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Science Learning Museums as an Extension of the Elementary Classroom

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SENIOR THESIS APPROVAL SHEET

This Honor's thesis entitled

"Science Learning Museums as an Extension of the Elementary Classroom"

written by

Aaron Ward

and submitted in partial fulfillment of the

requirements for completion of the

Carl Goodson Honors Program

meets the criteria for acceptance

and has been approved by the undersigned readers

Thesis Director

Second Reader

Third Reader

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Science Learning Museums as an Extension of the Elementary Classroom

Carl Goodson Honors Program
Aaron Ward
Tuesday, April 15, 1997

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"Like a balloon that once blown up never shrinks to its former size, the dimensions of a child's world are forever enlarged by a visit to a museum."

-Teach the Mind, Touch the Spirit

Introduction

The lack of good science education in the American school is a problem that will affect the future of the United States. Not only is the decline of science-based teaching of elementary school students due to lack of funds and increase of class size, it is caused by a deficiency of creative teaching methods. One possible method that has and can be cultivated and developed is the use of Science Learning Museums (SLM) as effective teaching tools. The integration of classrooms and science museums can bring about positive, creative, fun, and exciting ways to learn, bringing an unenthusiastic textbook example to the interesting possibility of the real world in which students live. The cooperation that a classroom and a science museum must attain is difficult work, involving many hours and many intricacies. The museum's ability to provide the right experience for the student is a crucial component of an integrative and creative learning system. This thesis will deal with the development of SLMs, students' learning in museums, how teachers can make use of museums, how museums can help teachers to provide an excellent education, examples of existing and working school/museum partnerships, and the importance of independent, lifelong learning.

Many elementary teachers go through their careers teaching students a wide variety of subjects. These teachers impart knowledge regarding reading, mathematics, language skills, and science. However, many teachers find that the science part of the curriculum is a dreaded drudgery. Usually attempting to understand the concepts themselves, the teachers become frustrated trying to create lesson plans and activities to present the information to the students in an organized and coherent manner.

Meanwhile, museums have become widespread and very specialized; one specialization is the Science Learning Museum (SLM), which is a center designed to create in children and parents an interest and an understanding of science by using interactive and hands-on exhibits. These museums are designed to intrigue, entertain, and teach people, especially children, about science, by bringing concepts together with interesting and eye-opening experiments or demonstrations. Unfortunately, the SLM is being underused as a teaching tool. Visits to SLMs are normally a playday, with little structure. A fast-growing idea in education and museum work is the combination of science lessons with visits to an SLM. This cooperation between classrooms and museums will hopefully allow the goals of the teachers and the museum educators to be met. Teachers will have a useful resource to lessen the chances of a failed unit on potential and kinetic energy, while eliminating or at least alleviating their own fear of science. Museum educators will have for their didactically designed exhibits a willing audience, who will appreciate the concept portrayed as well as the blinking lights and moving parts.

Historical Development of Science Learning Museums

According to the Association of Science-Technology Centers there are now 262 science centers open and operating in the United States (ASTC, 1997); SLMs are everywhere, and they are quite accessible. Though now the abundance of science centers makes them a common occurrence, SLMs, and even children's museums, are a relatively new thing. Interactive and

hands-on museums have exploded onto the scene in the past three and a half decades. The road leading to the current idea of a SLM began in the early 1900's, when the needs of children began to be addressed in correlation to museums, but the concept has come into full actualization only in the past thirty years.

Museums have traditionally been dusty halls that accumulate untouchable objects which must be contained within glass enclosures. Only those high-thinking, and usually considered boring, old men could touch and handle the pieces of antiquity; the "regular" person was confined only to look at the encased artifact, and read its Latin description that appeared on the nearby embossed brass plate. *Informal Science Learning* (1994) explains the genesis of museums; at first, they were "wonder rooms" in an aristocrat's home where the gentleman or lady could entertain dinner guests with "incongruous collections of 'Gee Whiz!' oddities like skulls, stuffed animals, and gallstones." These parlors of intrigue evolved into academic study-collections and then into public taxonomic display cases; museums developed into a "place to see, not learn."

In the early twentieth century, Jean Piaget's ideas of child psychology came into popular consciousness. Piaget disagreed with the earlier idea that small children were capable of logical reasoning. He proposed that children go through different thought-processing stages. Younger children rely on more than visual stimuli to learn; they must in effect experience something before it is actually learned. Piaget felt that children continually reorganize how they think the world works; to learn, a child must "examine and question their environment by comparing, classifying, and analyzing familiar as well as new objects and situations" (Cleaver, 1992). At about the same time that Piaget's ideas were becoming public knowledge, museums began to create special discovery rooms for the children of their patrons. These rooms usually contained specimens and artifacts of lesser quality, but these children's areas were an important step in the development of museums designed for children. Actually, discovery rooms became a favorite place of families

with children; it was a fun learning diversion that made the children excited about going to the museum.

A discover room became a norm for many museums; however, they were usually subjugated to the basement or a back gallery, not as a main focal "exhibit" for the museum. The "children's activities were simply one function of adult museums" (Cleaver, 1992). Even though children's areas were not treated as a forefront item, they became popular, and soon a few specifically designed children's museums came into existence. Some of these museums were composed of just the burdensome "unfascinating" collections that someone did not want to move when a traditional museum relocated, but several were purposely designed to be museums for children. Normally these museums were hands-on, and provided a scaled down version of everyday life. Children were allowed to play, imagining they were postmen, teachers, bankers, or housewives. While playing the children learned about the world around them. Children's museums became a place where children could develop new and broader ideas about their world.

Just as museums for art and history developed discover rooms for young patrons, museums of natural history, science, and technology did the same. These science-based discover rooms contained artifacts and specimens, like common fossils and skeletal remains, that the children could actually handle and touch. These learning rooms developed into a mainstay for most museums, and they became an attractor for families with small children. This trend continued until the "mid-century growth of hands-on activities for kids in school laboratories, summer camps, and local nature centers" that "encouraged adults to pressure museums into developing hands-on exhibits for children" (Cleaver, 1992). The exhibits were not the basement-relegated touch-and-feel rooms that had existed up to that point. Parents and children wanted "full-fledged" exhibit space. Some museums created gallery space that supported hands-on exhibits; however, these museums were soon eclipsed.

Frank Oppenheimer, brother of Robert Oppenheimer who was a major player in the development of the atomic bomb, created a unique and imaginative museum in the early 1960's . His museum, the Exploratorium, is located in San Francisco and houses 650 interactive, hands-on exhibits dealing with science, art, and human perception. The Exploratorium provides children as well as adults a place to learn science with no limitations. The interaction that the exhibits provide creates a tactile and cognitive response in the museum-goer; this hands-on approach allows the person who interacts with the exhibit to come away with a better recall of what has been learned. The Exploratorium was the first of its kind, and it has led the way for the many booming science learning centers.

Though the development of SLMs was prodded by suggestions from museum patrons, usually parents with young children, the main catalyst in the creation of the Exploratorium and other similar institutes were forward-thinking museum developers, like Frank Oppenheimer. These museum directors and educators saw in the general population a dislike, or more appropriately, a fear of science. To the average person, science was the boring and difficult class that was a requirement in high school. People did not enjoy science; they equated science with poor test scores, unintelligible text books, and stodgy teachers. Oppenheimer, and museum educators like him, wanted the public to know that science is a fun and exciting thing, not dull course work. Museum educators wanted science, in particular, and learning, in general, to be a wonderful experience that one could enjoy, not to be equated with a formal education of tests and quizzes. Learning should be a by-product of curious inquiry. Inquiry could be initiated and cultivated at museums which presented science in a way that would heighten memory and increase wonder and surprise. Learning in a museum should not be like learning in the classroom; Frank Oppenheimer said "no one flunks museum" (Dow, 1993). Creating an interactive place for people to learn about science would excite them and get them more involved in the learning process.

As more and more hands-on learning centers began to open, directors and curators of traditional museums recoiled at the idea of "interactive museums." An uneasiness in the museum community developed between those who held to the traditional and those who embraced the new. The problem did not really lie in the fact that the hands-on institutions were teaching science; most of the problem dealt with the fact that traditionalists did not recognize the SLMs as museums, only "learning centers." Traditionalists believed that a museum would not use participatory or children-geared exhibits as its main technique . The new wave in museum professionals felt that a museum was a place where one can learn independently, and so it should suit a particular audience (Cleaver, 1992). It seems that jealousies were the cause of this tension. Traditionalists wanted to keep a sense of stately dignity and aloofness associated with the term museum, while the new wave wanted the community influence and scholarly recognition that parallels a museum. Another likely reason for the feud dealt with attendance. Both types of institutions wanted to keep the stream of patrons flowing; however, this reason has, in some instances, been allayed, as museums in the same area or region have formed networks or systems to help encourage attendance at all institutions.

The major similarity between traditional and hands-on museums greatly outweighs their contrasting characteristics. A museum is a place to learn, and both types of museums do this; they simply use different vehicles to accomplish the goal. The American Association of Museums has stated that "the educational role of museums is at the core of their service to the public. This assertion must be clearly stated in every museum's mission and central to every museum's activities" (Sheppard, 1993). Museums recognize that they should "communicate ideas, impart knowledge, encourage curiosity and promote aesthetic sensibility" (Sheppard, 1993). Museums are educators; they are teachers. Just as each classroom teacher has a distinct teaching style, so does each museum. The museum should use its specific strengths to create an atmosphere for the development of knowledge. Frank Oppenheimer felt that "the museum's role was to provide an

environment for free-access learning" (Cleaver, 1992). His ideas have continued to influence museum educators to the present. Sheppard (1993) feels that museums should be "open-ended, self-directed, apprenticeship experiences, filled with dynamic projects based on the evocative content of collection." Museums should allow people, or more specifically children, the chance to roam the exhibits and create for themselves an impromptu self-directed learning experience.

Though it took a while for interactive centers to become a viable and independent member of the museum community, they have developed into places where students, adults, teachers, and families can go and be exposed to science in a fresh way that supports a lifestyle focused on learning. SLMs are places where people can lose themselves to learning; without the frustrations of test-taking, people can interact with scientific principles and gain a better understanding of how the world works.

How Students Learn at Museums

A useful tool to help teachers present science to students is a local SLM. Teachers can take children to a museum and show them an exhibit, specimen, or artifact that would not be available in the classroom. Questions have been raised about the effectiveness of learning at a public place such as a museum. Studies of students' learning in museums have taken place for quite some time. *Experimental Studies of the Education of Children in a Museum of Science*, originally published in 1935, was one of the first major looks at what students gain by visiting a museum. Though a museum visit can be reduced to a free day where the main interest is expending nervous energy, the visit can be a productive and educational experience.

Research has shown that a visit to a SLM is an effective way to further the learning of science. "Hands-on exploration substantially increases the amount and type of information available to visitors" (Serrell, 1990). "Participatory devices in exhibits often attract more attention and time from children and adults, and learning gains can result" (Crane, 1994). In an

SLM, visitors use vision, touch, and usually other senses; by being able to use more of their senses, the visitor will be more likely to remember the experience and the information being presented. As one matures, one relies more dependently on sight as the means of receiving information; children, on the other hand, rely less on vision, and more on hands-on activities to learn. It naturally follows that a place where a child can do, as opposed to a place where a child can only see, would provide an environment that increases the amount of information that a child takes in, recalls, and learns.

Learning in museums can be included in a broad category referred to as informal learning; that is, it is not a part of the formal education of the traditional classroom. "Informal science learning refers to activities that occur outside the school setting" (Crane, 1994). Informal learning involves gaining knowledge by museum visits, by television series, by community-based outreach programs, or by other means. Informal learning is the type of learning that children undertake at SLMs. Students are presented a concept in a new, and usually exciting, way, and they become intrigued by the concept. The students' curiosity takes over, and without their knowing it, they learn and want to learn more, quite voluntarily. The new concepts that they now understand are not necessarily connected to the topics that they are studying in school, but perhaps the visit has sparked an interest in self-directed lifelong learning. SLMs help to "protect and stimulate the motivation to learn" (Cleaver, 1992).

SLM learning is very different from conventional classroom learning. There is usually not a formal structure, with a pretest, presentation, quiz, review, test, and remediation. Children are left to roam the museum's facilities. They will do most of their learning at the museum's interactive exhibits. Crane (1994) believes the "learning experiences tend to be brief, fun, episodic, self-selected and self-controlled. Visitors are not under any obligation to learn." The children are allowed to make their own choices about which exhibits they visit and the time spent; they enjoy the freedom of choosing to do what they want; this eliminates the feeling of drudgery

that on occasion is present in the classroom. Kids find an exhibit that appeals to them; an exhibit tends to be especially appealing if it relates to the child's prior interest (Crane, 1994). If some other exhibit seems more appealing than the exhibit the children are currently involved in, the children are free to select another. If a student likes one particular exhibit, he is allowed to stay at that exhibit if he wants. To the casual observer it seems that students run willy-nilly from one exhibit to the next, but a close examination reveals that students stay around an exhibit area longer than expected. Michael Spock, son of the famed Dr. Spock and director at Boston Children's Museum, notes that "if you tracked one kid through a visit, you'd see a wonderful pattern of (him) keying in on something and exploring it for 10 to 20 minutes. Then he'd work up some nervous energy and run off to something else" (Cleaver, 1992). Children tend to stay at an exhibit or a group of similar exhibits longer than adults; "adult visitors (in traditional museums) particularly interested in an exhibit examine it for a whopping 10 to 30 seconds" (Cleaver, 1992). It has been shown that the length of visiting time at an exhibit is positively related to the amount of learning (Crane, 1994), so it stands to reason that if children are "into" an exhibit and spend time there, they will learn something.

When visiting SLMs children are surrounded by other learners; this fact makes museum learning a corporate venture. A visit to a SLM is commonly associated with a school field trip or outing and allows a child to experience the museum with a group of his classmates, his learning peers. However, a good percentage of SLM visitors are families; therefore, children also experience the museum with learners who are older than they, their parents. These different groups of learners who accompany a child will of course create different learning experiences for the child. Neither experience is better than the other; they are simply different. Students in school groups will usually have an experience that is fast-paced, sporadic, and exciting. Children in families will normally have a calmer, more in-depth visit, but one that is just as exciting. Though each of these types of visits focuses on different aspects and qualities of the museum, both still

initiate a positive response from children in regard to learning. In both situations, the child is a learner, and in most cases, at some point in the visit the child will be a teacher. Students will show other students how something works, and on more occasions than one would think, the child will explain something to a parent. When learning takes place in a SLM there is some type of teacher/student interaction, though this interaction is not comparable to the conventional concept. A second-time visitor, parent, student, docent, or even a label can act as the teacher. Sometimes the role of the teacher is assumed by a label reader, one who reads the placards that explain how an exhibit works, although many times labels are not read; they are overlooked. The visitor does not want to spend the time or effort it takes to read the label. Usually label reading does not consist of a group of people methodically reading the entirety of what is printed; reading is either done in quick scans or by one person in a group, the "teacher" (Serrell, 1990). SLMs offer children the opportunity to take on the unique roles of information gatherer and information distributor. Students learn to interact better with their co-learners in a museum as everyone works together to understand the presented information, and everyone benefits from the group collectively.

Though the classroom is the normal and most useful learning situation, museums can offer something that the classroom cannot. Museums offer an authentic experience. Just as people from urban areas are amazed when they see a cow for the first time, and people from rural areas stand in awe of skyscrapers, students can visit a museum and appreciate the wonder of actually seeing a thing of substance. At a SLM students can see the real instrument, experience the actual phenomena, and have access to an accurate, simulated device (Crane, 1994). Providing an authentic experience also allows museum visitors to be exposed to materials that are normally not available, or if available from a new vantage point (Cleaver, 1992). Students have the opportunity to go beyond their textbook and its examples; there is no reason to be satisfied with a description in a book. Children will be exposed to science first hand with their own hands. Though many

science texts discuss an interesting apparatus called a "Jacob's Ladder" or "Climbing Arc," most schools do not have the budget to acquire that piece of equipment. At a SLM students enjoy watching the stream of electrons "climb" up the two prongs in the "Jacob's Ladder," and the display lets them see and control this instrument that was discussed in their textbook. Likewise, an exhibit at a museum can create an analogy that children will be able to visualize; for example, to show the path that food takes through the body, The Discovery Place in Texarkana, Texas, (Thomae-Morphew, personal communication, January 6, 1997) uses a slide to represent the esophagus, a connected tent to portray the stomach, and a winding crawlspace symbolizes the colon. Children have fun sliding and making their way through the maze, but they now have a memorable base of reference for food consumption and digestion.

Museums allow students to "make quick connections between what is personally known and something new, resulting in new associations and relationships" (Crane, 1994). SLMs make things click. The presentation of new information or concepts cause the child to access something already learned that is related to the presentation. This accessing allows the child to add the new information to either correct or supplement existing knowledge, or to create a correlation between the two sets of knowledge, so that when one set is called up from memory, the other set will also be available. Discovery Place in Charlotte, NC, hosted a traveling exhibit entitled "A Show of Hands" (Brearly, personal communication, July 24,1996) that examined the anatomy, physiology, importance, and usage of the hand in an interactive format. A student is likely to know something about the hand prior to visiting the exhibit, but when the student goes through the exhibit he learns the meaning of the word "opposable thumb" and that humans and a few other animals possess a working opposable thumb. The student now understands that the thumb is a specialized tool that helps one grasp objects. Later in the school year, as the class learns about crustaceans and their specific body parts, the student studies the lobster's claw and learns that the pincers help the arthropod to grasp. This causes a connection between new information and prior

knowledge. The student makes a reference between the opposable thumb and the lobster's claw. Now the student possesses a new memory association; few animals have an opposable thumb, but there are other creatures who have an appendage that accomplishes the same action.

SLMs offer the opportunity to learn by interaction and by using a variety of senses; by presenting information in this manner, the museum creates an "experience." Creating an experience to relate a concept is an excellent way to teach. To solve a murder, police and law enforcement teams recreate the crime; they set up people to reenact the proceedings, and watch to see if any type of clue or pattern emerges. The best way for a person to understand how it feels to be at a major league baseball game is for the person to actually attend a game, to eat peanuts, to pass money down the row, to "do the wave," to stand up during the seventh-inning stretch. When one eats in a Chinese restaurant, one expects the cook and servers to be Asian. The decor must at least have an association to the Orient; there ought to be red tablecloths and chopsticks on the tables with bamboo and decorated fans on the wall, and fortune cookies should follow the meal. If the essence of a baseball game, crime reenactment, or Chinese restaurant is missing, then so is the experience. In the same way, if the essence of a concept or idea is missing, then so is part of the learning. But creating an "experience" is not a simple endeavor; experiences are more than just positioning "Kinetic and Potential Energy" exhibits into a circle and dubbing the area "The Ring of Power." To create an experience the SLM must "immerse the visitor in the exhibition environment" (Crane, 1994).

For the most part, the experience at museums is created by bright colors and a fun and carefree environment. However, when an exhibit or group of exhibits can be situated by themselves, museums try to enhance the area. Discovery Place of Charlotte, NC, (Brearly, personal communication, July 24, 1996) has an area dedicated to aquatic life; this area is decorated with all types of sailing equipment, nets, treasure chests, sea shells, barrels, and some

taxonomic specimens. The ambiance created by the decorations helps to pique the interest of children so that they will more thoroughly explore the exhibit area.

Instead of added decorations, the Buffalo New York Museum of Science, a natural history museum, (Syrek, personal interview, July 22, 1996) uses another approach in the entomological area. They engage the visitor's attention by adding insect vocalizations and sounds. The intonations are those of the various insects represented in the exhibit; each of the sounds emanates from a speaker that is positioned near the corresponding insect. The benefits from the use of sound in science museum exhibits have been substantiated by research.

One museum researcher Valerie Crane (1994) discusses an experiment at a "Gorilla Tropics" exhibit which included a soundtrack contained gorilla vocalizations and jungle background noise. The experimenters allowed two groups of people to visit the exhibit; one group heard the sounds; the other group did not. Twice as many people in the group who heard the sound track commented that they learned something than did those in the non-hearing group. Also, more people in the soundtrack hearing group said that the exhibit created a positive influence toward the ecosystem. Thus it can be said that the experience that SLMs offer greatly affects learning.

The traditional classroom has a lot to offer, and it is the classic mode of learning; however, the informal learning found in SLMs is a good supplement. Museums spark an interest in a child, making that child want to learn. SLM learning emphasizes some techniques that they will need later in life. Children are allowed to make decisions and choices, an occurrence they will face everyday. Students get to act as a corporate body, helping each other understand what is happening. SLMs encourage children to make associations and to build their memory and critical thinking skills. Students see how important authenticity is; the "real" thing is something to be appreciated and treasured. The SLM gives children an experience; they can take the memory of their visit with them through life. Most importantly, children will understand, maybe years later,

that someone cared enough to create a place where learning could be fun, and a teacher cared enough about them to make sure that they experienced the joy of learning.

Creating an Integrated Trip

Museums are really neat places, and students can learn a lot at a museum, but to insure that a child gets the most out of a trip to a museum, an integration must be fashioned between the school and the museum. In the classroom, information is presented, and in the museum, that information is reinforced and supported. Normally a trip to the museum is a free-day planned for the spring; this yearly field-trip is a fun day and is used as a way to expend students' pent-up energy. Though a museum specializes in informal learning, if a class goes to a museum and the teacher does not have a specific learning goal for the students, then academically it is a wasted trip. A museum is a good place for learning because it creates an environment where visitors are "tricked" into learning by not obligating them to learn; however, for a visit to a museum to be a valid school trip, some particular focus should be placed on the trip.

A teacher could take a class to an SLM and justify the trip by saying it is science-related, but it would be better if the teacher created an academic emphasis by saying, "At the museum, the students will look at and interact with specific exhibits that demonstrate the concepts of light and vision." Light and vision would be a subject that was being discussed in the classroom, and the use of the museum was another facet of the children's learning about those scientific principles.

Incorporating the museum visit into a unit of the curriculum seems like a great idea; however, to begin this incorporation, a museum and a school must have a working partnership. Sheppard (1993) says, "classroom teachers and museum educators must work together and come together physically and intellectually". Many times teachers and museum educators do not have the same expectations about what a museum visit should be. Teachers may feel that their job is finished when the kids hop off the bus. Museum people may feel that all their job entails is

keeping the museum exhibits safe from the destructive forces of excited elementary students. Teachers need to have prepared their students for a focused learning experience. Museum educators should be constantly evaluating and changing the museum activities as the visit proceeds to keep the students interested and to make sure that the goals of the trip are achieved. Some of the techniques that must be used to make the museum a teaching tool are the teacher's obligation, while other concerns are the sole responsibility of the museum educator. However, the teacher and the museum educator must work together for the integration of school and museum to work properly. There is so much that teachers and museum educators can do to create a valid SLM visit.

A SLM visit should not be justified as a science outing unless the trip has some correlation to the science curriculum. A museum is an informal place to learn, but if the museum visit is part of a school-sponsored trip, the students should be able to make a direct link to their formal schoolwork. In a SLM visit, the teacher should use the museum exhibits as visual aids; however, "the usefulness of the museum as a visual aid depends on the way the museum is used" (Melton, 1935). If the students do not make an association between classroom lessons and museum demonstrations, then the teacher has not successfully incorporated the SLM visit into the curriculum. A focused field trip has a "specific theme and a set of defined learning objectives" (Sheppard, 1993). Creating such a trip involves some work and some interaction with the museum educator. A teacher creates a theme by examining the science curriculum and deciding what scientific principles will best be enhanced by a visit to the SLM. Choosing a theme or group of like principles may prove to be somewhat troublesome, but most museums have a wide variety of exhibits that should meet the demands of classroom curriculum.

To establish correlation between curriculum and exhibits it is very helpful if the teacher previews the museum and learns about its exhibits. Most museums offer an educator's pass so that the teacher can visit the museum free of charge before bringing a class (Sheppard, 1993).

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Normally, a museum will also be able to provide teaching guides or brochures that address the concepts behind each exhibit. These printed materials will help the teacher choose an area of study. Narrowing the field to the few select science principles that will be examined in depth will probably be tougher than selecting the major concepts to be explored. The narrowing process can be made easier if the teacher determines which exhibits will best enhance learning for the students. If the students see a demonstration in a museum that could be seen in class, then there is really no need for a trip to the museum (Sheppard, 1993). The students should interact with those exhibits that present the targeted scientific concepts in an "easy to digest" manner, or those that bring to life an example in the science text. The teacher should also create specific objectives that the SLM visit will help the students to meet. There needs to be a recognizable result that becomes evident due to the trip. The objectives do not have to be strict or rigorous; they can be somewhat loosely defined, as long as they create an academic, curriculum-related emphasis that the trip will strive to produce.

Though the trip has a theme that is dependent on what has been taught and discussed in the classroom, the substance of the museum visit will, of course, rely on the exhibits that the museum houses. The museum is unique in its teaching in that it relies on objects to relate concepts and ideas; the textbooks of the SLM are the interactive exhibits that make up its collection. The thrust of the focused visit will depend on the complementary experience that a student will receive; the concepts of the classroom are blended with the objects of the museum, and classroom teaching methods are combined with visual learning techniques (Sheppard, 1993). The museum provides for reinforcement of learned material by communicating ideas through objects; the visual role that the exhibits play allows children to actually see science in action (Sheppard, 1993). For example, in class the teacher presents and teaches the concept that matter can have the characteristic of being light or heavy; in the museum, students are allowed to blow up a hot air balloon or send air bubbles through a vertical tube filled with clear oil. Without much

explanation, the students see the demonstration and realize that it is an example of the topic that has already been discussed in the classroom: the hot air and air bubbles, which are a form of matter called fluids, are lighter than the surrounding fluid, the room-temperature air or oil, and they rise. The principle is understood quite well by the students as they relate their classroom knowledge to their museum interactions. Though the children may have already been familiar with hot air balloons rising through the air, the museum visit reinforces their learning and lets the students experience first hand the concept that they are studying.

SLM as visual aid and teaching tool is a creative way to excite students about science, and students will make the connection between the classroom topics and the museum exhibits, but to ensure what students learn is ingrained in their memories, a little more instruction is needed. A well taught lesson incorporated with exhibit interaction produces good results in learning; however, to create even better learning strides, more is required. Very important for those visiting a museum with the classroom are the activities, associated with the topic of study and the museum experience, that are completed prior to the trip and after the completion of the visit. These activities are commonly referred to as pre-trip and post-trip activities.

These extra trip activities are a good source for teaching material, and they help to ease the integration of classroom curriculum and museum exhibits. Unfortunately, a plurality of teachers do not use extra-trip activities when they incorporate museum visits into the curriculum; this fact is extremely unbelievable in light of the fact that even in 1935, Melton in his experiments with students' learning determined that extra-trip activities make a major difference in learning. Sixty years have passed, and some teachers still do not use extra-trip activities. Teachers have demonstrated concern about the use of these activities because their lesson plan books are already full of required objectives that must be met every week, including spelling tests, math quizzes, and unit preparation. Teachers' complaints are understandable; teachers already have their lion's share of work without setting aside time for more activities. However, to achieve the most

academically focused trip, it is imperative that pre- and post- activities are used in connection with the visit; in most cases, the activities will correspond to or take the place of regular worksheets and group activities that will be used as part of the normal unit of study. The use of extra-trip activities helps to space learning out over days or weeks, not the two hours spent in a SLM (Sheppard, 1993), leading to better learning and recall in the students. The activities are extensions of the trip that help students learn the material better.

Pre-trip activities are of course completed before the trip and help to prepare students for the museum visit and guide the students to start forming the framework for learning in the museums. The pre-trip activities help students to make clear connections between classroom discussion and museum encounter, introduce the topic of study in correlation to object based teaching, introduce the SLM, and set the expectations for the visit (Sheppard, 1993). The use of pre-trip activities as orientation aids "can increase efficiency of use, time spent, attention, and recall" (Crane, 1994). Teachers can help students in their museum learning by describing scientific instruments that might resemble exhibit equipment and by mentioning the types of examples that will be encountered. The framework for museum learning can also be strengthened by helping to correlate an oral lecture or two-dimensional textbook picture with a three-dimensional exhibit. In the SLM students will be "studying" exhibits, so their object-based learning skills will be honed. Pre-trip activities are also useful to explain details about the trip, answering the students' questions about the SLM and assist in creating an idea of what to expect. The pre-trip activities do not have to be extra work; pre-trip activities can take the place of normal unit activities, or normal unit activities can be modified to prepare the students for the SLM. A teacher may also want to teach a lesson with a model or other three-dimensional article that will help the students gear up for object-based learning.

Post-trip activities are worked on after the visit and allow for a follow-up to the trip, by reviewing information and creating a satisfactory and meaningful ending to a course of study.

The post-visit activities help to bolster the previously learned material and its association to the newly acquired museum examples, allow for independent study, and create an outlet for students to share their experience. While completing post-trip activities, students will finalize the correlation between the previously discussed material and the museum interactions. Post-trip activities encourage students to begin independent study by allowing time for brainstorming sessions and access to references not normally available in classrooms. Activities that are completed after the visit give students the opportunity to discuss information learned and allow for artistic, oral, or written expression of their feelings, emotions, and newly gained knowledge. A teacher may want to play a game using questions that relate to an exhibit topic, reinforcing the material that the children have learned; it is wise to incorporate questions that specify certain, but not intricately detailed, aspects of the museum. Students can also be instructed to write a news story about their favorite exhibit, and volunteers can give a speech emphasizing the best part of the museum visit. Thank-you notes are always a good way to let students display their feelings about the trip, and besides being a nice thing to do, it lets students practice their writing skills. Teachers may also want to encourage students to look at references at home or in the school library to find out more about a similar subject.

Teachers can effect the integration of the classroom and the museum only so much; the museum educator must also assume responsibility to bring the learning of the classroom and museum into alignment. One important area in which museum educators can work to integrate learning is creating "ready-made" themed trips. Because these trip packages decrease the stress and work that the teacher faces when preparing for a visit such trips increase the likelihood that a teacher will use a museum as a place of learning. To be effective, a themed-trip demands many things: knowledgeable docents or museum educators, age appropriateness of exhibits, curriculum integration, administrative support, extra-trip activities and teacher guides, and logistical support (Sheppard, 1993).

A themed or focused trip should include many items that are necessary for a good visit. The SLM should provide a museum educator to lead the students in a discussion that deals with the exhibits and what the students will be learning. This museum educator does not take the place of the classroom teacher. The docent should teach and discuss with the help of the teacher; though the museum professional knows the SLM, only the classroom teacher knows the temperament and peculiarities of the children in the class.

The visit should center upon exhibits and activities that are appropriate for the age of the class. Fourth graders will be easily bored with an exhibit designed for first graders; likewise, first grade students will not comprehend a museum activity that is appropriate for the fourth grade. The reservation procedure of the museum should help to suppress any problems of age appropriateness.

The packaged trip should have a defined theme or emphasis; the closer this theme can be associated to the curriculum the better. SLMs have become more aware of the need to align their exhibits and activities to the curriculum of the surrounding school districts, and this awareness has led to more academically focused visits.

To increase the use of a museum by teachers in a school district, it is wise for an SLM to become familiar with the administrators of the school district. If a principal or superintendent is familiar with the museum educator or at least the museum, that administrator is more likely to approve a field trip to a SLM. The more visibility and good press that a SLM has, the better it will be received by the administration of the local school districts.

Teachers need teaching material when planning for an integrated trip, and they invite the possibility of receiving teaching aids that correlate with the trip. Teaching guides which are commonly distributed by museums normally introduce the teacher to the main objectives of the selected focused trip, provide worksheets and ideas for extra-trip activities, and give information to help make a correlation between classroom presentation and museum experience. The logistics

of the trip are very important; museum educators need to make teachers aware of specific requirements associated with visiting the SLM.

Visit logistics include such things as length of stay, group size, lunch, bus drop-off and pick-up, chaperones, and other details (Sheppard, 1993). Brochures or pamphlets are good ideas, giving information pertaining to the museum, the exhibits, and the specifics of museum visits. An introductory video is also a good idea; the teacher could even show the video to the class to prepare them for the visit.

Another important detail for a museum educator to consider is the use of the docent to guide the students through the exhibits with which they will interact. It is not the role of the docent to boringly lead students to the exhibits and elucidate on the acquisition of the exhibit or the materials used to build the exhibit. The docent should be an extension of the SLM in the aspect that the docent should be interactive, not just open for questions. The museum guide should also create an experience for the students, by including them in the demonstration of the exhibits and the presentation of some of the principles behind the exhibits. Instead of answering questions, the docent should be asking questions. By allowing the students to answer or at least attempt to answer the questions, the tour becomes focused on the students and allows them to draw from their prior knowledge (Sheppard, 1993). Sheppard (1993) makes clear that guides should not rush the group of students and should make sure that every child has the opportunity to see the demonstration of the exhibit. Children will not enjoy the experience and will not be as excited about the visit if most of their questions are not answered or if they were stuck at the back of the group. As explanation and discussion of the selected exhibits is taking place, it is important for the docent to demonstrate the use of the exhibits; this demonstration will help the students to properly interact with the exhibit and usually answers any questions the students have. Mental modeling is also the responsibility of the museum docent (Sheppard, 1993). The guide should involve the students in illustrations of critical thinking by leading the students in a problem solving

activity or demonstrating the way to use a skill. Above all else, the docent should be sure to demonstrate excitement for learning. The guide's enthusiasm will affect the students, so that they will also be excited about the museum and learning. Melton (1935) notes that "the type and quality of the guidance given by the docent" will greatly affect the learning of the students in the museum.

Museums can create a closer alignment with a school district by getting the teachers and administrators of that school district directly involved in the life of the museum. There are a variety of different museum-related activities that the professional educators can become a part of that will benefit the school district and the museum. A SLM can create advisory committees, administrate teacher inservice and training, initiate open houses, and distribute educational directories (Sheppard, 1993). An advisory committee is usually a group of people with an interest in the museum that can advise and suggest the direction that the SLM should be taking and how best to do that; it also allows the teachers and the administrators a chance to get involved with the SLM. As well as getting sound educational advice for the museum, an advisory committee that is populated with some area educators will more than likely become a proponent for the use of museum visits as part of the educational experience. The teachers who are on the committee will be more apt to take classes to the SLM, and administrators who are on the committee will be more apt to approve trips to the SLM.

SLMs that provide activities that incorporate area educators tend to be more involved in the district. Incorporating educators by offering teacher training and inservice activities for the local districts is highly effective. SLMs are great places for teachers to learn new teaching techniques. The museum, by opening its facilities for use by the local district, will create good will, but it will also create benefits for the SLM. Holding an inservice meeting at a museum will create variety in meeting places. In new surroundings teachers are more likely to enjoy the inservice "pep-talks" that will be presented. Using the museum as a meeting place also lets the

teachers see the museum first hand. Teacher training at a SLM can greatly benefit the museum as well as the teachers because the training can focus on the use of the museum as a teaching tool. Inservice and training at a SLM allows for awareness of educational opportunities at the museum, provides on-site familiarization with the museum and with object-based learning, creates an opportunity to train teachers to use the museum, and encourages teachers to help museums develop classroom integration (Sheppard, 1993). If the training and inservice activities can become well established and well respected, then the opportunity to develop courses for continuing education credit for teachers will be the next step that the museum will hope to take. Museums which have teacher training and inservice have increased respectability in the community and further the hope for classroom and museum integration. SLMs can also open their facilities for use by local schools for open houses. Usually, an open house or PTA meeting will take place in a school's cafeteria, but if given the chance, many schools might have administrators, teachers, and parents meet together in an SLM, especially if students will be learning there.

In most cities and towns there are many different types of educational opportunities, including science museums, historical museums and societies, arts councils, galleries, and music groups. However the majority of people, including teachers, do not consider these places to be resources for learning. Museums can create directories of all the local offerings of educational interest and distribute these directories to the schools. Teachers can then have a handy resource in which to locate area points of educational interest. By involving administrators and teachers a museum can increase the degree of integration that the SLM and school can achieve.

SLMs can further integration by going outside the confines of the museum facilities to initiate programs that reach out to the schools and communities of the surrounding area. Museums can provide resources and materials for the school, promote classroom visits and assemblies, and create community-based outreach centers. "Outreach programs broaden the

impact of a museum's educational resources by enlarging both the numbers of students reached and the ways in which they are taught (Sheppard,1993)." By taking materials and programs to the schools or to the communities where students live, outreach programs will help orchestrate learning experiences. Museums have developed many different types of materials that are loaned or rented to schools. Most of these materials are boxes that include instructions for experiments, teaching literature, and sometimes all materials necessary for the experiments. Many teachers are afraid of science and really do not know where to start. These boxes and kits let teachers get their feet wet by helping them to work with some science activities that they can do in their classrooms. Sometimes SLMs can even provide curriculum units and lesson plans that supplement the science kits. Especially in the case of natural history museums, the discovery boxes contain duplicate or non-museum quality artifacts; both teachers and students benefit from using these hands-on specimens. Audio/visual materials which can supplement the examples that a teacher uses in a particular unit of study are available for loan.

If a teacher fails to receive funding for a class trip to a SLM, a SLM can come to the class. Most museums have educators who go to schools for assemblies and presentations. These museum educators give scientific demonstrations and audience participation lessons. Both children and teachers gain from these presentations. Children become excited about science. Teachers are relieved of detailed lesson planning; their contribution includes providing complementary activities. Museums sometimes have vans or buses that serve as "museum on wheels" with a specific scientific emphasis. The buses are taken to schools, and the students are given a science lesson on board the vehicle.

At times, a museum may want to meet a special need in an underprivileged community; the SLM will develop a community-based science program. By creating a "science club" in an urban community, an SLM will initiate in children a love for science and learning (Brearly, personal communication, July 24, 1996). The science clubs are developed in association with

schools and community centers. By providing children a place to meet, get help, and learn, the SLMs establish a pattern for lifelong learning and goal-setting. Sheppard (1993) cautions the museum that such programs should support the museum's mission statement, reflect the museum's collection, and fill a felt need in the school community. As a museum considers expanding to cover some outreach areas, it should consider that warning. If a SLM's outreach program does not meet those standards, the effort will either be unnecessary or will not work.

Attempting to integrate classroom and museum is a difficult task. Yet it has been and can be effectively accomplished. It is imperative that classroom teachers and museum educators work hand-in-hand. Cooperation is important and necessary. The responsibilities of both groups must be met in order for a curriculum-focused trip to be created. Everyone involved in the education of the student must do their part to offer an excellent science education. Intricacies are numerous and varied, but an integration between classroom and museum is possible. With some research, hard work, and a little extra time, orchestrating a museum trip with a science unit to provide a creative and exciting learning experience can be successfully accomplished.

Examples of Classroom-Museum Partnerships

When schools and museums work together it is quite possible to create an effective integrated system of learning. The partnerships that are developed when merging museum visits into the curricular activities of a school are not formed overnight; usually, it is a long, drawn-out process. Misunderstandings will occur, and mistakes will be made. Yet, when all the details in a program are worked out, the results are pure magic. The program becomes an attractor of parents who want their children in a school district that specializes in a variety of teaching methods. Interesting programs that possess unique partnerships do exist.

Charles R. Drew Science Magnet School is special in its conception, design, and teaching premise. The elementary school stresses the importance of science education and relies on

hands-on teaching methods. The most interesting fact is that the school is housed inside the Buffalo New York Museum of Science (Syrek, personal communication, July 22, 1996). Having faced many problems, the school is finally in a comfortable position. Ms. Mary Jean Syrek facilitates the enrichment of science education in the school and in the district. A personal interview with her provided a wealth of information about the partnership between the school and the museum.

In 1978 Buffalo called for the desegregation of its schools. A court order insisted that appropriate schooling be provided for specific neighborhoods (Hertzberg, 1993). Two of the areas that were slated for integration were located near the Buffalo Zoo and the Buffalo Museum of Science. Buffalo decided to create a science magnet program. Teachers and administrators worked together to develop the programs, and the possibility of using the zoo and science museum as sites for magnet schools was discussed. The zoo school was first initiated and worked well. However, it took fifteen years to bring the museum school to complete fruition. The science museum was located in the Fredrick Law-Ohlmsted Park, and preservationists were unhappy with the thought of attaching a school to the museum and the possible demolition of the park. Mediation occurred: the school was planned to blend naturally into the facade of the museum. An atrium would separate the school and museum. Construction commenced, but completion was hampered by a swimming pool collapse, construction strikes, and the deaths of the architects. Although classes had been taking place in the museum, it was not until the 1990-1991 school year that the second through sixth grade took up permanent residence. Because Charles Drew School replaced a previous neighborhood school, the children of that community are guaranteed the privilege of attending. Ms. Syrek explained that "the rest of the student population is chosen by lottery from all over Buffalo" (personal communication, July 22, 1996). The school building is semicircular in design, and the classrooms are not separated by walls. Different grades are arranged in pods, but the classes are not separated from each other in

the traditional sense. State of the art electronic equipment, including 250 Macintosh computers, is used by all the classes.

The Buffalo Museum of Science is a natural history museum with almost all the exhibits under glass; it is not a hands-on type of museum. Even though the exhibits are not interactive, the teachers are able to use the museum as a teaching tool. Being an established museum offered the teachers the resource of the curators, verified Ph.D.'s who do research. Teachers invite the curators into the classroom to give lectures on their specialties. The paleontologist presented a lecture and slide show to explain how a dig is set up, the importance of gridding, and other techniques of dinosaur hunters, such as sifting, brushing, and preservation. The archaeologist presented a lecture and tour of Egyptian, Mesopotamian, and Near-Eastern artifacts that are housed in the museum's special collection. The students were allowed to view specimens that are not on display to the general public. Botanists and entomologists are also visiting lecturers to the classroom of the school.

The museum provides a museum-school liaison who works with the teachers to devise integrative approaches to learning at the museums. The liaison has set up numerous activities for the students. The "worm bin" is an example; the liaison works with the fourth graders on the project. This activity allows the fourth graders to work on a long-term scientific endeavor; each week a "worm warden" checks on the bin, counts the worms, and reports back to the class.

Though the curriculum of the school does not directly correlate to the collection of the museum, teachers have developed specific lessons to fit particular exhibit pieces. For example, a unit on flight might lead to the bird display. A lesson on outer space may call for a visit to the telescope or to the solar observatory, where sun spot activity is counted and recorded. When studying insects, a jaunt to the entomological displays are a must. There, as discussed before, speakers are set up to allow the students to hear the vocalizations of the particular insects. The unit on plants can be bolstered by a trip to the Marchand Botanical Display. This exhibit is

composed of realistic wax models of plant life; the students are able to examine the models to learn the different parts of the plant. Going outside the museum is also a technique that teachers use; students go to nature to learn firsthand about ecology and habitats. Students go outside after they examine the Marchand models to look at real plant life.

Also associated with the "outdoors" is the school's involvement in a grant funded project that studies the square kilometer surrounding the museum. The students map the area, learn about the animals and birds, research the history, businesses, buildings, people, and formulate a census. The surrounding outdoor area is an important asset that the school utilizes well.

The museum has developed a junior docent program in which students work at the museum's exhibits on Saturdays and Sundays. Known as "Stinging Scorpions" these older students facilitate the learning process of younger students. Stinging Scorpions helped to develop a special hands-on exhibit, designed for young children, for the museum. These students researched and learned about beavers and dinosaurs. The exhibit consists of a beaver's den, a puppet theater, and a dinosaur nest that were designed and constructed by the Stinging Scorpions. In addition to the junior docent programs, the museum has a summer program specifically designed for students. Each summer a Summer Science Circus, a hands-on physical science learning area, is available for students. The circus has many different stations that encourage knowledge of the physical sciences. One activity is rock climbing, which is effected by a wall that has rock-like nodules embedded in it. Other activities involve simple machines, sound, and pendulums.

Charles Drew Science Magnet School also functions as a teacher training center during the summer. The school offers the teachers of the district classes and workshops that enhance the teaching of science. Teachers develop lessons and activities from nationally recognized academic kits that they can take to the classroom and use.

The actual integration of a museum and a school into the same building has proven to be an effective teaching tool that helps students and teachers to learn better. This partnership between the museum and school yields benefits for each entity that would not otherwise exist.

Discovery Place, in Charlotte, North Carolina, is a SLM that has been closely integrated with the schools in the Charlotte-Mecklenburg School District. A large, hands-on museum, Discovery Place has worked to align itself with the schools and curriculum in the surrounding area. Through its hard work, it has become a "high profile and well respected science organization in the community" (Brearly, personal communication, July 24, 1996). Educating 660,000 visitors a year, including 22,000 students, the museum is a useful tool that is continually used by the teachers of Charlotte. Along with its many student visitors, it serves 70,000 students through its outreach programs. Donna Brearly is Director of Programs for Discovery Place. In a personal interview she explained the many facets that make up a great museum-school partnership.

Discovery Place is an integral part of the science curriculum for the students of the Charlotte-Mecklenburg area. In Charlotte, five school system employees work at Discovery Place to teach required courses. When developing new ways to educate children, Howard Gardner, a well-known researcher and psychologist, imagined "an educational environment in which children take 'courses' in their local science museum" (Sheppard, 1993). Charlotte-Mecklenburg schools with the coordinating help of Discovery Place have seen Howard Gardner's dream come to fruition. These courses or programs include: kindergarten and fourth grade planetarium visits, a fifth grade human growth and development course that covers topics like nutrition, health, and AIDS, a sixth grade visit to the Challenger Center, and an eighth grade course on electricity called "Sparks." All county school groups, public, private, or home schooled, are charged no admission fee to the museum. When developing activities and exhibits, Discovery Place has orchestrated its

efforts to academically align with the National Standards Curriculum, which encourages teaching methods that are constructivism focused, process oriented, and hands-on related.

Discovery Place has much to offer the teacher who plans a visit. Along with the OMNIMAX/Planetarium venue and Challenger Center, the SLM has galleries of exhibits specifically focused on Biological/Earth Science, Physical Science, Health Science, and an area designed for early childhood visitors. The OMNIMAX/Planetarium theater is immense. The screen is 79 feet in diameter and immerses the audience in the film. The planetarium, situated in the OMNIMAX theater is the world's most sophisticated planetarium system. The Challenger Center is "part of a growing network of space science centers nationwide established by the Challenger Center for Space Science Education, in memory of the Space Shuttle Challenger" (Brearly, personal communication, July 24, 1996). The Challenger Center is a simulator that provides students with a unique educational experience by allowing them to gain and demonstrate knowledge of science, mathematics, and technology. The biology gallery includes a three-story rain forest, huge aquariums, a salt-water touch pool, and other exhibits that are ecologically oriented. The earth science area focuses on geology and the structure of the earth. The physical science section has a great assortment of interactive exhibits that cover in detail the concepts of simple machines, physical principles, waves, astronomy, and mechanics. The physical science area also has a chemistry area, called "The Hearth," which is composed of a large, modified lab bench closely surrounded by seats. Children enjoy the presentations at "The Hearth" because they are allowed to participate in the chemical experiments. One show at this chemistry area is a demonstration of chemistry and physics at low temperatures. Using liquid nitrogen at minus 320^{o} Fahrenheit, students are shown how bananas can be used as hammers and how balls will break instead of bounce. Children are allowed to come to the lab bench and hammer nails with frozen bananas. The health sciences gallery emphasizes the physiology, care, and workings of the human body. The early childhood venue has specially designed exhibits that appeal to very young

children; Mrs. Brearly explains that the gallery for "crawlers to second-graders" is explicitly "sensorial, concrete, and hands-on" (personal communication, July 24, 1996). Teachers can design a plethora of themed trips when exploring all the possibilities that this museum offers.

Discovery Place is well prepared to contribute ideas and materials to teachers who need help when trying to focus a trip. For the 1996-1997 school year, the museum has at least forty-six different topical presentations that involve exhibits in the museum which teachers can schedule. These interactive discussions involve a wide scope of topics; presentations include "Circus of the Senses," "Touch the Rain Forest," "Lights, Lasers, Living," and "A Baby is Born." Four temporary exhibits are available. One of these, "Behind the Seams: Science in Fashion," looks at how the fundamentals of biology, chemistry, physics, mathematics, and technology are applied in the world of fashion. Eight different OMNIMAX and planetarium shows play at the theater. The Challenger Center is available for use, and the regular galleries are full of interesting and interactive exhibits. Teachers' guides are always available, and the staff is helpful and very knowledgeable about the museum. The museum even offers camp-ins where student groups have an overnight visit at the museum as they experience an OMNIMAX film, a planetarium show, a topical presentation, and hands-on science workshops (Brearly, personal communication, July 24, 1996).

The museum offers inservice and workshop sessions for teachers. Over fifteen inservice programs have been developed by the museum to help teachers learn to integrate interactive, hands-on science experiences into their lessons. Workshops are just as numerous and focus on current technology like creating Internet web pages. Discovery Place, through an association with the Carolinas Medical Center, provides nursing inservices. Charlotte-Mecklenburg School District teachers use Discovery Place as an indispensable resource. The museum constantly creates new and exciting techniques that teachers can use to further science education. Teacher camp-ins and summer institutes are offered to better equip teachers for the classroom.

The outreach of Discovery Place is extraordinary; having two main arms of extra-museum learning, the SLM has a wide reach into the communities and even surrounding states. ScienceReach is, in effect, a "museum on wheels." This service provides presenters who go into the schools and classrooms to give interactive, topical assemblies and classroom programs. Over twenty programs are available for presentation. Discovery Place has also set up six science clubs in economically and socially disadvantaged communities. Working with some citizens of the neighborhoods, and volunteers, the museum has programs that encourage students' interest in science. Children who are actively involved with the clubs can, as they grow older, volunteer at the SLM and after a certain time period are hired for summer or part-time work. Mrs. Brearly emphasizes that "these science clubs let the kids make formal and informal connections [in science] and gives them career options, and hopefully the clubs will stop the cycle [of economic and social disadvantage]" (personal communication, July 24, 1996).

Discovery Place as an institution in the city of Charlotte has come to symbolize what a place of learning should be. The gains in education that both the Charlotte-Mecklenburg County School Districts and Discovery Place have realized through their partnership have been immense. Discovery Place reaches 92,000 students a year through its many programs; the museum helps to provide a point of view that says, "science is fun, and so is learning." The benefits of integrating a museum into the workings and curriculum of the school district are well worth the work.

The partnership between museums and schools has proven to be an effective technique to bolster the science education of elementary students. Though the process of developing the partnership is labor and thought intensive, it can be done, and done quite effectively. The examples of Charles Drew Science Magnet School in Buffalo, New York, and Discovery Place in Charlotte, North Carolina, exemplify the relationships that different types of places of learning should have. A teacher should have the opportunity to use a museum visit to help students

understand scientific concepts better. Examples have shown that children are reached by school-museum partnerships.

Making an Independent Learner

The intrigue that is unearthed in students as they experience for the first time the wonder and excitement of fun learning can become a catalyst for lifelong, independent learning. Science Learning Museums facilitate an opportunity for fun learning. As a teacher more frequently uses a museum as a regular piece of educational armor, students become more interested and energetic in regard to learning. "Involving kids in science gets them excited about science, and that in turn gets them excited about learning" (Syrek, personal communication, July 22, 1996). The use of a SLM in orchestration with the classroom regimen is an efficient technique to get students involved in science; however, more importantly, the school-museum integration is an effective tool to plant in a child a love of learning. Modern schools have become places that install minimum standards, base requirements, and mediocrity in students. Many schools have lost their efficacy; students do not gain what they need to survive in the workplace, and even worse, they develop a dislike for learning. This sad state of affairs cannot be alleviated by any one person, institution, or idea, but, perhaps getting a student fascinated about just one subject can create a desire in that student to learn about that one subject As that subject is being learned, maybe new fascinations will develop. Hopefully, the student will begin to want to know about more and more subjects. Soon, the student has a desire to know about a plethora of subjects, and is constantly asking questions to gain more knowledge. The student now enjoys learning; some subjects and areas are more interesting than others, but there is a urge to understand many things. Soon, the student is no longer a child, but an adult, living and working outside of a school, who still has that desire to know. The fascination with learning has not stopped just because a formal education has. That one-time student is now a person who independently attacks a subject area

and delves into it, learning as much as possible, and continues this lifestyle of learning into old-age. Using SLMs as an extension of a classroom piques a child's interest in a particular subject, and through cultivation of that interest, the teacher can train that student to be an independent, lifelong learner, who possesses curiosity, enjoys research, initiates questions, and entertains discussion.

The old adage may be "curiosity killed the cat," but curiosity produces an insatiable drive to crave new knowledge; it is that force that no person, save those who have the strongest will or the laziest demeanor, can overcome. Curiosity is the siren who with her sweet song intoxicates the library patron, demanding that he flip violently through the leaves of the *Encyclopaedia Brittanica* to uncover the process by which yogurt is made. Curiosity is also the muse who whispers the most challenging of questions into the ear of the lecture attendee as he raises his hand to attract the attention of the speaker. Curiosity is the catalyst that brings about the desire to learn. A learner naturally wants to know how things work, or why things are, or who someone is. It is an intrinsic characteristic of a learner's nature. Eleanor Roosevelt said, "I think, at a child's birth, if a mother could ask a fairy godmother to endow it with the most useful gift, that gift would be curiosity" (Microsoft, 1995). Upon interaction with small children one realizes that these little persons must have had a fairy godmother because their favorite phrase is the unwavering and constantly repeated "WHY?" If people would just continue with that tenet throughout the rest of their lives, most would be lifelong learners. However, the idea that school and all school work is boring and not fun squelches the curiosity that at one time had been very evident. Thankfully, teachers can reverse the trend that has become the norm in school children. Students can be trained to be curious by involving them in an academic endeavor that excites them; one example, and the most appropriate for this paper, is science. Science can be made to be fun very easily with the many different types of resources available. As the thrust of this paper has demonstrated, the use of an SLM as a teaching tool can provide the experience that ignites or

reignites a child's curiosity. When this spark of fascination is fanned and tended, it can burst into a blaze of exciting curiosity that can lead the child into a love relationship with learning.

While taking a pause from reading the newest book on the hottest topic, the lifelong learner makes a note to look up the biography of the author and perchance find another book by the same writer that might temporarily quench his insatiable thirst for knowledge. Learners love research, but this is not necessarily the research that is done while ruminating about a dusty library under the piercing glare of the crotchety, old librarian. On the contrary, a learner most enjoys keeping up with the current events and hot topics of an ever-changing world. The great majority of the learner's research is the reading of newly published magazines, journals, and books, but part of that research is supplementing and buttressing the areas of knowledge that are lacking. Samuel Johnson, an eighteenth century English author, notes that there are two types of knowledge: "We know a subject ourselves, or we know where we can find information upon it" (Microsoft, 1995). Research has been a necessary pleasure, though some would say a necessary task, that constitutes the very basis of learning. When one does not know something, the person should seek to find a source that will render the information. Learning demands research, whether it be examining the latest issue of the *Journal of Biological Chemistry*, cross-referencing enormous and ancient encyclopedias, or asking an expert. Seeking information is a desire that learners experience. As an interest in formal and informal research continues to develop, a pattern of information seeking is ingrained in the person, and just like the embedded curiosity, the learner's enjoyment of research becomes an intricate part of the person's personality that will lead to a long life of learning.

Who? What? When? Where? Why? Questioning is intrinsic to the makeup of a learner. Questions facilitate the learning process by allowing for specificity in knowledge procurement; inquiry elicits knowledge. The mind, says French anthropologist, Claude Lévi-Strauss, "does not so much provide the right answers as ask the right questions" (Microsoft, 1995). The lifelong

learner develops a sense of what to ask; the keenness of Lévi-Strauss' observation spotlights the importance of a method; only by practice can one evolve the strategies to effectively and correctly discover information that is of interest. Question-asking is an important skill that a learner can expertly use; just as it takes practice for a rodeo cowboy to perfect his skill of throwing a lasso around an intended target, it takes practice to formulate a correct question that can zero in on a target. However, at the start of the quest for knowledge, learners may enjoy the fact that their questions aren't "heat-seeking;" questions that do not specifically designate one answer may possibly lead to more learning experiences. As learners mature with age and knowledge, they become connoisseurs of inquiry, appreciating the elegance of a concise but challenging question. Questions lead learners to their treasure, so it is therefore imperative that persons who will be lifelong learners know how to ask questions. Teachers can guide students to hone their inquiry skills by using thought provoking and interesting teaching aids.

Entertaining discussion seldom fails to give rise to controversy, but when one is learning, conflict can be a good thing. William Hazlitt, an English essayist, wrote, "When a thing ceases to be a subject of controversy, it ceases to be a subject of interest" (Microsoft, 1995). One part of learning about a subject involves finding out how other learners feel about that subject, and the only method to discover other people's feeling on the subject is by discussing the topic with them. The discussion is not required to have a moderator or timed speaking intervals; a simple one on one conversation over coffee will do. The importance of discussion is that it allows the learner to present a personal cache of information to someone else who may not be aware of that information, or who may totally disagree with a subject. It is imperative that a learner be able to demonstrate the ability to defend a point of view, or particular knowledge. Also of the utmost importance is a learner's ability to listen carefully to another person's thoughts, ideas, and remarks. Many people go through life afraid to discuss what they know for fear of ridicule; yet, lifelong learners will jump at the chance to share their information or defend their point of view.

The ability to comfortably entertain discussion is based on a learner's confidence. One can infer that if as a child a person had little self-confidence, it is less likely that person will be a lifelong learner, than a person who reeks of confidence. Confidence can be established at an early age; teachers can help by encouraging a child to pursue an academic interest, and then helping that student when he needs help.

Many different qualities make up an independent lifelong learner. A learner must be curious, enjoy research, ask questions, and participate in discussion. These qualities and characteristics can be developed in elementary school. A teacher who wants to guide students to becoming lifelong learners should try to instill in them the characteristics discussed above. Yet, the most traditional classroom regimen does not challenge students to acquire these traits; teachers need to be aware that new techniques and methods should be tried. Using a local SLM can greatly benefit the acceleration of students. By design SLMs are places where curiosity is aroused, interest is excited, and kids want to discover the concepts hidden in an interactive exhibit. Students can do their research at an SLM; there are so many exhibits at most science museums, that children can even be overwhelmed by the amount of knowledge that is contained in those galleries. At museums, questions fly like mosquitoes in summer; students cannot stop asking why and how. Inquiry is a major part of the museum experience; students will ask questions. Discussion is a good way to pull all of the learning acquired at the museum together; by allowing children to talk about what they have learned, the teacher promotes the dissemination of information, the processing of other's learning experiences, and can eliminate misconceptions. If an integration of the classroom and museum does take place, it leads to great opportunities where children can practice the skills that they will need to be lifelong learners.

Conclusions

This paper has examined the idea of using a museum to benefit classroom learning. This idea is not a new one; schools have been taking trips to museums for decades. The methods that best incorporate the museum visit into the academic curriculum of the classroom have also been recognized for decades. Yet, for some reason, these methods of incorporation are not being used. Though a trip to a museum is fun and allows students to have a fond memory of fourth grade, the usefulness of a field trip is not pleasure; it is learning. This paper has discussed the function of the museum as a place for informal learning, but more than that, this paper has attempted to stress the building of a relationship between the classroom and the museum. A school-sponsored visit is not simply a time for undirected informal learning; it is a time for the buttressing of the already presented curricular information. A visit to a museum should have a particular subject emphasis. The specificities of the emphasis may be loosely defined, but there must exist that focus. Of course, the previous statement will lead to the obvious question, "How loosely defined can the focus be?"

The emphasis must correlate to a specific goal or objective of the curriculum for the appropriate age level. A third grade teacher who is taking a class to a museum needs to develop a focused trip that corresponds to the curriculum and lessons that are being taught to the third graders. The focused trip should have a theme, such as sharks, with set objectives that can be demonstrated by the students upon completion of the trip. Objectives can range from being able to name five different types of sharks, to explain how sharks respire, or to qualitatively describe the make-up of the aquatic food web and the status that a shark may have in that food web. Focusing a trip is not a difficult thing to do; it does not take long to develop five or six learning objectives. Visits must be used in conjunction with classroom lessons, not simply as a free day. Creating a focused trip is very important when visiting a SLM.

In conjunction with a focused trip, a teacher must emphasize prior and post learning techniques. Part of the creation of a focused trip with specific learning objectives is developing and performing activities that can be worked on before the trip and after the trip. Presenting information to children through normal lecture and teaching is effective, but if a trip is to be integrated into the topic of the lecture, then it is imperative that students see the association between the subject matter and how the museum exhibits demonstrate the subject matter. It is important for teachers to use extra-trip (pre- and post-) activities if a SLM visit is in the lesson plan. Unfortunately, a great number of teachers still do not use extra trip activities in conjunction with SLM trips. Children learn better with the classroom reinforcement. Without pre- and post-activities, a focused trip loses its power to teach, and as a focused trip loses its power to teach, the usefulness of a museum as an academic tool is diminished.

A teacher may wish to use a museum as a visual aid to learning, but if a focused trip, one that emphasizes either curriculum or lesson plans, cannot be developed from the materials available at the museum, then the teacher really has no reason to use the SLM. It is the responsibility of the museum to keep up with the fluxes and changes that occur in the curriculum of adjacent school districts. Just like any other type of business, a SLM must change as the world changes. In some museums, the exhibit material is so removed from any semblance to the school district's curriculum that teachers feel like engineers trying to maneuver their trains on tracks of a different gauge. To keep up their end of a integrated partnership museums must initiate changes in exhibits or develop new exhibits to meet the demands of the changing curriculum. Cultivating friendships in the school district will help the museum "keep up;" one way to make these friendships is to establish educational advisory boards and invite school district people who know about the changes to serve on the board. It is also important to keep up with other museums. There should be good communication with colleagues at other institutions who can help in the development of programs and exhibits. Programs are just as important as exhibits because many

times a teacher wants a presentation to accompany the interaction at museum exhibits. The presentations and programs should be in better alignment with the curriculum than the exhibits. The use of exhibits and the concepts taught with an exhibit are a lot more flexible than that of programs, so having curriculum compatible presentations is essential. Museum personnel should remember that the partnership must grow to survive, and many alterations to plans may need to be made if a working and integrated relationship is to last.

A SLM is quite different from a traditional museum in the way that learning takes place. A traditional museum's exhibits are on display in glass cases, while a SLM's exhibits are positioned in the open so that interaction can occur. Nothing in a traditional gallery is touched, but at interactive museums, everything in the gallery is supposed to be handled. Traditional museums' exhibits are preserved, but the exhibits of SLMs by design are constantly being used up and worn down. This tends to be a problem for SLMs. The average cost of wear and tear for one child visitor is more than the admission price for that child (Cleaver, 1992). It is difficult for museums to maintain their exhibits, but maintenance is a needed thing. The more aesthetically pleasing a gallery appears, the more likely it is that teachers will use the museum and will make return visits. Though maintenance of the interactive exhibits is the responsibility of the museum, it is also the responsibility of teacher and student. Students should not put undue strain on the galleries, and teachers should not allow students to damage exhibits. The usefulness of an exhibit is partially determined by it having all of its parts, so it is necessary to manage the up-keep of a museum.

If a museum is to partner with a particular school or school district, then it is important that the community that makes up that school district helps support the museum. The benefits of learning from a museum visit have been demonstrated over and over; to ensure that those benefits befall the children of the community, the parents and the community leaders need to support the museum itself. Museums normally have a society or member's club to help defray the cost of

running a museum; members of the community should join. Citizens need to support a museum through financial avenues as well as through volunteerism. In the majority of cases where a community does not support the museum, the partnership between the museum and schools will be ineffective. An inactive community indicates the potential for problems with integration methods. Such integration of programs will probably mean a higher tax rate for the community. Those in the community who do not support a partnership could create a backlash against the whole idea of education at a museum and could cause problems for the museum and the school. It is in the SLM's benefit to create as positive a public image as possible before trying to forge an alliance with the local schools. By building a high profile, a SLM will initiate in the community a tendency to accept and to support the museum and the potential educational partnership that could possibly occur. The community would be more willing to pay the cost to develop and continue the partnership.

Reaching out to those who would not normally visit a museum should also be a priority that the museum keeps in mind. Outreach can help build and establish a SLM in the community and create a reason why the community should support the museum. Outreach efforts are beneficial for the museum; they solidify the relationship between the museum and the community. These solid relationships are also beneficial to the community. Just as ScienceReach and the science clubs have allowed Discovery Place to initiate beneficial programs for the different neighborhoods in Charlotte, outreach programs will allow any SLM to reach out to an isolated or underprivileged group who may have no hope for the future or no desire for learning. Many young people have been touched by the outreach programs that are supported by SLMs (Brearly, personal communication, July 24, 1996). The programs that let the museum take part of itself into an area where fun and exciting learning has never been show kids that they are special and are very capable of controlling their future. The science, but mostly the concern and care, brought to these underprivileged children reveals that options exist for anyone to seek a brighter future and

tomorrow. Museums have the ability to affect the surrounding communities in such a way as to drastically change the ideas that children have about themselves and others and to provide for the establishment of employment and training programs.

SLMs have a unique opportunity to create a method of learning that teaches relationships between different disciplines. The science museum can integrate the concepts of science with the art, literature, and the social sciences. Just as there has been a call for "writing across the curriculum," museums can help institute the practice of teaching with a multi-disciplinary focus. Science and art fit together quite well. Science gives definition to art by giving understandable explanations to the fascinating enigmas of artistry. Science can explain why oil paint cannot be used to create a fresco; it can determine the structure and granularity of a piece of marble; and, it can diagnose why artists can be so absent-minded. Art extrapolates science by creating an approximation of the physical world. Art shows the order of mathematics and geometry, magnifies the complex beauty of the human form, and demonstrates the wonder of biological interactions.

The relationship between science and literature can be entertained as a subject of study in a SLM. Literature is dependent on science as a means of description; language is full of usages of scientific words. Catalyst is a commonly used word, but writers would write better and achieve more demonstrative word choice if they understood the literal meaning of the word. Science also offers interesting situations like nuclear war, space travel, and biological warfare that add considerably to the plot of a book. Science is crucially dependent on literature; if the written word did not exist, there would be no correspondence between scientists nor would there even be a way to record findings. The interdependence that literature and science share can be discussed in detail during a presentation, and some neat classroom activities can be developed.

Social science is another area that has an overlap with science; the name itself, "social science" reveals the overlap. Population studies, behavior disorders, and economic cycles all

share a relationship with science. At Mid-America Museum in Hot Springs, Arkansas, geological movement and erosion due to rivers is shown in an exhibit that is inspired by the geography of Arkansas' three main rivers (McDowell/Nannemann, personal communication, October 17, 1996). The visit to a SLM can initiate a study of the similarities between the natural sciences and the social sciences. A museum experience can guide students to see the importance of science, art, literature, and the social sciences and the relationship that all these disciplines share.

Since some areas are very isolated geographically and do not have access to a local museum, how can a teacher use a museum as a teaching tool? If it is not logistically possible to take a class to a SLM, perhaps the SLM could come to the classroom. Museums usually have a presenter who can travel. The presenter can come to the classroom and bring simulations and experiments that are not feasible for a regular classroom. A bonus to such a visit is that there is no gathering of permission slips, no scheduling of buses, and no fear of losing a child in the museum. The museum does all the work. If the idea of bringing in a presenter is not practical, a teacher has options. Museums have loan boxes that are available at a nominal fee. These boxes contain all the items necessary for doing a battery of experiments and projects.

If no museum circulates loan material in a particular area, the most creative option can be the one taken. A teacher can create a science learning museum in the classroom, sometimes called learning centers or science centers. There are many different resources in print that give ideas for science projects; teachers could adapt these ideas for use in the classroom as "exhibits." This idea is probably the most labor intensive; however, willing students can help. The skills that the students will develop while working together to create a class museum are numerous. Math skills, science knowledge, material science knowledge, aesthetics, teamwork, critical thinking, leadership, and self confidence are all traits and qualities that children can gain by working on a class project like a museum. Two first-grade teachers in St. Louis, Missouri, combined their classes to put together a museum, and they saw unbelievable academic development and

maturation in their students during the process of creating the museum (Wallach, 1994). While museums have planners, researchers, carpenters, and many other skilled people to develop exhibits, students can do these jobs well if given the chance. The best resource for developing a classroom museum is the set of "Snack Books" created by the Exploratorium (Exploratorium, 1996).

I Hear and I Forget

I See and I Remember

I Do and I Understand

is the sentiment of an old Chinese proverb that fits quite well with the thrust of this thesis. The media and television commercials continue to exert that American students are not learning science as well as children in other countries. Teachers can be blamed, but it is not the fault of the teachers; it is everyone's fault. Though in today's occupational structure it is almost impossible to get a good job without at least a bachelor's degree, students continue to portray an intelligent person with a negative stereotype (nerd, geek, etc.). In the elementary classroom, this stereotype needs to be put to death. By getting students excited about learning, they are less likely to accept this negative stereotype. As more and more students become more and more apathetic to the thought of learning, teachers must use new techniques to fan the flames of interest.

Teachers have many options to try to get students excited about learning. One feasible option is the use of science learning museums as a teaching tool. More than just a teaching tool, teachers can actually integrate the SLMs into their science curriculum. As discussed in this thesis allowing children to visit a museum excites them and helps to facilitate learning by disguising it with fun. A school and a museum can coexist peacefully as partners, even as occupants of the same building. The demonstration of scientific experiments and applications is getting to the point where it is no longer practical in the classrooms. Schools should allow museums, as specialists, to

provide the students with visual and interactive demonstrations, presentations, and exhibits. As the children get more accustomed to this new extension of their classroom, they will get more accustomed to the skills that they use at the museum. These skills spill over into their non-school life, and students become curious learners. The use of science learning museums as an extension of the modern classroom will shower the benefits of knowledge, information, curiosity, and excitement on students, who will take their love of learning with them as they grow and effect change on the world.

Appendix

Donna Brearly is Director of Programs at Discovery Place, Inc. in Charlotte, North Carolina. As well as coordinating exhibits, presentations, and inservice programs, she is directly involved in ScienceReach. Mrs. Brearly is also associated with the science clubs that Discovery Place sponsors.

Linda McDowell works as Education Director at Mid-America Science Museum in Hot Springs, Arkansas. Mrs. McDowell coordinates activities with school teachers and creates resource materials that complement museum exhibits. She also maintains the lending of activity boxes to teachers.

Susan Nannemann is Assistant Director of Mid-America Science Museum in Hot Springs, Arkansas. Mrs. Nannemann conducts the placement of traveling exhibits and oversees the daily workings of the museum.

Mary Jean Syrek coordinates science education at the Charles R. Drew Science Magnet School in Buffalo, New York. She facilitates the enrichment of science education and helps teachers to integrate museum exhibits into their teaching activities.

Susan Thomae-Morphew is Education Director for the Texarkana Museum System. She coordinates educational activities between school groups and Discovery Place, a science museum in Texarkana, Texas.

Reference List

Association of Science-Technology Centers [ASTC] *Homepage*. (1997).

Cleaver, J. (1992). *Doing children's museums*. Charlotte, VT: Williamson Publishing.

Crane, V., et al. (1994). *Informal science learning*. Ephrata, PA: Science Press.

Dow, P. (1993). Teaching with objects: No fault learning? *Social Studies, 84*, 230-231.

Exploratorium Homepage. (1996).

Hertzberg, L. (1993). It's all happening at the zoo. *Electronic Learning, 12*, 22-23.

Melton, A., Feldman, N., & Mason, C. (1935). *Experimental studies of the education of children in a museum of science*. Washington: American Association of Museums.

Microsoft Bookshelf 1996-1997 for Windows 95 (1995). *The Columbia Dictionary of Quotations*. [Computer program]. Redmond, WA: Microsoft.

Serrell, B. (Ed.) (1990). *What research says about learning in science museums*. Washington: Association of Science-Technology Centers.

Sheppard, B. (Ed.) (1993). *Building museum and school partnerships*. Harrisburg, PA: Pennsylvania Federation of Museums and Historical Organizations.

Wallach, C. & Callahan, S. (1994). The 1st grade plant museum. *Educational Leadership, 52*, 32-34.

Sources Consulted

Boyd, W. (1993). Museums as centers of learning. *Teachers College Record, 94*, pp. 761-70.

Bradshaw, B. & Downey, A. (1995). A deep sea adventure. *Science Scope, 18*, pp. 63-5.

Cammack, N. (1993). Rex's reading center is a roaring success. *American Libraries, 24*, p. 428.

El Nasser, H. (1996, June 3). Innovative museums help kids discover science. *USA Today*, Section D, p. 6.

Farmer, D. (1995). Children take learning into their own hands. *Childhood Education, 71*, pp.168-9.

Grobman, A. (1992). Is science fun? *Science Teacher, 59*, pp. 28-31.

Harte, D. (1989). Fine tuning the learning experience: An information age model for excellence. *NASSP Bulletin, 73*, pp. 96-101.

Hertzberg, L. (1993). It's all happening at the zoo. *Electronic Learning, 12*, pp. 22-3.

Holzberg, C. (1990). Where kids experience the future. *Technology & Learning, 11*, pp. 50-2.

Karp, I. & Lavine, S. (1993). Museums must take on new roles in this multicultural society. *Chronicle of Higher Education*, 39, p. B3.

Murphy, B. (1991). Museums are on the move. *Educational Technology, 31*, p. 62.

Ogintz, E. (1996, March 10). When the kids start to bug each other, visit a science center. *Arkansas Democrat-Gazette*, Section H, p. 5.

Smith, F. (1986). *Insult to Intelligence*. New York: Arbor House.

Sussman, B. (1995). Late night at the museum. *Science Scope, 18*, pp. 60-2.

Swartz, C. (1991). Extracurricular fun and games. *Physics Teacher, 29*, p. 260.

Sweeney, J. (1995). Invited papers. *Science Teacher, 62*, p. 10.