Research Supported Statements Related to Learning in Informal / Free Choice Environments Such as science museums, field sites, and zoos

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This brief list provides a sample of the rich set of empirical studies that provides a foundation for the study of learning in informal environments. If you send me (mccomas@usc.edu) an e-mail request I will provide you with a version of the current ten page set of research supported statements, recommendations, comments, and references related to leaning in informal environments. We encourage you to add statements and references to this list once you have reviewed the whole document.

In an investigation of seven different scientific inquiry activities on visitors' understanding of the science underlying an interactive exhibit, Allen found that the interpretation activity was the most effective in facilitating visitors' understanding and the prediction activity was the least effective.

Allen, S. (1997). Using scientific inquiry activities in exhibit explanations. *Science Education, 81*, 715-734.

Year Eight students who underwent novelty-reducing pre-orientation to the physical environment of an interactive science museum and had prior experience visiting the museum learned more than their counterparts. Exhibits most frequently recalled shared a combination of characteristics such as large physical size, prominence in the exhibit galleries, and diversity of sensory modes employed.

Anderson, D., & Lucas, K. B. (1997). The effectiveness of orienting students to the physical features of a science museum prior to visitation. *Research in Science Education, 27*, 485-495.

Students prefer the freedom of social interactions during a visit to a zoo or museum, and identified the importance of companions who allow for sharing of information and experiences.

Birney, B. (1988). Criteria for successful museum and zoo visits: Children offer guidance. *Curator, 31*, 292-316.

Visitors at a science museum discovery space were most attracted to exhibits with concrete presentations, holding power was highest for exhibits with high interaction and concrete presentation, and engagement levels were highest for high interaction exhibits.

Boisvert, D. L., & Slez, B. J. (1995). The relationship between exhibit characteristics and learning-associated behaviors in a science museum discovery space. *Science Education, 79*, 503-518.

Seven characteristics (including multi-sided, multi-use, accessible, multi-outcome, multi-modal, readable, and relevant) were identified as related to successful family learning exhibits.

Borun, M., & Dritsas, J. (1997). Developing family-friendly exhibits. *Curator, 40*, 178-188.

"What each individual child gained from the experience is unknown, but observation shows that a high proportion of the interaction with exhibits was what the designers had intended. So - judged as a learning environment – the center provided a context that motivated encouraged meaningful behavior and social interaction was pleasurable, and held the potential for learning scientific facts and principles." pg. 32

Carlisle, R. (1985). What do school children do at a science center? *Curator, 28 (1),* 27-33

Teachers did not specifically prepare students for a visit to a discovery center of natural history and exhibited formal school behaviors in the informal environment. Students manipulated a variety of objects with and without teacher assistance; however, teachers who initiated hands-on experiences had students who were engaged in a variety of activities for greater lengths of time.

Cox-Petersen, A. M., & Pfaffinger, J. A. (1998). Teacher preparation and teacher-student interactions at a discovery center of natural history. *Journal of Elementary Science Education, 10*, 20-35.

"The findings from this study support the contention that visitors can and do acquire both factual and conceptual information as a consequence of relatively brief interactions (on the order of 2-5 minutes) with clusters of related science exhibits; and this learning can be facilitated by explicitly and repeatedly displaying the conceptual messages to be communicated." pg. 679

Falk, J.H. (1997). Testing a museum exhibition design assumption. *Science Education, 81 (6),* 679-687.

Placing children in an extremely unfamiliar setting may cause sufficient stress to block any meaningful learning experience.

Falk, J.H., Martin, W., and Balling, J.D. (1978). The novel field trip phenomenon: Adjustment to novel settings interferes with task learning. *Journal of Research in Science Teaching, 15*, 127-134.

"The early-elementary-school field trip recollections of 9, 13, and 20+ year old individuals were virtually identical in the categories of items and/or experiences recalled. These findings strongly suggest that museum field trips – regardless of type, subject matter, or nature of the lessons presented – result in highly salient and indelible memories. These memories represented evidence of learning across a wide array of diverse topics." p. 216.

School trips to museums and other informal environments promote long term recall. 80% of children and adults could recall three or more specific areas linked to a school trip; many of these responses related specifically to content.

Falk, J.H. and Dierking, L.D. (1997) School field trips: Assessing their long term impact. *Curator, 40 (3),* 211-218

Teachers who participated in a year-long research endeavor with local ecologists had increased self-perceptions about science resulting from their authentic practice of science and from the connections to the scientists' culture.

Falk, J. H., & Drayton (1997). Dynamics of the relationships between science teachers and scientist in an innovative mentorship collaboration. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

"We have described the science learning process via the exhibit as an experiential, exploratory and explanatory process. The users first undergo an experience in which they can actively participate; then they give meaning to the experience through their own interpretations and explanations." pp. 47-48

Feher, E. (1990). Interactive museum exhibits as tools for learning: Explorations with light. *International Journal of Science Education, 12 (1),* 35-49

Teachers can increase the potential for cognitive and affective learning in museums by planning structured activities before and after field trip visits.

Finson, K. D., & Enochs, L. G. (1987). Students' attitudes toward science-technology-society resulting from a visit to a science-technology museum. *Journal of Research in Science Teaching, 24*, 593-609.

A critical incident approach is most helpful in analyzing the learning that takes place in student groups.

Gilbert, J., & Priest, M. (1997). Models and discourse: A primary school science class visit to a museum. *Science Education, 81*, 749-762.

In a study of science museum exhibit preferences of upper elementary children and adults, girls were more likely than boys to use puzzles and exhibits focusing on the human body and boys were more likely to use computers and exhibits illustrating physical science principles.

Greenfield, T. A. (1995). Sex differences in science museum exhibit attraction. *Journal of Research in Science Teaching, 32*, 925-938.

Most teachers studied during a museum trip did not prepare students for the trip, used task-oriented teaching practices, and made little effort to link school topics to those topics encountered during a museum visit.

Griffin, J., & Priest, M. (1997). Models and discourse: A primary school science class visit to a museum. *Science Education, 81*, 749-762.

By reducing the novelty effect, on-task exploratory behavior increases and greater cognitive learning occurs.

Kubota, C. A. and Olstad, R. G. (1991). Effects of novelty reduced preparation on exploratory behavior and cognitive learning in a science museum setting. *Journal of Research in Science Teaching, 28*(3), 225-34.

Affective learning is a poorly understood phenomenon and objective-setting and evaluation for learning in the affective domain are often neglected in educational programs.

Meredith, J. E., Fortner, R. W., & Mullins, G. W. (1997). Model of affective learning for nonformal science education facilities. *Journal of Research in Science Teaching, 34*, 805-818.

In an assessment of learning of elementary teachers in three different informal environments—a science center, wildlife refuge, and a zoological sanctuary – teachers' conceptual development and understanding were greatly enhanced.

Neathery, M. F. (1998). Informal learning in experiential settings. *Journal of Elementary Science Education,10*, 36-49.

Modeling effective field trip strategies in preservice teacher education programs promotes both the learning of effective field trip practices and the likelihood of taking field trips during their first year of teaching.

Olson, J. K., Cox-Petersen, A. M., & McComas, W. F. (in press). The inclusion of informal environments in teacher preparation. *Journal of Science Teacher Education.*

"Field trips to informal science settings produce beneficial outcomes when the trips are undertaken with a purpose in mind, students are prepared to profit from the visit, and the novelty of the event has been minimized." pg. 124 " . . . a zoo visit can be an important learning experience for students in the context of formal learning if their teachers are adequately briefed about the topic and opportunities for learning that can be found at the informal science setting." pg. 139

Smith, W.S., McLaughlin, E., & Tunnicliffe, S.D. (1998). Effect on primary level students of inservice teacher education in an informal science setting. *Journal of Science Teacher Education, 9 (2),* 123-142.

In an investigation of the effects of a six-week extracurricular hands-on science program using portfolio artifacts, inquiry-guided exploration, and socially assisted learning on interest and learning about biology in third, fourth, and fifth graders, there were significant increases in science interest and improvement in problem-solving skills. Girls had more positive attitudes about science and higher problem-solving skills than boys.

Paris, S. G., Yambor, K. M, Packard, B., Wai, L. (1998). Hands-on biology: A museum-school-university partnership for enhancing students' interest and learning in science. *Elementary School Journal, 98*, 267-288.

Novel environments are poor settings for imposed task learning when compared with familiar settings.

Rice, K. and Feher, E. (1987). Pinholes and images: Children's conceptions of light and vision.*Science Education, 71*(4): 629-639

In a study describing childrens' interactions with exhibits and each other in a school-based, science-focused mini-museum, children appeared to make some gains in their learning and scientific skills and processes, with the largest gains made in the development of positive attitudes towards science.

Rix, C., & McSorley, J. (1999). An investigation into the role that school-based interactive science centres may play in the education of primary-aged children. *International Journal of Science Education, 21*, 577-593.

The more prior knowledge a visitor has, the more they will learn at a museum.

Shettel, H.H., Butcher, M., Cotton, T.S., Northrup, J. and Slough, D.C. (1968). *Strategies for determining exhibit effectiveness*. Pittsburgh: American Institutes for Research.

Students exhibited greater cognitive learning with structured docent tours but exhibited more positive attitudes when they participated in a less structured lesson led by the classroom teacher.

Stronck, D. R. (1983). Comparative effects of different museum tours on children's attitude and learning. *Journal of Research in Science Teaching, 20*, 283-290.

Teachers who participated in physical science workshops coupled with science exhibits patterned after those of the Exploratorium increased their confidence and competence in understanding science and delivering inquiry-based science instruction. These teachers continued to develop exhibit-like props in their classrooms for their students to investigate scientific phenomena.

Sukow, W. W. (1990). Physical science workshops for teachers using interactive science exhibits. *School Science and Mathematics, 90*(1), 42-47.

Pre-trip tasks of site orientation and content preparation before an outdoor field trip affected students' task behavior at the site.

Orion, N., & Hofstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching, 29*, 1097-1119.

In a comparison of conversations generated by elementary school groups at animatronic animal displays in several free choice environments, it was found that moving animal models in themselves are insufficient to induce many visitors to talk about them in other than a superficial, cursory manner.

Tunnicliffe, S. D. (1999). It's the way you tell it! What conversations of elementary school groups tell us about the effectiveness of animatronic animal exhibits. *Journal of Elementary Science Education, 11*, 23-37.

Findings supported by multiple studies:

In novel settings, children often devote more mental energy to familiarizing themselves with the new environment than they devote to the lesson being taught.

Falk, J.H. (1983). Time and behavior as predictors of learning. *Science Education, 67*(2), 267-276.

Martin, W.W., Falk, J.H., and Balling, J.D. (1981). Environmental effects on learning: The outdoor field trip. *Science Education, 65*(3), 301-309.

Not only is it important to familiarize students with the field trip setting, sharing the instructional objectives with students is important to help them focus on intended learning activities.

Schibeci, R.A. (1993). Evaluation of the educational benefit of the "Sports Works" exhibition at Scitech Discovery Center Science. *Education International, 4*(1), 22-25.

Koran, J.J. and Baker, S.D. (1979). Evaluating the effectiveness of field experience. In

M.B. Rowe (ed.), *What Research Says to the Science Teacher*, No. 2. (pp. 50-67). National Science Teachers' Association, Washington DC.

Wiley, D. and Humpheys, D. (1985). The geology field trip in ninth-grade earth science. *Journal of Geological Education, 33*, 126-127.

Students' prior knowledge is important in determining how they interact and what they learn from exhibits at museums.

Beiers, R.J. and McRobbie, C.J. (1992). Learning in interactive science centers. *Research in Science Education*, 22, 38-44.

Falk, J.H., Koran, J.J., and Dierking, L.D. (1986). The things of science: Assessing the learning potential of science museums. *Science Education*, 70, 503-508.

Gottfried, J.L., (1980). Do children learn on school field trips? *Curator*, 23, 165-174.
Lucas, A.M., McManus, P., and Thomas, G. (1986). Investigating learning from informal sources: Listening to conversations and observing play in science museums. *European Journal of Science Education*, 8, 341-352.

Sakops, M. (1984). Optimizing the Educational Impact of a Museum Tour. *Curator.* 27(2): 135-140.

Sneider, C.I., Eason, L.P., and Friedman, A.J. (1979). Summative evaluation of a participatory science exhibit. *Science Education*, 63, 25-36.

Tulley, A., and Lucas, A.M. (1991). Interacting with a science museum exhibit: Vicarious and direct experience and subsequent understanding. *International Journal of Science Education*, 13, 533-542.

Comments and Recommendations Related to Learning in Informal / Free Choice Environments such as Science Museums

The National Science Education Standards should be used as a mechanism for bridging formal and informal science education. Based on a review of the educational effectiveness of science museums, they found that specific science content from the Standards is outlined as potentially useful in informal settings for increasing student learning.

Hofstein, A., Bybee, R. W., Legro, P. L. (1997). Linking formal and informal science education through science education standards. Science Education International, 8, 31-37.

Following an examination of craft knowledge and research-based literature of science learning, the author described informal science education programs and discussed implication for science teaching, focusing on the importance of such learning for children and inservice and preservice teachers. She proposed a model for enhanced school/information science education and school-level policy change.

Ramey-Gassert, L. (1997). Learning science beyond the classroom. *Elementary School Journal, 97*, 433-450.

Rennie and McClafferty (1995) synthesized educational research about learning in interactive science and technology centers, museums, aquaria, and zoos, and distilled from it guidelines for science teachers to ensure that class visits enhance the learning for their students.

Rennie, L. J., & McClafferty, T. (1995). Using visits to interactive science and technology centers, museums, aquaria, and zoos to promote learning in science. Journal of Science Teacher Education, 6, 175-185.

Rennie and McClafferty (1996) reported on the interactive science center and its history over the last four decades. They recommend the use of cross-site studies to develop a model of learning in this setting.

Rennie, L. J., & McClafferty, T. P. (1996). Science centres and science learning. Studies in Science Education, 27, 53-98.

Other Useful References Related to
Learning in Informal / Free Choice Environments such as Science Museums

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Bresler, C.A. (1991). Museums and environmental education. *NAPEC Quarterly*, 2(1), 6.

Carey, S and Others. (1988). *An experiment is when you try it and see if it works: A study of junior high students' understanding of the construction of scientific knowledge.* Office of Educational Research and Improvement, Washington, DC. Accession No: ED303366.
Colloquium on Museums as Educational Institutions. (1982, December). New York: Clark, Phipps, Clark and Harris, Inc.

Commission on Museum for a New Century. (1984). *Museums for a New Century*. Washington DC: American Association of Museums.

Danilov, V. (1976). Museums as educational partners. *Childhood Education*. 52(6): 306-311.

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Dolmans, D.H.: And Others (1994). The relationship between student-generated learning issues and self-study in problem-based learning. *Instructional Science*, 22(4), 251-267.

Flexer and Borun, M. (1984). The impact of a class visit to a participatory science museum exhibit and a classroom science lesson. *Journal of Research in Science Teaching,* 21, 863-873.

Follette, R.L. (1987). Development of a guide for teachers to use in planning museum field trips for school groups. (Doctoral dissertation, University of Pittsburgh, 1987). *Dissertation Abstracts International*, 49(4), 711.

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Hancock, M. and Farris, P. (1988). Nurturing intellectual and personal growth through outdoor education. *The Delta Kappa Gamma Bulletin*, 54(3), 47-51.

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Madden, J.C. (1985). To realize our museums' full potential. *The Journal of Museum Education,* 10(4), 3-5.

McManus, P.M. (1987). It's the company you keep: The social determination of learning-related behavior in a science museum. *International Journal of Museum Management and Curatorship,* 7, 37-44.

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Price, S., and G. Hein. (1991). More than a field trip: Science programmes for elementary school groups at museums. *International Journal of Science Education.* 13(5): 505-519.

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West, S.A. (1992). Problem-based learning-a viable addition for secondary school science. School Science Review, 73(265), 47-55.

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Wolf, R.L. (1986). The missing link: A look at the role of orientation in enriching the museum experience. *The Journal of Museum Education*, 11(1), 17-21.

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