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Determining the Influence of a Science Exhibition Center Training Program on Elementary Pupils' Interest and Achievement in Science

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This research aimed to examine the effects of visiting exhibitions and participating in the activities offered by science centers on raising the interest of second level students of primary education in science and improving their academic achievements. Thirty one 8th grade students chosen randomly from primary schools participated in the research carried out in the Feza Gursey Science Center (FGBM) in Ankara in November 2005. The "Single Group Pre Test-Post Test Model" was used in the research. The data was obtained through an "interest scale" and an "academic achievement test" prepared by the researcher. Descriptive statistics, One-Way ANOVA, and Simple Linear Regression Analysis were utilized in data analysis. Study results showed that the exhibitions and activities carried out in FGBM brought about a permanent increase in the 8th grade students' interest in science and thus improved their academic achievement. In terms of predicting the interest scores of the students in the experimental group, the relationship between the interest scores and academic achievement scores was examined and it was observed that there was not a meaningful relationship between academic achievement and the interest scores of the students. Within this context, it is very important to develop museum training programs associated with the primary education curriculum and taking learning theories and teaching methods into consideration. Furthermore, it is necessary to repeat planned visits at sufficient intervals on a regular basis.

Keywords: Literacy, Religion, Science, Sociocultural, Superstition

SCIENCE AND SCIENTIFIC LITERACY

Science has been spectacularly successful, with things like international air travel, space flight, and curing of medical illness now routine. The impact of enabling technologies like micro-computers which now dominate much of everyday life, have become available to the general population only as recently as the 1980s. High speed computing and huge increases in cheap, small, memory storage devices is likely to further increase scientific and technological advances.

In order to help increasing number of people to easily and enjoyably acquire and understand new information obtained through the rapid developments in science and technology, it is necessary to support

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formal education in schools with informal learning environments.

Though formal education and informal education are interlocked and complementary with each other, they have totally different features. While formal education is obligatory, pre-planned, class and institution-based, structured, has specific aims, requires less social interaction and is costly; informal education is voluntary, is not class or institution-based, is unplanned and less structured, involves more social interaction and is less costly (Wellington, 1990).

Informal education is generally considered to be a kind of learning which continues in every part and phase of an individual's life and usually occurs outside a formal educational establishment. Educators in informal education focus on empirical learning which enables people to discover different experiences and learn from experience (Best, 2007). It is also described as the learning process taking place out of classroom environment such learning can occur through an educational television program, during a travel or a visit to a museum, art gallery, historic site or zoo. Informal environments encourage learning in various ways which usually do not exist in traditional classroom environments. Informal environments can meet the needs of students by offering different learning styles and allow each student to learn at their own speed (Melber and Abraham, 1999).

Informal learning environments give students the opportunity to make an individual relationship with real objects and by this way improve the comprehension and retention of the information gained by providing new perspectives, attitudes and values. There are numerous examples of informal learning environments such as television, radio, newspapers, magazines, internet; sport centers, science centers, science and technology museums, natural history museums, zoos, botanic parks, timberlands, libraries, aquariums, outdoor laboratories, natural centers (caves, lakes, rivers, coastal areas etc.), camps and houses (Davies, 1997; Hannu, 1993; Kelly, 2000; Martin, 2004; Pedretti, 2004).

Among the above-listed learning environments, probably the most important one is the science center since it is one of those unique institutions offering a combination of science, technology and training. Today developments in science and technology are increasing rapidly and young people need to gain both understanding and practical skills in order to become the workforce of tomorrow. Science centers contribute to science education and vocational training by building a bridge between science and education and technology and education.

In this context, it is very important to raise awareness of authorized bodies, institutions and science teachers on this issue and to light the way for the efforts to establish new science and technology museums by proving the positive effects of the science centers on students' interest in science and on their academic achievement.

AIM OF THE RESEARCH

This study was carried out in order to answer the question, "Does visiting the exhibitions and participating in the activities carried out in Feza Gürsey Science Center (FGBM) in Ankara affect the interest of the second level students of primary education in science and their academic achievements?" In this context, the sub- problems of the research are as follows;

a) Do the exhibitions and activities carried out in science centers affect the 8th grade students' interest in science?

b) Do the exhibitions and activities carried out in science centers affect the 8th grade students' academic achievement?

c) Is there a significant relation between interest levels for science and academic achievement of the 8th grade students who visit science centers?

METHODOLOGY

Research Model

The "Single Group Preliminary Test- Final Test Model" was used in the research. Both pre-test (preliminary test) and post-test (final test) measurements are made in this model (Karasar, 2000). A control group was not formed because the independent variable is "the visits to the science centers" and that the academic achievement tests and interest scales which were prepared in order to examine the effects of the independent variable on the dependent variables (interest and academic achievement) are limited to the exhibitions and activities in FGBM.

Participants

Thirty one 8th grade students who were chosen randomly from primary schools participated in the research carried out in FGBM in November 2005. 2 guides, 3 teachers and 1 researcher accompanied the participant students.

Learning Environment

After Ankara Major City Municipality signed an agreement with authorities of Ontario Science Centre (OSC) in 1992 construction of the first science center of Turkey begun. A total of 48 experiment packs worth of US$ 2,300,000 were purchased. The selection of experiments and exhibition units was done according to the Turkish curriculum in cooperation with universities and the museum during the process of establishment of the science center. The recommendation of the Ministry of Education about the science center to the primary school and secondary school students on 25th January 1995 shows that how the selection fits.

The name of foremost physicist of Turkey and the world, Feza Gursey, who died in 1992, was given to the science center. Feza Gursey Science Center was put into service on 23rd April 1993 with the assistance of Ankara Major City Municipality.

More than 1.2 million people visited the science center between 1994 and 2005. In this center which has 1000 m^2 experimental area and 2000 m^2 total area, 7 personnel and 10 to 20 (it changes) guide works. The guides working in the science center whether part time or full time are young people graduated from the university or under graduation in the physics, chemistry, biology, science teaching, astronomy, mathematics, computer and geology departments of the universities. The science center working with appointment system gives free service to the students of Ankara city center and districts. Ankara Major City Municipality also provides free transportation to the schools that come to science center.

FGSC serves for the aim of introducing, pleasing and comprehending the basic principles of science by doing experiments and especially in an entertaining environment helping students to understand and apply what they learn theoretically in science lessons. Because of this, each unit designed in an appropriate form to let visitors do the experiment and observe individually.

Data Collection

The "Interest scale" and "Academic achievement test" which were prepared within the framework of the exhibitions and the test mechanisms selected from FGBM were used in order to determine to the extent which "visiting science centers" affect the primary education second- level students' interest in science and their academic achievement.

Interest Scale

The interest scale covering the exhibitions and test mechanisms in FGBM included expressions to determine the students' levels of interest in science, thus, it was considered to be acceptable for this research

Items on the scale consisted of a total of 20 elements, 12 of which are positive and 8 are negative on a 5-point Likert Type scale. In the validity study of the interest scale which was prepared within the framework of the exhibitions and the test mechanisms in FGBM and which was given to 112 students, the scope and structural validity of the interest scale was examined. There were 10 titles under the scale: Static Electricity, Generator and Dynamo, Characteristics and Use of Liquid Nitrogen, Circulatory System and the Effect of Smoking on the Lungs, Pressure, Characteristics of Materials, Characteristics of Sound, Movement, Microscopes, and Other (X rays, reflex etc.). It was observed that for all the items on the scale the item-total correlations ranged between 0.30 and 0.49 and the t values were significant. Regarding the reliability of the scale, Cronbach Alfa reliability coefficient was found to be 0.83 (α = 0.83). The Kaiser-Mayer-Olkin (KMO) value and Barlett value of the interest scale was found to be 0.763 and 604.192, respectively; and the common factor variances of the items of the scale was found to range between 0.370 and 0.694. When the analysis results of the main components of the items on the scale were examined, it was concluded that the factor-load values gathered on the first factor and the factor-load values of 20 scale items was minimum 0.402 (Bozdoğan, 2007). Some of the scale items was;

Attending conference about the importance of electricity in our lives is boring.

I am not interested in documentaries on how the big passenger carrying balloons can fly.

I want to see the plasma state of an object etc.

Academic Success Test

An ample number of questions were determined which covered the same subjects with the exhibitions and test mechanisms offered by FGBM; the appropriateness of these questions for the level of students was decided after taking the opinions of the experts and the museum authorities. The pre-application of those questions was given to 111 primary school students not in the experimental group. As a consequence of the statistical analysis, the average differentiation capacity of the items of the preliminary test and the final test was found to be ($D_{(avr)}$) 0.437 and 0.416, and difficulty levels of these tests were ($P_{(avr)}$) 0.409 and 0.447, respectively. KR- 20 the reliability coefficient was 0.78 and 0.75, respectively. As the preliminary and final academic achievement tests -which were prepared in relation to the materials in FGBM- were different from each other, the Pearson Correlation technique was used to identify the relationship between those tests. A high level positive and significant relationship was found between the preliminary and final tests of academic achievement (r = 740, p< .01) (Bozdoğan, 2007). Some of the questions items was;

1. Why does the metal rod held with bare hands which was rubbed with wool cloth not attract small pieces of paper?

a) The fact that it was not charged with electricity by rubbing

b) The fact that an electric charge was not maintained

c) The fact that it did not interact with the wool cloth

Table 1. Central Tendency and Diffusion Measurements of the 8th Grade Primary Students' Total Scores of Preliminary and Final Interest Test, and Retention Test.

Interest Scale	N	$\overline{X}$	S
Preliminary test	31	69.48	12.23
Final test	31	83.32	10.73
Retentiveness Test	31	75.03	14.92

Table 2. Single-Factor ANNOVA Results for the Reiterative Measurements Related to the Interest preliminary Test, Final Test and Permanence Test Total Scores of the 8th Grade Students of Experimental Group.

Source of the Variance	Total of the Squares (KT)	Sd	Average of the Squares (KO)	F	P	Significant Difference
Between Subjects	10668.731	30	355.624			
Measurement	3007.247	2	1503.624	22.778	.000	2-1, 3-1
Error	3960.753	60	66.013			
Total	17636.731	92				

1. Preliminary Test
2. Final Test
3. Retentiveness test

d) The fact that the paper and metal rod have the same charge (polarity)

2. Which of the following statements accurately describes the association between heating the air in a balloon and the ascent or descent of the balloon?
a) The density of heated air within the balloon is lower than the density of the surrounding air
b) The density of heated air is higher than the density of the surrounding air
c) The density of heated air is equal to the density of the surrounding air
d) Heating leads to a reduction in the volume of the balloon
3. Which of the following are the structures that swallow objects in space in an irreversible manner?
a) Black hole b) Supernova
c) White dwarf d) Black dwarf

One feature of the incredible and seemingly ever increasing advance of science and technology is a sense of unease amongst some of the general population about sciences potential to change our lives, in sometimes unpredictable and alarming ways. Public understanding of science and ability to engage in debates about science is part of what is referred to as 'scientific literacy', which according to much recent literature, is of increasing concern worldwide (Carson, 1998; Laugksch, 2000). The term 'scientific literacy' actually represents a diversity of views, but a common theme in the literature is that of being 'learned' or knowledgeable about some science content, and being able to critique scientific debates. According to Laugksch (2000) a scientifically literate person does not accept opinion about a contentious scientific matter uncritically. Rather, he or she wants to see logic or evidence for any stance taken on the issue (Miller, 2000). Some authors argue that the success or otherwise of a science education system can be evaluated by reference to the literacy of the citizens (Preece & Baxter, 2000; Yates & Chandler, 2000).

Implementation

Following discussions with officers at FGBM, the schools which had booked a museum visit were listed and then, a primary school was selected randomly for the experimental study. After meeting the staff of the selected school, 31 8th grade primary students were chosen for the experimental group of the visit to be arranged. Prior to the visit, the school was re-visited and the interest scale and academic achievement preliminary tests were given to the students of the experimental group on the school premises under the supervision of school staff.

During the visit to FGBM the students, accompanied by guides, were introduced to various exhibitions and carried out the activities individually.

The exhibitions and activities included an electricity show, a plasma ball, a black hole model, a hot-air balloon, singing bowls, Bernoulli blower and dynamo etc.

The final tests were applied in the week following the school visit. During the week of the visit, the 8th grade students were learning at school the subjects under "Genetics" and this topic was not included in the exhibitions and activities at FGBM. Almost 5 weeks later, the retention tests were given the students in the experimental group.

Analysis of the Data

Within the general framework of the study, Descriptive Statistics, One-Way ANNOVA, and Simple Linear Regression Analyses were utilized for the necessary statistical analyze of the collected data of the sub problems. The numerical data was converted into tables and interpreted. Whether there was a significant difference between the independent variables was tested at $\alpha = .05$ level.

FINDINGS

Findings Regarding the Interest Scale Scores of the 8th Grade Experimental Group students

The overall distribution of the science interest of the students, who visited FGBM exhibitions and participated in the activities in the centre, and the variation of this distribution as to classes are as follows;

The arithmetic average and standard deviation values related to the total scores of the preliminary and final interest tests and retention test of the 8th grade experimental group are given in Table 1.

When Table 1 is examined; arithmetic average of the 8th grade students' total scores of interest preliminary test (carried out before the practice study in FGBM) was found to be ($\bar{x}$=69.48), arithmetic average of total scores of final test was calculated as ($\bar{x}$=83.32), arithmetic average of total scores of retention test was found as ($\bar{x}$=75.03). An increase of almost 14 points can be seen between the average preliminary test scores and average final test scores of the students participating in the research.

Table 3. Central Tendency and Diffusion Measurements of the 8th GradeStudents' Total Scores of Academic Success Preliminary test, Final test and Retentiveness Test.

Academic Success Test	N	$\overline{X}$	S
Preliminary test	31	6.25	2.79
Final test	31	9.38	2.88
Retentiveness Test	31	9.77	2.72

Table 4. Single- Factor ANNOVA Results for the Reiterative Measurements related to the Academic Success Preliminary Test, Final Test and Retentiveness Test Total Scores of the 8th Grade Students of Experimental Group.

Source Of The Variance	Total Of The Squares (KT)	Sd	Average Of The Squares (KO)	F	P	Significant Difference
Between subjects	431.183	30	14.373			
Measurement	230.473	2	115.237	25.09	.000	2-1, 3-1
Error	275.527	60	4.592			
Total	937.183	92				

1. Preliminary Test
2. Final Test
3. Retentiveness test

Table 5. Simple Regression Analysis Results Regarding Predicting the Interest Scores of the 8th Grade Students of the Experimental Group.

Variable	B (Regression Coefficient)	Standard Error (B)	β	t	p
Stable	78.913	6.724	-----	11.736	.000
Academic Achievement	0.470	0.686	0.126	0.685	0.499

R = 0.126, R2 = 0.016
F(1-29) = 0.469, p >.05

Single-factor variance analysis (ANOVA) was carried out for the reiterative measurements related to whether the preliminary interest test, final interest test and retentiveness test scores of the students was different and the results are given in Table 2.

When Table 2 is examined, it was observed that there was a significant difference in favor of final test between the preliminary interest test and final test total scores of the experimental group of 8th grade students and also in favor of the retention test between the preliminary interest test and retention test [$F(2\text{-}60)= 22.778$, $p<.05$]. It is seen that the effect size of this difference is ŋ=0.99. These findings demonstrate that the implementation practices carried out in FGBM had a considerable effect on increasing the interest of the students in scientific subjects. The Interest scores of the students decreased slightly in the retention test when compared to the final test. However, the existence of a significant difference between the preliminary test and retention test interest scores shows that the students' interest in science is maintained.

Findings Regarding the Academic Achievement Scores of 8th Grade Students Constituting the Experimental Group

The general distribution of the academic achievement of the students who visited FGBM and participated in the practice studies, the variation in these distributions according to the classes is given below.

The arithmetic average and standard deviation values related to the total scores taken by the 8th grade students in the experimental from preliminary and final academic achievement tests and retention test are given in Table 3.

When Table 3 is examined; arithmetic average of the 8th grade students' total scores of preliminary test for academic achievement applied before the implementation in FGBM was calculated as ($\bar{x}$=6.25), arithmetic average of total scores of final test was calculated as ($\bar{x}$=9.38) and the arithmetic average of total scores of retention test was calculated as ($\bar{x}$=9.77). An increase of almost 3 points was observed between the average preliminary test scores and the average final test scores of the 8th grade students participating in the research.

Single-factor variance analysis (ANOVA) was carried out for the reiterative measurements related to whether the preliminary and final academic achievement tests and retention test scores of the 8th grade students were different; and the results are given in Table 4.

In Table 4, it can be seen that there was a significant difference between the total scores of preliminary academic achievement test and the final test in favor of the final test and between the preliminary academic achievement test and the retention test in favor of the retention test [$F_{(2\text{-}60)}= 25.09$, $p<.05$]. It is seen that the effect size of this difference is ŋ=0.97. These findings show that the implementation practices carried out in FGBM increased the academic achievement of the students. In addition, existence of a significant difference between the preliminary test and retention test academic achievement scores shows that students sustain their academic achievement.

Findings regarding Predicting the Interest Scores of the 8th Grade Students Composing the Experimental Group

Simple regression analysis results supporting the prediction of the interest scores of the 8^{th} grade students composing the experimental group are given in Table 5.

According to the results in Table 3 in which the relationship with the academic success scores were examined in order to predict the 8^{th} grade students' interest scores, it is seen that academic success has not been a significant predictor of the students' interest scores ($R = 0.126$, $R2 = 0.016$, $F(1\text{-}29) = 0.469$, $p >.05$).

As a result of the research, it can be stated that the tools and the activities carried out in FGBM have a considerable effect on the increase of the interest of experimental student group in science and of their academic achievement. Guisasola, Morentin, and Zuza (2005) found that the school visits to museums affect the students' future opinions, understanding of the concepts of science and their attitudes towards science. The authors commented that combining the educational materials in museums with the education in the school during the training and education process in the museums provides a wider and better science education for the students. In the study they carried out, Jarvis and Pell (2005) found that there was progress in the student attitudes towards science and astronomy. Bowker (2004) stated that associating such kinds of education activities providing cognitive, affective and social learning opportunities for the students with the topics to be taught in the school curriculum will serve as a catalyst in helping the children to understand those topics better. Fadigan and Hammrich (2004) suggested that museum visits should be disseminated as they play an important and positive role in students' education and career development. In their research, Tenenbaum et al. (2004) stated that after visiting exhibitions and participating in activities in science museums student attitudes towards science are affected in a positive way. In particular, several authors commented that combining the curricula of the school and the museums educational program is effective in facilitating the students' acquisition of more accurate information and improves their ability to comprehend the concepts related to various topics. Pace and Tesi (2004) proposed that field excursions have long-term effects in terms of students' acquiring educational and social experiences. This is supported by Falk and Adelman (2003), who reported a positive development in knowledge and attitude of individuals after visiting informal science education institutions such as science centers, zoos, aquariums and natural history museums. Gerber et al. (2001) determined in their research that students gained more scientific thinking skills in rich informal learning environments. Henriksen and Jorde (2001) discovered that students not only reinforced prior knowledge after a museum visit but also learned the concepts they have met for the first time in the informal museum environment. According to Paris et al. (1998), out-of-school activities can provide a certain level of increase in students' interest in science and can facilitate development in students' problem solving skills.

CONCLUSION

The conclusions of this current research are parallel with the results found in the literature review, given above. In this research in Turkey that following the visits to FGBM (or a science centre) has resulted in an increase in primary education students' interest in science and an improvement in their academic achievement. It is considered that this increase is due to the following; that the activities in FGBM were appropriate to the level of the students, the guides were experts and able to help the students (or respond to their questions), and finally, that the students were able to individually participate in each activity in the science centre.

In the framework of the experimental study carried out in FGBM, the relationship between the academic achievement scores and interest scores was examined for predicting the interest scores of the experimental group of 8th grade students. It can be seen that academic achievement is not a significant predictor of the students' interest scores. The reasons for this is thought to stem from the facts that the visits were carried out in a single session of 1.5 hours, that the visits were not repeated in the long term and that there are differences in the internal motivations of the students.

The need for visits to informal education centers to be carried out on a regular and long term basis is supported in the literature. Lukas and Ross (2005) commented that random visits to the zoos did not change the knowledge levels and attitudes of the visitors and thus these kinds of visits do not have any educational function. Pace and Tesi (2004) showed in their study that field excursions do have long term effects on students' acquisition of educational and social experiences, thus, at least one annual field excursion associated with the school curriculum will give the students the opportunity to learn through social interaction out of the class. Knapp (2000) pointed out that long term field excursion practices have important effects on students' cognitive and affective domains. Rapp (2005) determined in his study that long term and renewed museum excursions contributed to students' learning and comprehension.

Students' interest in science and the acquisition of a positive attitude towards it is of great importance for career selection in individual terms and for the development of the country in social terms. Science centers have a very important function in increasing the students' interest in science and scientific subjects and, in promoting their academic achievement. In this context, taking the learning theories and teaching methods into consideration, museum training programs associated with primary education curriculum should be developed, their effects on students' cognitive, affective and psychomotor attitudes should be examined and their practicability should be researched. Furthermore, schools should be able to have the opportunity of visiting sciences centre on a regular and repeated basis.

Furthermore, the importance of these regular visits should be understood particularly by the students' families and teachers and the children themselves. In order for the student's to fully benefit from the visit program, trainee teachers and teachers should be involved in the visit preparation, the planning of the visit and the post visit assessment. Trainee teachers should be given lectures at undergraduate level. Trainee teachers should be made aware of the importance of the visits to science centers and it should form part of their training. Professional teachers should be informed via in-service training courses run by education institutions, and the museum staff. Brochures can be created to inform students' families about science centers and to ensure their participation; these centers should be advertised in visual and written media. Finally, various social activities can be arranged in museums for teachers, trainee teachers and the families of primary age children.

Since it is recognized that visits to science centers has an important effect on the development of the students' cognitive, affective and psychomotor characteristics further research is necessary. Existing studies involving connection between science centers and science education should be examined. Also further work is necessary in the preparation and application of effective scales to be used in this field and they should be used in the curricula to be prepared. Level of interest in science, and their increase in academic achievement, of school visits and the relevance of the science centers exhibitions and activities.

End Note

a) This research is a part of unpublished doctoral dissertation. "Bozdoğan, A. E. (2007). *Bilim ve teknoloji* *müzelerinin fen öğretimindeki yeri ve önemi.* Gazi Üniversitesi Eğitim Bilimleri Enstitüsü İlköğretim Bölümü, Ankara. (Yayınlanmamış Doktora Tezi)."

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REFERENCES

Best, S. (2007). Quaker events for young people: informal education and faith transmission. *Quaker Studies, 11,* 259-281.

Bowker, R. (2004). Children's perceptions of plants following their visit to the EDEN project. *Research in Science and Technological Education, 22*(2). 227-243.

Davies, K. (1997). The challenge of materials gallery: A new exhibition at the science museum. *New Materials,* 169-172.

Fadigan, K.A. and P.L. Hammrich.(2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Jourmal of Research in Science Teaching, 41*(8), 835–860.

Falk, J. H. and L. M. Adelman. (2003). Investigating the impact of prior knowledge and interest on aquarium visitor learning. *Journal of Research in Science Teaching, 40*(2), 163-176.

Gerber, B.L., Cavallo, A.M.L. and Marek, E. A. (2001). Relationships among informal learning environments, teaching procedures and scientific reasoning ability. *International Journal of Science Education, 23*, 535- 549.

Guisasola, J; M. Morentin and K. Zuza. (2005) School visits to science museums and learning sciences: A complex relationship. *Physics Education, 40*(6), 544-549.

Hannu, S. (1993). Science centre education. motivation and learning in informal education. Helsinki University Department of Teacher Education. Finland. (Unpublished Doctoral Dissertation).

Henriksen, E. K. and D. Jorde. (2001). High school students' understanding of radiation and the environment: Can museums play a role? *Science Education 85*, 189–206.

Jarvis, T. and A. Pell. (2005). Factors influencing elementary school children's attitudes toward science before, during, and after a visit to the UK National Space Centre. *Journal of Research in Science Teaching. 42*(1), 53-83.

Karasar, N. (2000). *Bilimsel araştırma yöntemi (Scientific Research Methods)* Ankara: Nobel Yayınevi.

Kelly, J. (2000). Rethinking the elementary science methods course: A case for content, pedagogy, and informal science education. *Intenational Journal of Science Education, 22*(7), 755-777.

Knapp, D. (2000). Memorable experiences of a science field trip. *School Science and Mathematics, 100*(2), 65-72.

Lukas, K. E. and S. R. Ross. (2005). Zoo visitor knowledge and attitudes toward gorillas and chimpanzees. *The Journal of Environmental Education, 36*(4), 33-48.

Martin, L. M. W. (2004). An emerging research framework for studying informal learning and schools. *Science Education, 88*(1), 71-82.

Melber, L.H. and L.M., Abraham (1999). Beyond the classroom: Linking with informal education. *Science Activities, 36*, 3-4.

Pace, S. and R. Tesi. (2004). Adults' perception of field trips taken within grades K-12: Eight case studies in The New York Metropolitan area. *Education, 125*(1), 30-40.

Paris, S.G.; K.M. Yambor and B.W. Packard (1998). Hands-On biology: A museum, school, university partnership for enhancing students' interest and learning in science. *Elementary School Journal, 98*(3), 267-288.

Pedretti, E. G. (2004). Perspectives on learning through research on critical issues-based science center exhibitions. *Science Education, 88*(Suppl. 1), 34– 47.

Rapp, W. (2005). Inquiry-based environments for the inclusion of students with exceptional learning needs. *Remedial and Special Education, 26*(5), 297–310.

Tenenbaum, H. R., G. Rappolt-Schlichtmann and V. V. Zanger. (2004). Children's learning about water in a museum and in the classroom. *Early Childhood Research Quarterly, 19*, 40–58.

Wellington, J. (1990). Formal and informal learning in science: The role of the interactive science centres. *Physics Education, 25,* 247-252.

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