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The Effects of an Informal Science Education Setting on Students' Attitudes towards Learning Science

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The Effects of an Informal Science Education Setting on Students' Attitudes towards Learning Science

by

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Table of Contents

Abstract

Informal science education is becoming increasingly popular in today's classrooms, and for this reason, it is important to understand the effects of informal science education on students. In this study, the Children's Attitude Survey (Wulf, Mayhew, & Finkelstein, 2009) was used to measure the effects of informal science education on students' attitude toward science. Questionnaires were administered to two sample sets, and results indicated a slight decrease in attitude after participating in an informal science field trip. Continuing research in this area will provide more insight into why these effects were seen, and how informal science education can be best incorporated into the classroom.

Chapter 1: Problem Statement

Teachers are beginning to utilize informal education in order to enhance classroom curriculum and make students more interested in the subject at hand. Informal education takes place outside of a classroom setting, and it tends to include more student interaction and participation than an average lesson plan (Riedinger, K., Marbach-Ad, G., McGinnis, J.R., Hestness, E., & Pease, R., 2010). Students are participating in informal education when they are engaged in learning outside of the classroom curriculum. Because more teachers are incorporating informal education into their curricula, it is important to understand not only if students are benefiting from this out of the classroom experience, but also if informal education has an effect on students' attitudes toward learning science.

Papers such as, "Rethinking the Elementary Science Methods Course: A Case for Content, Pedagogy, and Informal Science Education" by Janet Kelly (2000) and "Impact of informal science education on children's attitudes about science" by Wulf et al. (2009), study whether or not students gain knowledge from informal education programs. Less research has

been done to focus on whether students' attitudes toward science are influenced. It is important for teachers and researchers to better understand if participation in informal education changes students' attitudes towards science. Perhaps allowing children to learn about science in a different environment will help them realize that there are many aspects of science that they had never considered before, and this realization would evoke a newfound excitement. This excitement could also make a career in the sciences more appealing. A book recently published by the National Research Council (2009), states that many informal educators make the assumption that excitement invoked by informal education actually leads students to be more intrinsically motivated to learn (National Research Council, pg 130). This assumption seems safe to make, but it also brings up another question of how students of different ages and intelligences react to informal education.

There must be some differences in learning that distinguish gifted students from nongifted students, and these differences may lead to unequal benefits of informal education for each group. It has been shown that gifted students differ from nongifted students on speed and efficiency of elementary cognitive processes. According to Adele Eskeles Gottfried (1990), intrinsic motivation is positively correlated to higher achievement and intellectual performance. While, research does support that the intrinsic motivation often seen in gifted students increases achievement, there is very little research focused on how informal education changes the attitudes of children of different intelligence levels.

With this project, I planned to investigate if students' attitudes toward science were changed after visiting the Biological Sciences' Learning Center (BSLC) on the University of Southern Mississippi's campus. The BSLC was created in 1997 as 1) a resource for young students to visit, 2) a teacher preparation facility, and 3) an undergraduate learning environment.

The BSLC offers many different informal education opportunities. One opportunity is known as "Friday Night at the Museum." School aged children are invited to spend a Friday night in the BSLC. Each Friday Night at the Museum has a theme. Recent themes include "The Human Body," "Arachnid Night," and "Reduce, Reuse, Recycle." Another informal education opportunity is the Biology Trail. The Biology Trail is a docent-led tour of the museum in the BSLC. Students are exposed to live animals, skeletons, and even a large-scale cell replica. The Biology Trail also includes outdoor exploration, and students are exposed to the biodiversity of Lake Byron. I researched the effects of field trips to the Biology Trail on students' attitudes toward learning science.

My research questions for this study were 1) do children's attitudes change after an informal education program? and 2) do students change their career choice after participating in an informal science education program? I hypothesized that students' attitudes toward science would increase after visiting the BSLC, and that those students whose attitude do change also would change their career choice. The purpose of this experiment was to better understand if informal education changes students' attitudes toward science.

Chapter 2: Literature Review

Informal education encompasses a vast array of different learning opportunities including informal science educator guest speakers, live animal presentations, or even virtual field trips (Riedinger et al., 2010). Riedinger et al. (2010) describes informal education as "an active learning environment [that] would further engage all learners by shifting instruction away from teacher-centered, textbook-based instruction to a student-centered approach that builds on students' strengths as a way to address their needs." While formal education will always be necessary to provide the basic frameworks of education, informal education can enhance this framework by providing a more relaxed environment in which students can take advantage of resources and opportunities provided for them (Kelly 2000).

The National Research Council recently published a book entitled *Learning Science in Informal Environments* (2009). In this book, the authors describe six different possible areas, or "strands", that should in some way be influenced when students engage in informal education. These strands include developing interest in science, understanding science knowledge, engaging in science reasoning, reflecting on science, engaging in scientific practice, and identifying with the scientific enterprise respectively. How much a student's excitement level is influenced is included in strand one, which states that students who engage in informal education "experience excitement, interest, and motivation to learn about phenomena in the natural and physical world" (National Research Council, page 43). The authors discuss the difficulties of measuring this shift in excitement levels due to participant bias (National Research Council, page 59). It seems that the most accurate way to measure the shift of excitement in students is through pre-visit and post-visit questionnaires, and it will be necessary to keep these questionnaires completely anonymous so as to eliminate as much participant bias as possible.

In an article published in the Journal of Science Education and Technology, F. James Rutherford (2005) reviewed the past 50 years in science education, discussing the shortcomings and the hopes for future reform. Rutherford noted that in the past 50 years dozens of science museums have been built in the United States. However, he mentions that these museums have not been used to their fullest extent and that "curriculum design remained stagnant". While the presence of science museums in America is beneficial to the community, they are most beneficial when incorporated into an updated classroom curriculum.

There is a program in place similar to the Biological Science's Learning Center in Colorado known as the University of Colorado's Partnership for Informal Science Education in the Community (PISEC). Many students from the university volunteer in this after-school program which aims to increase knowledge as well as interest in the sciences in primary school children (Bartley J.E., Mayhew, L.M., & Finkelstein, N.D., 2009). Jessica Bartley and her team of researchers (2009) decided to look at the effects that informal science education in after-school settings has on "at-risk" students. In order to collect data, Bartley used two different components of the PISEC assessment suite: Children's Attitude Survey (CAS) and Conceptual Survey of Circuits and Children (CSC). The CAS was derived from the Colorado Learning Attitudes about Science Survey, which was created to research college students' attitudes towards the sciences. For this study, the survey was made much shorter and simpler with elementary-aged students in mind. The CSC only tested the knowledge of the study subjects before and after the program (Bartley et al., 2009). It was necessary to use two separate surveys because both interest and knowledge were being measured.

While the knowledge of circuits was shown to increase significantly after the program was over, it is interesting to note that children's interest in the sciences did not increase. In fact,

there was a negative shift in interest when asked the question, "How would I feel about doing science as my job?" (Bartley et al., 2009). Students were allowed to leave comments after each question, but researchers only published two positive comments.

A similar study was conducted through the same PISEC program, but this study focused only on attitude changes after engaging in informal science education. Rosemary Wulf also used the CAS to measure children's attitudes toward science. The questionnaire consisted of four questions. Interviews were also conducted to test the validity of each CAS version administered to children (Wulf et al., 2009). In this study, all pre- and post-semester questionnaire scores were positive, but there was no statistically significant shift in scores (Wulf et al., 2009). This means that children's attitudes toward science did not change after participating in an informal science program.

The intelligence levels of children should perhaps be taken into consideration when researching what effects informal education has on children's views towards the sciences. Ellen Winner describes gifted children as "those with high ability in one or more domains" (2000). In her article entitled, "Giftedness: Current Theory and Research" she also states that the question of how intellectually gifted children should be educated is of huge importance. Much research has already been conducted that distinguishes the differences in gifted and nongifted children. It has been found that differences in gifted and nongifted groups increases with increasing complexity on elementary cognitive tasks, but the difference is almost negligent if the task at hand is too simple (Johnson, J., Im-Bolter, N., & Pascual-Leone, J., 2003). It is still being argued whether this group difference is due to gifted children being more efficient when it comes to cognitive tasks or whether this difference reflects increased attention, motivation, organization of long-term memory, prior learning, or executive processes (Johnson et al., 2003). A recent article

was published in Current Directions in Psychological Science (2000) that discussed the correlation between giftedness and motivation. According to this article, gifted children appear to be qualitatively different than ordinary students in their motivation to learn (Winner 2000). Therefore, it is plausible that different learning environments, such as formal education verses informal education, would be more conducive for groups of gifted and nongifted students alike.

Chapter 3: Methodology

The Children's Attitude Survey:

A pre-visit questionnaire was distributed to each participating student upon entering the BSLC. Numbered questionnaires were prepared ahead of time in order to keep the identity of the subjects unknown. This eliminated participant bias. Because the children in this study were six to ten years old it was important to keep the questionnaire short and simple. Questions were the same for every student. Permission was obtained to use the Children's Attitude Survey (Wulf et al., 2009) in this study (Appendix A,Table 1).

Table1. CAS questionnaire (Wulf et al., 2009)

I like doing science activities	Strongly agree /Agree /Neutral / Disagree/ Strongly disagree
I can touch something to do with science right now.	Strongly agree /Agree /Neutral / Disagree/ Strongly disagree
I can figure things out by myself.	Strongly agree /Agree /Neutral / Disagree/ Strongly disagree
What do you want to be when you grow up?	

For this study, we changed the option *neutral* to no opinion, as this option may be easier for third grade students to understand. We also added the question "I can see myself working with science when I grow up."

Sample Set #1:

To begin this project, field trips were organized to the Biological Science's Learning Center. The entire third grade class from Petal Upper Elementary, located in Petal, Mississippi, 15.9 miles away from Southern Miss's campus, visited the museum on October 25, 2011. Any student who returned the proper consent forms participated in the research. Petal Elementary

school is 49% female and 51% male. The student population is 1% Asian, 15% Black, 3% Hispanic, 0% Native American, and 81% White (Office of Research and Statistics, 2011). Of the 322 third graders at Petal Upper Elementary, 54 students completed the pre- and post-visit questionnaires.

Pre-visit Questionnaire (1):

Upon arrival, students who were allowed to participate in the study took the pre-visit questionnaire before entering the museum. Teachers helped locate the students who had the parent consent forms returned. The students rushed to finish the survey, so they could go inside the BSLC as soon as possible. It took approximately ten minutes for the students to read and sign the consent form and complete the questionnaire.

Tour of the museum (1):

After the pre-visit questionnaire was completed students immediately began participating in informal education. This field trip was not structured, in that students were not divided up into groups, docents did not introduce exhibits, and students were allowed to wander throughout the museum at their leisure. Time restraints were tight, and the groups were able to tour the BSLC for approximately 30 minutes. This is not an adequate amount of time to explore all of the exhibits and information that the BSLC has to offer. In a typical Biology Trail, students learn numerous facts about reptiles, insects, spiders, extinct animals, and the cell. For this Biology Trail, students simply observed the animals and pictures posted around the museum, as opposed to learning the facts and history of each exhibit.

Post-visit Questionnaire (1):

Post-visit questionnaires were distributed to the teachers. The post-visit questionnaire was the exact same as the pre-visit questionnaire, and once again, numbers were used on the questionnaires in order to reduce bias. In order to match the correct pre-visit questionnaire with the correct post-visit questionnaire, numbers were placed by the students' names on the teacher's rosters. Because there was not enough time to complete the post-visit questionnaire immediately following the tour, the students completed the post-visit questionnaire as soon as they arrived back at the school. Completion of the post-visit questionnaire took about five minutes. I was able to pick up the questionnaires from Petal Upper Elementary the next morning.

Sample Set #2:

A second field trip was organized with the gifted fifth and sixth grade classes at Purvis Upper Elementary. This field trip took place on December 2, 2011. Again, any student who returned the proper parent consent form was able to complete the pre- and post-visit questionnaires. Purvis Upper Elementary School is 48% female and 52% male. The student population is 12% Black, 1% Hispanic, and 87% White (Office of Research and Statistics, 2011).

Pre-visit Questionnaire (2):

Upon arrival, students who were allowed to participate in the study were seated at tables in the BSLC. Questionnaires were distributed to the students, and they took about five minutes to complete. These students were able to read through and answer the questions with ease. As soon as all of the students finished the questionnaire they were separated into groups of approximately 10 students and began a tour of the museum.

Tour of the museum (2):

This field trip was structured and organized because the class had plenty of time to spend in the BSLC. Docents were undergraduate students who either work in the BSLC or often volunteer in the BSLC. Each docent was given a list of facts and talking points for each exhibit. This ensured each group of students was given the same tour with the same factual information. One docent was assigned per group of students. Groups stopped and discussed the biological significance of each exhibit. Docents were encouraged to ask questions to the students and involve them in the learning process as much as possible. This allowed for more interactive learning that is not always utilized in a classroom. Also, the teacher requested a microbiology section be added to the tour of the BSLC, so microscopes were set up and students were able to view microscopic organisms they collected from Lake Byron.

Post-visit Questionnaire (2):

Post-visit questionnaires were distributed to students as soon as the tours came to an end. Students sat at the same table where they had taken the pre-visit questionnaire in order to keep distribution of post-visit questionnaires as organized as possible. Also, students received a post-visit questionnaire with the same number as the pre-visit questionnaire they had taken one hour before. This eliminated bias and made it possible to match the correct pre-visit questionnaire with the correct post-visit questionnaire.

Statistical Analysis:

It was necessary to use a paired sample t-test, since our study contained data from pre/post- questionnaires. A requirement of using a paired sample t-test is that the datum from one sample is correlated with only one other datum from the same sample (Zar 1999). In this study,

each subject is one student, the first datum is the pre-visit test scores, and the correlated datum is the post-visit test scores. Using a paired sample t-test, I was able to determine if there was a significant shift in attitude scores after visiting the BSLC and participating in an informal science education experience.

Chapter 4: Results

Sample 1:

I hypothesized that students' attitudes toward science would increase after participating in an informal science education program, insinuating that post-visit scores would be significantly higher than pre-visit scores. The confidence interval for all statistical tests was established at 0.95. On a scale of 1 to 5, where 1 equals "strongly disagree," 2 equals "disagree," 3 equals "no opinion," 4 equals "agree," and 5 equals "strongly agree," the mean pre-visit score for all questions of 54 third graders was equal to 3.75, and the mean post-visit score for all questions was equal to 3.59.

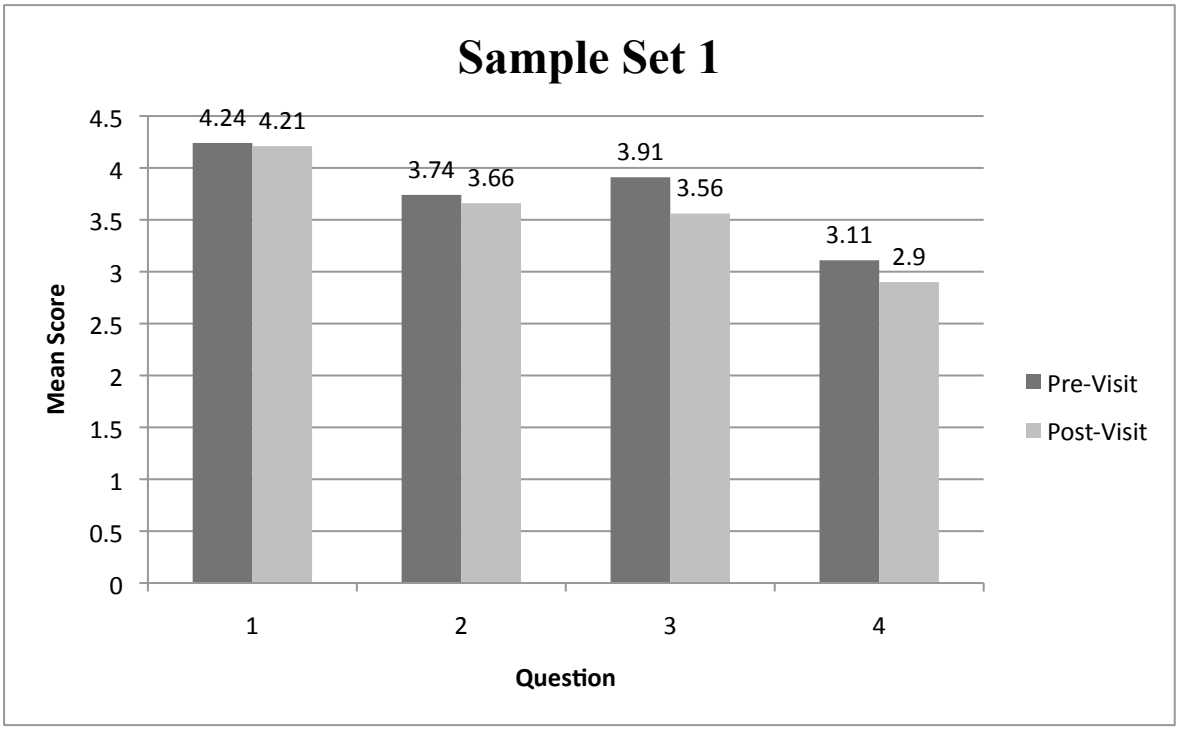

Figure 1: Average scores of pre-visit responses and post-visit responses from CAS

The overall difference in mean scores of the third graders was statistically significant ($t(53) = 2.39$, $p = 0.020$). There was a decrease in scores for all questions, but the greatest

decrease was seen in question 3 (*I can figure things out by myself*). Based on the last question of the questionnaire, two out of 54 third graders changed their career choices after participating in this informal education program. One student changed his/her answer from a "policeman" to an "army man," and the second student changed his/her answer from "science" to "constructor."

Sample 2:

The mean pre-visit score of 26 gifted fifth and sixth graders was 3.94, and the mean post-visit score was 3.92.

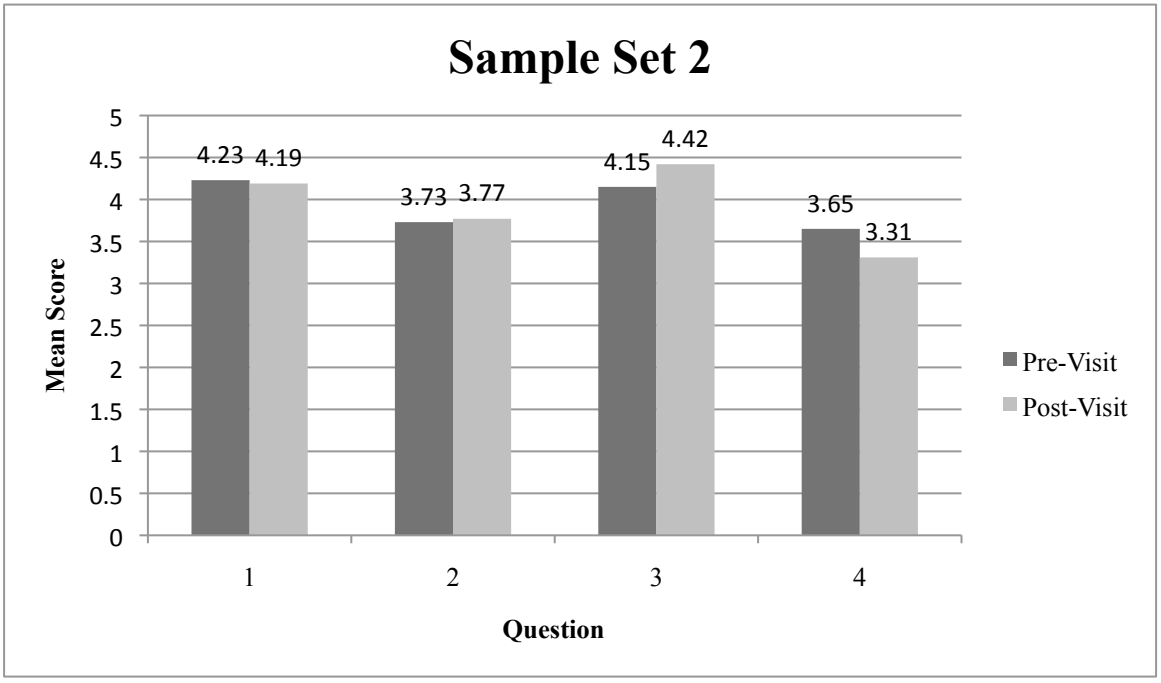

Figure 2: Average scores of pre-visit responses and post-visit responses from CAS

There was no statistically significant difference between pre- and post-visit scores for the fifth and sixth graders ($t(25) = 0.198$, $p = 0.844$). There was a decrease in scores for questions 1 (*I like science*.) and 4 (*I would consider a job in science*.). However, there was a slight increase in scores for question 2 (*There is science in my life outside of school*.), and a greater increase in scores for question 3 (*I can figure things out by myself*).

One out of the 26 fifth and sixth graders changed his/her answer concerning career choice after participating in this informal education program. This student changed his/her career choice from a “nurse” to a “biology scientist.”

Chapter 5: Discussion

The results found in this study do not support the first hypothesis, which proposed that students' attitudes toward science would increase after visiting the BSLC. There was not a statistically significant increase in scores for either sample, meaning the students' attitude did not increase after visiting the BSLC. Further, the third graders' scores were statistically significant; however, the scores decreased after visiting the BSLC. In addition, the results did not support the second hypothesis, which stated that students' would have a change in career goals after being exposed to an informal science setting. While one student did change her career from "nursing" to "biology scientist," there was no significant change in career choices.

While the results reject the hypotheses, this study does provide insight into the effects of informal education on students' attitudes toward learning science. Students were engaged and eagerly participating in the tour. To support this observation, the teacher from Purvis Upper Elementary sent a follow-up email to the BSLC stating that her students continued talking about how much they enjoyed their trip to the BSLC and that this was a "turning point" for many of them (Appendix B). Also, the results from the Purvis students show their scores increased on Question 3 ("I can figure things out by myself."). In a study recently published by Tara Henderson and David Atencio (2007), the authors analyzed the importance of integrating "play" into learning. Inquiry-based museums such as the BSLC encourage play because children are encouraged to explore and investigate. Perhaps this engaging informal learning center revealed to the students that they are capable of problem-solving when they use resources and when they are prompted to think outside of a textbook. This research was not without flaw, but many students did, in some way, benefit from this informal education program.

While there was evidence for beneficial effects of this informal science program at the BSLC, quantitative results of the third grade field trip show a decrease in scores for all questions and results of the fifth grade field trip show that there was a decrease in scores when asked to rank attitudes toward the questions, "I like science;" and "I would consider a job in science." Similarly, in the study conducted by Bartley et al. (2009), there was a significant decrease in scores when asked the question, "How would I feel about doing science as my job?" This commonality could indicate an aspect of informal science programs that deters students from choosing a career in the sciences. It is not known why these negative shifts are seen in the scores, but further research could reveal variables that influence changes in attitude.

In the study conducted by Wulf et al. (2009) results also showed no significant changes in attitudes after participating in the same ISE program. Perhaps since the questionnaires were so short, students simply remembered how they answered the pre-visit questionnaire and felt they should answer the post-visit questionnaire in the same way. This could have also been an error in this study.

There are other errors in this study that could account for the decrease in scores after the students visited the BSLC. For one, the students from Petal Upper Elementary rushed through the pre-test questionnaires so that they could enter the BSLC as quickly as possible. Also, they were not exposed to as much biology during their field trip as anticipated. The time constraints only allowed for students to tour the museum on their own accord. Students were not able to follow a docent, and therefore, were not able to hear all of the information about each exhibit. This field trip is still considered informal education, since they were exposed to educational resources outside of the classroom. However, it can be argued that since they were in the BSLC for such a short amount of time and with such little direction, that they were not exposed to

informal education in an amount that would allow for positive a change in attitude toward learning science.

Another possible error of the Petal Upper Elementary field trip was that the post-visit questionnaire was not taken directly after their visit to the museum. The students toured many other areas of The University of Southern Mississippi's campus before they were given a chance to take the post-visit questionnaire. This time gap between the actual visit and the taking of the post-visit questionnaire could have allowed for other variables to influence the students' answers.

The students from Purvis Upper Elementary experienced a much more organized field trip, and they were exposed to many different aspects of biology. In addition to touring the entire museum under the direction of a docent, they also collected water samples from Lake Byron. Students created wet mounts and viewed their own samples under a microscope. The overall reaction of this field trip was extremely positive, and the teacher even sent a follow-up email stating that her students were still talking about how much they enjoyed their time in the BSLC. While there was no statistically significant change in the Purvis students' attitude scores, they expressed a qualitative change in attitude in the classroom (A. Rogers, personal communication, December 14, 2011).

The second field trip went smoothly, and the students were able to experience a wide variety of biology, but this field trip was not without error. The students took the pre-test questionnaire in an organized and quiet manner. Since only students who had returned parent consent forms were allowed to participate in the study, the students had to be sorted after the field trip was over to make sure the correct students took the post-visit questionnaire. This was

difficult after the field trip because groups of students were finishing the tour at different times, and they were extremely talkative. With the help of the teacher, most, but not all, of the students were able to complete the post-visit questionnaire. The two students who did not complete the post-visit questionnaire had to be disregarded in the study.

The CAS was used in this study because it was designed to specifically measure change in attitude after participating in an informal science program. The questionnaire and the questions were kept short since the students were so young. However, the length of the survey does limit the research. A longer questionnaire could have elicited more accurate results regarding attitude towards science.

For future studies, it would be beneficial to have an equal amount of time allotted for field trips, so that different samples of age and intelligence can be directly compared. It would also be helpful to rearrange the order of the questions on the pre-test and post-test. This might discourage students from simply remembering the pre-test and answering the post-test with the same answers. Continuing research of informal science education will allow teachers to understand the role it can play in their students' education, and hopefully, it will be fully integrated into all classroom curricula.

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Appendix A

Subject: Re: Research question
Date: May 5, 2011 4:38:35 PM CDT
To: "Lauren Finley" <lauren.finley@eagles.usm.edu>

Hi Lauren,
I just asked my adviser if that is ok and we both agree that you are welcome to use the CAS.

If you have any questions about anything I'd be happy to try to help. I actually did my undergrad honors thesis on the CAS!

Rosemary

Appendix B

Children's Attitude Survey

1. **I like science.** Strongly agree Agree No opinion Disagree Strongly Disagree

2. **There is science in my life outside of school.** Strongly agree Agree No opinion Disagree Strongly Disagree

3. **I can figure things out by myself**. Strongly agree Agree No opinion Disagree Strongly Disagree

4. **I would consider a job in science**. Strongly agree Agree No opinion Disagree Strongly Disagree

5. **What do I want to be when I grow up?** _____

Wulf, R., Mayhew, L.M., & Finkelstein, N.D. (2009). Impact of informal science education on children's attitudes about science. AIP Conference Proceedings 1179(1), 93-96.

Appendix C

From: grogers758@aol.com[SMTP:GROGERS758@AOL.COM]
Sent: Wednesday, December 14, 2011 10:04:09 AM
To: J Sellers
Subject: Field trip
Auto forwarded by a Rule Michael,

The kids are still talking about how how much fun they had on the field trip to USM. It really was a turning point for many of them. They are now so motivated to prepare for college. Thank you staff for making them feel so welcomed and "grown up". I appreciate all you do and keep me updated about the upcoming events. You will probably see some of their faces soon! Amy R