Running head: MUSEUMS AND EDUCATION

Museums and Education:

Connecting the Elements of Education to Science and Children's Museums

Samantha Bane
Peabody College at Vanderbilt University
Capstone

Abstract

Museums are informal environments that incorporate various elements of learning, such as: the learner environment, learners and learning, curriculum and teaching strategies, and assessment. This paper focuses on these elements that are apparent in children's museums and science museums. Important aspects of these topics that are discussed include: participation, agency, mediation, collaborative learning, novelty of resources, community connections, partnerships between museum and researcher, the use of background knowledge, motivation, interest, inquiry, the zone of proximal development, discourse, and play. There are also implications to be considered from understanding these elements of the informal museum setting, and how they relate to and affect the formal classroom setting.

Museums and Education: Connecting the Elements of Education to Science and Children's Museums

In an interview with Richmond Wolf, a PhD in Geology and a member of the Board of Directors at Kidspace Children's Museum in Pasadena, California, it became clear that museums were instrumental in shaping Dr. Wolf's life interests (R. Wolf, personal communication, August 7, 2008). Dr. Wolf described how visiting museums as a child gave him the desire and drive to become a scientist. He described how his experiences at museums helped him formulate his opinion of science, and inspired him to be a scientist. Dr. Wolf went on to express how museums provide the opportunity to participate in tactile learning, which differed from the formal classroom.

Science museums and children's museums are both important informal learning environments for children, as they explore and understand their world. Museums give children the opportunity to experience an environment that promotes the values of curiosity, questioning, and problem solving. Children who learn the principals associated with science are able to expand their knowledge, as the cycle of questioning, problem solving, and making conclusions feeds upon it's self. Future engineers, biologists, astronomers, physicists, and doctors, to name a few occupations, are "made" when children are inspired by their science experiences. The role of the learning environment is extremely important when it comes to a child's engagement in science, and their ability to be inspired by science. The formal classroom is important, but the informal environment is another realm of learning that can inspire student's science experience. The following essay will address the learning environment, learners and learning, curriculum and instructional strategies, and assessment in the area of science, and how these areas are reflected in science and children's museums.

Formal Education vs. Informal Education

The environment in which learning occurs is an important predictor for the actual learning that will take place. Formal and informal education represent different settings for learning. Formal education occurs in the setting of the classroom, while informal education occurs in settings outside of the classroom: museums, after-school programs, and libraries, for example (Norland, 2005; Rogers, 2005). Norland (2005) cites Etling's (1994) comparison of formal and informal or "nonformal" education. In formal education, the focus is on the technique of teaching, while non-formal education focuses on learning that stems from engaging and meaningful experiences. Formal education is also controlled by a set curriculum, where informal education has more flexibility in terms of curriculum. Informal settings, often, are not focused on helping students gain specific content knowledge. The goals of informal environments, rather, may emphasize broader ideals, like forming "self-identities," for example (Schauble, Beane, Coates, Martin, & Sterling, 1996). The relationships built in the formal education setting are often hierarchical, where teachers direct students in learning (Rogers, 2004). The relationships built in informal settings are more relaxed, and adults are facilitators rather than directors. The relationships among students, and their social interaction with each other, are extremely valuable in informal settings (Schauble et al, 1996). Informal education also produces a relationship between the community and the student (Schauble et al, 1996). The resources used in formal education mostly stem from state and federal government funding, where resources for informal education stem from more localized or private funding. Formal education is also characterized by structure, where informal

education is often less controlled. The learning that takes place in formal and informal education will therefore be different, reflecting the differences inherent in both settings.

Museums as Informal Learning Environments

Museums are unique learning environments, with changing roles throughout history. Museums have shifted from meeting the needs of the elite few, to providing experiences that meet the needs of the diverse public. Instead of just focusing on the taking care of artifacts and preserving history, museums now think about the future, and the public that supports them.

Museums provide an environment where students can connect their formal, classroom experiences with novel experiences that museums can provide. This makes student's learning meaningful. Student's museum experiences are also not confined to the time spent in the museum, as those experiences may help students assimilate knowledge in the future. Museums also give students the opportunity to access new tools and resources that schools may not have. Museums facilitate student's interaction and conversations with each other and adults, as they provide a realm of participation and choice for visitors (Matusov & Rogoff 1995). Museums are important contributors to children's development and learning.

Science museums and children's museums are informal learning environments that are beneficial to student's understanding and learning in the area of science. The following sections will describe science museums (the Franklin Institute, the California Science Center, and the Carnegie Science Center) and children's museums (Boston's Children's Museum, the Children's Museum of Indianapolis, and the Children's Museum of Pittsburgh), and their approach to learners and learning, the learning environment,

curriculum and teaching strategies, and assessment. It is important to understand that these headings are not mutually exclusive; they are all related to each other. For example, the learning environment directly relates to how learning happens. Also, as the focus here is the informal learning environment, it is important to note that there are implications and connections to the formal classroom environment as well.

The learning environment. The informal learning environment of museums is very different from that of the formal classroom. Luehmann and Markowitz (2007) describe a theory called "situated cognition," which states that learning is significantly affected by the elements of the learning environment, both social and physical. For example, how students interact with peers and adults or if students are able to engage in their own hands-on activities with their own tools, can greatly influence student's learning and understanding. There are several components of the museum learning environment that effect learning, including: participation and agency, mediation, family learning, novel resources and media, community connections, and partnerships between museums and researchers.

Characteristics of the museum learning environment that are different from the formal learning environment include participation and agency. Museums often require a higher level of personal involvement from visitors, as they are in charge of seeking out information and exploring exhibits. Eugene Matusov and Barbara Rogoff (1995) discuss how museums are environments that require the visitors to make decisions regarding their own participation. The formal classroom is less likely to provide opportunities for decision making on that level. The museum environment gives visitors the opportunity to decide on the exhibits they want to visit, how long they choose to be there, and how they

will go about their visit (Matusov & Rogoff, 1995). There is much more freedom and choice involved in this learning environment.

Another distinctive characteristic of the museum learning environment is mediation. Leona Schauble and Karol Bartlett (1997) describe how museums, as they provide choice, also need to be aware of the "mediation" that takes place in museums, and how that effects visitors and their learning. Mediation involves "the signage, gallery layout, tools, and notations that signal meaning within the museum space, as well as the way that children's interactions with each other and adults contribute to the meaning that gets constructed" (Schauble & Bartlett, 1997, p. 790). At the Pittsburgh Children's Museum, researchers describe this mediation as "communication opportunities," that enhance visitor's museum experiences. The Pittsburgh Children's Museum categorizes these communication opportunities as advanced organizers, information, learning content, and interaction scaffolds for parents (Werner & Golomb, n.d.) The learning environment is characterized by choice, but it is mediated by the construction of the actual environment and the collaboration between children and parents.

Museums are also different learning environments because they invite families to learn together. The formal classroom is usually composed of teachers and students, but the informal learning environment of museums presents the concept of families experiencing something together. Children are especially likely to visit museums with their families, and it is important to understand how this dynamic effects the learner and learning, which will be addressed below in the following section.

Museums present media and resources that are different then what the child may be exposed to in the classroom. Museums are usually made up of both traveling and

permanent exhibits, which present new forms of media and stimulus for visitors. The California Science Center (http://www.californiasciencecenter.org/, 2008) offers various exhibits and attractions from which the visitors can choose. Some of the exhibits include "Creative World," "World of Life," "Air and Space," and the "Weingart Exhibit Gallery." The Transportation exhibit at the California Science Center is part of the "Creative World" exhibit, which offers visitors the opportunity to race solar powered cars, design cars with the help of a computer, and discover which sail on a sail boat is most effective. The California Science Center also offers "attractions" like a high wire bicycle, a motion-based simulator, and an ecology cliff climb. Exhibits often involve visitors in reading plaques or exhibit descriptions, listening to docents, taking tours, or just merely doing hands-on exploring with novel tools. Choice is again a major component of the actual museum visit, as visitors choose what to read, who and what to listen to, and how to explore. Students in a classroom may not experience the ability to choose what and how they learn. The museum environment presents more of an inquiry based way of learning, which formal science classrooms can learn from and model.

Museums are environments that promote enrichment programs outside of the formal school setting. Museums represent learning environments that are deeply connected to the communities they serve. Most museums have significant resources, and it is characteristic that museums connect their resources with the community. Luehmann and Markowitz (2007) describe how many museums give students access to enrichment programs, where students use novel tools to do their own experimentation and investigation, for example. The goal of these programs is to foster a love of science and exploration through inquiry. The Carnegie Science Center

(http://www.carnegiesciencecenter.org/, 2005) has a program called the Girls, Math & Science Partnership that focuses on girls and their participation and interest in the fields of math and science. The Franklin Institute (http://www2.fi.edu/, n.d.) also has a program called Girls at the Center, which supports females in the field of science. The goal of these two programs is to target the female youth population in the surrounding area, and to provide them with opportunities that may not occur within the formal classrooms. The Carnegie Science Center also has a program entitled Mission Discovery, where students partake in a year-round academic enrichment program. Families are an integral part of this program, as parents are required to volunteer at least four hours a month. The Carnegie Science Center describes programs like the Girls, Math & Science Partnership and Mission Discovery as outreach programs. The Carnegie Science Center states that, "Since 1983, these outreach programs have provided informal science education to over 1.5 million students" (http://www.carnegiesciencecenter.org/, 2005). Museums provide a way of connecting to and meeting the needs of their community.

Museums are unique learning environments where partnerships can form with researchers and universities to better understand learning in informal settings. This allows museums to understand what happens when people visit, and how museums can increase their effectiveness. The focus of most research in the education field is on "best-practices" within the classroom setting, but little research has been done on "best-practices" within informal settings, like museums. The Children's Museum of Pittsburgh (http://www.pittsburghkids.org/, 2004), for example, is a learning environment that partners with Kevin Crowley and his team at the University of Pittsburgh Center for Out-of-School Environments (UPCLOSE). UPCLOSE helps the museum execute exhibits and

programs that are developmentally appropriate. In turn, UPCLOSE is able to research family learning in museum settings (Werner & Golomb, n.d.). This research presents important implications not only for museums as educators, but for the formal classroom and learning at home.

Learners and learning. Learners and learning is an overarching theme for this paper, as learners and learning effect and are affected by the learning environment, curriculum and teaching strategies, and assessment. There are several facets of the learner and learning that relate to the informal learning environment of museums, which include: prior knowledge or background knowledge, motivation, engagement and inquiry, interest, collaborative learning, the zone of proximal development, family interaction, discourse, and play.

The prior knowledge that museum visitors bring to their museum visit effect the learning that occurs. Children come to museums with background knowledge that they have acquired through lessons in the formal classroom, discussions with parents, or their own experimentation. Anderson, Lucas, & Ginns (2003) reference the human constructivist view on learning, and the importance of previous experiences, when describing the way learning occurs in museums. The human constructivist model states that, "Individuals' present conceptions are products of diverse personal experiences, observations of objects and events, culture, language, and teachers' explanations" (Anderson, Lucas, & Ginns, 2003, p. 180). The elements that make up a child's understanding and learning reflect their previous experiences, and this influences the new connections they make.

Museums present a novel environment for understanding motivation and it's effect on the learner and learning. Motivation is key a factor for learning that is meaningful and deep. Csikszentmihalyi and Hermanson (1995) write about intrinsic and extrinsic motivation, and their relationship to museum learning. Extrinsic motivation describes drive that comes from an external reward. Individuals who are extrinsically motivated merely seek a means to an end. Individuals who are intrinsically motivated act without any external reward. They are motivated, instead, by the experience itself. Csikszentmihalyi and Hermanson (1995) write that individuals who are intrinsically motivated tend to have higher achievement scores, higher levels of curiosity, and highly developed skills. Extrinsic motivation may be associated with a decrease in achievement, curiosity, and skill as the focus of learning shifts from the internal joy of learning to the reward gained. The formal environment of the classroom usually stresses more external motivation. Students are motivated by grades or by the ability to please parents or teachers. Museums offer environments that foster intrinsic motivation, as exhibits are avenues for visitors to explore their interests. Sue Allen (2004) writes about museum exhibit design and the learning process. She describes how superior exhibits are highly intrinsically motivating throughout the visitor's entire experience. Museum exhibits that are highly motivating are more likely to maintain visitor's attention and focus.

Museums give learners the ability to be active participants in their learning. Active learners are engaged in inquiry, as they try to understand their world. They are curious, they question, and they seek to find answers. Museums present opportunities for visitors to become active in learning as they pursue their interests and answers to their questions. Csikszentmihalyi and Hermanson (1995) describe the importance of curiosity

and interest in learning. They describe the differences between situational interest and individual interest. Situational interest occurs when one meets a new environment or challenge that peaks curiosity. Individual interests pertain more to one's long-term inclination towards certain subjects or topics. Museums present the opportunity for visitors to build on both situational interest and individual interest.

Museums are important environments because they are capable of "grabbing" visitors with novel resources, and therefore increasing visitor's situational interest. Hands-on activities are key elements of museums that can influence visitor's motivation and interest. Sue Allen (2004) describes how allowing visitors to participate in hands-on experiences makes the visitor an active participant in their learning, where they are encouraged to hypothesize, experiment, interpret and make conclusions. Paris, Yambor and Packard (1998) write about the importance of hands-on activities shown in their research. The research shows that hands-on science learning programs increased student's interest in science, student's ability to problem solve, and gave females a more positive attitude toward the field of science. The Boston Children's Museum stresses that learners learn through "hands-on engagement and learning through experience" (http://www.bostonchildrensmuseum.org/, n.d.). For example, the Boston Children's Museum offers an exhibit called the Japanese House. Visitors to the Boston Children's Museum may come without an individual interest in Japanese culture, but the opportunity to walk into an authentic two-story home from Japan may spark visitor's situational interest. Visitors may find themselves wanting to learn more about Japanese culture then they originally thought. The hands-on experience sparks interest, and therefore motivation, creating a meaningful experience.

Individual interest is also an extremely important facet of learning. Museums present wonderful environments for visitors to seek out their own interests. John Dewey (1913) describes, in *Interests and Efforts in Education*, that personal interest is a great predictor in understanding how and why students learn. If a student is not interested in the material being learned he/she will not have a deep understanding of that topic. Csikszentmihalyi and Hermanson (1995) describe how museums are environments where learners can form deeper understanding and meaning as they seek out their interests. Again, choice is an important aspect of a museum learning environment that benefits visitors who already have individual interests. For example, The Franklin Institute (http://www2.fi.edu/, n.d.) offers "The Train Factory Exhibit," where visitors are able to immerse themselves in a train factory. If a visitor to The Franklin Institute has a personal interest in locomotives, this exhibit offers a wonderful opportunity for he/she to expand their interest, and make learning meaningful. Leona Schauble and Karol Bartlett (1997) describe their work on constructing a science gallery ScienceWorks at The Children's Museum of Indianapolis. They describe how visitor's interests and motivations are key aspects to consider as one designs an exhibit. They describe the "funnel approach" to designing galleries, where visitors are given a wide range of opportunities for involvement in "the big ideas" associated with science. Then, as visitors spend more time in the exhibit they are given more options to delve deeper into areas that interest them. Schauble and Bartlett (1997) describe how it is important to give visitors the opportunity "to go beyond attract mode" (p. 784) and to seek out interests and take them to higher levels of involvement. For example, at ScienceWorks visitors may be immediately attracted to The Creek where visitors experiment with the principals of fluids. Then, if a

visitor finds himself/herself immersed in this area, they may want to go to the Dock Shop, where they can work on designing boats. The level of involvement increases as interest peaks.

Museums are unique learning environments because they give visitors the opportunity for collaborative learning. Collaborative learning is important because it allows for young visitors to problem solve and understand things within their zone of proximal development. Proximal development occurs when a child is able to accomplish a task, that they would not otherwise be able to master, with the help of another. Matusov and Rogoff (1995) describe Vygotsky's (1978) idea of the zone of proximal development, and how museums are key players in helping children work through their zone of proximal development. For example, a visitor may not be able to solve a problem at an exhibit, but she/he may be able to solve the problem with the help of another. In museums this collaboration may be between children or between parent or docent and child. Doris Ash (2003) writes that families, and specifically parents, are key players in dialogue and interaction that help children work through their zone of proximal development. Parents, through conversations, help their children construct knowledge within the museum environment.

Museums are places that involve extensive interaction, both positive and negative, between families, and this influences learning. Kevin Crowley and Maureen Callanan (1997) describe collaborative learning as an integral aspect of socio-cultural theory inspired by Vygotsky (1978). In this theory, it is the interaction that makes learning meaningful. In the formal classroom setting parents are less involved in the day-to-day learning of their child, as the teacher is the lead in this effort. Home-school connections

are important to make in formal classrooms as this makes learning meaningful. Museums focus on slightly different connection making. The focus is more on understanding how families will connect with the museum itself, and how those connections can continue to be made at home. It is important to understand how children interact with parents as they navigate museums and gain understanding.

Discourse is an important aspect of learners and learning, and a major form of collaboration between children and parents. It is the interaction that makes learning meaningful. Karen Knutson (2008), who is part of the University of Pittsburgh Center for Learning in Out of School Environments (UPCLOSE) that collaborates with the Children's Museum of Pittsburgh, writes about the importance of discourse in museums. Knutson (2008) writes that conversations are ways for visitors to share their experiences and make connections to each other. The connections made between individuals can help further meaning making and understanding. Research done by Crowley and Callanan (1997) shows that parent participation can increase their child's engagement with an exhibit. They also found that parents can have different learning goals than children's, and this can inhibit a child's experience and understanding of an exhibit. The Children's Museums of Pittsburgh (http://www.pittsburghkids.org/, 2004) stresses that parent involvement is a huge part of children's learning and understanding in museums. The goal is to give parents opportunities for meaningful engagement with their children both during and after the museum visit. The Children's Museum of Pittsburgh and UPCLOSE describe how mediation in the form of signs, labels, and facts, etc. help families communicate. The Children's Museums of Pittsburgh and UPCLOSE focus on how they

can align parent and child learning goals, as this will make the learning experience a positive process.

Collaborative learning in the museum setting also supports the element of play in the learning process. Play gives younger children the opportunity to socialize and interact with others and their environment, while their imaginations help them learn. Schauble and Bartlett (1997) describe how play was an important aspect in designing the ScienceWorks gallery at The Children's Museum of Indianapolis. They write that cooperative play and social interaction were two key aspects associated with forming the exhibit. Museums give visitors the opportunity to play and try out different roles. The Boston Children's Museum (http://www.bostonchildrensmuseum.org/, n.d.), for example, offers an exhibit called Play Space, where visitors age 0-3 can climb a tree house with bridges and slides, interact with a toy train landscape, and paint on a see-through wall. The Carnegie Science Center also offers an exhibit called SportsWorks, where they encourage visitors to "stay and play all day!" (http://www.carnegiesciencecenter.org/, 2005). At SportsWorks, visitors can play optical illusion mini-golf, climb a rock wall, and design their own rollercoaster. Again, the hands-on, minds-on activities are key to sparking interest, motivation, and meaningful learning.

Curriculum and teaching strategies. Museums offer a unique way of viewing curriculum and teaching strategies. The curriculum of the museum relates to the exhibits and the resources that the museum offers. Leichter, Hensel, and Larsen (1989) point out that the curriculum of museums is unique because visitors are in charge of creating their own path as they move throughout museums. Visitors are also privy to curriculum resources that are not typical in formal classrooms, such as: workshops, exhibits, audio

tours, seminars, traveling exhibits, information booths, gallery guides Leichter, Hensel, and Larsen, 1989, p. 31-32).

The main difference between a children's museum and a science museum is the curriculum they present. Science museums offer a wide range of exhibits related mostly to the "big ideas" of science. The Franklin Institute, for example, focuses their mission on "inspiring a passion for science and technology learning" (J. Grinspan, personal communication, January 23, 2008). The exhibits at The Franklin Institute (http://www2.fi.edu/, n.d.) include Amazing Machine, Franklin…He's Electric, The Giant Heart, and Kid's Science. The focus of the curriculum is science related. Children's museums present a slightly different focus. The curriculum of children's museums is often broader then that of science museums, and is related to connecting to the lives of the community. The Children's Museum of Indianapolis, for example, writes that their mission is to, "…transform the lives of children and families" (http://www.childrensmuseum.org/, n.d.). This mission is much more abstract then that of The Franklin Institute, and this matches the curriculum and exhibits within the Children's Museum of Indianapolis. Oftentimes, children's museums present more of a social or humanistic curriculum, rather than a focus only on science.

Children's museums offer exhibits that are based more on social understanding and culture. The focus is on connecting the exhibit itself to the community of visitors. For example, The Children's Museum of Indianapolis (http://www.childrensmuseum.org/, n.d.) has an exhibit called The Power of Children, where visitors learn about the lives of Anne Frank, Ruby Bridges, and Ryan White, and how one individual can make a difference. This exhibit gives visitors the opportunity to make connections between the

exhibit and their own lives, a key aspect of museum curriculum. The Boston Children's Museum (http://www.bostonchildrensmuseum.org/, n.d.) also offers an exhibit, called Boston Black…A City Connects that is more socially driven. The exhibit allows visitors to experience the diversity of the Boston's Black community, and spark conversations on race and identity. Again, connections between visitor's lives, the community, and the museum exhibits are key elements of the museum curriculum.

Teaching strategies at most science and children's museums include hands-on, minds-on opportunities for exploration. Inquiry is at the heart of teaching and learning, where children can use scientific knowledge and attitudes to think critically. Museums give opportunities for inquiry as they set up important questions that spark curiosity. Martin, Sexton, Franklin, and Gerlovich (2005) write about the 4-E learning cycle that describes how students learn science in more formal classrooms, however, implications can be made about learning within museums. The cycle consists of Exploration, Explanation, Expansion, and Evaluation. Exploration consists of hands-on activities and investigations, where children form preconceptions and explore their ideas. Museums are environments where visitors can search out their interests and form new understandings. As visitors discover new information in museums they connect this new information to previous knowledge. This is a key element of the museum strategy, as play and experimentation drive exhibits. Explanation consists of students processing their exploration, and identifying and describing the concept they are exploring. This may be where mediation (signs, facts and docents, for example) and collaborative learning (parents and social play) help museum visitors form the concept they are interested in. Expansion consists of students expanding their understanding of a concept through

continued questioning and activities. This may be where the "funnel approach" described by Schauble and Bartlett (1997) comes into play, as the museum exhibit ScienceWorks allows visitors to deepen their level of involvement as their interests direct them. Visitors are able to form concepts and expand those concepts as they think, reason, and apply their learning. Evaluation consists, in a formal classroom, of understanding what learning took place. Museums represent a unique outlook on evaluation and assessment.

Assessment. As museums are informal environments, assessment is an area that can be difficult to measure. Formal assessments used in the formal classroom, tests, quizzes, and progress reports for example, are normally not available for understanding learning within the museum setting. Assessment within the museum setting may relate to the effectiveness of the museum in general, the effectiveness of the exhibit in particular, the learning and involvement that takes place within the museum walls, and the learning that takes place outside of the museum, after a visit.

Learning in museums is typically a difficult thing to assess because not all learning occurs within the museum walls. Leichter, Hensel, and Larsen (1989) describe how museum learning is hard to measure effectively because the learning and understanding associated with the visit may come much later. For example, as families return home after a museum visit they may discuss concepts together, and learning can still occur. Parental involvement, collaborative learning, and discourse are key as parents and children work toward understanding or synthesizing their museum experience. Learning can also occur after a museum visit as visitors begin to use the knowledge they acquired during their visit to make connections to new experiences they encounter.

Museums present a wonderful opportunity for researchers to assess how learning takes place. This assessment allows museum personnel the opportunity to understand what is effective, and what is not effective. There are several ways scientists assess learning and conduct research within museums. Crowley and Callanan (1997) describe two methods of assessment that can be used in the museum setting. One method of assessment is interviews with visitors. This type of assessment is parallel to tests given in a formal classroom. Visitors are assessed on how well they communicate about the museum content. Crowley and Callanan (1997) write about another approach to assessing learning that is less formal. Instead of interviewing visitors, researchers track the visitor's activity within the museum. They may "shadow" a visitor to assess what exhibits interest him/her. Researches may also look at how visitors interacted with the exhibit, and how much time was spent on task, for example. Museums may assess how visitors used signs or directions, and if they inspired or inhibited learning. Researchers may also look at the quality of conversations and the collaborative learning that takes place. Researchers like Crowley and Callanan (1997) look to see how parent involvement may help/hinder a child's learning in a museum, and how the museum can help make sure that parents enable their child's learning and understanding. Other areas that researchers assess are curiosity, fun, and interest, according to Crowley and Callanan (1997). Combining this "data" can give researchers and museum personnel the opportunity to see how learning takes place and what constitutes an effective exhibit.

Implications and Conclusions. Museums are important educational resources, and they provide an element of social learning. They present opportunities for children to have a "crystallizing experience," (Walters & Gardner, 1986) that will shape the rest of

their lives. The learning environment, learners and learning, curriculum and teaching strategies, and assessment are all areas that are reflected in the informal environment of museums. These areas are also interconnected, as aspects like mediation and discourse, for example, are elements of the learning environment and how learning takes place. Museums present a unique way of understanding these topics, as the informal museum environment is extremely different from that of the formal classroom.

There are also several implications to be made for the formal classroom, as one understands the effectiveness of museums. Aspects of the informal museum environment, such as participation, agency, mediation, collaborative learning, novelty of resources, community connections, the use of background knowledge, motivation, interest, inquiry, the zone of proximal development, discourse, and play, are tools that should be considered by the formal classroom teacher. The formal and informal environments should "blend" to improve science learning (Anderson, Lucas, & Ginns, 2003, p. 178). As a teacher, this means that one should give students the opportunity to connect with their world, to explore, question, work together, and talk together. When elements of the formal and informal learning environment combine, a "crystallizing experience" (Walters & Gardner, 1986) can occur.

Reference

Allen, S. (2004). *Designs for learning: Studying science museum exhibits that do more than entertain*. Wiley Periodicals, S17-S33.

Anderson, D., Lucas, K. & Ginns, I. (2003). Theoretical perspectives on learning in an informal setting. *Journal of Research in Science Teaching, 40* (2), 177-199.

Ash, D. (2003). Dialogic inquiry in life science conversations of family groups in a museum. *Journal of Research in Science Teaching, 40* (2), 138-162.

Crowley, K. & Callanan, M. (1997). Describing and supporting collaborative scientific thinking in parent-child interactions. *Journal of Museum Education*.

Csikszentmihalyi, M. & Hermanson, K. (1995) Intrinsic motivation in museums: Why does one want to learn?. In J.H. Falk & D. Durking, (Eds.), *Public institutions for personal learning* (67-77). Washington, D.C.: American Association of Museums.

Dewey, J. (1913). *Interest and effort in education*. Boston: Riverside Press.

Knutson, K. (2008, July). *Expertise and experience: Museums, a place for talk.* Position Paper for the National Academies: Future of Libraries and Museums in the 21st Century, Washington DC., 7-8 July 2008.

Leichter, H., Hensel, K., & Larsen, E. (1989). *Museum visits and activities for family life enrichment*. Haworth Press, Inc.

Luehmann, A. & Markowitz, D. (2007). Science teachers' perceived benefits of an out-of-school enrichment programme: Identity, needs and university affordances. *The International Journal of Science Education, 29* (9), 1133-1161.

Martin, R., Sexton, C. Franklin, T., Gerlovich, J. (2005). *Teaching Science for All*

Children, An Inquiry Approach. Pearson Education Inc.

Matusov, E. & Rogoff, B. (1995). Evidence of development from people's participation in communities of learners. In J.H. Falk & D. Durking, (Eds.), *Public institutions for personal learning* (97-104). Washington, D.C.: American Association of Museums.

Norland, E. (2005). The nuances of being "non": Evaluating Nonformal education programs and settings. In E. Norland & C. Somers (Eds.), *Evaluating nonformal education programs and settings* (5-12). Massachusetts: Wiley Periodicals, Inc.

Paris, S., Yambor, K., & Packard, B. (1998). Hands-on biology: A museum-school-university partnership for enhancing student's interest and learning in science. *The Elementary School Journal, 98* (3), 267-288.

Rogers, A. (2004). *Non-Formal Education; Flexible Schooling or Participatory Education?* Hong Kong, China: Comparative Education Research Centre.

Rogoff, B. (1995) Observing sociocultural activity on three planes: Participatory appropriation, guided participation, and apprenticeship. In J. V. Wertsch, P. del Rio, & A. Alvarez (Eds*.), Sociocultural studies of mind* (139-164). Cambridge, Eng.: Cambridge University Press.

Schauble, L. & Bartlett, K. (1997). *Constructing a science gallery for children and families: The role of research in an innovative design process*. John Wiley & Sons, Inc.

Schauble, L., Beane, D., Coates, G., Martin, L., & Sterling, P. (1996). Outside the

classroom walls: Learning in informal environments. In L. Schauble & R. Glaser (Eds.), *Innovations in learning; New environments* (5-24). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Walters, J. & Gardner, H. (1986) The crystallizing experience; Discovering an intellectual gift. In R. J. Sternberg & J. E. Davidson (Eds.), *Conceptions of giftedness* (306-331). New York: Cambridge University Press.

Werner, J. & Golomb, J. (n.d.) Met life foundation and association of children's museums promising practice award. Retrieved on August 21, 2008 from http://www.pittsburghkids.org/Templates/CMP_Main.aspx?CID=95&SECID=4&MENUID=40

Vygotsky, L. (1978) *Mind in society: The development of higher psychological process*. Cambridge, Mass: Harvard University Press.