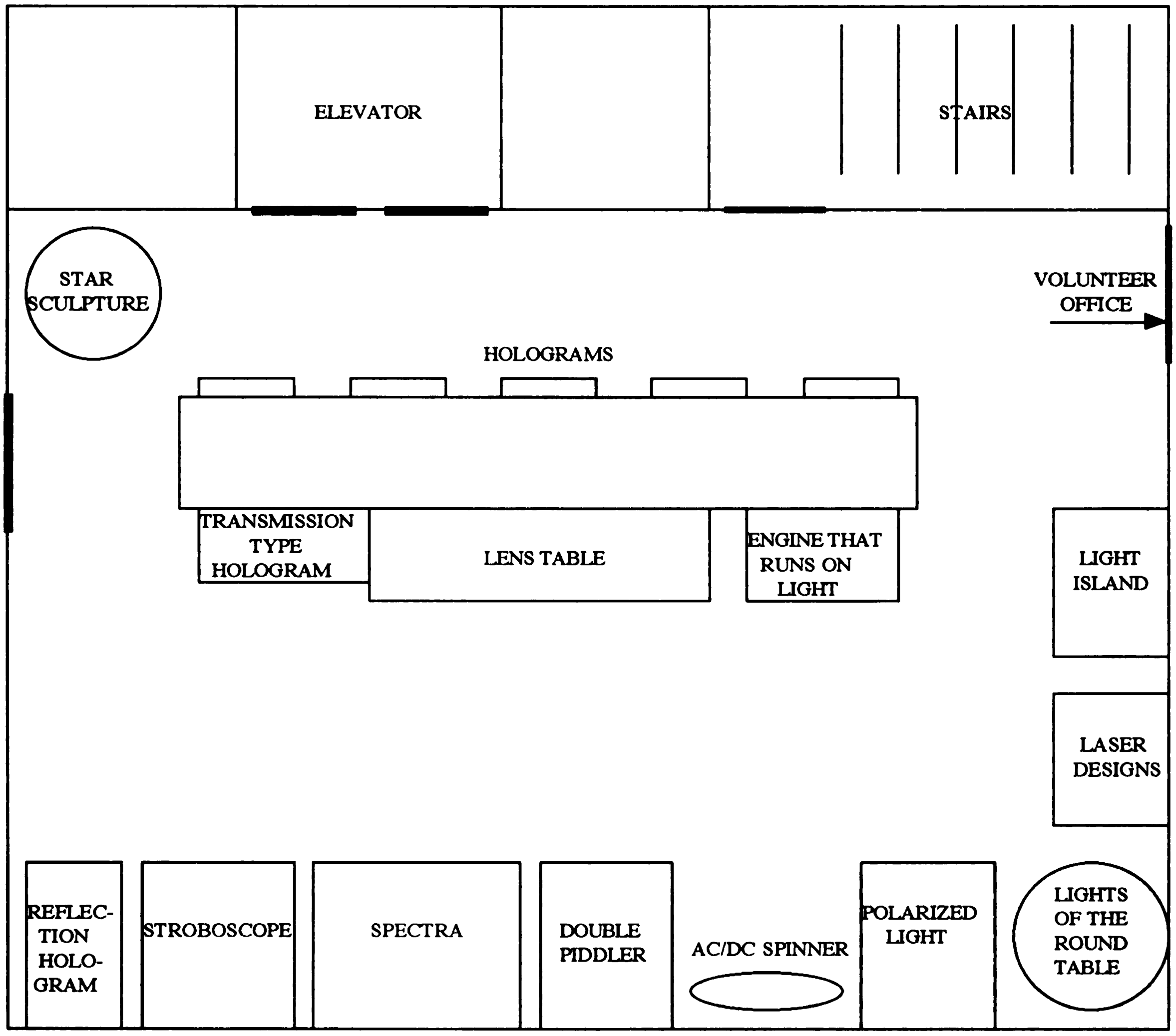


Figure 3: Third Floor ("Light and Optics")

The fourth floor, entitled "How Things Work," contains exhibits that depict mechanical operations of everyday objects. For example, there is a cut-away toilet to show how it flushes; pulleys; a working model of a Wimhurst generator; a circuitry table where visitors can create circuits and turn cranks to ring bells or illuminate light bulbs; and many puzzles and games. The layout and names of the fourth floor exhibits can be seen in Figure 4.

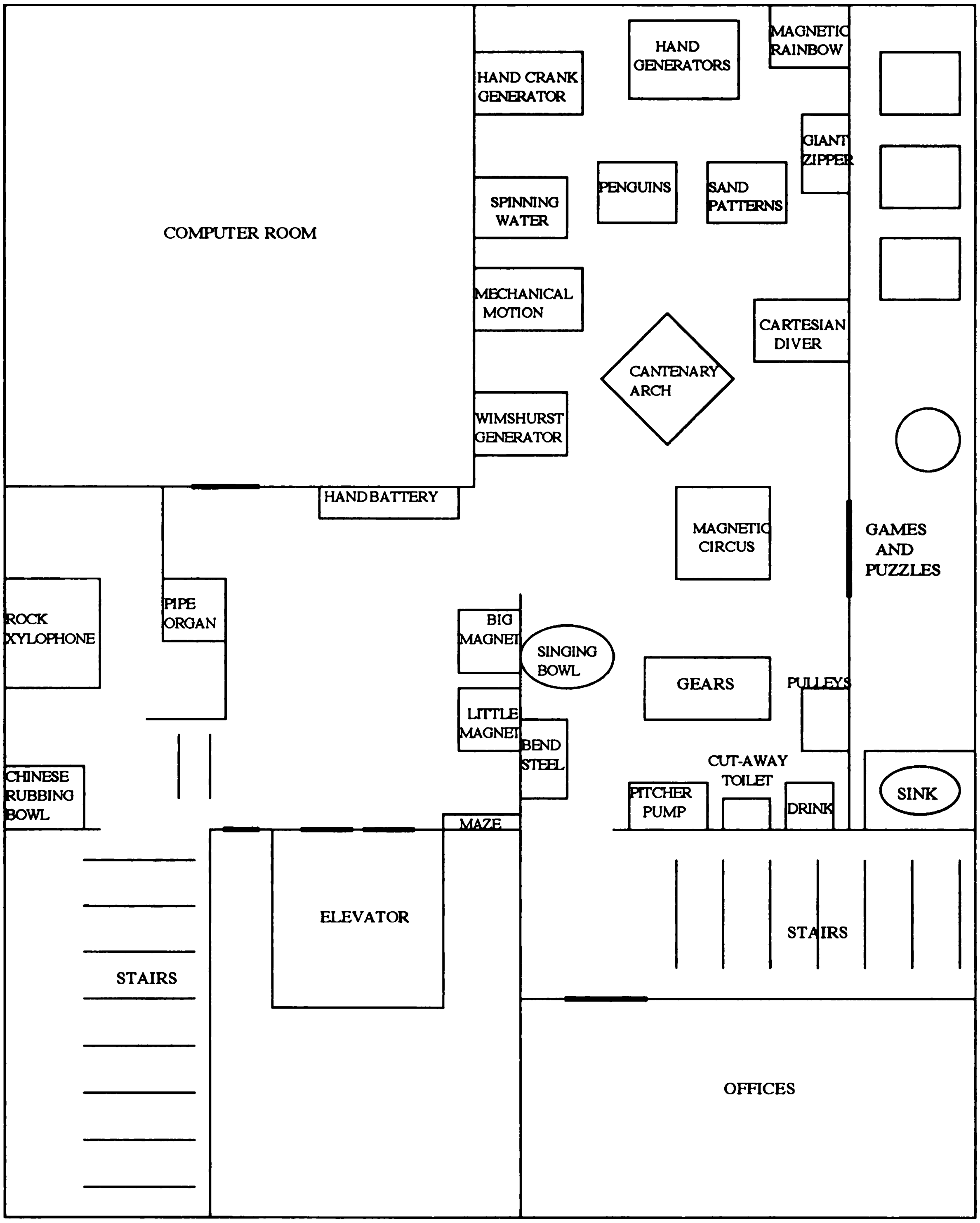


Figure 4: Fourth Floor ("How Things Work")

A devoted staff of employees and volunteers maintain the museum, its exhibits, and several programs and services. The paid staff includes the executive director, the associate director, the outreach coordinator, the educational coordinator, the volunteer coordinator, the administrative assistant, the gift store manager, two public relations personnel, and two program instructors. Programs and services include School Field Trips, Saturday Workshops, Weekend Demonstrations, Special Events such as birthday parties, Teacher Training Workshops, Overnight Science Camp-In Programs, Outreach Programs, and visiting exhibitions.

The museum provides field trip experiences for any group of students able to come to Ann Arbor. Most classes are from Ann Arbor and neighboring Michigan schools, but some come from as far away as Ohio and Illinois. There is a morning and an afternoon field trip schedule. There can be as many as four different groups per schedule (up to 180 persons scheduled to be at the museum at any one time), with groups rotating among floors every twenty-five minutes. Each field trip begins with a five to ten minute orientation presented by the Explainer Guide who will accompany the group throughout the visit. During the orientation, visitors are given a brief history and description of the museum and its contents, told the locations of the bathrooms and water fountains, and are given any instructions pertinent to their specific group. At the appointed times, overhead announcements are made directing visiting groups to follow their appointed Explainer Guide to the next floor. Every group may opt to visit the gift store and any visiting exhibitions located in the mezzanine of the museum.

The classroom. The classroom in this study is in a small elementary school (190 students) located in the Willow Run School District (approximately 3,000 students in all) outside Ypsilanti. Ypsilanti is a mid-sized city (population 24,800) east of the larger city of Ann Arbor (population 109,600). The Willow Run area once centered on an automotive manufacturing plant. The plant shut down a few years ago, leaving many people unemployed and forcing several families to move out of the area. The result is a damaged economy with all remaining families in the middle to low income bracket. Approximately 50% of the people in the area are African American; approximately 45% are European American; and approximately 5% are Hispanic.

Participants

The classroom is a third-grade general education classroom. In all, there are twenty-six students in the class (seventeen boys and nine girls). Six of the students (four boys and two girls) are classified for special education services. Five of them spend half of each school day in the special education room. One is included full-time into the general education classroom. The six special education students' classifications are as follows: (1) learning disability (LD); (2) learning disability (LD); (3) learning disability and emotional impairment (LD and EI); (4) educable mental impairment and speech and other language impairment (EMI and SLI); (5) physical and other health impairment and educable mental impairment (POHI and EMI); and (6) trainable mental impairment (TMI).

The students were classified with these disabilities in accordance with the following definitions:

Learning Disability (LD): The Individuals with Disabilities Act (IDEA) of 1990 defines a specific learning disability as "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. The term includes such conditions as perceptual handicaps, brain handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage (Section 5[b][4])" (Hardman, Drew, Egan, & Wolf, 1993, p. 173-174).
In addition, the students at this school classified as having a learning disability are of average intelligence with a discrepancy of two standard deviations from the norm between their present grade level and academic test scores in one or more academic area.

Educable Mental Impairment (EMI): A student is classified with EMI if his or her intelligence score on a standard intelligence test is 55 to 70; if his or her

scores on standard academic tests lie in the sixth percentile or below; and if he or she exhibits an impairment in adaptive behavior (e.g. mobility, self-help skills, social competency).

Trainable Mental Impairment (TMI): A student is classified with TMI if his or her intelligence score on a standard intelligence test is 40 to 55; if his or her scores on standard academic tests lie in the sixth percentile or below; and if he or she displays an impairment in adaptive behavior (e.g. mobility, self-help skills, social competency).

Emotional Impairment (EI): A student is classified with EI if he or she displays emotional responses different from generally accepted, age appropriate, ethnic or cultural responses that adversely affect educational performance and that cannot be explained by environmental factors. The behavior must be displayed in more than one setting, at least one of which is the school setting.

Physical and Other Health Impairment (POHI): The student with POHI was classified as such because he has a health disorder that has caused limited physical and intellectual ability. He has an inborn error of metabolism called galactosemia which is an inability to digest galactose, a natural sugar found in milk. Galactose in his diet as a newborn caused serious illness with lasting effects.

Speech and Language Impairment (SLI): Speech and language impairments can affect receptive or expressive language. The student in this classroom who has SLI has impaired expressive speech. Hardman, Drew, Egan, & Wolf (1993) describes such individuals as those who have difficulty formulating and using spoken language, have limited vocabularies, have immature speech (i.e. baby talk), and have personal interaction difficulties.

The special education classroom has one teacher, three paraprofessionals, and one student teacher. The paraprofessionals often accompany the students with disabilities to the general education classroom for one-to-one assistance. Fourteen of the students are African American, eleven are European American, and one is Hispanic American. This is representative of the population of Willow Run as a whole. The participants have varied levels of experience in children's museums, but all have a good deal of experience with field trips.

Although all of the students in the class attended the field trips, only eighteen students returned signed consent forms allowing them to be official participants in the study. All six of the students with disabilities were among the participants. At the beginning of the study, ten participants were boys and seven were girls. Eight were African American, eight were European American, and one was Hispanic American. After two field trips, halfway through the study, one European American boy left the class and one African American boy returned his consent form. Thus, at the end of the study, the sample of students included ten boys and seven girls; nine African Americans, seven European Americans, and one Hispanic American. All six of the students with disabilities remained in the study for the duration. Table 1 displays information regarding all eighteen participating students by the number printed on their assigned lab coats. To note, this student was actually assigned lab coat #19, and no one was assigned to #18. For the sake of simplicity, this student will be referred to as Lab Coat #18.

Table 1: Student Participants

Student (by lab coat #)	Age	Sex	Race	Disability Classification	Notes
1	9	F	African American	Learning Disability Emotional Impairment	
2	9	M	African American	None	
3	9	F	European American	None	
4	9	M	African American	Learning Disability	
5	9	F	European American	None	
6	9	F	African American	None	
7	8	M	European American	None	Left class Jan. 6, 1997 (after second field trip)
8	9	M	African American	None	
9	9	M	European American	Physical/Health Imp. Educable Mental Imp.	Mother attended fourth field trip
10	9	F	Hispanic American	None	
11	9	F	African American	None	
12	10	M	European American	Trainable Mental Imp.	
13	10	M	African American	Learning Disability	Included full-time
14	9	M	European American	None	
15	9	M	African American	None	
16	9	F	European American	Educable Mental Imp. Speech/Language Imp.	
17	9	M	European American	None	
19	9	M	African American	None	Entered study Jan.16, 1997 (before third field trip)

The sample of participants for this study was not randomly selected. Instead, maximum variation sampling, a type of purposive sampling, was used. The reasons for this are best summarized by Lincoln and Guba (1985). "In naturalistic investigations, which are tied so intimately to contextual factors, the purpose of sampling will most often be to include as much information as possible, in all of its various ramifications and constructions; hence, maximum variation sampling will usually be the sampling mode of choice" (p. 201). In this study, maximum variation sampling aided in yielding a sample classroom with variation in (a) learner ability, (b) learner and teacher experience with children's museum settings, and (c) race and ethnicity.

The researcher sent notice of the project to schools in the area of AAHOM. This class was chosen after the special education teacher expressed an interest to have her third-grade students participate in the project. The third grade general education teacher seconded the interest. Parents of all students were also invited to participate in the study. Four parents returned signed consent forms indicating the desire to participate. Thereafter, three of the parents did not participate at all. They could not be reached after several telephone calls and notices sent home with the students. The fourth parent, the mother of the student with POHI and EMI, participated to a small extent. She was able to meet the researcher for an informal, untaped conversation and was able to attend the fourth field trip.

Design

This is the case study of an elementary class of students and the adults with whom they interact. As the students visited a children's museum with their classmates and teachers, and as they participated in their classroom routine, a rich description of their actions, interactions, and performances were recorded.

A case report of one classroom has many strengths as a research design. Lincoln and Guba (1985) name the following: (1) the case report provides a thick description essential for transferring findings to other, similar settings; (2) the case report incorporates the multiple realities occurring in a real-life, value-laden setting; and (3) the case report is a rich, grounded, holistic, real-life way to communicate with the reader. Case studies relate to the reader's experience, helping them achieve personal understandings and make "naturalistic generalizations" (p. 119).

Lincoln and Guba (1985) also state that "the case study is a fitting capstone to the *continuous* reporting process that characterizes naturalistic inquiry -- the culmination and codification of myriad formal and informal reports that have gone before" (p. 358). Thus, other studies that explore learning in children's museums and how it carries over to other learning settings can be enhanced by the case of this classroom of students (Rapp, 1997).

Data Collection

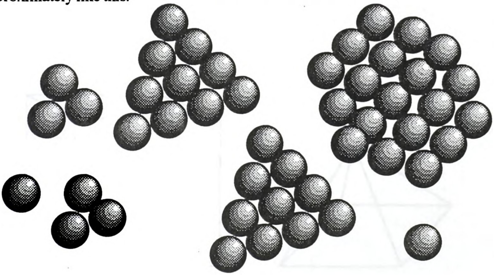
Methods and Materials

Human-as-Instrument is the instrument of choice for a qualitative, naturalistic study (Lincoln & Guba, 1985). For this study, the measures to be employed under this concept include observation, prepared interviews, on-the-spot interviews, document analysis, questionnaires, and a researcher's log. They will depend upon the human-as-instrument for analysis.

Observations. The participants were observed during four half-day field trips to the museum and during four full-day visits by the researcher to the classroom. The observations were videotaped. Videotaping was accompanied by researcher field notes.

Two stationary cameras were set up in the children's museum. They were in the same places for all four field trips. One camera was on the second floor, near the gyroscope exhibit space, focused on the kiosk containing "Tennis Balls in a Cube," "Tetrahedron in a Cube," and "Carnival Circles." These exhibits were chosen because they are puzzles that students can work on individually, with a partner, or in a small group. Also, the relatively few steps required to solve the puzzles are more cognitive rather than physical in nature. Figures 5, 6, and 7 describe these three exhibits in detail.

The materials for this exhibit include a clear, plastic cube with one open side and six puzzle pieces made out of tennis balls. The six pieces look approximately like this:

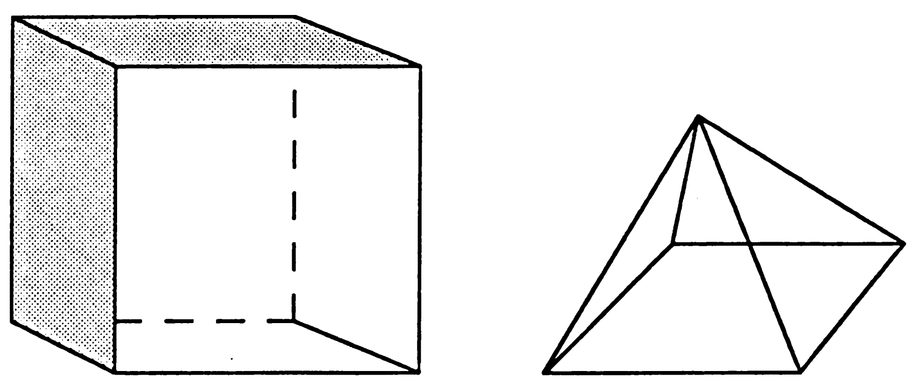


The object is to fit all of the tennis-ball puzzle pieces into the cube. There is only way to solve the puzzle so that the pieces fit in the cube (by forming a cube themselves).

The solution is to layer the pieces from smallest to largest, then back to smallest again. The pieces must be laid from corner to corner rather than directly on top of one another. This solution is in written and pictoral form on the exhibit label.

Figure 5: "Tennis Balls in a Cube" Exhibit

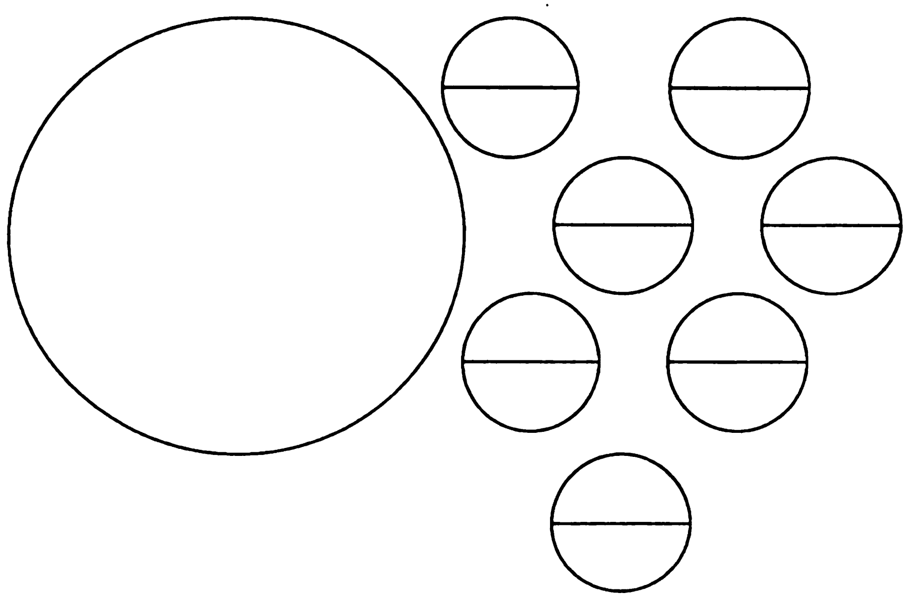
This exhibit consists of a clear, plastic cube with one open side and a pyramid-shaped block:.



The object is to position the tetrahedron so it fits inside the cube.

Figure 6: "Tetrahedron in a Cube" Exhibit

This exhibit consists of one large, red, plastic circle and seven small, yellow, plastic circles. All of the yellow circles are the same size and have black lines drawn through the diameter:



The object is to place the small, yellow circles on the large, red circle so that they completely cover the red circle.

The solution is to place the yellow circles so that each end of the black lines rests on the border of the red circle.

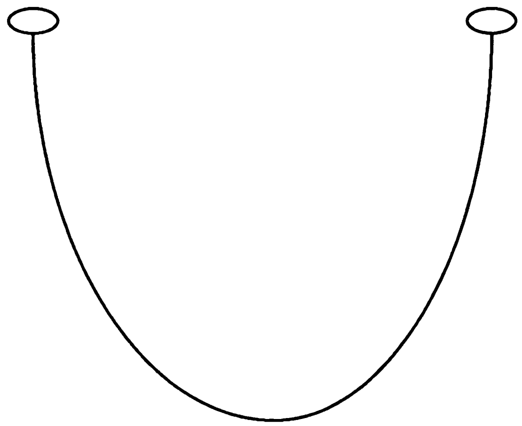
Figure 7: "Carnival Circles" Exhibit

The second camera was on the fourth floor focused on the "Catenary Arch." This exhibit was chosen because it can also be done individually, with a partner, or in a small group. However, it requires more steps than the puzzles on the second floor, and they are more physical than cognitive in nature. It takes a steady hand to complete the arch. This exhibit is described in detail in Figure 8.

This exhibit consists of a platform that can be lifted from a horizontal to a vertical position, and twenty-one numbered blocks that form an arch when placed together. On the platform is a diagram depicting where each numbered block should be placed.

The object is to first form an arch with the blocks on the platform while it is lying in the horizontal position. Then, lift the platform to the vertical position and lower it again, leaving the arch standing alone in an upright position.

The phenomenon behind this exhibit is the catenary arch which was mathematically calculated in the 17th century. If a chain or rope is hung by its two ends, it forms a **catenary** curve:



When arches of blocks are made in the proportions of this curve, they will stand alone without glue or mortar. Thus, this arch has been used most often in architecture since ancient times (Crane, 1991).

Figure 8: "Catenary Arch" Exhibit

The cameras were turned on only when the participants were in the area. When the participants left the area, the cameras were turned off. A third, mobile camera was carried by the researcher to record activity occurring outside the range of the stationary cameras. The mobile camera was not used continuously, so as to be as inconspicuous and unintimidating as possible. However, the availability of a mobile camera was important in order to collect thorough data.

Consent for videotaping participants was obtained in writing. All adult participants and the parents of seventeen students in the classroom signed a consent form prior to the onset of data collection. A copy of this consent form is included in Appendix A. With regard to the inadvertent videotaping of general public visitors who may have walked within the range of any three of the cameras while recording was taking place, a sign was posted at the entrance to the museum. This sign informed visitors of the presence of the cameras and the researcher, informed them of the purpose of the study, and ensured them that no information other than that obtained about the intended participants would be used or published in any way. A copy of this sign is also included in Appendix A. Participants were distinguished from general public by wearing white laboratory coats. The coats were coded with numbers for each participant. Only the researcher and participants knew who was assigned to which number.

In the classroom setting, one stationary camera and/or one mobile camera were used during observation. The stationary camera was focused on the classroom as a whole. The mobile camera was used occasionally to record close-ups of student activity, to zoom in on student work, or to record activities occurring in different areas of the classroom. Consent for videotaping in the classroom was given as part of the written consent form mentioned above. Before the first field trip, the researcher addressed the entire class of students, informing them of the purpose of the field trips and preparing them for the presence of the cameras. A sample protocol for this address can be found in Appendix A.

Interviews. Interviews were prepared ahead of time by the researcher. There were slightly different interviews for students, teachers, and museum staff. Interviews were conducted four times: (1) before museum and classroom visits started; (2) in the middle of the study (after two field trips and classroom visits were completed); (3) immediately after the museum and classroom visits ended; and (4) approximately one month after the museum and classroom visits ended. Sample protocols of all interviews are included in Appendix B. These interviews were audiotaped, with the exception of the third interview with the special education teacher. A written interview form was mailed to her as she was on medical leave.

Interviews with the teachers, students, and one informal, untaped conversation with a parent were conducted in the school setting. Interviews with museum staff were conducted at the children's museum. Consent to have these interviews audiotaped was also given as part of the written consent forms mentioned above.

Questions in students interviews were asked to assess what and how much the students were learning from their experiences at the museum, as well as how their perceptions were changing regarding the two settings, their peers, and their learning styles and interests. Questions in teacher, parent, and museum staff interviews were asked to assess their perceptions of how the students' performances and behaviors were changing in both settings over time.

During museum and classroom visits, the researcher engaged the students in on-the-spot interviews to expand upon or clarify observations made. Examples of questions for on-the-spot interviews in the museum are: (1) Could you explain to me how to do that activity? (2) How did you learn to do that activity? (3) What is the goal of that activity? (4) How did you and your friend help each other complete that activity? These interviews were not audiotaped, but sometimes were recorded on the videotapes.

Questionnaires. After each museum visit, questionnaires were distributed to the students, teachers, and museum staff who worked with the school group during the visit. The general purpose of the questionnaires was to ask what was accomplished that day. A sample questionnaire is included in Appendix B. The questionnaires were completed at school the day of or the day after each field trip. In most cases, the students were able to complete the questionnaires without help. Some students, however, required help in reading and writing. These students completed them with teachers who read them the questions and wrote their answers on the questionnaire form. The questions asked in this format were used to assess what the participants remembered most about their most recent visit, so these perceptions could be compared and contrasted over time.

Document collection. Over the course of the study, the researcher requested that teachers put aside any student work samples, lesson plans, or class projects that reflected activities or exhibits in the children's museum.

Researcher's journal. During the study, the researcher kept a log, consisting of the following: (1) a schedule of observations and interviews; (2) a list of collected documents and questionnaires; (3) methodological ideas such as predicted data analysis results; and (4) a reflective journal of personal reactions to the study and its progression.

Procedures

On October 1, 1996, the researcher met with the general and special education teachers, the principal, and two museum staff embers to discuss the goals and procedures of the study. The teachers agreed to prepare the students in advance for field trips; to use activities in the classroom relating to content in the museum; and to gather student work samples, lesson plans, and class projects relating to activities/exhibits in the museum. The principal confirmed his full support for the study and the participation of the third grade class. The museum staff members agreed to create a consistent museum setting by assigning the same Explainer Guide as often as possible to the class; to schedule all field trips for the same time of day and the same day of the week; and to have the class follow the same field trip tour each visit. The researcher agreed to arrange payment for bus transportation, museum admission, and laboratory coats.

On all four field trips, the students toured the four floors of the museum in the same order. They started on the second floor and continued to the third, fourth, and first floors. When applicable, the mezzanine with visiting exhibits was visited last. The first and second field trips ended with a visit to the special traveling exhibit on bats. The fourth field trip ended with a visit to the special traveling exhibit on the human brain. The third and fourth field trips were scheduled two weeks, rather than four weeks, apart. This is because the fourth trip needed to be scheduled before Special Olympics (Monday, February 3 through Friday, February 7, 1997) and before the special education teacher left on medical leave (February 7, 1997). During the fourth classroom visit, following the fourth field trip, the researcher conducted a hands-on activity pertaining to ocean life with the students. The class was currently studying oceans and ocean life as a science unit. It was predicted by the researcher and teachers that a hands-on activity directly related to their school studies would increase recall and learning about the topic. A schedule of all interviews, field trips, questionnaires and classroom visits is included in Appendix C.

Data Analysis

Transcribing and Categorizing of Tapes

All audiotapes were transcribed by a hired university transcriber. The transcriber signed an agreement to keep all data confidential. All tapes, hard copies of transcriptions, and disk copies of transcriptions were returned to the researcher.

All videotapes were categorized by the researcher. Each tape was viewed several times, while notes were made regarding activities and conversations of participants. Any section of tape containing valuable data was transcribed fully. All in all, approximately 50% of tapes were fully transcribed.

<u>QSR NUD-IST Software Program</u>

Analysis of all collected data was aided by the use of a qualitative data analysis software program called QSR NUD-IST (1996). This program provides functions such as coding and organizing data so it is easier to retrieve, group, display, and analyze. Information is entered into the data analysis software in the form of "trees." Each tree has several branches (details) stemming from a trunk (category).

The categories or trunks for this study were the different methods of data collection. Thus, there were trees for: (a) videotaped observations in the museum; (b) videotaped observations in the classroom; (c) prepared, formal interviews; (d) on-the-spot informal interviews; (e) questionnaires; (f) field notes; (g) documents; and (h) researcher's journal.

The first set of branches for each tree pertained to the different dates and times each occurred. For example, there were four branches stemming from the museum observation trunk, to sort data by the four field trips, and there were four branches stemming from the interview trunk to sort data by each set of interviews conducted.

The second set of branches for this data set pertained to the different participants. Each participant had his or her own "twig" stemming off of each "branch" stemming off each "trunk.

Interpreting Data

Using the tree diagram formation of the QSR NUD-IST program made it possible to interpret data in many different ways. Information obtained from observations were compared and triangulated with information obtained through interviews, questionnaires, field notes, and other methods. Each participant was viewed across time and across settings.

Trustworthiness

In a qualitative study, the issue of trustworthiness (whether the study is well-done and fair) is very important. In a more quantitative study, the concepts of internal validity, external validity, reliability and objectivity are discussed in respect to results of data collection and analysis. Lincoln and Guba (1985) point to the appropriateness of using different terms in a qualitative or naturalistic study. These terms are "credibility" instead of internal validity; "transferability" instead of external validity; "dependability" instead of reliability; and "confirmability" instead of objectivity (p. 219).

In this study, the degree of credibility was increased by prolonged engagement in the setting, persistent observation, triangulation of data, peer debriefing, negative case analysis, and member checks (Lincoln & Guba, 1985). In other words, the researcher collected data in the settings for a period of five months, rather than performing isolated spot checks, such a pretests and a post-test. The researcher observed the actions of participants the entire time they were in the settings. The researcher confirmed units of data by comparing and contrasting them with data collected by different means. For instance, data observed on a videotape of a setting could be used to reinforce or find anomalies in information gleaned from the interviews. As the researcher engages in formative data analysis, ideas and tentative conclusions were reviewed by the researcher's peers and advisory committee to minimize bias on the part of the researcher. As the study progresses, the researcher modified theories and expectations according to the information that was collected and analyzed. Finally, all information obtained during the study, especially in the interviews and questionnaires, was reviewed by the participants to ensure accuracy and to minimize misunderstandings of meaning.

To increase transferability in this study, the researcher obtained a thorough, thick description of the settings. These settings are unique and exact matches in other situations are unlikely if not impossible. However, transferability is more likely if the original setting is described carefully so that similarities among settings can be noted.

Lastly, to increase dependability and confirmability in this study, the researcher kept careful notes and logs of the details of the study. In the event of a misinterpretation of data, careful recording of these details could be used in what Lincoln and Guba (1985) call an inquiry audit. The researcher and peers could trace back to the information in question and review the circumstances that led to misinterpretation. Modification could then be made to restore dependability and confirmability that procedures were followed fairly and correctly.

Chapter Summary

This study employs a qualitative research approach. The research questions are investigated in two settings - the Ann Arbor Hands-On Museum and a third grade classroom in the Willow Run school district outside Ann Arbor. The study was designed as a case study of this classroom of third graders, their teachers, parents, and museum staff. Participants included twelve general education students (two of whom did not participate throughout the duration of the study), six special education students, the general education teacher, the special education teacher, two paraprofessionals, the mother of one special education student, and two Explainer Guides from the museum. The methods of data collection included videotaped observations in both settings, audiotaped interviews, written questionnaires, untaped on-the-spot interviews and conversations,and researcher field notes and log. Data analysis involved transcribing all video and audio tapes, and categorizing and analyzing data with some assistance from a data analysis software program called QSR NUD-IST.

Chapter Four: Results

Chapter Introduction

In this study, one third grade classroom attended four field trips to the Ann Arbor Hands-On Museum. In addition, they were visited in their classroom four different times by the researcher and completed interviews and questionnaires. Eighteen of the students in the classroom, including the six students with disabilities who were included part- to full-time, were official participants of the study.

The nature of the study was to examine the potential of the children's museum to enhance their classroom education experiences; to examine the potential of the museum to foster cognitive and social development; to examine the potential of the museum as a successful learning environment for students with learning disabilities; and to examine whether learning in the children's museum generalizes to the classroom setting. The nature of the study was not to compare the classroom setting to the children's museum setting, nor was it to compare the performance of general education students to that of special education students.

The results of the study are presented in two ways. First, findings for each individual student will be presented separately by the number printed on his or her assigned lab coat. Since all of the participating students demonstrated differences that merit reporting, each of them are presented here. The findings are based on videotaped observations of each student in both settings; information from student, teacher, museum staff, and parent interviews; information from student and teacher questionnaires; and researcher field notes. Second, general findings will be reported by research question. These findings are also based on videotaped observations in each setting; information from interviews and questionnaires; and researcher field notes.

The results are presented in this fashion to provide a "nested" presentation and analysis. Data is first presented by student so their individual differences in behavior and accomplishments could be determined. From there, data can be viewed across students to assess how many students made gains in which areas. Next, data can be viewed across time to determine which behaviors developed or diminished throughout the course of the study. Finally, data can be viewed across settings to determine the degree to which differences generalized from the museum to the classroom.

Individual Students

Lab Coat #1

The girl who wore lab coat #1 on the field trips to the museum is nine years old, African American and classified with a learning disability and emotional impairment. She reads at a first grade level. Her educational goals include continuing to develop her reading ability, developing counting and beginning addition and subtraction skills, identifying feelings, and resolving conflicts without aggressive behavior. She is a very talkative student who is always dressed neatly in the newest fashions with her hair done in rows of braids and beads.

There were two main differences in behavior over time regarding this student. The first was the degree of aggression demonstrated by the student. In the beginning of

the study, the student showed many signs of aggression toward peers in both settings:

Field Trip #1: She approached the Sand Pendulum exhibit where two other students were engaged. She joined them and soon began yelling loudly at them for interrupting her activity. She repeatedly stated she was there first and raised her hand as if to slap one student who would not give her the sand funnel. The other students quietly let her take the pieces of the exhibit from them and waited until she left to resume their activity.

Field Trip #1: A very similar situation occurred at the Circuit Table. This time, the special education teacher approached and, without having been present during the altercation, automatically deemed Lab Coat #1 to be at fault for starting the argument and instructed her to leave the other students alone.

Field Trip #1: This type of behavior happened again at the computer that was running the BusyTown software program. Here, she aggressively warded off all other interested students by raising her voice and telling them she would not move. They stopped asking for a turn and she spent the remainder of time on the fourth floor alone at the computer.

Other students seemed to avoid her. She consistently mentioned in interviews and questionnaires that she likes to

play with Lab Coat #6. However, Lab Coat #6 never mentioned preferring to play with Lab Coat #1, and the general education teacher mentioned a definite rivalry between the two.

At the beginning of the project, her place in the community was of a person whose peers let her have her way and cleared her a path, so to speak. However, rather than doing this out of respect, they seemed to do it out of fear or self-preservation. They preferred to let her have her way rather than bother with an argument or risk being reprimanded for getting into an altercation with her. To speculate on why this student felt the need to force her way into the community is not possible based on the information gathered in this study. It is possible, however, to see that the incident occurring on the third field trip had a positive effect on her demeanor, and subsequently her place in the community:

> Field Trip #3: The special education teacher and a paraprofessional praised the student profusely for her ability with the Busy Town computer program. Having had her expertise with this activity acknowledged, the student immediately became much less aggressive about maintaining her position at the computer as evidenced by the softer, quieter tone of her voice, her pleasant facial expression, and her actions. She was heard offering to teach Lab Coats #2 and #6 how to play the game.

She consistently mentioned in interviews and on questionnaires that she liked the Busy Town computer program and the dollhouse the best.

In the classroom, however, her aggression did not change significantly over time. She continued to be rude and demonstrative with peers, as evidenced by actions such as those descried in the following example. She came into the classroom, noticed that her chair was a few feet from her desk, and called out in a loud voice, "Who's been moving my chair? Nobody better be messing with my chair!" Incidents of this nature continued in the classroom setting throughout the duration of the project.

The second difference in behavior regarding the student who wore lab coat #1 is the decrease in the degree to which she was distracted by the video cameras. In the beginning of the study, the student was highly distracted by the cameras; more so than any other student:

> Field Trip #1: She spent six (6) of the nineteen (19) minutes of the time devoted to the second floor in front of the stationary video camera rather than interacting with exhibits or peers. She began by holding up objects and asking questions, such as, "What is this strange thing?" She continued by introducing students who walked by the camera. Next, she sang a song for the camera, and as the group left to change floors, she bowed to the camera, announcing, "Our show is done."

> Field Trip #1: During the other 13 minutes spent on the

second floor, Lab Coat #1 often placed herself in the view of the researcher's roaming camera and told the researcher to follow her as she related information and fabricated stories about various exhibits. Most often, the stories were not connected to museum exhibits or content. Once, however, the student began describing the contents of the antique dollhouse to the researcher and soon became engrossed with the display rather than the camera.

These behaviors of being preoccupied by the cameras were also seen in the classroom:

Classroom Visit #1: During an art activity, Lab Coat #1 did not complete her clay project. Instead, she spent most of the lesson time in front of the camera, putting the clay on her eyes, dancing around and jumping up and down. After several admonitions from the teacher, she was finally told by both the special education teacher and the researcher that she would have to leave the room if she would not stop playing near the camera. She discontinued dancing near the camera, but continued to wave at it from her seat for the remainder of the lesson time.

By the fourth museum and classroom visits, the student was rarely distracted by the camera. She often requested the researcher's attention, but most often it was to ask a question about an exhibit or share her school work, rather than to perform for the camera. Thus, differences in the museum, in some instances, carried over to the classroom setting. Being recognized for her cognitive abilities in the museum seemed to spark in her the realization that she could be recognized in the classroom for other than demonstrative behavior.

In summary, Lab Coat #1 became much less aggressive in the museum setting once she found an exhibit which she enjoyed and for which her expertise was recognized and respected by the community. Her aggressive behavior remained the same in the classroom setting. However, the student's diminished interest in the video cameras and her increased interest in exploring activities did generalize somewhat to the classroom setting.

Lab Coat #2

The student who wore lab coat #2 on the field trips is a nine-year-old, African American boy. He is still missing several front teeth, which helps account for his "baby face" look. He has two older adult siblings who enjoy buying him clothes. He is always well-dressed, and even his casual clothes are "trendy."

A difference in behavior over time regarding this student was the improvement in his interest in and focus on activities. This student was described by the general education teacher as being academically and socially immature. She felt that he did not take the time to put effort into his schoolwork and very little interested him in the classroom. She sat him alone in the very front of the class so he would not be distracted by the actions of other students. In interviews, the student also reported not being interested in school activities other than physical education and recess. He said he also liked math and reading but not that much. There seemed to be little in the classroom setting that motivated him, except for socializing with other students, which was why he sat alone in the front of the classroom, facing the blackboard. Basically, he was not easily engaged in academic activities. He was easily bored or satiated with activities before they were finished.

In the museum setting over time, he became engaged for longer periods of time than in the classroom, focusing on activities long enough to finish them, and finding enough exhibits to interest him:

> Field Trip #1: Lab Coat #2 began exploring on a very superficial level. He stopped only briefly at exhibits to push buttons or touch objects. He did not seem to read any labels or pursue the intended activities. He spent the most amount of time at simple, familiar, social exhibits such as the telephones.

However, satiation did occur in the museum setting as well. From the first to the second field trip, Lab Coat #2 became satiated with the telephones. They went from being his favorite to his least favorite exhibit:

Questionnaire #1: Q: What was your favorite thing?
A: I talked on the phones.
Q: Why was that your favorite

thing?

A: Because I talk to my best friends.

Questionnaire #2: Q: What was your least favorite thing?

A: The phones.

Q: Why was that your least favorite thing?

A: Because all you could do was talk.

Field Trip #2: Lab Coat #2 showed an interest in many of the light and optic exhibits. He spent more time at these exhibits pursuing the activities than at other exhibits in the museum. When asked about one such exhibit by the researcher, he read the label and explained the mechanism as an engine than runs on light. It was a simple yet accurate explanation of the exhibit.

In summary, Lab Coat #2 seemed to become more focused and exert more effort into activities over time in the museum setting. Although he satiated with exhibits quickly from one field trip to the next, there were enough activities in the museum to hold his interest for longer periods of time than in the classroom. This student seemed to need continuous novelty to remain motivated. The museum did provide more novelty than the classroom setting. However, his interest and focus on activities, albeit short-lived, did not generalize to the classroom setting.

Lab Coat #3

The student who wore lab coat #3 on the field trips is a nine-year-old, European American girl. She has long, blond hair and wears pink glasses. She speaks politely with a soft voice.

This student showed a significant preference for hands-on activities over pen-and-paper tasks typically assigned in the classroom. The general education teacher described her as having a need for more active, hands-on experiences. She said this student is often unfocused and off-task in the classroom. It is difficult to get her started on an assignment and even more difficult to get her to remain focused on the assignment. During classroom visits, the student was observed many times playing with her shoes or hair accessories, drawing pictures on her class work papers, unbending and rebending paper clips, or staring at the blank wall in front of her while others were busy working. Without hands-on stimulation, she would slip into what the teacher and Lab Coat #3's parents called the "Lab Coat #3 Zone." Apparently this occurred at home as well. Perhaps it is unfair to say she did not remain focused in the classroom, and it is more appropriate to say she did not remain focused on the task being presented by the teacher.

Experiences in the museum setting made a significant difference for Lab Coat #3. She thrived in this hands-on, active environment, focusing intently on each activity she tried and seeing each through to the end. She was diligent and determined and did not lose her concentration or

attention span as she did with academic activities in the classroom. She approached exhibits systematically, one by one, read the directions, performed the activities until they were completed, and moved to the next one. Often, it was time to change floors before she had completed very many exhibits. She remained focused during the whole of each visit, and visited new exhibits each time:

> Field Trip #1: Lab Coat #3 spent seven (7) minutes and twenty (20) seconds out of the ten (10) minutes devoted to the third floor interacting with the Lens Table Exhibit. This exhibit consists of several large lenses, a holder for the lenses in front of a light source, and an adjustable screen. When a lens is placed in the holder, the screen must be adjusted so the image shown through the lens can be focused on the screen. The student systematically positioned each and every lens in the holder, precisely adjusting the screen each time to view the image in focus.

With each subsequent visit, she would become more deeply engaged with each exhibit she visited, repeating the activity several times or experimenting with variations not outlined in the instructions. In the last interview, she was able to recount several exhibits, their purposes, and the activities she performed with them.

In summary, the museum setting was very conducive to Lab Coat #3's preferred learning style. She is an active, tactile learner who needs active, hands-on activities to keep her on task. In the classroom, her behavior remained the same. When not actively engaged in a hands-on activity, she did not remain on task.

Lab Coat #4

The boy who wore lab coat #4 on the field trips is nine years old, African American, and classified with a learning disability. He reads at a second grade level. His educational goals include continuing his reading ability to reach grade level performance, writing in cursive, and improving his spelling ability. He has a big smile, and is very pleasant and polite. He often volunteers to help when needed. He helped me carry things several times, and everyday he escorts another student to the nurse for medication.

In many ways in the classroom, Lab Coat #4 is already a successful student. His teachers described him as hard-working, well-behaved, well-liked and friendly. He finds interest in many class and school activities. He enjoys learning new things and helping others learn when he can. However, difficulties associated with his learning disability keep him from progressing on schedule. One difficulty he has is the lack of ability to monitor his own work. In the classroom, he relies heavily on his teachers to determine when he is correct and when he is finished. This seems to be reinforced by an environment where most assignments have one correct answer contained in the "teacher's answer key."

One important difference in behavior regarding this student was the improvement he made in attempting to solve problems on his own. In the museum setting, this student

used a trial-and-error approach to many of the exhibits to solve problems and see them through to the end. He did not have to rely on the teacher to tell him if it was correct or not. This he determined on his own by observing the exhibits:

> Field Trip #3: Lab Coat #4 was interacting with the Ping Pong Maze exhibit with another student. This exhibits consists of a foam pad cut with diagonal and vertical slots and affixed to a wall. The object is to place flat wooden blocks into the slots to form a maze for the ping pong ball to fall through from top to bottom. At first, Lab Coat #4 began putting pieces in randomly. After a while, as the other student expressed his desire to modify the maze to manipulate the path of the ball, Lab Coat #4 began placing pieces in the foam, dropping the ball, and adjusting pieces when the ball did not do as they predicted. He did not seem to plan in advance how the pieces should be placed in order for the ball to fall certain ways. Rather, he used trial-and-error adjustments until the ball did as they predicted. The other student continually praised Lab Coat #4 for his efforts and solutions. Once he declared, "[#4], you're a genius! A genius!"

Another difference in behavior regarding this student was his ability to understand exhibits better by talking them through:

Field Trip #3: Lab Coat #3 was interacting with the Turbulent Orb exhibit that he was using. This exhibit consists of a clear glass ball filled with blue water and placed on a spinning platform. The concept depicted is that of momentum of water. When the ball is spun, the water forms a whirlpool that continues to move even after the ball stops. The exchange between the student and researcher follows:

Researcher: What is that [exhibit] doing?

Lab Coat #4: (Shrugs shoulders, then watches it again). Spinning. When I stop it, the water inside keeps spinning.

Researcher: Why do you think the water keeps spinning inside?

Lab Coat #4: It can't stop as easily.

In summary, Lab Coat #4 was able to make use of the hands-on and visual characteristics of exhibits to help him solve problems at his present ability level. His questions of, "Did I do it right?" in the classroom were replaced by exclamations of, "I did it!" in the museum. The needs of this student include freedom from one-correct-answer activities and access to many-correct-answers experiences. The actions of the exhibits themselves told him if he was correct or not. He did not need the feedback of a teacher. Also, this student used the visual aspects of exhibits, describing what he saw, to verbalize his understanding of their purpose and concepts.

Lab Coat #5

The student who wore lab coat #5 on the field trips is a nine-year-old, European American girl. She is very small and thin. She has wispy, blond hair and pale skin. She is quiet and shy. She hardly speaks, and when she does, her voice is barely audible.

This student started out with behaviors that were the opposite of those described for Lab Coat #3. Unlike Lab Coat #3, Lab Coat #5 is very focused and diligent in the classroom. She follows directions to the letter, completing each assignment thoroughly and correctly before moving on to the next. She follows classroom routine and instructions for assignments to the letter. She rarely talks to other students during work time unless it is to answer questions they have asked her about assignments or instructions. During direct group instruction, her focus is on the teacher and on her work. She works carefully and checks her work before moving on to the next assignment. Once, when the researcher volunteered to help check math papers, Lab Coat #5 was the first one finished with every answer correct. When the researcher congratulated her on having it all right, she replied that she thought it would be right because she checked it carefully. During an art activity with clay, she watched and listened to the demonstration carefully, then perfectly replicated the object made by the teacher. Many of the other students went to her for help, asking her how she did it. She replied that she followed exactly what the teacher had done.

In contrast, her behavior in the museum on the first field trip was very unfocused. She exhibited a great deal of "button-pushing" behavior. She approached exhibits, quickly pushed any buttons or pulled any levers, and then moved on. Without specific directions on what to do and in which order, she seemed to lose her organizational skills and thoroughness. There seemed to be very little in the museum to interest her or keep her on-task for as long periods of time as in the classroom.

On subsequent field trips, following encouragement from the general education teacher to carefully read the labels affixed to each exhibit, Lab Coat #5 became more focused in the museum setting over time. She moved more purposely from exhibit to exhibit, reading the instructions and attempting the activity. She did not always follow through to the end, but she seemed to find more activities to hold her interest from one field trip to the next. However, it still took her a while to choose an exhibit in the first place. This is the opposite sort of behavior seen in the classroom where she always settled down to work immediately.

In summary, this student possesses a very different learning style than students like Lab Coat #3. Her preferred style was supported only to a small extent by the museum setting. Certain elements such as the instructional labels provided her with the detailed guidance she needed to focus her efforts. However, this individual also needs a structured agenda in order to continue to focus in this setting as she does in the classroom setting. For this student, it seems there was too much freedom and too much choice in the museum setting. It might be good practice for her to be able to make her own decisions about her activities and goals, but she would need to have this scaffolded gradually.

Lab Coat #6

The student who wore lab coat #6 is a nine-year-old, African American girl. She is thin, with short hair that she wears pulled into a tiny bun. She is very warm and friendly, and often held my hand while she talked to me.

The main difference in behavior regarding this student was social in nature. In both settings, this student was very involved with a small group of girl friends. This clique consisted of Lab Coats #6, #10, #11, and two other girls in the class. She was often reprimanded in class for talking to them and not paying attention to lessons or assignments. This student seemed more interested in social activities with the four other girls than on activities occurring in the classroom. In interviews, she consistently named these girls as those she prefers to work and play with in both settings. The general education teacher mentioned that if she wasn't always so wrapped up in what the other girls were doing, wearing, talking about, etc., she would be a much better student. She is very bright, but her priorities lay with keeping up with the "gaggle of girls," as it was familiarly called, rather than keeping up with her school work.

At first, this behavior was also seen in the museum setting. On the first and second field trips, Lab Coat #6 was always with at least one of her friends. Many times they would stay at an exhibit for a long time talking or playing,

but not necessarily interacting with the exhibit:

> Field Trip #1: Lab Coats #6, #10, and #11, and one other girl spent several minutes at the chalkboard with the drafting tools (T-square, stencils, angle measures), talking and giggling. They were not using the tools but were drawing pictures and writing their names on the chalkboard.

When she did interact with exhibits for their intended purpose, she chose those that required another person:

> Field Trip #2: Lab Coat #6 spent several minutes at the Whisper Dishes with Lab Coat #11, reading the instructions to her in a whisper across the room.

This behavior began to change on the third and fourth field trips when Lab Coat #6 began to venture away from the group of friends and explore exhibits on her own. At times, she separated herself from her friends altogether:

> Field Trip #4: At the special Brain Exhibition, she was interacting with a sound memory exhibit that plays a series of tones and the visitor must replicate them on a xylophone-type instrument. She was concentrating on this exhibit, trying to master all of the tone sequences. When one of the friends called her over to another exhibit, she did not seem to hear.

In summary, Lab Coat #6 became much more socially independent in the museum setting over the course of the project. She stopped interacting solely within the same group of girls and ventured off to explore on her own or with other classmates, finding many different exhibits of interest to her. However, no significant differences in her social behavior were noted in the classroom setting. It is difficult to determine why she felt comfortable enough to leave the group of friends and pursue activities on her own. Perhaps her interest in the exhibits was more powerful than her interest in the actions of the group. Perhaps the freedom to interact socially in the museum lessened her need to be in contact with the group at every possible moment. Knowing that she could meet up with them and talk or play at any time made the act of actually doing so less coveted.

Lab Coat #7

The student who wore lab coat #7 is an eight-year-old, European American boy. He is the youngest student in the class by nearly a year. He has dark hair, wears glasses, and speaks extremely clearly, articulating every syllable.

This student was not a participant for the duration of the project. He was promoted to fourth grade following winter recess on January 6, 1997. Before leaving the project, he attended two field trips, completed two interviews and two questionnaires. One of the most profound differences in behavior regarding this student was the degree to which he worked cooperatively with other students at the museum as compared to the classroom. The general education teacher remarked several times that she never saw him work

with anyone else in the classroom due to his high academic level. He was by far the most advanced student in her class, receiving college-level math and science tutoring from University of Michigan engineering students. In the classroom, he always chose to work alone, completing assignments and projects his way.

At the museum, even as early as the first field trip, differences were observed:

> Field Trip #1: Lab Coat #7 was heard calling to many other students to come use exhibits with him and complete activities with him. He spent several minutes at the Ping Pong Maze with Lab Coat #2, creating a maze. He seemed to be the leader of the activity, but respectfully considered the other student's ideas and contributions. This is behavior that was much different than that he exhibited in the classroom.

In summary, Lab Coat #7 already had a good command of complex science concepts. The museum still had a lot to offer him, providing a setting for him to further his knowledge as well as to develop his cooperative learning skills. The exhibits in the museum were challenging and interesting to Lab Coat #7. The excitement that he felt for the experience was a common thread he held with his peers, providing him with the opportunity an desire to work and play alongside them. Whether or not this carried over to the classroom setting was not able to be seen as he left the classroom after the second field trip and before the second classroom visit.

Lab Coat #8

The student who wore lab coat #8 is a nine-year-old, African American boy. He is neat, well-dressed, and soft-spoken. He is pleasant and friendly, with a bashful smile that is almost always on his face.

This student did not demonstrate a significant difference in behavior over time. He had already exhibited many of the same behaviors in both settings from the beginning of the project. Lab Coat #8 is a diligent and eager-to-please student, following directions and consistently completing assignments whether he particularly enjoys them or not. In the museum, he found many exhibits that interested him and interacted with them diligently and systematically. Over the course of the project, he became more and more independent in completing the activities, setting higher goals as he achieved previous ones.

Lab Coat #8 completed many activities with the guidance of adults as well as on his own. Eventually, he taught peers how to complete some of these activities:

> Field Trip #1: When Lab Coat #8 first interacted with the Tennis Balls in a Cube exhibit (see Figure 6), he received a great deal of guidance from an Explainer Guide in order to solve this puzzle.
>
> Field Trip #2: He attempted the Tennis Balls in a Cube exhibit on his own at first, but needed guidance from one of the paraprofessionals to finish it successfully.

Field Trip #3: He was able to complete the puzzle on his own, using the written instructions and not an adult's help to finish it successfully. Later, he demonstrated the puzzle to a peer without using any prompts at all.

Questionnaire #1: He reported asking an Explainer Guide for help.

Questionnaires #2, #3, #4: He reported receiving no help.

Over the course of the project, he began to study the exhibits and their labels repeatedly on his own to arrive at the intended conclusion:

Field Trip #3: The Little Magnet exhibit consists of a chain affixed to a table with a magnet positioned overhead. The chain is not quite long enough to reach the magnet, but the force of the magnet is strong enough to hold the chain in a vertical position. Lab Coat #8 spent several minutes interacting with the Little Magnet Exhibit with no prompting or instruction. Finally, he discovered how to get the chain to reach upward without touching the magnet. He turned to the researcher and declared, "Look! There's air here. It's not touching." When the researcher asked how it was able to do that, he replied, "Because the magnet pulls it up here like this."

In summary, Lab Coat #8 was an independent learner in both settings. It is not possible to conclude that this independence was a result from his exposure to the museum setting, because he displayed the skill since the first classroom visit. However, it is possible to say that the exhibits in the museum reinforced his independence and provided him with many areas of interest.

Lab Coat #9

The boy who wore lab coat #9 is nine years old, European American, and classified with physical and other health impairments and educable mental impairment. He reads at the pre-first grade or primer level. His educational goals include continuing to improve his reading ability, completing simple addition problems, and identifying place value in mathematics. He is small and frail with blond hair and very pale skin. He walks slowly and sometimes unsteadily. He always wears his Buzz Lightyear cartoon character watch.

Of all the participating students, this student showed the most marked difference in his behavior between the classroom and museum settings. In the classroom, it was often observed and repeatedly reported by teachers and his mother that he "shut down" when it came to doing some assignments. When this happened, he put his head on the desk and refused to look up or participate in the activity. He did this more often with new or unfamiliar activities, but also with routine assignments. He was described by teachers, paraprofessionals, and his mother as being withdrawn on other field trips, with a tendency to hide behind his mother or a paraprofessional. In a conversation with his mother, she stated that he does not like to try anything new unless heavily prompted and assisted. She also mentioned that he is physically unsteady on his feet and does not like to run or climb. Teachers and Mother all predicted that the busy, open atmosphere of the museum would cause him to withdraw and hide behind the paraprofessional who works most closely with him in the classroom.

His mother was wary about attending field trips even if her work schedule allowed because she thought he would spend the whole time hiding behind her. In one note to the researcher, she wrote, "The only reason I don't want to attend this trip is because [#9] won't do what you need him to do if I'm there. It's not that I don't want to participate, it's just that I know my child. [#9]'s performance is greatly different when I'm around." She reported that her presence on other field trips caused him to withdraw from any activities and interaction with others. On their weekly bowling trips, he had just begun to feel comfortable participating when she attended a trip. He then stopped participating again until he felt comfortable with the activity in his mother's presence.

This predicted behavior was not seen in the museum, however. As early as the first field trip, Lab Coat #9 ventured off on his own, looking and touching many of the exhibits. He was rarely seen in the company of the paraprofessional, let alone hiding behind her. Not once was he observed refusing to participate. By the end of the first field trip, he had found a couple of exhibits that were very interesting to him, such as the hot air balloon, as evidenced by his returning to them frequently throughout each field trip.

The hot air balloon is suspended over a table in a corner of the second floor. On the table are two toasters which can be activated by pushing a single button. The heat emitted from the toasters fills the balloon with warm air and causes it to rise along a wire to the ceiling several feet above the table. After about a minute without any heat from the toasters, the balloon returns to the table from the ceiling.

Field Trip #1: Lab Coat #9 spent a lot of time trying this exhibit as well as watching it from about six feet away while the others tried it.

Field Trip #2: Lab Coat #9 went to this exhibit first, spending several minutes at it, making the balloon rise and fall many times over.

Field Trip #3: He began experimenting with the balloon, keeping the toasters on even after the balloon had risen to see how long it would stay up, or letting go of the button just before the balloon rose to see if he could give it just enough (and not a bit more) heat that it needed to rise.

Another observation regarding this student was the degree to which his assertiveness increased over time:

Field Trip #1: If another student approached an exhibit that Lab Coat #9 was using, Lab Coat #9 would immediately back away without a word and let the other student move in. Sometimes he would stay to watch from a few feet away, but most often he would leave the area entirely. Also, if other students were gathered around an exhibit, he would watch from a few feet away and approach the exhibit only when no other children were present.

Field Trip #2: A student approached Lab Coat #9 at the hot air balloon and tried to reach in and push the button. Lab Coat #9 pushed the student's hand away gently and told him it was not his turn yet. This same progression of assertiveness on Lab Coat #9's part was observed at other exhibits. He was also observed approaching exhibits occupied by several children and waiting among them for a turn.

Field Trip #3: Lab Coat #9 was observed interacting with others at the hot air balloon. He was showing Lab Coat #3 how to let go of the button just before the balloon rose to see if it had just the right amount of heat to rise.

Field Trip #4: He demonstrated all of his favorite exhibits for his mother. He reported this to the researcher in the third interview.

Finally, by the third field trip, Lab Coat #9 was seen running and even skipping from exhibit to exhibit, trying almost everything on his own without prompting or assistance. He was even observed climbing the ladder to the Whisper Dish to whisper with another student across the room. These are all behaviors that the teachers and his mother predicted they would never see him do in the museum setting. During interviews and conversations, they all reported their surprise and excitement over his unpredicted behavior. The special education teacher was "amazed," the general education teacher said she couldn't say enough great things about his progress in the museum, and his mother said she learned something about his interests and abilities that she never knew before.

In summary, Lab Coat #9 responded positively to the museum setting, feeling comfortable enough to try new activities and venture off on his own without prompts or assistance. His assertiveness increased to the point where he no longer relinquished his turn to avoid interacting with peers. He found many exhibits to interest him rather than refusing all activities offered him, and his immediate caregivers learned new things about his behavior and interests.

<u>Lab Coat #10</u>

The student who wore lab coat #10 is a nine-year-old, Hispanic American girl. She is very proud of her ethnicity and often told me stories about her family, such as their names and what they mean in Spanish. She does not speak Spanish fluently but knows some words. She is tall for her age, thin and wears wire-rimmed glasses.

This student showed some of the same social differences between settings as did Lab Coat #6, but only to a small degree. Lab Coat #10 is also closely tied to the small group of girl friends that includes Lab Coat #6 and Lab Coat #11. In the classroom, she tries hard, but is often distracted by what is happening socially within her group of friends.

In the museum, she stayed with at least one of the friends on all four field trips. She spent most of the time at exhibits that required a partner, such as the Whisper Dishes, the Whisper Tube, or the Delayed Speech Exhibit. On rare occasions, she ventured off on her own, but not for very long. One time, on the fourth field trip, she joined the general education teacher in the Discovery Room to look for coral and sea shells that they were studying in the classroom. Before long, she left in search of one of her friends to join her. The types of questions she asked about exhibits became slightly more sophisticated and the amount of time spent at each exhibit increased slightly, but not significantly so.

In summary, Lab Coat #10 exhibited few differences across field trips. She came to explore a couple of exhibits on her own (e.g. the Discovery Room exhibits), but for the most part, remained with her group of friends, doing what they did.

Lab Coat #11

The student who wore lab coat #11 is a nine-year-old African American girl. She has a round face with big round eyes and has a shy smile that she tries to hide. She always dresses in blue jeans or sweat pants, tee shirts and hiking boots. She wears her hair in rows of short braids, sometimes with beads.

This student demonstrated minimal differences over time. She was also closely involved with the group of girl friends including Lab Coats #6 and #10. However, Lab Coat #11 seemed to be the most independent of the group members in both settings. In the museum setting, she began venturing out on her own, pursuing her own individual interests as early as the first field trip. She was often observed alone at the musical exhibits, such as the Pipes of Pan and the Organ-Piano.

In interviews, Lab Coat #11 often reported that school was boring and that not very many activities interested her. However, she reported the museum as being "cool," "fresh," and "fun." She said some of the exhibits were boring, but she didn't do those ones. She also stated in one interview that the museum was different for her because she liked to read the exhibit labels but did not like to read books in school.

In summary, the museum setting provided activities that captured Lab Coat #11's attention, whereas she reported during interviews as often being "bored" in school.

Lab Coat #12

The boy who wore lab coat #12 is ten years old, European American and classified as having trainable mental impairment. He is a non-reader. His educational goals include recognition of self-help sight words (e.g. Stop, Men, Danger), number and letter recognition. He is the tallest boy in the class with black hair and bright eyes. He often wears football jerseys or tee shirts with football team logos on them. He does not smile very often, but is always pleasant.

This student is very low functioning academically in the classroom. He needs one-on-one assistance by a paraprofessional for nearly all of his assignments. A non-reader and non-writer, he completes all writing tasks by tracing words that the teacher has written for him. He talked most about a few, familiar subjects that highly interest him. These include football, natural disasters such as tornadoes and earthquakes, and animals that bite. He seemed to be more concerned with activities that were going to happen next, rather than ones that were occurring at the time. He was often heard asking questions such as "What are we going to do next?", "When is lunch?", and "Are we going to gym today?"

In the museum, Lab Coat #12 engaged in a great deal of "button-pushing behavior" across all four field trips. For the most part, he wandered around watching what others were doing, sometimes touching the exhibits, but not manipulating them purposefully. On two occasions he interacted with exhibits in ways that mimicked what he had just seen other

students do:

Field Trip #1: After one student had solved the Tennis Balls in a Cube exhibit, Lab Coat #12 approached the box of balls, emptied it and piled all the balls on top of the box.

Field Trip #2: After he was seen watching two students use the Whisper Dishes, he climbed the ladder to one dish, asked "Can you hear me?," and climbed back down. There was no one using the exhibit with him.

Exhibits in which he showed the most interest were the special bat exhibit, the aquaria of fish, the beehives, and the tarantula in the Discovery Room:

Field Trip #2: He was very interested to know which of the fish bit and which ones did not. He asked the researcher about each individual fish.

During interviews, he was able to recall the computers and the animals that could potentially bite (the bats, the fish, the tarantula, and the bees). His interactions and questions did not become increasingly more sophisticated over time; rather they were sporadic. He asked questions in the Discovery Room on the first and second field trips but was not observed asking questions on subsequent field trips:

Teacher Interview #3: The general education teacher

said, "like [#12], [it's great] for him to get in there and get his hands on things. I'm not sure how much he understands, but it gives him another opportunity to experience things firsthand."

In summary, although no significant differences were seen with Lab Coat #12, the museum setting did offer him increased opportunities to build on his existing knowledge and interests. One point made by the general education teacher was very important. A student at this academic level needs a lot of exposure to new things in order for it to become familiar and understandable. Although he may have not fully understood many of the activities in the museum, the repeated exposure made them more familiar, a step toward better understanding and learning. The activities in the museum, added to the daily activities of the classroom, enhanced his overall learning experience. This is certainly true for all of the students, but it seems most valuable for this particular student.

It also gave him a chance to interact socially with peers, an area that the special education teacher reported as needing more work. Even though his cognitive functioning is very low in relation to his peers, there were exhibits at the museum with which he could associate and understand at his present level.

Lab Coat #13

The boy who wore lab coat #13 is ten years old, African American, and classified with a learning disability. He reads on grade level. His educational goals include improving his reading comprehension skills and decoding unfamiliar words. He is tall and wears his hair shaved very short. He is warm and friendly with a loud, deep voice.

The most significant difference in behavior regarding this student was the difference in the amount of time he spent focused on each activity. One of the main concerns the general education teacher expressed having for this student was that he rushes through his class assignments too quickly to really focus on what he is doing or to do them correctly. He is included full-time in her classroom this year, following approximately two years of part-time inclusion. She is pleased with the academic and social progress he has made with the exception of his habit of working too hurriedly. During one classroom visit, the students were completing an assignment on subtraction with three and four digit numbers. The teacher noted that when she sat next to Lab Coat #13, he would carefully follow the steps necessary to arrive at the correct answers. However, as soon as she left to tend to other students, he would begin to rush and skip steps, resulting in incorrect answers every time. Sometimes, when the teacher was not near, he was heard telling other students which number he was on and asking where they were, as if completing the assignment was a race. Even if the other students did not accept his "challenge" to race through the assignment, he would race through on his own.

In the museum, this student took some time deciding which exhibits interested him, but once there, he interacted carefully and purposefully. Two examples of this are his interactions with the Delayed Speech Exhibit and the Sand Pendulum. The Delayed Speech Exhibit is an audio unit with two sets of headphones and one microphone. When one person speaks into the microphone, the speech is delayed one quarter of a second and replayed over the two sets of headphones, causing an echo effect.

> Field Trip #2: Lab Coat #13 spent most of the time devoted to the first floor at this exhibit. He called other students over so he could demonstrate the echo effect for them. He organized the students so that each one could have a turn creating and listening to the echo.

The Sand Pendulum consists of a funnel at the end of a chain, suspended from the ceiling over a table top. When the funnel is filled with sand and let loose to sway back and forth over the table top, a design of sand is made on the table depicting the path of the pendulum.

> Field Trip #1: Lab Coat #13 contributed to the process by helping other students gather sand from the table top to refill the funnel. After one try, he left the exhibit.

> Field Trip #2: Lab Coat #13 completed the whole process on his own. However, instead of letting the pendulum sway on its own, he pushed it back and forth across the area. When the design appeared differently from the one

he made with his classmates, he left the exhibit.

Field Trip #3: He patiently tried the exhibit more than once, finally realizing that the desired effect results from letting the pendulum swing on its own.

In summary, certain exhibits at the museum provided Lab Coat #13 with the opportunity to improve the length and quality of attention spent on activities over time. At first, he seemed to rush around, trying to take in everything at once. However, as soon as the end of the first field trip, he had chosen exhibits of interest to him and was attempting to perform the steps of the activity carefully. Perhaps, since all the other students were doing different things, it was not possible for him to compete with them. Also, since there is not one correct answer for interacting with an exhibit, he could feel successful for completing a new activity rather than for being the first one to finish. However, no significant change was seen in the classroom setting where he continued to be rushed and unfocused in his work.

<u>Lab Coat #14</u>

The student who wore lab coat #4 is a nine-year-old, European American boy. He has light brown hair and braces. He is quiet and shy, but pleasant.

The differences seen in this student were social in nature. In the classroom, this student was a self-reported and teacher-reported "loner". He chose to work and play alone and did not identify any of the students in the class

as friends.

On the first field trip, this solitary behavior was also seen at them museum. He explored and interacted with exhibits on his own, not talking to peers. Over the course of the next three field trips, he became increasingly more interactive with peers. He was heard several times calling a classmate over to an exhibit to use it with him. Other students were also heard calling him over to exhibits. On the second field trip, he was welcomed by a group of boys using the Ping Pong Maze, and on the third field trip by a student trying the Cantenary Arch. This difference did carry over into the classroom where he began working with other students and was sometimes reprimanded for talking to peers during lessons.

In summary, Lab Coat #14 became more socially interactive with peers over the course of the project. He went from being a loner to making friends in both settings.

<u>Lab Coat #15</u>

The student who wore lab coat #15 is a nine-year-old, African American boy. He is very outgoing and talkative with a broad, inviting smile. He is proud of his work when he does well in school and told me time and again how many A's and B's he received on his school report cards.

This student exhibited some of the same difficulties in the classroom as Lab Coat #13. He was easily distracted and attacked assignments with no real sense of organization as reported by the general education teacher during interviews and informal conversations. She described him as very "scattered." During the second teacher interview, she stated that her goal for him was to get him to slow down and concentrate more on what he is doing.

In the museum, Lab Coat #15 exhibited this "scattered" type of behavior:

> Field Trip #1: He spent only a few seconds at each exhibit, visited exhibits in random order, and often stopped abruptly in the middle of an activity to move to another exhibit. One example is his interaction with the air conditioning exhibit in The Testing Zone on the second floor. This exhibit consists of a hair dryer wired to a thermostat. When a student pushes the button, the hair dryer activates and warms the thermostat. When the temperature reaches a certain degree, the hair dryer automatically shuts off until the temperature falls again. The whole process takes two or three minutes to complete. On the first field trip, Lab Coat #15 approached this exhibit, pushed the button to activate the hair dryer and waited less than half a minute, looking over his shoulder all the while at other students and exhibits. Without looking back at the air conditioning exhibit to see if there had been a change, he left to go to the Whisper Dishes.

On subsequent field trips, his attention to individual exhibits increased. He would often remain at one exhibit until he had completed the activity from beginning to end at least two times before moving on.

The way in which he described exhibits and what they demonstrated also became more organized and thoughtful. When asked on the first field trip how the handcrank-generated train engine worked, he explained that it moved when you do this (turn the handle). Later, he explained that turning the crank gave the train engine power enough to move around the track. When asked about the Spectra exhibit on the first field trip, he replied, "It's kind of a scientist thing." Later, his explanation described how the lights were different colors because they were different kinds of lights. Actually, each light is lit by a different gaseous element (neon, argon, etc.) which glows a different color and reveals a different spectrum when viewed behind a special glass plate.

> Teacher Interview #3: The general education teacher stated: [#15] you should be really impressed with, because most of the time he is so scattered. He is just in pieces all over the place. He doesn't slow down. He's one of these fast kind of kids. He tackles something, and instead of doing one thing at a time, he'll just jump in, jump in the middle, jump in at the end. There's no pattern. But I was sitting next to him on the bus on the way home and he was able to tell me all about the parts of the brain and if you hurt this part of your body it could really effect you for the rest of your life. I was really impressed by that. Then we got to talking about more.

In summary, Lab Coat #15 became more organized and purposeful in his actions and verbal descriptions of exhibits and activities. By the fourth interview he was most able of all students to clearly describe what he did in the museum.

Lab Coat #16

The girl who wore lab coat #16 is nine years old, European American, and classified with educable mental impairment and speech and language impairment. She reads at a first grade level. Her educational goals include continuing to improve her reading and spelling ability, to regroup addition problems and identify place value in mathematics. She is chubby, with light brown hair and bright blue eyes. She rarely smiled at first, but was always looking around at others and what they were doing.

At the beginning of the project, this student was very dependent in the classroom. She did not take any initiative on her own to complete assignments. She waited until given instructions. Also, she did not always ask for help when needed, but would sit quietly until a teacher or paraprofessional noticed she was not working and offered her help. She interacted with others when they approached her, but did not initiate interaction herself. In the second teacher interview, the general education teacher expressed concern for this student, because her family had moved and she had changed schools several times in recent years. The teacher described her as needing consistency and needing encouragement to participate.

This was also seen in the museum setting:

Field Trip #1: Lab Coat #16 did not interact verbally with adults or peers. She spent most of the time watching others and occasionally touching the exhibits. She did not participate in activities with other students. Once, she built the Cantenary Arch with an Explainer Guide after he encouraged her to try the activity and remained with her to guide her actions.

The general education teacher noted that she wanted to focus on this student and be sure to encourage her to participate and explore. Over time, the student did become more involved with the exhibits. She started trying things without prompting and asking questions about the activities:

> Field Trips #2 and #3: Lab coat #16 began to approach and interact with exhibits on her own without an adult telling what to do next. However, she rarely engaged in activities with peers.

> Field Trip #4: She began to ask questions about the exhibits that interested her. On the third floor, where the light and optic exhibits are located, she went to each one in turn and asked questions of the researcher. Since she is a very low reader, she asked the researcher to read the labels to her while she tried the steps of the activities.

To some extent, this behavior carried over to the classroom setting. She asked more questions and began to request help when needed. She was still quiet, but smiled

more often and invested more effort into assignments.

In summary, Lab Coat #16 began to engage in more social interactions and take more initiative in participating with exhibits and classroom activities over the course of the project. Whereas she needed much prodding and encouragement to try activities at the beginning of the project, she was actively engaging in activities on her own accord by the end.

Lab Coat #17

The student who wore lab coat #17 is a nine-year-old, European American boy. He has a large build for a boy his age. He often wore football jerseys and resembled a miniature football player. He is very pleasant and friendly.

This student did not demonstrate any significant differences in behavior or performance over the course of the field trips. However, the museum did offer him many opportunities to explore phenomena with which he showed interest. The general education teacher described this student as a little distracted, and as the type of student who likes to fiddle with objects and collect paraphernalia. In the interviews, he talked about the many different things there were to do and see at them museum. He stated that he liked wearing the lab coat in the museum and at home so he could pick things up off the ground and put them in his pockets.

In summary, Lab Coat #17 did not demonstrate any differences in behavior over time or across settings. Nonetheless, the museum did provide him with opportunities to pursue his individual interests.

Lab Coat #18

The student who wore lab coat #18 entered the project just in time for the third field trip. In fact, he returned his signed consent form that very morning. On the third and fourth field trips, he was observed engaging primarily in "button-pushing behavior." The amount of data collected regarding this student was minimal. From the data obtained, no significant differences could be established from the third to the fourth field trip.

Summary of Results for the Individual Students

Table 2 shows a display of the types of differences seen over time with each student and indicates whether or not the differences were seen across settings. It does not include Lab Coats #7 or #18. Each student is noted for the area in which they showed the most behavior. Some of the students showed differences to equal degrees in more than one area.

Table 2: Display of Results for Students

Lab Coat # (*Spec. Ed.)	Differences Demonstrated Over Time	Corresponding Research Factor	Type of Difference
1*	• Decreased aggression in museum. • Increased interest in both settings.	• Learning Community • Responsive Instruction; Meaningful Activities	• Social • Cognitive
2	• Increased interest in museum. • Increased engagement in museum.	• Responsive Instruction; Meaningful Activities • Self-Regulation	• Cognitive • Cognitive
3	• Increased engagement in museum. • Increased systematic investigation in mus.	• Self-Regulation • Learning Skills	• Cognitive • Cognitive
4*	• Increased problem-solving in museum. • Increased control over learning in museum.	• Learning Skills • Self-Regulation	• Cognitive • Cognitive
5	• Slightly increased engagement in museum.	• Self-regulation	• Cognitive
6	• Increased independence from peers in mus.	• Learning Community	• Social
8	• Increased interest in museum. • Increased ability with exhibits in museum.	• Responsive Instruction; Meaningful Activities • Learning Skills; Scaffolding; Responsive Instruction	• Cognitive • Cognitive
9*	• Increased assertiveness in museum. • Increased ability with exhibits in museum.	• Learning Community • Learning Skills; Scaffolding; Responsive Instruction	• Social • Cognitive
10	• Slightly increased independence from peers in museum.	• Learning Community	• Social
11	• Slightly increased interest in museum.	• Responsive Instruction; Meaningful Activities	• Cognitive
12*	• Increased hands-on experiences in museum.	• Responsive Instruction	• Cognitive
13*	• Increased systematic investigation in mus. • Increased role as "expert" in museum.	• Learning Skills • Learning Community	• Cognitive • Social
14	• Increased relationships with peers in both settings.	• Learning Community	• Social
15	• Increased systematic investigation in mus. • Increased discussion of learning.	• Learning Skills • Dialogue	• Cognitive • Social
16*	• Increased relationships in both settings. • Increased interest in both settings. • Increased engagement in both settings. • Increased question-asking in both settings.	• Learning Community • Responsive Instruction; Meaningful Activities • Self-regulation • Learning Skills; Dialogue	• Social • Cognitive • Cognitive • Cognitive Social
17	• Reinforcement of interests in museum.	• Responsive Instruction; Meaningful Activities	• Cognitive
All of the students showed some type of difference, albeit to various degrees.	Scaffolding....................13% of all students; 50% of these were special education students. Meaningful Activities......38% of all students; 33% of these were special education students. Self-Regulation.............31% of all students; 40% of these were special education students. Responsive Instruction.....50% of all students; 50% of these were special education students. Learning Skills...............44% of all students; 57% of these were special education students. Dialogue.......................13% of all students; 50% of these were special education students. Learning Community......44% of all students; 57% of these were special education students. Parental Involvement.......None of the students had the opportunity to demonstrate differences in interactions with parents over time, although #9 demonstrated differences across settings. He was more readily comfortable with his mother present in the museum. Play.............................All of the students engaged in play during all four of the field trips to the museum; although few opportunities for play were observed in the classroom setting.		81% of students showed cognitive differences. 46% of them were special education students. 50% of students showed social differences. 50% of them were special education students. 38% of students showed both types of differences. 80% of them were special education students.

Several points can be made regarding Table 2. First, all of the students showed differences of some type. However, these differences were seen to varying degrees. Some students showed very obvious differences over time or between settings. Others showed very subtle differences.

Second, all of the research factors were represented by differences demonstrated by the students. However, these were also seen to varying degrees. Parental involvement was demonstrated in one case in the museum setting, but the nature of differences in the involvement could not be seen over time as the parent only attended one field trip. Play was observed in all cases in the museum setting throughout the duration of the project.

Third, cognitive differences were demonstrated to a greater extent (shown by 81% of all students) than social differences (shown by 50% of all students) over time. To see cognitive differences is also to see social differences, because social development underlies and leads to cognitive development.

Fourth, the special education students make up approximately 38% of the participating students displayed in Table 2. However, with the exception of Meaningful Activities, they make up at least that percentage of students who demonstrated differences for each research factor. They make up 80% of the students who showed both cognitive and social differences.

Research Questions

Although cognitive factors and social factors are covered by two different research questions and discussed in two different sections, they are not theoretically separate from each other. They are interdependent rather than dichotomous. When the social factors are evidenced in the data so are the cognitive factors and vice versa, because cognitive growth by learners is based on social interaction, according to social constructivist theory. This follows the social constructivist and holistic framework of this study.

Research Question One

In what ways and to what extent do children's museums foster cognitive learning for students with and without disabilities over time?

In what ways and to what extent is children's learning scaffolded? There are two main ways in which the students' learning was scaffolded during this project. The first way is by the teachers and researcher. The teachers played a large role in scaffolding the students' reading of the exhibit labels. The teachers decided after the first field trip to encourage this behavior. They were dissatisfied with the amount of time most students spent at each exhibit, and were disappointed that the students were rarely seen reading the labels. Since the students were asking questions about how exhibits worked and what they were all about, the teachers realized they were ready to learn what the labels could offer. Beginning with the second field trip, the teachers scaffolded the students' reading of the labels by modeling of the behavior and by assisting low or non-readers with their reading. From the second field trip on, they reminded the students that reading the labels would help them know what steps to take to perform the intended activities and help them understand the science concepts behind the exhibits. More importantly, the teachers modeled the action of reading the labels and following the activity steps one by one. Whether they were alone or with students at the exhibits, the adults could be seen reading the labels, following the text with their fingers, and referring back to the labels if they were having difficulty with the activity. In response, the amount of time that students spent reading the labels alone, with teachers, or with peers increased over the course of the project. On questionnaire forms, the teacher often expressed that their role during the field trips was as "helper" or "facilitator," assisting the students in reading labels and answering questions.

One example of the teachers' modeling and scaffolding an activity for a student occurred on the first field trip. The general education teacher was at the Catenary Arch exhibit (see Figure 8) on the fourth floor putting blocks in place. Lab Coat #5 approached and joined the teacher in putting the blocks in place. The teacher stopped placing the blocks and move around the table to read the instruction label to herself. One of the paraprofessionals approached and observed the activity. Then both adults helped Lab Coat #5 put the rest of the blocks in place. When finished, all three smoothed the arch and switched some that were in the wrong place. The general education teacher began to read the instructions out loud and followed them as she lifted the platform very slowly. Lab Coat #5 looked under the platform as if to see how it is attached and then helped the teacher lift it to a vertical position. They lifted it too far and the blocks fell over forward into the tray. The teachers asked if Lab Coat #5 wanted to try again, but she walked away. The teachers set the blocks up a second time on their own. Lab Coat #5 returned in time to lift the platform. The teachers guided her in unhooking and lowering the platform. This time, the arch stood alone. The teacher praised Lab Coat #5 for successfully building the arch. Lab Coat #5 smiled broadly and went over to another student and told him to look at the arch she made. The teachers assisted the student, allowing her to decide when to enter and exit the activity. Even though they were the ones that built the arch the second time, the teachers gave her the credit, boosting her confidence and sense of accomplishment.

The researcher also scaffolded the students by modeling ways in which to find answers to the questions she asked them during the field trip. When she asked them a question that they answered incorrectly or could not answer at all, she demonstrated how to find the answer by referring to the label, watching another student at the exhibit, or by investigating the parts of the exhibit:

> Field Trip #3: Lab Coats #6 and #11 were at the Double Piddler on the third floor. This exhibit consists of two water faucets inside a glass case that can be lit by a strobe light. There are three controls: one activates the strobe light, one activates the flow of water, and one controls the rate of the water flow. When the strobe light is on, the human eye can not keep track of the flashing and the water flow at the same time, so it

blends them, creating the illusion of separate drops rather than a steady stream of water falling from the faucet. If the flow is slowed down, the drops appear to stand still and then move upward back into the faucet. When the researcher asked Lab Coat #11 how she was able to get the drops to flow upward, she said, "By turning the knob." Lab Coat #6 added to this explanation by saying, "You do this (activate the strobe light), and do that (slow the flow of water), and it do like that (drops appear to flow upward)." The researcher asked if it was the light that made the drops look different. They turned the light on and off, so the water appeared as a stream and then separate drops. Then they agreed it was the light that created the effect.

Field Trip #3: Lab Coat #15 was at the Spectra exhibit on the third floor. This exhibit consists of six glass tubes containing six different kinds of gas. By pushing a button, the gases can be lit up. The lighted tubes all appear white in color. When a diffraction grating is placed in front of the lit tubes, different colored spectra designs appear (e.g. neon is mostly red as in a neon sign, with small strands of other colors). The researcher asked Lab Coat #15 why the spectra were all different. He replied, "It's kind of a scientist thing." The researcher pointed to the labels naming each of the gases and assisted him in reading them. The researcher said, "They all have different names. Maybe they are all different things. Do you think that's why they have different colors?" Lab Coat #15 responded by nodding his head vigorously. Later in the field trip when asked about the spectra, he replied that they all appeared different colors because they were made of different things.

Field Trip #3: Lab Coat #9 was at one of the telephones on the first floor making the other phone ring. The researcher picked up the second phone and initiated a conversation. After the researcher hung up the receiver and left, Lab Coat #9 made the second phone ring again. Another student came over and answered the second phone. This time, Lab Coat #9 initiated a conversation.

The second way in which the students' learning was scaffolded was by the exhibits themselves. The exhibits contain many different aspects. They are brightly colored to be visually attractive, they contain manipulative parts and controls, and they are all accompanied by labels describing activities and scientific phenomena.

Over the course of the project, students were seen acting along a progression of learning behavior. At the beginning of the progression is the behavior of watching. Students at this level watched others at the exhibits or looked at the exhibits without touching them. The next level is "button-pushing behavior." Students at this level touched the exhibits, pushed the buttons, moved the levers and handled the pieces but did not purposefully manipulate them to complete the intended activity. At the next level,

students purposefully manipulated the exhibits in an attempt to complete the intended activity. Some students were unable to complete them on their own, while others were able to complete them after several tries, while still others were able to complete them successfully time and again and even experiment with their own activities. The exhibits in the museum are designed to support the students in any and all of these stages. The following are just a few examples from each floor, each with a description of the exhibit and a list of progressive activities that were observed:

Reaction Time exhibit (first floor): This exhibit tests one's reflexes by releasing a yard stick vertically toward the floor out of a magnetized holder. One must catch the yardstick before it reaches the end of its "leash." There are markings on the yardstick that indicate how quickly it was caught. A warning bell that signifies the yardstick is about to be released can be turned on or off. The progression of activities observed include: (a) watching someone else perform the activity; (b) ringing the bell by banging it with the yardstick; (c) setting the activity up and seeing it through as intended one time only; (d) repeating the intended activity several times to improve the reaction time; and (e) repeating the activity with and without the warning bell to assess the difference in reaction time.

Peripheral Vision exhibit (first floor): This exhibit measures one's peripheral vision. By placing one's eyes at a certain place on a large semi-circular platform and focusing on a dot straight ahead, two knobs can be moved outward along the platform towards the person's ear until they can no longer be seen. The progression of activities observed include: (a) watching someone perform the activity and looking at the exhibit; (b) playing with the knobs on the platform; (c) performing the intended activity to measure peripheral vision; and (d) performing variations such as testing one eye at a time or using moving people in the background instead of the knobs to measure peripheral vision.

Bernoulli Ball (second floor): This exhibit consists of a large balloon and a pipe blowing air up toward the ceiling. The pipe can be moved back and forth. When the balloon is placed in the air stream it floats in mid-air above the pipe. When the pipe is moved slowly from side to side, the balloon is trapped in the air stream and moves with it from side to side. This movement of the balloon with the air flow is the Bernoulli Principle. The progression of activities observed include: (a) watching others perform the activity; (b) playing with the balloon like a volleyball or playing in the air stream (e.g. pretending it is a hair dryer); (c) moving the balloon in the air stream as intended to demonstrate the Bernoulli Principle; and (d) experimenting with the air stream by moving it at different speeds or testing how long a hand can block it before the balloon falls out of the stream.

Pipes of Pan (second floor): This exhibit consists of a series of wide plastic pipes in different lengths arranged like an organ. A leather paddle is provided for hitting the opening of the pipes to create various musical notes. A chart of notes is displayed. If followed correctly, the tune played is "Hail to the Victors." The progression of activities observed include: (a) looking in the pipes or watching someone else play a tune; (b) randomly hitting pipes with the paddle, hitting other things or people with the paddle, or yelling into the pipes; (c) following the chart to play "Hail to the Victors," and (d) playing other tunes on the pipes.

Lens Table exhibit (third floor): At the Lens Table, as described earlier, different lenses can be used to view images on a screen. The progression of activities observed include: (a) watching someone else perform the intended activity; (b) looking through the lenses as if they were eyeglass lenses or making shadow puppets on the screen; (c) place each of the lenses in the holder in front of the light source and adjust the screen to focus the displayed images.

Star Sculpture (third floor): This exhibit consists of luminous electrical streamers inside a glass ball and a fluorescent light tube. When the ball is touched, the streamers are attracted to the areas being touched. If the fluorescent light tube is touched after the ball, it will glow. The progression of activities observed include: (a) watching the ball or watching someone else touch the ball; (b) touching the ball with one or two hands; (c) touching the ball with different body parts (forehead, nose, elbow, fingertips, etc.); (d) touching the ball and then the flourescent light tube to make the tube glow.

Computers (fourth floor): There are several computers in a separate computer room. Each has a different software program installed on it. All have either a keyboard or a mouse, and some have both. Some of the programs are BusyTown, Dinosaurs, Create-A-City, Musical Instruments, and KidDraw. The progression of activities observed include: (a) watching someone else at the computer; (b) playing with the keys or the mouse; (c) attempting the program without reading directions; (d) following the program from the beginning, reading the directions to perform it correctly; and (e) retrying the program over and over to improve performance.

Tic-Tac-Toe (fourth floor): This is a three-dimensional tic-tac-toe game. There are four tiers of clear plastic, directly over each other. Each tier has sixteen holes arranged in a four-by-four grid. The holes are large enough to hold a tennis ball without letting it fall through. There are several green and

several yellow tennis balls accompanying the game. The object is to get four in a row, either on the same tier or across all four tiers. The progression of activities observed include: (a) watching others play the game; (b) playing with the tennis balls, juggling the balls, or sticking hands through the holes in the tiers; (c) playing a game of Tic-Tac-Toe with a partner; and (d) inventing variations of the game by oneself, with a partner, or in a small group.

In what ways and to what extent are activities meaningful and contextualized for the learners? Every exhibit in the museum is intended to relate to familiar objects and phenomenon in the visitors' lives. Since the background knowledge of the students in this class was limited, the meaning of the exhibits in their lives was more obvious in some cases than in others. The toilet was very meaningful for them, because they all had toilets in their homes. The dollhouse was meaningful for Lab Coat #1 who had always wanted a dollhouse but never had one of her own. The exhibits containing familiar toys and activities (e.g. the Giant Slinky, the bubbles, the bicycle wheel and chain, the train engine) were more meaningful for the students who had these toys at home than those who did not. The beehives and fish tanks were more meaningful than the sea shells and starfish because the students had more experience with the former than the latter.

One way that the exhibits are contextualized is that each floor contains exhibits having to do with a certain theme. The first floor, "The Subject is You," contains exhibits all having to do with the human body. The second floor, "The World Around You," contains exhibits all having to do with the physical world. The third floor, "Light and Optics," contains exhibits all having to do with light, optical illusions, and visual perception. The fourth floor, "How Things Work," contains exhibits all having to do with mechanical objects and their parts.

Another way in which exhibits are contextualized is the degree to which they are connected with the classroom curriculum being studied by the students. In the case of this class, the science curriculum studied at the time of the project pertained to oceans and sea life. Therefore, the Discovery Room, containing objects from the sea was more contextualized for the students than other parts of the museum.

The labels at each exhibit also help to contextualize their scientific concepts by giving examples of where this could be seen in daily life:

> The "Bucky Ball" (second floor): This exhibit displays the concept of a geometric structure developed by Buckminster Fuller. The structure is comprised of hexagons and pentagons and is used in buildings domes for strength. The exhibit displays a giant soccer ball and the label describes this object as a more familiar way to envision the scientist's structure.

> Ball Bearings (second floor): This exhibit displays

different types of ball bearing apparatuses and an activity using ping pong balls and a circular tray demonstrate the inner mechanics. The label names household items that use ball bearings, such as washing machine agitators and bicycle pedal cranks, to contextualize the concept.

Resonant Rings (second floor): This exhibit displays a set of rings that can be struck with a mallet and a device that measures the degree of resonance. The concept of resonance is more familiarly described using the idea of the springs of a mattress responding in a certain way when one jumps on a bed.

<u>In what ways and to what extent do children regulate their own learning?</u> Of all the cognitive aspects of the study, self-regulated learning is most prominently demonstrated. All students who participated in the study showed self-regulation of learning, some to a greater degree than others, but all did to a certain extent. They set their own goals, increasing the demand of these goals as their abilities and knowledge increased, and made decisions regarding whether or not they reached their goals. They made their own choices as to which exhibits to visit, in which ways (i.e. whether they would perform the intended activity or manipulate the pieces according to their own purpose) and to what extent (i.e. how long they would spend at each exhibit and how many times they would attempt the activity before moving on). They were free to choose exhibits that

interested them and free to choose with whom they interacted. Following are several examples of individuals regulating their own learning. These examples were chosen because they are representative of the great number of instances of self-regulated learning. Also, these examples depict how self-regulation occurred across students, exhibits, and time in the museum setting:

Lab Coat #8 at the Tennis Balls in a Cube exhibit: Over time, he modified his goal to increase the challenge. At first, he completed it with a great deal of help from an Explainer Guide, then he completed it with only minimal help from a paraprofessional. After that, he tried it on his own using only the label for help, then completed it without any help. Finally, he assisted other students in solving the puzzle.

Lab Coat #9 at the Hot Air Balloon: Over the course of the project, he modified his goals for this exhibit. At first he watched another student raise the balloon, then he tried it, pushing the button himself. Then he experimented with different procedures to make the balloon rise. Also, this student modified his goals with respect to interacting with peers and asserting his position as a member of the group. Over time, he interacted with peers more and became more assertive of his interest and his turn at exhibits.

Lab Coat #13 at the Catenary Arch exhibit: On the first field trip, he approached the exhibit and began randomly handling the blocks, lifting them and setting them down randomly. An Explainer Guide came up and began to explain how to perform the intended activity correctly by placing the blocks in order on top of the pattern provided. Lab Coat #13 left the exhibit. He had set his own goal which did not match the Explainer Guide's goal or the intended goal of the exhibit. When urged by the Explainer Guide to abandon his goal for another, he stopped using the exhibit.

Lab Coat #6 at the Brain Exhibition's sound/memory exhibit: She continually "upped the ante" on her goals for this exhibit as she mastered more and more difficult levels. Every time she successfully replicated a tune on the xylophone, she pressed the button for the next difficult level and tried repeatedly until she successfully replicated the longer, more advanced tune.

Lab Coat #3: This student set goals that closely, if not exactly, matched the intended goals of the exhibits. She followed the instructions to the letter and systematically performed the intended activities.

Lab Coat #18: In contrast to Lab Coat #3, this student set his own goals that rarely matched the intended goals of the exhibit. A prime example occurred on the fourth field trip when he took a puzzle piece from the Tennis Balls in a Cube exhibit and used it to make a pattern in the Pin Table.

The teachers and paraprofessionals commented on the students' self-regulation during interviews:

> Teacher Interview #2: The special education teacher stated that the students chose the exhibits that they liked the best and spent longer amounts of time at them.

> Teacher Interview #3: The general education teacher stated that the students made decision to read labels and to learn more. She said they chose to go to the Discovery Room because it connected with their classroom activities on sea life. She saw them deciding where to go based on their interests.

> Teacher Interview #3: The special education teacher said this about the decisions students made for themselves: "The first decision, of course, is what exhibit to do first, second, etc. Decision-making, even as simple as this, can be different for special education students. Next, they have to make decisions about each exhibit - what to do, how to try it, what to do next."

Occasionally in the museum, the teachers or paraprofessionals would say, "Come look at this," or "Try this one." At these times, they were making certain decisions for the students, such as which exhibit to use or where to go next. Also, the Explainer Guides sometimes interrupted a student's activity to tell them the "correct" way to do it, making the decisions for the student of which goal to set and how to accomplish it. However, this rarely happened compared to the number of instances where students made these decisions for themselves.

In what ways and to what extent do activities and exhibits support individual learning styles and rates? The exhibits in the children's museum are designed to stimulate most of the sense modalities - vision, hearing, touch, and sometimes even smell. All of the exhibits are stimulating for the visual learner, painted in bright colors and accompanied by text labels to read. All of the exhibits can be touched and manipulated for the tactile hands-on learner, except for the contents of the antique dollhouse, the fragile fossils, and the live animals. Many of the exhibits include recorded explanations and/or sound for the auditory learner. Some of these are the Ultrasound, the Vowel Sounds exhibit, the Delayed Speech exhibit, the Reaction Time exhibit, the computers, the Singing Bowl, the the Voice Waves exhibit, the telephones, the Whisper Dishes and the Whisper Tube. Finally, some of the exhibits include smell. These are the bubble exhibits, the Bat Exhibition's exhibit matching mother to baby bat by smell, many objects in the Discovery Room, and the Brain Exhibition's Olfactory exhibit.

Regardless of the learning modality a student prefers, there are exhibits to support them. Exhibits are also designed support different styles of learning from passive to active; silent to verbal; individual to partner to group;

slow-paced to fast-paced.

The participants in this study demonstrated a wide range of preferred learning modalities, styles, and rates. Regardless of this vast range, all students were able to find exhibits that were interesting, fun, challenging and worthwhile.

In what ways and to what extent do children's museums foster the learning of lifelong learning skills (confidence, curiosity, problem-solving, creativity, divergent thinking, systematic investigation, and scientific inquiry)? Cooperative learning was the lifelong skill most observed to develop. Students were observed working together more than usual for the classroom, with more students at one time than usual, and with particular students more than usual:

> Lab Coat #7: On the first field trip, Lab Coat #7 worked with Lab Coat #2 at the Ping Pong Maze on the fourth floor. The general education teacher stated in conversations and in the second interview that she was surprised at Lab Coat #7's cooperative behavior, because he usually did not work cooperatively with any of the other students.

> Lab Coat #14: Over the course of the project, Lab Coat #14 became increasingly more socially active with peers. He began to interact with them at exhibits in the museum setting and interact with them in the classroom setting.

> Teacher Interview #3: The special education teacher

stated, "I see a lot of cooperative learning skills and asking questions. I see these more than science facts being learned. A lot of working together. I am very excited about that."

There was some evidence of the students developing problem-solving skills on their own and with peers in order to complete activities successfully. Examples of this are Lab Coat #4 using trial-and-error to improve his design of the Ping Pong Maze, and Lab Coat #16 trying different strategies to "unstick" the chain at the Bicycle Chain exhibit, after observing several other students giving up on it when it didn't work the first time.

However, the students developed the ability for scientific inquiry and systematic investigation to a minimal extent. Although some individual students were able to do this by the end of the project, and generally there was some progress, the general education teacher felt a lot more work was needed in these areas, as well as with remembering specific science facts:

Teacher Interview #2: "I'm sure a lot of them aren't thinking real scientifically yet. They just take so much for granted. They just don't think what led up to this - inventions and things."

Teacher Interview #3: "Being kids, they still want to hop all over to different things without thinking them through."

Research Question Two

In what ways and to what extent do children's museums foster social development in students with and without disabilities over time?

In what ways and to what extent is a learning community established? There is evidence that a learning community different from that of the classroom was established in the museum setting. First, the extent to which students worked cooperatively improved over time in the museum setting.

Second, students were given the opportunity to establish goals that they could work toward together, in pairs or small groups. Exhibits that fostered this include the Ping Pong Maze, the Catenary Arch, the Whisper Dishes and Whisper Tube, and the Shadow Wall where students push a button, pose in front of a phosphorescent wall, and wait for the light flask to temporarily fix their images on the wall.

Third, there were instances where students were left to sort out arguments amongst themselves without the help of an adult:

> Field Trip #1: Several students were at the Sand Pendulum, arguing over who should hold the funnel while it was being filled with sand and who should let the pendulum swing once the funnel was full. There were no teachers near the area. The researcher was nearby, videotaping the scene. The students noticed the researcher watching but not intervening, so they decided among themselves to take turns performing the different

steps of the activity.

Field Trip #1: As with nearly every school field trip, the Bubble Capsule was the most popular exhibit on the second floor. This exhibit consists of a platform surrounded by a giant bubble wand. Students can stand on the platform and pull the chain for the circular wand, creating a giant, cylindrical bubble that engulfs them on all sides. If too many students are standing near or leaning on the exhibit, the fragile bubble will pop before it is complete. This exhibit became overrun by a large group of students when the class entered the second floor. With minimal guidance from adults, they established an orderly waiting line that began a few feet from the exhibit, for best possible results in creating the bubble.

Fourth, students came to acknowledge each others strengths and abilities to teach as well as learn. Lab Coat #15 acknowledged Lab Coat #4's ideas at the Ping Pong Maze, praising him as a "genius." Lab Coats #6 and #2 acknowledged the expertise and experience of Lab Coat #1 at the BusyTown computer program. Lab Coat #3 acknowledged Lab Coat #9's experience with the Hot Air Balloon. Finally, on questionnaires and during interviews, most of the students consistently mentioned that peers helped them in both the museum and classroom settings.

Fifth, the social goals for the inclusion classroom were being met. In the third interview with the general education teacher, she said, "they really went beyond my expectations as far as the inclusion students go. They really have grown a lot as a group."

Lastly, on the teacher questionnaires, even the teachers and paraprofessionals expressed pleasure in being able to learn alongside the students, taking on the role of learner as well as teacher.

<u>In what ways and to what extent is the social construction of knowledge facilitated?</u> There were a few incidents of students interacting with each other as they performed activities at the exhibits. For example, Lab Coats #4 and #5 discussed a plan at the Ping Pong Maze and communicated ways in which to bring it to fruition. They hypothesized as to why the ball did what it did at certain places in the maze and what they would have to do to change the ball's course.

Students asked questions about exhibits in the museum setting and answered questions about their experiences on questionnaires and in interviews. The answers of students on the questionnaires were brief. They answered with one or two words, or with "yes" or "no." In interviews, their answers were similarly brief. Attempts by the researcher at having them elaborate on their responses were unsuccessful.

<u>In what ways and to what extent are parents involved with their children and in their children's learning?</u> There was extremely little parent involvement with this study beyond the signing of consent forms. The parents of eighteen students (including the one who left the project early and the one who entered the project late) signed consent forms

for their children to participate in the project. The parents of all the students signed separate school permission slips for their children to attend the field trip. Four parents signed consent forms agreeing to participate in the study themselves. After this initial signing, only one of the four could be reached for further communication regarding the study. This parent, the mother of Lab Coat #9, responded to written correspondence agreeing to help in anyway she could. However, due to her work schedule, she was only able to attend the fourth field trip, and this one only after she was convinced her son wished to have her come along. She was often available at school in the early morning for informal conversations with the researcher. The other three parents never again responded to written notices or phone calls.

This parent demonstrated concern regarding her son's learning and comfort in all settings. She herself was able to learn from the experience, coming to know more about her son's learning preferences, abilities, and attitude in different settings.

The teachers and paraprofessionals described the nature of parent involvement in their classrooms as minimal yet sincere. Parents were generally concerned but had little time to be physically present. Most parents in the area work many part-time and odd jobs to make up for being laid off from the closed manufacturing plant. Thus, their free time is sporadic and unpredictable.

After the second field trip, the researcher gave each student two specially-marked free passes to the museum to determine if the number of visits by families after school or on weekends would increase (to this point, none of the participating students said they had been with their families outside of school). However, it does not seem that the free passes alone were enough to significantly increase family visits. To date, only one of these passes has been used.

What role does play serve in the setting of the children's museum? Most of the students generalized the museum as a place to play while they generalize to the classroom as a place to work. When describing what they did at the museum, they often said, "I played with the...", whereas they described school activities as, "We are working on..." They described both of the settings as places to learn.

The general education teacher felt that the vast choice the students were given at the museum made for a hectic, playground-type environment. She was concerned that there was not enough structure:

> Teacher Interview #3: "Well, the museum is a very busy place, and the kids knew they could explore and investigate and do anything they wanted to do. I was worried about it not being restricted enough for them. I didn't want them to go nuts. The classroom is very structured. They know that they don't just get up unless it's a given time when they can get up and go sit down and read on the carpet."

Research Question Three

In what ways and to what extent is learning in children's museums generalized to other settings over time?

The lifelong learning skill of cooperative learning generalized to the classroom, as did a positive attitude toward the museum and science in general. However, very little specific scientific knowledge and very few of the observed individual differences were generalized.

A much greater degree of self-regulation occurred in the museum setting than in the classroom setting where many decisions were made for the students by the general education teacher:

> Classroom Visit #1: Lab Coats #9 and #12 had the general education teacher check their tracing assignments in order to determine if they are done with their work.

> Classroom Visit #1: The general education teacher told all the students exactly how she wanted them to color their pictures of Pilgrims and Indians and exactly how she wanted them to paint their Indian vests.

> Classroom Visit #2: The general education teacher told all of the students how to color and design their work for the class bulletin board.

> Classroom Visit #3: The students listened to *McElligot's Pool*, by Dr. Suess. They were then given an

assignment to draw and color any kind of imaginary fish they wanted, like Dr. Suess had done in the story. Many of the students had difficulty getting started and staying focused as evidenced by their repeated questions about what to do and several times discarding their unfinished papers to start again. It was as if they were unsure what to do when given very few guidelines or restrictions for completing their work.

Of the students who demonstrated differences between the classroom and the museum, only some of the behavior of Lab Coats #1, #14, and #16 changed in the classroom setting as well.

Teacher Interview #2: The general education teacher stated that she hasn't been doing any follow-up activities with the students in class, but she did ask them questions while they were at the museum. She thought the exhibits did not tie in very well with what they were doing in class. If they tied in more, she felt there would have been more carry over and retention of facts.

Teacher Interview #2: The special education teacher stated that the students mentioned things they did at the museum a couple of times, but there was not very much follow-through in the classroom, except for their improved cooperative learning skills.

According to the special education teacher, the development of cooperative learning skills carried over to the special education classroom setting:

> Teacher Interview #3: "[The museum] has had a positive impact on my class. My students were excited about going to the museum and this excitement carried over into the classroom. The students continued to work together in the classroom, which carried over from the museum."

Other sources of data were not available to reinforce this report by the special education teacher. Observations were not conducted in the special education classroom, because students from several other grades were also present in that room. Consent was given only for observing the third graders. Cooperative learning skills were not observed to have carried over to any significant degree to the general education classroom. There were few opportunities to observe small-group cooperative learning skills in the general education classroom, as most of the lessons are in large-group, direct-instruction format.

There was some evidence of the students gaining the ability to verbally discuss experiences, scientific concepts, and new knowledge. Some example of this are Lab Coat #4 talking about the Turbulent Orb exhibit, Lab Coat #9 talking about the Hot Air Balloon to the researcher in interviews and to his mother at home, Lab Coat #15 explaining a brain exhibit to the general education teacher on the bus ride back to school, and Lab Coat #3 talking to the researcher about several different exhibits during interviews.

Teacher Interview #3: The general education teacher reiterated that the exhibits needed to be more connected to classwork and prior knowledge for their to be more purposeful learning. She felt they did not have enough reinforcement for the learning of science facts to be carried over into the classroom. She wished there had been more carry over.

Teacher Interview #3: The special education teacher felt that some areas tied in with the classroom curriculum enough to result in some generalization of facts. Also, the demonstration on seashells, horseshoe crabs, and crayfish that the researcher brought to the classroom helped to reinforce learning: "We were doing a unit on sea life and the students were able to see first hand the things we were talking about in class....The demo was great and it helped them to carry over what we saw in the museum."

Chapter Summary

This study investigated several factors pertaining to the potential of a children's museum to be a successful learning environment for students with learning disabilities. These factors are: (a) scaffolded instruction; (b) meaningful and contextualized activities; (c) self-regulated learning; (d) instruction responsive to learning style and rate; (e) learning community; (f) social construction of knowledge; (g) parental involvement; and (h) play.

Twelve general education and six special education students participated in the study. Of these, two general education students did not participate for the duration of the project. Other participants included the general education teacher, the special education teacher, two paraprofessionals, one parent, and two members of the museum staff. Videotape transcriptions of observations in the museum and classroom, interview transcriptions, questionnaires, and field notes were analyzed to determine the ways and extent to which the aforementioned factors were present.

Results were reported first by individual student, then by each factor under investigation. All of the students demonstrated individual differences between the classroom and museum settings. Some students showed significant differences while others showed very subtle differences. There were examples seen for all of the factors under investigation, some more so than others. Self-regulation of learning by the students was the most prominent. Generalization of differences from the museum setting to the classroom setting were minimal.

Chapter Five: Discussion

Chapter Introduction

This chapter is organized similarly to "Chapter Four: Results." First, the results of each of the student participants are discussed. Next, the three main research questions are discussed: (1) In what ways and to what extent do children's museums foster cognitive learning for students with learning disabilities? (2) In what ways and to what extent do children's museums foster social development in students with learning disabilities? (3) In what ways and to what extent is learning in children's museums generalized to other settings. Each of the first two questions are discussed in detail by the subquestions outlined on pages 5 and 6. Following is a discussion of the problems that arose while conducting this study and a successful school-museum program that would build on the strengths and remedy the problems of the current study. Lastly, implications for further research are addressed.

Discussion of the Individual Students

All of the students, including those with disabilities, demonstrated differences. The differences were cognitive in nature, social in nature, or both. The differences that were seen for each student are described, then discussed in light of their individual classifications and/or goals, and what they could gain from these behaviors carrying over to other settings.

Lab Coat #1

This student is classified with a learning disability and emotional impairment (LD/EI). Over the course of the project, she exhibited a decrease in aggressive behavior in the museum setting. This served to give her a more positive place among adults and peers in the learning community. For a student with learning difficulties that are intertwined with emotional impairment, more positive and productive social behavior is important for increased cognitive development.

Also, she demonstrated an increase in interest in activities in both settings. The exhibits were responsive to her interests and thus more meaningful to her. Instead of constantly seeking to perform for the video cameras, she developed more appropriate ways of seeking attention, such as sharing her work and offering to teach a computer game to peers. These behaviors would be beneficial to her in the classroom setting as well.

Lab Coat #2

This student is not classified with a disability. In the classroom setting, he is easily bored or satiated with activities. The teacher sees his socializing as a problem that distracts him from his learning, so he is somewhat separated from the rest of the class. In the museum setting over time, he demonstrated more interest in the exhibits. They were responsive to his individual interests and more meaningful to him. He was also more engaged with exhibits than he was with class assignments. This is a sign that he was regulating his learning and making decisions about his degree of involvement with activities.

Although he still satiated fairly quickly, there was more variety available to him. This is a benefit to this

project, she exhibited a decrease in aggressive behavior in the museum setting. This served to give her a more positive place among adults and peers in the learning community. For a student with learning difficulties that are intertwined with emotional impairment, more positive and productive social behavior is important for increased cognitive development.

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Although he still satiated fairly quickly, there was more variety available to him. This is a benefit to this

student in that he needs more avenues of stimuli to keep him focused on cognitive learning tasks. Also, social interaction in this setting is beneficial as it leads to cognitive development. If this notion was carried over to the classroom, perhaps he would demonstrate differences there as well.

Lab Coat #3

This student is not classified with a disability. In the classroom setting, she did not focus on class activities. The teacher and her parents expressed concern over her distractedness. In the museum setting over time, she demonstrated increased engagement with exhibits. She regulated her own learning, set goals and accomplished them without the teacher reminding her to stay focused.

Her ability to systematically investigate exhibits also increased. This student seemed to thrive on active, hands-on learning experiences which led to an improvement in her learning skills. When offered these activities, she is an independent, thorough learner. If these behaviors were to carry over to the classroom setting, the teacher would need to spend less time reminding her to remain on task. Also, with guidance, this student could be aware of her preferred learning style and use it to her advantage in any setting.

Lab Coat #4

This student is classified as having a learning disability (LD). Over the course of the project, he demonstrated an increased ability to solve problems and to learn independently. Rather than relying on a teacher to assess his success, he became more able to regulate his own learning to determine when he had accomplished his goals.

For this student, improved learning skills and self-regulation are a start toward becoming a more independent learner who would need less individualized attention from teachers. This could lead to his spending less time in the special education resource classroom and more time included in the general education classroom.

Lab Coat #5

This student is not classified with a disability. In the classroom, she is a highly structured and organized learner. If given specific directions, she can independently complete assignments with great success. However, she seems to rely heavily on the teacher to set academic goals for her. In the museum setting, this student was left to her own decision-making and goal-setting, with little guidance as to what her "assignment" was. Although the labels served to guide her to some degree, she remained far less organized and focused as compared to the classroom.

This student provides a strong example of why the informal museum setting cannot replace the formal classroom setting. This student needs the structure and guidance of a more formal, traditional learning environment to be successful. Over time, with guidance, her budding self-regulatory skills could develop more fully in the museum setting.

Lab Coat #6

This student is not classified with a disability. In the classroom setting, she is very preoccupied with her peers. Although she is a very bright student, she places social interaction as a higher priority than classwork. The teacher views this preoccupation with social interaction as a deterrent to academic success.

In the museum setting over time, she found exhibits and activities that interested her more than social interaction with her friends. She became more self-motivated than peer-motivated, altering her position in the learning community to being a more independent member. Also, in this setting, social interaction was seen as beneficial rather than problematic. If this notion were carried over to the classroom, her socializing would be combined with cognitive development, rather than the two being mutually exclusive.

Lab Coat #8

This student is not classified with a disability. in the classroom, he is an independent learner, but is not always interested in the activities. It seems as if he goes through the motions of completing classwork without recognizing the purpose or importance of the assignments.

In the museum setting, he showed increased interest in the exhibits. The exhibits were responsive to his individual interests and were more meaningful to him. Over time, he became more successful in completing activities in the museum. The exhibits and adults scaffolded him according to his present level, helping him to improve his skills. He also seemed more aware of what each activity was teaching him. This knowledge in the classroom would make assignments more meaningful and learning more long-lasting for him.

Lab Coat #9

This student is classified with a physical or health impairment and educable mental impairment (POHI/EMI). Over the course of the project, this student exhibited the increased ability to be assertive regarding his interests and taking his turn at exhibits. For student who is usually very withdrawn and timid (perhaps due to his physical and health impairment), assertiveness altered his role in the learning community among peers, increasing his confidence and risk-taking behavior. He was able to break away from a possible cycle of being sheltered and seeking shelter from interactions with people and activities. Continuing this behavior may help him to be a much more independent learner, leading to less required individualized attention, leading in turn to more time spent included in the general education classroom.

He also demonstrated increased ability with the exhibits. He was scaffolded in his efforts according to his ability level. This improvement in learning skills would also serve to help him be a more independent learner in the classroom.

Lab Coat #10

This student is not classified with a disability. She places a high priority on peer social interaction. In the museum over time, she became slightly more socially independent from her peers, changing her pattern of behavior within the learning community to a small degree. She seemed to have a glimmer of self-motivation, but most often repressed it if her peers were interested in something different. The museum setting began to build on this glimmer of self-motivation. Increased exposure to what interests her most and increased encouragement to pursue her own interests could help this student become a more independent learner across settings.

Lab Coat #11

This student is not classified with a disability. In the classroom, she seems easily bored with activities. In the museum, she showed a slight increase in interest over time. The musical instrument exhibits seemed to appeal most to her individual interests and to be most meaningful to her. If this and other patterns of interest were reinforced in the classroom as well, she could become a more invested student across settings.

Lab Coat #12

This student is classified with trainable mental impairment (TMI). Over the course of the project, this student did not demonstrate any significant differences in behavior. However, he was provided with many reinforcing, hands-on learning experiences in the museum. As the general education teacher pointed out, repeated exposure to the museum setting and its contents provided him with an additional educational resource. It reinforced his existing knowledge and introduced him to new knowledge. Continued experience with the museum that is responsive to his needs and abilities may slowly but surely support him in incorporating new knowledge over time.

Lab Coat #13

This student is classified with a learning disability (LD). Over the course of the project, this student demonstrated an increase in the ability to systematically investigate exhibits in the museum. This improved learning skill is very important for a student like this who does not approach classroom assignments systematically and who needs a great deal of individualized attention to complete assignments successfully. The ability to investigate and complete activities systematically would help this students be a more independent learner and require less individualized attention from the teacher.

His role of "expert" rather than "novice" in the learning community also increased over time. There were a few exhibits with which he seemed to feel most comfortable and with which peers acknowledged his ability.

Lab Coat #14

This student is not classified with a disability. He began as a quiet "loner" in both settings. Over time, he began to form social relationships with peers that carried over to the classroom setting. This changed his place in the learning community, making him a more active member. This increased social interaction, if reinforced and developed further could lead to further cognitive development as well.

Lab Coat #15

This student is not classified with a learning disability. In the classroom, this student lacked organizational skills. Although he was interested in many activities and often talked about he importance of an education, the teacher was concerned about his achievement. In the museum, his ability to systematically investigate exhibits increased over time. This improved learning skill is important for this student's future success. The exhibits in the museum harnessed his interest and motivation in learning and helped him be successful while building organizational, investigative learning skills.

He also discussed his learning more over time. Continued engagement in dialogue could help to foster social construction of knowledge and improve his learning across settings.

Lab Coat #16

This student is classified with educable mental impairment and speech and language impairment (EMI/SLI). Over the course of the project, this student increasingly initiated social interactions with others. This improved interaction helped her to develop a more visible place in the learning community. She also demonstrated greater interest in and engagement with exhibits and classroom activities. Finally, she asked more questions and sought more help over time. This behavior was both socially and cognitively beneficial to her as it provided with her more opportunities for dialogue and helped her develop an important learning skill. For a student such as this one whose learning difficulties are intertwined with speech and language difficulties, becoming more engaged with her surroundings and communicating more with others can lead to increased opportunities for cognitive development.

Lab Coat #17

This student is not classified with a disability. He is a very unique child. Described as a collector and inventor, his imagination was viewed by the teacher as a hindrance to his success in the classroom. The museum reinforced his unique interests, responding to his individuality and providing him with meaningful activities. In the museum, his imagination was harnessed and viewed as a strength that could help him develop new knowledge. This student described himself as a scientist when he wore his lab coat in the museum and at home. His association with being a scientist needs to be transferred from the lab coat to himself so he can see himself as a scientific learner in all settings.

Summary

All of the students who participated in the study from beginning to end and even the student who left early demonstrated differences in behavior, either cognitively, socially, or both. Each student exhibited differences as individualized as they and their learning styles were. Regardless of the nature of the differences, all were equally important for the individual student who exhibited them. Some students, such as Lab Coats #1, #6, #7, #9, and #14, made progress socially, learning to interact with others or learning to be more independent socially. This is no less important than the students who made progress of a cognitive nature, learning to solve problems, focus on exhibits and perform activities systematically, such as Lab Coats #3, #4, #13, #15, and #16. The needs of these students lay in those particular areas, and any differences seen mean that the

student is making strides where he or she needs it most.

The special education students as a group seemed to show more differences than the general education students as a group. Although all the students received benefits from their experiences in the children's museum, it is likely that students with disabilities who have more difficulty in traditional, formal classroom settings received more benefits. Perhaps these students have more trouble than their nondisabled peers adjusting their learning style to the teacher's teaching style. The museum offers them experiences already adjusted to their individual learning styles. Perhaps it is the novelty of the museum setting that offers a future of learning success and fun rather than a history and stigma of learning failure and frustration.

Unfortunately, only a few of the strides accomplished were seen in the classroom setting. Lab Coat #1's obsession with the cameras diminished in both settings allowing her to concentrate instead on exhibits, activities and classwork; Lab Coat #14's interaction with peers increased in both settings; and Lab Coat #16's interest and investment in her surroundings increased in both settings. However, data collected in this study did not provide evidence that the accomplishments led to permanent learning or that strides made by others generalized to other settings. As important as these strides were to the individuals, it can only be said that they were differences in behavior for the most part bound to specific settings, not permanent learning or acquisition of skills generalizable to all settings.

Discussion of the Research Questions

Discussion of Question One

In what ways and to what extent do children's museums foster cognitive learning for students with and without disabilities over time?

The data collected and analyzed in this study provided many examples of: scaffolded instruction; meaningful and contextualized activities; self-regulated learning by the students; activities responsive to learning style and rate; and lifelong learning skills. All of these factors were seen in the museum setting.

Scaffolded instruction. There were two ways in which the students were scaffolded in the museum. The first was active scaffolding by the teachers and researcher. When adults scaffolded the students' learning, they actively determined what would help the students take the next step toward higher learning and coached them in it or modeled it for them or both. Reading of instructional labels on the exhibits is an excellent example of this. Noticing that the students were highly interested, yet seemed (from their observations) to lack the ability to approach the exhibits and learn from them systematically, the teachers sought for a way to help the students focus and follow some sort of plan toward understanding the exhibits. Knowing that the labels helped them to better understand the exhibits and the scientific phenomena behind them, they verbally reminded the students to read the labels and could be seen throughout each field trip reading the labels themselves. This act of scaffolding did increase the students' reading of labels and understanding of the activities, but did not necessarily increase their understanding of the underlying scientific concepts.

Second, the students were passively scaffolded by the exhibits themselves. Obviously, the exhibits are not able to detect the students' present levels of ability and then introduce them to the next level. Instead, they inherently provide for varying levels of ability at all times. Wherever the student is cognitively, the exhibit is right there to meet him or her and put forth a new challenge.

Meaningful and contextualized activities. The exhibits in the museum are all meant to illustrate scientific concepts that most people use everyday or at least have encountered in their lives. Some are more familiar than others, but all tie into the lives of visitors in some way, thus providing them with a base on which to build further knowledge. Also, the exhibits do not present concepts in an arbitrary manner. Each one is contextualized within a group of exhibits following a theme of daily life. The data in this study provides many examples of the exhibits having meaning for the students.

Yet, in designing exhibits that match the daily lives of people, one must make assumptions about what those people encounter in their daily lives. For example, to assume that the concept that heat rises is meaningful when illustrated via the Hot Air Balloon exhibit, one must assume the visitor is familiar with hot air balloons and the fact that they float in the air. In most cases, it would be safe to assume this. The students in this class, however, have not had the

advantages in their daily lives as most other people have. The general education teacher said she often catches herself assuming they are familiar with an object or concept that they have never before experienced. Once she talked about a sailboat to explain wind as power, and wondered why the students were confused until she realized few of them had ever seen or heard of a sailboat. These students do know what a hot air balloon is, but there were quite possibly other simple objects in the museum that are beyond their background experiences. Thus, the exhibits were designed to be as meaningful and contextualized in daily life as possible, yet assumptions were still made about what makes an object meaningful and contextualized to whom.

Self-regulation of learning by students. Throughout the course of the project, there were a remarkable number of instances of students regulating their own learning goals and accomplishments in the museum setting. It is evident that the students felt comfortable and free to make their own decisions about which exhibits they used, what they did with them, how long they used them, and with whom they used them.

Although there was great evidence of self-regulation occurring, it does not follow that its presence led to deep or even correct understandings of the underlying scientific concepts. It also does not follow that the students are automatically able to regulate their own learning and make their own choices in other settings. In the classroom, most decisions were made for them so that opportunities to see how well they made their own decisions in that setting were very rare. The ability may be confined to the setting where it is allowed to occur. There is one example from the classroom that suggests this but is not enough to form a strong conclusion. When the students were given the opportunity to create any kind of fish they wanted during an art activity, many of them had trouble getting started. The freedom of choice may have been a hindrance rather than a benefit in the classroom setting.

Activities responsive to individual learning style, rate and ability level. The students in this class possessed many different learning styles, as reported by the teachers and as observed to some extent by the researcher. Despite the variety, both teachers and paraprofessionals alike said that the students needed more hands-on experiences than were provided in the classroom, and predicted that the hands-on exhibits at the museum would be very beneficial to them:

> General Education Teacher: "I lot of the kids have to have that tactile stuff. I have some students, like I say, at the end of it that can probably absorb it, but they all enjoy following up with [hands-on] activities." "I know that they need a lot of hands-on to give them a chance to explore and be involved and be an active learner instead of just a listener (which is a lot of what we do). They need more of that."

> Special Education Teacher: "I really think [the project] is going to help the learning disabled students and special education students - some of my lower grades too. Best of all, I really see it helping those

students who have problems learning in a book or from the chalkboard....We try to do a lot of hands-on in the classroom, but I think actually going out to the museum and seeing the exhibits and videos that that's really good."

"Students, especially special education students, learn by doing. They really need the hands-on provided by the museum."

Paraprofessional #1: "Each one of them is so different. You're dealing with special needs kids who don't always see things the same way others do....Some kids learn by seeing (visual). They have to have some visual account of things. They can pick up and actually see it in front of them. Other kids can learn off the paper....So there's all kinds of different styles...but the sense of feel more than anything else, probably."

Researcher: "Do you see the children's museum supporting the different learning styles that they have?"

Paraprofessional #1: "I think so. because some things work with one child and some with more, and you have a lot of things that some of the kids really like."

Paraprofessional #2: " Most of our kids...learn better from hands-on than just right out of a book."

Lifelong learning skills. There are certain skills a person can have to help them be lifelong learners with a lifelong love learning. For the purpose of this study, the skills focused on were confidence, curiosity, problem-solving, creativity ,divergent thinking, systematic investigation, and scientific inquiry. The special education teacher added cooperative learning to the list of skills which are beneficial for students to possess in order to continue learning. Of these, confidence, curiosity, problem-solving, systematic investigation and cooperative learning were observed in the museum setting.

They were rarely, if at all, observed in the classroom setting. Lab Coat #16 showed more confidence in the classroom setting, and the special education teacher reported that her students' cooperative learning skills continued in the special education classroom. However, as mentioned earlier, there were no opportunities to observe this ability in the general education classroom in order to reinforce the teacher's observation with other data. Some of the aforementioned skills were observed, but there is no evidence that they will continue in other settings or throughout the students' lives.

Summary. Since instances of these cognitive factors were seen in the museum setting, it can be said that the children's museum does foster them. In turn, it can also be said that the children's museum has the potential of being a successful learning environment for all students, including those with learning and other disabilities.

Yet, there was little to no data that supported the fact

that these cognitive abilities were permanently learned by the students and carried over to other settings, in particular the classroom setting. Therefore, children's museums have the potential to be successful learning environments, but they cannot be the only learning environment for students. There needs to be something else in place for the students to be fully successful in this setting and for their success to carry over to other settings.

Discussion of Question Two

In what ways and to what extent do children's museums foster social development in students with and without disabilities over time?

As with the cognitive factors investigated in this study, examples of the social factors were also seen in the museum setting, to some extent. There were examples of: the establishment of a learning community; the social construction of knowledge; parental involvement; and play.

Establishment of a learning community: A definite learning community was established in the museum setting. Within this community, each member had their own interests and were free to pursue them during the field trips. Each member learned certain exhibits very well and other members of the community recognized and respected their knowledge. Two prime examples of this were Lab Coat #1's expertise on the BusyTown computer program and Lab Coat #9's expertise with the Hot Air Balloon. The members of the community, children and adults alike, were observed taking on the role of learner and the role of teacher. The common goal of the group was to enjoy the opportunity to explore and investigate new activities at their own pace. Each member contributed to this goal via his or her individual investigations. The atmosphere was one of cooperation, not competition.

Dialogue and the social construction of knowledge. There is only minimal evidence of students' social construction of knowledge. Individual students began to ask more questions, and the researcher and teachers often prompted students to explain what they were doing at the different exhibits. However, with the exception of Lab Coats #3 and #15, students consistently gave very terse, vague responses during interviews and on questionnaires.

The observational methods used in this study made it difficult to obtain data regarding the students' thought processes. Interviews were meant to provide more insightful information, but the students generally did not say very much during interviews.

Parental involvement. Parental involvement in this study was extremely limited. The perceptions of only one mother were available. Due to her unpredictable work schedule, it was impossible to meet with her regularly. A few informal conversations took place between the mother and the researcher when they happened to meet at the school in the morning when she dropped off her son (Lab Coat #9).

This does not mean that she is the only parent involved in her child's education. The teachers and paraprofessionals reported in interviews that many parents are concerned but cannot always participate in school activities due to having to work and/or tend to small children at home.

What was gleaned from talking with the one parent participant was that she learned a great deal about her child and his learning over the course of the project. She was pleasantly surprised by the initiative and assertiveness he demonstrated. The teachers and researcher informed her of his performance on the first three field trips, and she observed it herself on the fourth field trip. She even jokingly commented that she would no longer be able to count on him to be underfoot, right at her side, and that she would start having to keep track of him all over the place like his younger brothers. Also, Lab Coat #9 was given the opportunity to reinforce what he was learning by sharing it with his mother on the fourth field trip.

These are the findings that were hoped for in this study. However, without more parent participants and more data regarding this parent, strong conclusions cannot made regarding the effect of parental involvement on student learning. The museum certainly offers the opportunity for parents to join their children at the museum, but it is not always possible for them to take advantage of that opportunity.

The role of play. Play served a large role in the setting of the children's museum. It was viewed by both teachers and students as a place to play, just as the exhibits were viewed as things to play with. Students and teachers alike appreciated the fun and casual atmosphere the museum offered.

During the second interview, many students (Lab Coats #3, #6, #7, #10, #11, #13, #15, and #16) said the settings were different because they could play in the museum and they had to work in school. During the third interview, some students (Lab Coats #3, #4, #8, #11, #15, and #17) also reported that the settings were alike because they could read about and learn new things.

The teachers also felt that the opportunity to play did not necessarily mutually exclude the opportunity to learn. The general education teacher expressed concerns that the museum setting was too unstructured, but admitted they were still learning some things, even if "by accident." She felt that the lack of reinforcement after the field trips was more of a hindrance to learning than the opportunities to play. One paraprofessional felt that the museum offered the opportunity to learn even though the students play there. She stated, "The museum is not just playthings...like the bubble things out there where they play, it's something that they're actually learning."

Summary. All of the factors were evidenced in the children's museum. Although there was variation in the ways and extent to which they were evidenced, the children's museum can be seen as having the potential to be a successful learning environment for all learners.

Discussion of Question Three

In what ways and to what extent is learning in children's museums generalized to other settings over time?

As discussed throughout this chapter, generalization of individual differences and examples of the learning factors from the museum to the classroom setting were minimal. This was of great concern to the general education teacher. She

had hoped to see more "carry over" of both facts and skills to the classroom. She thought that maybe they had picked up some things, but couldn't tell what or to what extent from their performance or behavior in the classroom.

The special education teacher was pleased that cooperative learning skills carried over to the special education classroom, but there was no other data to corroborate this. This was not observed by the researcher or reported by the general education teacher as having generalized to the general education setting.

It was difficult to determine if the workings of the learning community seen in the museum setting were carried over to the classroom setting. Certainly a learning community existed there, but whether or not the same common goals and respect for each other's areas of expertise existed could not easily be seen. The atmosphere of the two settings were very different. In the museum, interactions between community members and between members and exhibits occurred constantly. In the classroom, interaction was limited to the teacher addressing the students and the students answering questions. Any acknowledgement of their goals, interests and areas of expertise were kept private rather than shared publicly with the group.

The general education teacher noted the great difference between the two settings during the third teacher interview:

> General Education Teacher: " Well, the museum is an extremely busy place, and the kids knew they could explore and investigate and do anything they wanted to

do. I was worried about it not being restricted enough for them. I didn't want them to go nuts. The classroom is very structured. They know that they don't just get up unless it's a given time when they can get and go sit down and read on the carpet....I don't have a center-oriented classroom. If I didn't have the constraints of time, they could visit and explore, but I don't. Most of my lessons are group interactions and discussions, so they don't have too much time during the day where they can go and do individual things."

There are two main reasons why little generalization of student differences in learning behavior may have occurred from the museum to the general education classroom setting. First, there was a great discrepancy between the learning theories and teaching styles present in the two settings. The children's museum setting was informal, unstructured, and learner-directed. The general education classroom setting was formal, highly structured and teacher-directed. The students did not have the same opportunities to display differences across settings. Secondly, the teachers may have had very different goals for the project than did the researcher. The teachers and researcher did not share perceptions of what was important in order for learning to occur. While the teachers may have viewed structure, organization, and specific activities as most important, the researcher viewed the eight research factors as most important.

Discussion of the Children's Museum Setting

Inclusion Setting

The children's museum has great potential for being a successful inclusion setting. In this study, the special education students were not specifically compared to the general education students. Even so, no significant differences were discerned between the two groups in the museum setting. All of the students enjoyed themselves and found exhibits of great interest to them. All of the students interacted with each other and helped each other. The general education students were not always the leaders or peer tutors. Special education students were often seen taking the lead at exhibits or teaching the activities to others. Examples of this include: Lab Coat #1 offering to teach the BusyTown computer program to two general education students; Lab Coat #4 taking the lead at the Ping Pong Maze and receiving praise for doing so from Lab Coat #15; Lab Coat #9 demonstrating the Hot Air Balloon for Lab Coat #3 and his mother; and Lab Coat #13 taking lead at the Delayed Speech exhibit.

In effect, it was very difficult if not impossible to identify which of the students were classified as having disabilities based on their behavior and performance in the museum. When asked, one of the Explainer Guides who worked with the group said he thought he could identify one student as requiring special education due to the student's short attention span and confusion over one of the exhibits. However, further questioning revealed that the student he was describing did not wear a lab coat. All of the students in

special education wore lab coats for all four field trips.

Supplemental Setting

The children's museum has the potential to be a very valuable setting for all students. Nonetheless, by no means is it a possible replacement for a classroom setting. It is valuable as a supplement, not an alternative. The museum setting has many aspects to offer that cannot be found in the classroom, and the classroom has many aspects necessary for learning that cannot be found in the museum. Morrissey (1989) states:

> While museums are an appealing setting, learning is also more difficult in this setting for many reasons and a large and consistent body of research has shown a lack of learning for most museum visitor (Shettel, 1973; Screven, 1974; Koran and Koran, 1986; Falk, Koran, Jr., and Dierking, 1986). Within the museum setting, the visitor is exposed to vast amounts of stimuli for very brief amounts of time and generally with little or no individual intervention between the visitor and the exhibit (Bitgood, 1988). This is contrasted to formal education where the learner is generally exposed to controlled amounts of stimuli for a greater length of time and with the support of an instructor or some type of mediator (p. 88).

Although Morrissey (1989) is speaking in regard to all museums, the same is especially pertinent when referring specifically to children's museums. In addition, Byrd (1990) says:

> There are no alternative techniques that will replace

> the need for classroom teachers and the traditional approach to instruction. However, in a classroom of up to 35 students with diverse academic and social needs, viable techniques must be available to teachers who seek the best education for their students, whether they are regular or LD students (p. 117).

Positive Attitudes

One theme that emerged from this study was the positive attitude that all participants formed of their experience with the project. The students were highly motivated by the field trips to the museum. Whenever the researcher came to the classroom to observe or meet with the teachers, the students cheered and asked if it was time to go back to the museum. They all reported that they liked the museum a great deal and that they hoped to go there with their families.

Initially, the teachers were a little overwhelmed by the busy, chaotic nature of the museum setting. The first field trip was difficult for them because their reflex was to preserve strict order and quiet in a learning environment. Once they realized it was not possible to establish the same orderliness as in the classroom or on other field trips, they accepted the "organized chaos" of a children's museum field trip. They too reported enjoying the museum and learning a great deal themselves.

Supplementing the classroom experience is not necessary for students to receive a valuable education. But, adding a new setting to the students' repertoire adds richness to the overall learning experience. It broadens the horizons of their firsthand experiences. It introduces another place to

learn and another way to love learning.

Summary

In this chapter, results were discussed as differences seen in the museum setting. The differences were seen primarily in the museum setting and very rarely in the classroom setting. Also, there is no basis for determining whether or not the differences were permanent. These differences are important and merit becoming areas of permanent developmental growth. The children's museum setting's support of inclusion should be reinforced and continued. The question now is how can the potential of the children's museum be harnessed and combined with the positive aspects of the classroom setting?

Problems with the Current Study

Lack of Preparation and Follow-Up

The limited generalization of findings from the museum to the classroom setting can be contributed to the lack of preparatory (pre-visit) and follow-up (post-visit) activities in the classroom. The teachers were not prepared for the atmosphere. This led to frustration on their part during the first field trip when they were unable to enforce usual field trip behavior rules of remaining quiet and moving about in an orderly fashion (i.e. in a single-file line). Nor were they familiar with the content of the museum. This gave them no way to present introductory material to the students to prepare them for the activities of the first field trip. All pre-project meetings between the teachers and the researcher were held at the school, assuming it was more convenient for the teachers. While more convenient, it kept them from being

fully prepared for the field trip. At least one pre-project visit to the museum by the teachers should have been arranged to give the teachers a sense of the museum's physical environment and the behavior of students on field trips. As for the content of the museum, the teachers could have been provided with a copy of Crane's (1991) *Explore and Discover: The Ann Arbor Hands-On Museum Exhibits Guide*. This guide pictures, describes and explains many of the museums exhibits within the contest of each floor's theme. This may have been helpful to the teachers in preparing pre- and post-visit lessons for the students.

The students were also poorly prepared for the field trips. Research indicates that students' experiences are more enjoyable and educational when they know what to expect on a field trip (Bitgood, 1990; Falk & Dierking, 1992; Kubota & Olstad, 1991). Had they known what to expect prior to the first field trip, they may have been able to spend more time concentrating on the exhibits than orienting themselves to the surroundings.

Also, information gleaned from follow-up questionnaires and interviews with the students was sparse. Most of the students were unable to write more than a couple words as their responses to the questionnaires, and most students gave very terse, vague answers on the interviews. Continued questioning meant to elicit more informative answers usually elicited shrugs or silence. A better way for this class of students to express what they experienced in the museum would have been to implement dialogue journals. Rather than having to answer on-the-spot, they could have written or drawn in

their journals whenever they remembered something from he museum. Discussing their entries with the researcher on a regular basis may have given them a more comfortable forum to open up. Talking about their writings and drawings would have been easier for them than recalling information out of the blue.

Lack of Parental Involvement

It is true, there was very little that could have been done differently to encourage parents to chaperone on field trips or meet with the researcher to talk about what the children were carrying over to the home setting. Several informal notes and phone calls were made, to no avail. Efforts to communicate could have been made even if they weren't in person. Dialogue journals taken home every night or every weekend would have been one way to let parents know what their children were learning and what they were connecting with experiences at home. Having the parents comment on their children's writings would have given the researcher information about the parents' perceptions. In addition, a two-way notebook could have been sent home regularly with the children as a means for communication between the researcher and the parents who could not meet at school or attend field trips.

Absence of Documents

One of the resources of data outlined for this study was the collection of documents or student work samples that indicated generalization between the museum and the classroom settings. No documents were gathered during the course of the project. The teachers were asked to compile any

participating student's work or copies of their work that indicated a connection between the settings. They also volunteered to keep notes about the students' comments during class discussion and while they were socializing that may have indicated they were making connections.

However, this was not done. Regardless of the efforts on the part of the researcher to remind the teachers of this aspect of data collection, perhaps more could have been done to help the teachers with the task. A bin could have been provided by the researcher that was clearly labeled for student work samples that reflected museum experiences. Perhaps a constant, physical reminder may have increased the possibility of documents being collected. Perhaps providing the teachers with a form to complete regularly would have encouraged them to tune into and record the students' comments.

Another reason why the teachers may not have saved documents is because they had a different notion from the researcher of what constituted a significant piece of data. Of all the documents the teachers did not save because they did not feel they showed a connection to learning in the museum, the researcher may have found some of them useful. A shared notion of useful data should have been derived between researcher and teachers prior to the onset of the project.

<u>Lack of Consistency with Explainer Guides</u>

In order to establish consistency on the field trips to the museum and to obtain the perceptions of museum staff who had worked closely with the class over the course of the project, it was hoped that the same two Explainer Guides

would be present at all four field trips. However, despite the efforts of the museum's Volunteer Coordinator who assigns Guides to school groups, there was poor consistency in this area. Scheduling difficulties and last-minute problems made it impossible for the same two young men to be present each time. Both Guides, students at the University of Michigan, were present for the first field trip. Guide #2 was ill and could not attend the second. Guide #1, who did attend the first two trips could not schedule a time for an interview, so he completed a lengthy written questionnaire instead. At this time, he began an out-of-state exchange program and was no longer an active museum volunteer. Neither Guide was able to attend the third field trip, and only Guide #2 attended the fourth field trip. Many efforts were made to schedule an interview with Guide #2, to no avail. He did not return several phone calls or written questionnaires that were sent to him. Although no suggestions are made that could have changed the outcome of this situation, it is acknowledged as an important limitation to the study.

Large Sample Size and Number of Variables

For the purpose of this study, to explore all the ways in which a children's museum could be a successful learning environment for students with and without disabilities, many different variables were investigated and many participants were studied. Although this provided insight into many aspects of learning in such a setting, it made it extremely difficult to investigate any one variable in depth. In future studies, where evaluating the effectiveness of specific programs may be the purpose, fewer variables should be investigated with fewer participants to yield more detailed data.

A Successful School-Museum Program

Learning Environment Continuum

Before describing what a successful school-museum program might look like and how it might remedy some of the problems discussed above, it is important to discuss the idea of a "learning environment continuum." The concept of a learning environment continuum stems from the ideas put forth by Morrissey (1989) and Byrd (1990). Museums offer exposure to large amounts of stimuli for brief periods of time, while classrooms offer exposure to controlled amounts of stimuli for longer amounts of time. Stimuli in museums are not usually mediated, while stimuli in classrooms are always mediated by a teacher.

On one end of the continuum is a formal environment that is highly structured with preset goals for all learners. The goals are not made by the learners. The learners have little or no control over their own learning in this situation. The teacher, or perhaps even an administrator, controls what is to be learned. The learners are not given the opportunity to make their own decisions or choose their own activities. Lessons are not modified to accommodate the various learning styles, rates, and ability levels of the learners.

On the other end of the continuum is an informal environment where no structure is imposed at all. There are no preset goals for learning. The learners in this situation have complete control over their own learning and what is to be learned. The learners set their own goals and choose

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On the other end of the continuum is an informal environment where no structure is imposed at all. There are no preset goals for learning. The learners in this situation have complete control over their own learning and what is to be learned. The learners set their own goals and choose

their own activities, based on their interests, learning styles, rates and ability levels.

Neither end of this continuum is conducive to successful learning. The situation on the first end is too restrictive, and the situation on the second end is too relaxed. While preset goals and curriculum are not appropriate and supportive for all learners, some guidance or mediation by a more knowledgeable other is needed for learners to advance their learning.

The classroom in this setting lies very close to the first end of the continuum. The setting is very structured. The curriculum and goals for most of the students are set preset by people other than the learners. The learners are not given the opportunity to choose their own activities or evaluate their own learning. Lessons are modified for ability level and learning rate, but not for learning style. The children's museum setting lies very close to the opposite end of the continuum. There is very little structure, other than the field trip plan. There are intended goals and activities for each exhibit, but learners can choose to modify or completely abandon these goals and replace them with their own. The learners control their own experiences based on their interests, preferred learning styles, and present ability levels.

A successful school-museum program would reflect a "happy medium" on the continuum. At this point on the continuum, interesting, motivating exhibits and learner choice and empowerment would be combined with individualized goals and mediation by a more knowledgeable other.

The Program

Based on what I learned from conducting this study, I propose here several components of a school-museum program. I feel this proposed program would be effective in facilitating cognitive and social development in students with and without disabilities.

Combining formal and informal environments. An effective program would combine the benefits of both the museum (hands-on experiential exhibits; open, inviting space; experienced staff members; community resources) and the classroom (curriculum areas on which to concentrate; short-term and long-term academic and social goals; measures of student performance; evaluation of student progress). Perlmutter and Burrell (1995) describe such a program as "a learning web that supports integrated learning, formal and informal" (p. 16). Each setting has benefits that cannot be denied. From the current study I learned that the museum sometimes offered the students too much freedom, and the classroom generally offered too little. Also, there was little way of assessing what the students learned about the exhibits and science concepts because no performance measures were conducted.

Repeat visits to the museum. The notion of repeat visits is very important for learning to occur. Many visitors, teachers, and parents view repeating visits as repeating the exact same experience. In fact, each visit holds a new experience that is different from and builds on the last experience. It is important for all those involved, including the students, to realize that each visit has a purpose. The purpose of initial visits is to familiarize oneself with the learning environment. Just as new kindergartners need to familiarize themselves with the workings of a classroom environment, new visitors need to familiarize themselves with the workings of the museum environment before learning can take place. The purpose of later visits is to to concentrate on new stimuli and information and to continue to build on experiences to form new knowledge. All those involved must also realize that the process in highly individualized. Some visitors can feel very familiar with a new environment during the first visit, while others may need to return a few times before they feel comfortable with the surroundings.

Preplanning. The program should begin with extensive planning between teachers and museum staff. The teachers need to know the physical layout of the museum, the exhibits that are available and the scientific concepts that the exhibits illustrate. The museum staff needs to know the daily and weekly schedule of the classroom, the abilities and needs of the students, and the curriculum the teachers are required to cover.

Once this information is shared among teachers and museum educators, a plan needs to be outlined that intertwines museum exhibits, demonstrations, workshops and outreach kits with school curriculum and students' abilities. In the classroom setting, the teachers would introduce concepts with preparatory lessons and/or outreach kits. Once a foundation of the concept is established and the teacher has evaluated what each student needs to incorporate and master the new knowledge, the class would visit the museum. The visit should be structured so that the students focused on certain exhibits for longer periods of time and perhaps attend a demonstration or workshop. These exhibits, demonstrations, and workshops would serve to reinforce and elaborate upon the lessons introduced in the classroom. After the museum visit, the teacher needs to follow up in the classrooms with culminating lessons and/or outreach kits.

It is important that the museum visits not be seen as "add-ons," or simply an extra experiences for the students. Rather, they should be seen as integral parts of the classroom schedule (Institute of Museum Services, 1996). Bitgood (1990) describes how to get the most out of visits to the museum with these guidelines: (1) integrate the museum program into the school curriculum; (2) conduct a front-end evaluation of student knowledge, interest, and experience; (3) prepare students for the setting and agenda; (4) prepare students with pre-visit activities in the classroom; (5) make the field trip experience-driven rather than information-driven; (6) design on-site museum activities with care; (7) test the impact of the program as it develops; (8) follow-up with post-visit activities; and (9) minimize behavior problems by planning how they will be handled.

In the current study, the teachers did not know what to expect any more than the students did. As a result, the teachers felt ill-equipped to prepare the students for the field trips. Research on better field trips points out that students learn more when they know what to expect and when they are provided with preparatory lessons (Bitgood, 1990).

Also, the teachers were frustrated in the beginning over the surprisingly free environment of the museum. Finally, the museum staff did not know what the students were studying in school or what their academic goals were, so they could not plan any demonstrations or workshops for reinforcement.

Supporting teachers in change. Establishing a long-term program with a community resource such as a children's museum is a monumental change in practice for many teachers. Current research on school reform and change in teacher practice discusses many issues that must be addressed in order for efforts of change to be successful and long-lasting.

First, it must be recognized that change in structure (e.g. new school-day schedule or longer class periods) does not automatically bring on change in practice (Elmore, 1992, 1995). For example, implementing a new schedule that includes visiting a children's museum regularly does not necessarily mean that teachers will change their practice to integrate classroom learning with museum learning.

Second, it must be recognized that teachers are not solely responsible for the success of change efforts (Sykes, 1996; Wilson, Peterson, Ball & Cohen, 1996) and that teachers need support from all levels (Elmore, 1992; Schifter, 1996; Sykes, 1996; Wilson, Peterson, Ball & Cohen). In other words, teachers need support from peers, administrators, policy makers, university researchers, museum staff, and parents. Peer support and self-reflection are crucial to the process of successful change (Schifter, 1996; Sykes, 1996). Teachers cannot implement new practices on their own and expect to incur the intended results. On the Early Literacy Project, teachers implementing the new literacy curriculum were supported and advised by other teachers and by university researchers for up to four years.

Third, once changes in practice are in place, they should not become part of a fixed routine. Following constructivist theory, new practices should be continually modified and developed to meet the continually growing and changing needs and knowledge of teachers and learners (Schifter, 1996). Teachers also need to be self-regulating, independent learners as do their students.

Fourth, it must be recognized that change brings discomfort and discontinuity to those who are involved. Change may cause teachers to feel that they have to weigh "what works" against "what they are expected to do." Open communication, shared goals among all participants, administrative support, and recognition of their constraints by museum staff are important in helping teachers work through the discomfort and discontinuity (Sykes, 1996).

<u>Ongoing evaluation of student learning.</u> Throughout the course of the program, students' ability levels must be evaluated regularly. When this is done, the students can be continually scaffolded and gently challenged in both settings in order to further their knowledge at critical points in the learning process. Also, the learning styles, rates and ability levels of each student must be continually evaluated. In this way, instruction can be provided that is responsive to individual need and preference. Evaluation of student understanding must occur regularly during the program to

ensure that students are developing correct conceptions of the scientific concepts. Any misconceptions should be addressed and corrected as soon as possible. Since students build new knowledge on existing knowledge, misconceptions can lead to further incorrect learning.

In this study, no performance measures were employed to accurately assess the students' learning or their conceptions of the scientific phenomena. Responses by the students in interviews and on questionnaires did not provide insight into their understanding or knowledge.

Background knowledge of students. The teachers and museum staff must be careful not to assume, based on their own experiences what is meaningful or familiar to the students. They must continually determine the background knowledge of each student in order to match it with exhibits and activities that will be meaningful to them.

Opportunities for self-regulation. In both settings, there would need to be many opportunities for students to regulate their own learning by making some decisions about their own learning. At the same time, the students should have guidance in learning how to make appropriate decisions that will further their independence and metacognitive knowledge of their own learning processes.

There were many examples of self-regulating behavior by the students in the museum setting. However, this was not the case in the classroom setting, so this ability was not reinforced. Students should associate choice, decision-making, and empowerment with learning, not only with a particular setting.

Reinforcement of learning and learning skills. In order for learning skills such as problem-solving, divergent thinking, systematic investigation, scientific inquiry to become lifelong skills, modeling and other scaffolds must be in place for students to develop and use them successfully. Once they appear, these skills need to be reinforced and encouraged in both settings so that they will not be extinguished.

The teachers in the current study were aware that many of the students preferred and benefited from hands-on activities, such as those offered in the museum setting. They also acknowledged the difference it made in those students' performances in that setting. However, little was done to also provide those experiences in the classroom, so that the students could benefit across learning environments. The teachers did not have a systematic way of observing individual students in the museum setting to determine when they were demonstrating new abilities. Thus, many opportunities to for them to evaluate the students' ZPDs and support them in new learning were missed.

Establishment of learning communities. To establish a learning community in both settings, the students need to be provided with opportunities to work collaboratively in both settings. All members of the community should be given opportunities to help each other, and to take on the role of teacher as well as learner. All members should be recognized for their strengths, interests and areas of expertise. Both settings can then be atmospheres of collaboration, not competition.

The learning communities were very different across the two settings in this study. Students often had the opportunity to take on the role of expert in the museum, but rarely had a chance to do so in the classroom. This caused the community that was beginning to form in the museum to stagnate, because it was not nurtured in the classroom.

Dialogue. Opportunities for dialogue should pervade every aspect of the program. In order for new knowledge to be socially constructed, students need to talk and ask questions about their activities, their observations, and their thought processes. They need to be scaffolded regarding the kinds of questions to ask about activities and about their own learning. The use of dialogue journals in the program would offer the students a method of expressing and recording their learning in an on-going, written yet public format with peers and adults.

Dialogue and social interaction is the first step toward cognitive development. In the current study, when students were observed interacting, talking, questioning, responding, or explaining, they were beginning to develop new knowledge. Opportunities for this need to occur all the time.

Involvement of parents and families. It is important to any school-museum program to involve the parents and families of the learners. Efforts must be made continually to solicit parental involvement. When it is not possible for parents to participate in person, they must still stay involved with the happenings of the programs via the dialogue journals and newsletters.

Lab Coat #9's mother did learn important information about her son's learning that she could reinforce in the home environment. This is crucial to his education.

Play. Finally, play must serve a role for a program to be successful. There needs to be many opportunities for individual and group play in both settings. At the end of each structured visit to the museum, the students should have free time to explore. Outreach kits, centers, and genuine free time provide opportunities for play in the classroom.

The students in this study saw the museum as a setting for play. However, this did not keep them from also seeing it as a setting for learning. Increased enjoyment through play leads to greater motivation, which could lead to more successful learning.

Implications for Future Research

I am very pleased with the several aspects of the current study. It demonstrated that children's museums can be successful inclusion environments. The students left this project with positive attitudes about children's museums, science, learning, and working together. All of the students showed some type of difference over time, although very subtle in some cases.

I am also disappointed with some aspects of this study. I expected to see more generalization of new learning from the museum setting to the classroom setting. I hoped for more consistency with the Explainer Guides. I hoped for the teachers to be more comfortable with me as a researcher and with implementing reinforcing activities in the classroom. I expected there to be more parental involvement. Finally, I hoped to obtain more examples of the students' classwork and

to obtain more information from them in interviews and on questionnaires.

I would like to continue my research with teachers, museum staff, and parents. I am excited to implement different programs to assess their success with students with learning disabilities. After conducting this study, I feel even more strongly that children's museums are a valuable asset to the village that raises our children.

One question must be answered in order for future research in this area to be more effective. What can be done by researchers, teachers, parents, and students to facilitate the greatest differences in learning over time and across settings for the greatest number of learners?

Researchers, teachers, parents, and students must share the same goals and vision. One drawback in the present study was the fact that the researcher formed the goals and vision for the project without involving the teachers, parents, or students. While my goal as the researcher was to seek out evidence of the eight research factors, the goals of the teachers and parents may have been to see definitive gains in science knowledge, and the goals of the students may have simply to have fun without focusing on what, how and why they were learning.

I, as a researcher, must understand what is important to teachers, parents, and students and help them to understand what is important to me. Rather than impose my vision of important learning factors on them, I must share my knowledge with them and share in dialogue that will help them construct a working knowledge of the research factors and of social constructivist learning theory. This working knowledge would be based on their previous knowledge and experience. At the same time, they would share their knowledge with me so I can construct new knowledge as well. No party can force their ideas or knowledge on the others and hope for a shared vision. The "old" visions must come together to form one "new" vision. In this way, all parties see their ideas in a different light. For instance, teachers may come to share the vision that social interaction does not distract from academic success, but may actually facilitate cognitive development. The researcher may come to see that teacher-directed activities do not rob the students of choice and empowerment, but can actually be a form of scaffolding.

It is important to also recognize that changes in structure do not necessarily lead to changes in theory or practice and then to changes in student learning (Elmore, 1995). Changing structures or schedules is highly visible yet highly superficial. Just as in this study, sending a class of students on regularly-scheduled field trips to a children's museum did not ensure that the teachers would incorporate the theories and styles of the museum into their classrooms, that they would employ similar activities in their classrooms, or that the students would demonstrate significant cognitive and social gains across all settings. Elmore (1995) suggests that:

> the relationships between structural change in schools and changes in teaching and learning are mediated by relatively powerful factors, such as the shared norms, knowledge and skills of teachers, and that changing

structure has a slippery and unreliable relationship to these mediating factors (p. 26).

Therefore, the establishment of a new program structure is just the beginning, or perhaps should be just the endpoint. What needs to come before and during is the construction of shared goals and visions regarding successful learning for all students.

Chapter Summary

This study was successful in that it served the intended purpose of exploring the potential of a children's museum to be a successful learning environment for students with and without disabilities. The data collected established that all of the factors to be investigated were present in the museum setting. A children's museum such as the Ann Arbor Hands-On Museum can help all students develop both cognitively and socially.

However, in order to be most effective and successful, programs must be initiated that combine the benefits of the children's museum with the benefits of the classroom. Studies must be done to determine the effectiveness of these programs, studies that implement qualitative and quantitative methods of data collection. Case studies of individual students examining a few of the variable at a time would provide researchers with a clearer picture of student learning in children's museums. This study did establish the potential of children's museums as it set out to do, and it also established the need for future research, carefully planned school-museum programs, and more precise, in-depth investigation of these programs.

APPENDICES

APPENDIX A

Appendix A

Consent Forms and Announcements

Consent Form for Adult Participants

For questions about this study, please contact:
Whitney Hosmer Rapp; K. Elementary School

Description: You are invited to participate in a research study examining how children's museums can be successful learning environments for all students, especially those with learning disabilities who may learn differently or with more difficulty than others. The study will look at different learning factors that are in place in children's museums (play, parental involvement, learning communities, self-regulated learning and choice, dialogue, and different learning styles) and how these factors can help learners be more successful. The study will also look at the extent to which learning in the children's museum is carried over to the classroom setting. I plan to videotape observations in the children's museum and in the classroom. I also plan to audio tape interviews with each participant four different times about their experiences; distribute questionnaires after each museum visit; and collect student work samples from the classroom. All tapes will be coded so identity is kept confidential. Only I will see or hear the tapes and only pseudonyms (or no names at all) will be used in written reports of the data. All video tapes will be kept in a secure place and all audio tapes will be destroyed after they are transcribed.

Risks and Benefits: There is the risk that negative comments made about someone or something could be identified and be reacted to in a negative manner. Since all information will be kept confidential, this risk is very small. However, the benefits are many. This study will help find out more about what makes a successful learning environment for all students, especially those with learning disabilities. Parents will have an opportunity to spend more time with their children and learn more about their children's learning styles. Most of all, trips to the children's museum are fun and exciting!

Time involvement: Field trips will take place about one half-day per month from November to January (four field trips). Classroom observations will take place one full school day for each field trip (four school days). Each interview will last 20-30 minutes. Each person in the study will be interviewed four different times (early November, mid December, late January, late February). The questionnaires will be handed out at the end of each field trip and can be completed in five to ten minutes.

Payment: You will not be compensated for agreeing to participate in the study.

Subject's Rights: Please understand that your participation is voluntary and you have the right to withdraw at any time without penalty. You have the right to refuse to answer any questions or participate in any part of the study. Your privacy will be maintained in all published and written data resulting from the study.

The extra copy of this form is for you to keep.

Signature: ______________________________
Date: ______________________________

Consent Forms for Minor Participants

For questions about this study, please contact:
Whitney Hosmer Rapp; K. Elementary School

Description: Your child has been invited to participate in a research study examining how children's museums can be successful learning environments for all students, especially those with learning disabilities who may learn differently or with more difficulty than others. The study will look at different learning factors that are in place in children's museums (play, parental involvement, learning communities, self-regulated learning and choice, dialogue, and different learning styles) and how these factors can help learners be more successful. The study will also look at the extent to which learning in the children's museum is carried over to the classroom setting. I plan to videotape observations in the children's museum and in the classroom. I also plan to audio tape interviews with each participant four different times about their experiences; distribute questionnaires after each museum visit; and collect student work samples from the classroom. All tapes will be coded so identity is kept confidential. Only I will see or hear the tapes and only pseudonyms (or no names at all) will be used in written reports of the data. All video tapes will be kept in a secure place and all audio tapes will be destroyed after they are transcribed.

Risks and Benefits: There is the risk that negative comments made about someone or something could be identified and be reacted to in a negative manner. Since all information will be kept confidential, this risk is very small. However, the benefits are many. This study will help find out more about what makes a successful learning environment for all students, especially those with learning disabilities. Parents will have an opportunity to spend more time with their children and learn more about their children's learning styles. Most of all, trips to the children's museum are fun and exciting!

Time involvement: Field trips will take place one half-day per month from October to January (four field trips). Classroom observations will take place one full school day for each field trip (four school days). Each interview will last 20-30 minutes. Each person in the study will be interviewed four different times (mid October, late November, early January, late February). The questionnaires will be handed out at the end of each field trip and can be completed in five to ten minutes.

Payment: You or your child will not be compensated for agreeing to participate in the study.

Subject's Rights: Please understand that your child's participation is voluntary. Your child has the right to withdraw at any time without penalty, refuse to answer any questions or participate in any part of the study. Your child's privacy will be maintained in all published and written data resulting from the study.

The extra copy of this form is for you to keep.

Signature: ______________________________
Date: ______________________________

Sample dialogue for explaining study participation to students

I will be working with you in the children's museum and in your classroom for four months. During that time I will be videotaping what you do in both places, I will be asking you some questions as you do your everyday things, and I will be pulling you aside to tape-record interviews with you (to ask you some extra questions I might not get a chance to ask you while you do the everyday things).

I am doing all these things because they will help me find ways to make learning more fun and successful for students your age. Some students have more difficulty learning than other students, and I want to find a way to help all students learn well and to have fun learning. I think that children's museums are good places to learn and to have fun. That is why we will be going there in addition to me coming to your classroom. I will not be watching you or talking to you for a grade or to report behavior to your teacher or parents.

I am the only person who will see or hear the tapes I make. There may be some time for me to show the video tapes to your class, but I will never show them to anyone who is not part of this project. That's called confidentiality. When I share my ideas and the results of the project with other people, I will use pseudonyms (pretend names) for everybody or leave your names out altogether.

If you have any questions about what I am doing or what you are supposed to do and why, please ask me at anytime. I want to make sure you understand everything you do for the project. I appreciate you volunteering to help me with the project. If at anytime you do not want to participate, or if I ask a question you do not want to answer, just tell me. You do not have to anything you don't want to do.

Public Information Sign for Museum Entrance

During your visit today, you may notice video cameras set up at certain exhibits and a college student traveling around the museum with a video camera. The college student's name is Whitney Rapp. She is from Michigan State University. She is studying the Ann Arbor Hands-On Museum and all the different things that children can learn here.

She is only watching and recording a certain group of students who came here with her today. The cameras will only be turned on when those students are in the area. If you happen to get in the picture, that's okay. Whitney will be glad to see you enjoying the exhibits with other children, but she will only be writing about the students who came here with her today.

If you do not wish to be videotaped at all, please let Whitney know or have another museum staff member let her know. She will be glad to stop recording while you are in the area.

Thank you for your cooperation. We hope you are as excited as we are to find out more about how hands-on science museums can help children learn and grow! If you are interested in reading Whitney's findings, please write to her at:

341 East Washington Street
Howell, Michigan 48843

APPENDIX B

Appendix B

Interview and Questionnaire Protocols

First Student Interview

1. What is your name, age, and grade?
2. Whose class are you in?
3. Have you ever been to the Ann Arbor Hands-On Museum before?
4. What do you think you will see/do there when we visit?
5. What are your favorite subjects? Why
6. What are your least favorite subjects? Why?
7. What do you learn in school?
8. What do you think you will learn at the Hands-On Museum?
9. What do you like best about school? Why?
10. What do you like least about school? Why?
11. What is easy for you in school? Why?
12. What is difficult for you in school? Why?
13. Have you ever visited the Hands-On Museum with your parents or family?
14. Who do you like to be with in school?
15. If you could pick three other students to work with in school, who would you pick?
16. Do you have anything else you wanted to say or ask?

Second Student Interview

1. What are your favorite subjects in school? Why?
2. What are your least favorite subjects? Why?
3. What kinds of things do you do in school?
4. What kinds of things do you do at the Hands-On Museum?
5. What do you learn in school?
6. What do you learn in the Hands-On Museum?
7. How are school and the museum alike?
8. How are school and the museum different?
9. What do you like best about school? Why?
10. What do you like least about school? Why?
11. What do you like best about the museum? Why?
12. What do you like least about the museum? Why?
13. What is easy for you in school?
14. What is difficult in school for you?
15. What is easy for you in the museum?
16. What is difficult for you in the museum?
17. What do you talk/ask about in the museum?
18. Who do you like to be with in school?
19. Who do you like to be with in the museum?
20. If you could pick three other students to work with in school, who would you pick?
21. If you could pick three other students to work with in the museum, who would you pick?
22. If you could bring one exhibit home with you from the museum, which one would you pick?
23. Do you have anything else you want to say or ask?

Third Student Interview

1. What do you like to do best in school? Why?
2. What do you like to do least in school? Why?
3. What do you like best about the Hands-On Museum? Why?
4. What do you like least about the Hands-On Museum? Why?
5. What is your favorite exhibit at the museum?
6. What does the exhibit do/How does it work?
7. What other exhibits do you remember form the museum?
8. What do they do/How do they work?
9. Who do you like to be with at the museum?
10. Who do you like to be with at school?
11. What do you talk/ask about at the museum?
12. Does anyone help you at the museum? Who? How?
13. Do you help anyone at the museum? Who? How?
14. Does anyone help you at school? Who? How?
15. Do you help anyone at school? Who? How?
16. How are school and the museum alike?
17. how are school and the museum different?
18. Do you have anything else you want to say or ask?

Fourth Student Interview

1. What do you like to do best in school? Why?
2. What do you like to do least in school? Why?
3. What do you like best about the Hands-On Museum? Why?
4. What do you like least about the Hands-On Museum? Why?
5. What is your favorite exhibit at the museum?
6. What does the exhibit do/How does it work?
7. What other exhibits do you remember from the museum?
8. What do they do/How do they work?
9. Who do you like to be with at the museum?
10. Who do you like to be with at school?
11. What do you talk/ask about at the museum?
12. Does anyone help you at the museum? Who? How?
13. Do you help anyone at the museum? Who? How?
14. Does anyone help you at school? Who? How?
15. Do you help anyone at school? Who? How?
16. How are school and the museum alike?
17. How are school and the museum different?
18. What can you tell me about the activity we did in class together the last time I visited?
19. Do you have anything else you want to say or ask?

First Teacher Interview

1. What is your name and what grade do you teach?
2. How many years have you been teaching? This grade? In this school?
3. What experience do you have, if any, with the Ann Arbor Hands-On Museums?
4. What is the usual nature of field trips for your class?
5. How do you apply field trip experiences to your classroom?
6. What expectations do you have for this project?
7. what are your short and long term goals for your students?
8. What role do you see the Hands-On Museum playing in your students' education?
9. What do you hope to learn as a teacher from this experience?
10. What factual knowledge, if any, do you expect your students to gain?
11. What learning skills, if any, do you expect your students to gain?
12. What use, if any, do you expect to make of museum outreach program, kits, and workshops?
13. To what extent do you see yourself collaborating with museum staff and parents?
14. To what extent are parents involved in your classroom?
15. Can you describe the atmosphere of your classroom? How do you expect that to compare to the atmosphere of the museum?
16. Describe the learning styles of your students. To what extent do you expect those styles to be supported in the museum?
17. Do you have any additional comments or questions?

Second and Third Teacher Interviews

1. What role do visits to the Hands-On Museum play in your students' education?
2. How do you tie museum visits into classroom learning?
3. What are you learning as a teacher from this experience?
4. What factual knowledge, if any, are your students gaining?
5. What learning skills, if any, are your students gaining?
6. What use, if any, are you making of museum outreach program, kits, and workshops? What would make it easier for you to do so?
7. What general/individual differences do you see in your students from field trip to field trip?
8. Do students make references to museum experiences when in the classroom?
9. To what extent are the learning styles of your students being supported in the museum?
10. Do you have any additional comments or questions?

Written Interview for Special Education Teacher on Leave

1. What goals (academic, social, emotional) have your students been working toward this year?
2. What role, if any, do you see the Hands-On Museum playing in helping your students reach these goals?
3. Has the experience of this project impacted your classroom in any way? Please explain.
4. What have you, as a teacher, learned from this experience?
5. What factual science knowledge, if any, have your students gained from their visits to the Hands-On Museum? Do they carry this over into the classroom setting? If so, in what ways?
6. What learning skills, if any, have your students gained? Do they carry this over to the classroom setting? If so, in what ways?
7. What advantages do you see for on-going school-museum visits? What disadvantages do you see?
8. Do you have any plans to use of outreach, kits, workshops or museum programs in your classroom in the future?
9. To what extent do you see your self collaborating with parents and museum staff in the future and is this different from the past?
10. How would you describe the atmosphere provided by the Hands-On Museum? Is this different or the same as the classroom environment? Please explain.
11. Has the students' "talk" in the Hands-on Museum changed over the course of the project?
Have the questions they ask you and each other changed? Please explain.
12. Have the students' interactions with the exhibits changed? Please explain. Have their abilities changed? Please explain.
13. What kinds of decisions do the students make in the Hands-On Museum? What goals do they have? Who regulates these decisions and goals (teachers or students)?
14. Describe the learning styles of your students. Are these styles supported in the Hands-On Museum?
15. Do you have any other comments to add?

Interview with Museum Volunteer Coordinator and Education Director

1. What is your name, position and experience with the Ann Arbor Hand-On Museum?
2. What are your goals and procedures for school group visits?
3. What are your expectations with regard to this project?
4. What learning characteristics do you expect from this group of students?
5. Can the museum support these learning characteristics? How?
6. How important do you view on-going school-museum partnerships?
7. How important do you view parental involvement in education?
8. Does the museum support parental involvement? how?
9. What advantages/disadvantages do you see for school group visits to the museum?
10. What type of atmosphere does the museum offer?
11. What effect does that have on learning?
12. To what extent do the exhibits relate to the everyday lives of children?
13. Do you have any additional comments or questions?

Written Interview for Explainer Guides

1. What is your name and position?
2. What is your experience with the museum?
3. What are your goals and procedures for school group visits?
4. What type of atmosphere does the museum offer?
5. What effect does this atmosphere have on student learning?
6. Do the exhibits in the museums relate to the everyday lives of students?
7. What differences, if any have you seen in the way these students approach and interact with exhibits? Interact with each other and adults? Talk/ask about exhibits? Behave overall?
8. What role do you play during field trips?
9. What role do the teachers/chaperones play?
10. Have you been able to identify any students in this group who are classified for special education? Explain.

Student Questionnaire Form

1. What did you see/do in the children's museum today?
2. What was new for you today?
3. What was your favorite thing? Why?
4. What was your least favorite thing? Why?
5. Did any one help you in the museum today? Who? How did they help you?
6. Did you help anyone today? Who? How did you help them?

Adult Questionnaire Form

1. What differences, if any, have you noted in the students' behaviors, interactions since their last visit?
2. Did the students try anything new today? What was it? With whom?
3. What questions, if any, did the students ask you today?
4. What was your role in the children's museum today?

APPENDIX C

Appendix C

Schedule of Data Collection Procedures

Day	Date	Time	Setting	Data Collected
Tuesday	Oct. 1	3 - 3:30 pm	School	Preliminary meeting with teachers, principal, and museum staff members.
Tuesday	Nov. 5	9 - 11:45 am	School	Addressed entire class regarding details and procedures of study. First interveiw with ten students.
		12 - 2:00 pm	Museum	Interviewed Volunteer Coordinator.
Thursday	Nov. 7	9 - 10:00 am	School	First interview with special education teacher and two students.
		10:30am-noon	Museum	Interviewed Educational Director.
Tuesday	Nov. 12	9 - 11:00 am	School	First interview with two paraprofessionals and one student.
Thursday	Nov. 14	8:15-9:15 am	School	First interview with general education teacher and one paraprofessional. Provided students with lab coats and briefed them regarding first field trip.
		9:30am-3pm	Museum	Prepared cameras and sign for field trip. Field Trip #1 from 1:00 - 2:30 pm.
Tuesday	Nov. 19	8:30-9:30 am	School	First interview with three students who were late returning consent forms.
Thursday	Nov. 21	8:30am-3pm	School	First classroom observation.
Thursday	Dec. 12	9 - 9:30 am	School	Conversation with one parent.
		10am-2:30pm	Museum	Prepared cameras and sign for field trip. Received 50 passes from Executive Director. Field Trip #2 from 1:00 - 2:30 pm. Explainer Guide completed written interview (chose not to do oral interview on tape).
Tuesday	Dec. 17	9am - 12pm	School	Second interview with fifteen students.
Tuesday	Jan. 7	9am - 2pm	School	Second interview with special ed. teacher. Second classroom observation.
Thursday	Jan. 16	1:15-2:45pm	Museum	Field Trip #3.
Thursday	Jan. 23	9am-2:30pm	School	Third classroom observation.
Thursday	Jan. 30	1:15-2:45pm	Museum	Field Trip #4.
Mon.-Fri.	Feb. 3-7			Special education students gone to Special Olympics
Friday	Feb. 7			Special education teacher begins medical leave.
Tuesday	Feb. 11	9:30-11:30am	School	Third interview with fourteen students.
Thursday	Feb. 13	8:30am-3pm	School	Third interview with general education teacher and two students. Written interview sent to special ed. teacher and one paraprofessional. Fourth classroom observation. Conducted ocean life activity with class.
Thursday	Mar. 13	9am - 12pm	School	Fourth interview with seventeen students.

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