AN EVALUATION OF CROSS AGE SCIENCE OUTREACH WITHIN PUBLIC SCHOOLS

By

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

In

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2013

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July 2013

DEDICATION

For my understanding and supportive husband Troy, my loving children Kaylei and Ansen, my high school science teachers Mr. Petty and Mr. Winston, my students in Broadus, Montana, my educational advisor, John Graves, and all the staff and educators that are part of the MSSE program at Montana State University, Bozeman.

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ABSTRACT

The purpose of this project was to evaluate the effectiveness of using advanced science high school students to teach science to elementary students. High school students were given a life science topic and worked in groups to develop a lesson that covered key concepts. High school students worked in groups of two to three to develop the lessons and teach the elementary students. Both, the high school and elementary students were given pre and post tests to determine if and how much content knowledge was gained during the experience. Both groups also received pre and post interest surveys to determine if the students' perception of science changed during this experience.

Results showed that elementary students were actively engaged in the learning and showed an increase of content knowledge of the lessons that were presented by the high school students. Also, the high school students gained a deeper understanding of the concepts they were teaching. Upon completion of the outreach project, both the elementary teacher, and students involved were excited about the science outreach and ready to participate in more outreach experiences.

INTRODUCTION AND BACKGROUND

Powder River County District High School (PRCDHS) is the only public high school for 9-12 grade students within an approximate 75 mile radius of Broadus, Montana. It is located in the Southeast corner of Montana in a very rural and isolated area. Broadus is the county seat of Powder River Country, with a town population of 468 and 1,743 in the county. With 3,297 square miles in the county, there is less than one person per square mile in the county (Powder River County, 2012).

There is one local public elementary school and several country schools, often referred to as one-room school houses, for students in grades K-8 within this district. The high school has 12 full-time teachers and an enrollment of 122 students in 9-12. PRCDHS is composed of 91% Caucasians, 5 % Native Americans, 3% Hispanics, and less than 1% African Americans (Public Schools K12, 2012).

In 2011, I accepted a part-time biology teaching position at PRCDHS. I taught two sections of biology and one section of advanced biology. Since it had been two years from when I had last taught science, this was a great opportunity to get back into the classroom. Upon my arrival to PRCDHS, I was glad to see small class sizes usually less than 20 students, as I had previously taught in school district with 30 or more students per teacher in science lab courses.

In 2012, my contract was renewed to teach biology and advanced biology, but I was also asked to teach fifth grade science. The elementary school had combined the fourth and fifth grade classes due to diminishing numbers and the loss of an elementary teacher two years prior. There are ten students in the fifth grade class. The combined

class elementary teacher needed some relief and asked the administration to have me teach science.

The experience reminded me of a course I took in high school. In 1999, I was part of an honors environmental science class that taught themed lessons to third grade students in the same school district. We were given a broad topic and required to design lessons to teach the third grade students. Prior to this course, I had no interest in teaching or in science. In combination with another elective science I took that year, I started my journey to become a science teacher.

As I reflected on this experience, I wondered where I would be if I did not have the opportunity to share science with others. I knew with the budget cuts that it would not be likely to get a course set up similar to the one I had in high school without some proof of solid benefits. My goal was to show the administration that a course similar to the one I took in high school had the potential to guide students into teaching and further their understanding and excitement for science.

The purpose of this action research based project was to determine the effect of science outreach taught by high school students to elementary students. The high school students were advanced biology students attending Powder River County District High School. The elementary students were first grade students attending Broadus Elementary School.

The high school students were junior and senior students enrolled in advanced biology for the 2012-2013 school year. These students had completed biology the previous school year with an A or B for both semesters. The focus point of this class was

advanced biological topics including a nine week study on anatomy and physiology. The other three quarters covered zoology, ecology, and botany.

CONCEPTUAL FRAMEWORK

The best way to learn something new is to teach it. By giving high school students the opportunity to share their knowledge of the world with elementary students, high school students are able to gain a greater understanding and appreciation of what they are teaching. Science outreach is the use an outside source to teach or share science to a less knowledgeable group. Science outreach programs also have the ability to lesser the burden on classroom teachers looking for teaching material to help enhance the learning environment for their students (Moskal & Skokan, 2011). Classroom teachers receive teaching support from science outreach programs that aid in the planning, preparing, and executing of science lessons, which may be done by teachers other than the regular classroom teacher.

Jean-Pol Martin, a German educator and researcher, developed a teaching concept called "*Lernen durch Lehren*," (LdL) which is translated as "Learning by Teaching" and has been described by Grzega (2005). The idea is to hand the task of teaching over to the students and the teacher is present as the moderator and supporter. The students need to be given as much of the teaching responsibility as possible. This gives students the opportunity to be creative with their learning, and they gain self-confidence while teaching their peers. "The most important thing is to realize that LdL is a method that allows students both to gain something for their personal development and to prepare for professional life" (Grzega, 2005, p. 10).

The purpose of science outreach has been to develop science thinking skills, increase science interest, and supplement science education in K-12 classrooms (Baker, DeCoito, Pedretti, & Shanahan, 2011; Joesten & Tellinghuisen, 2001; Swim, 1999; Wilson & Chizeck, 2000). Baker et al. (2011) described science outreach as an opportunity for science presenters to inspire younger students to choose an educational path that would lead to a career in science.

When developing an outreach program for a variety of age groups, it is imperative to consider the stages of learning that are taking place. According to Piaget, in the elementary years, students are transitioning from egocentric thought to pre-operational thought (Huitt & Hummel, 2003). Learning needs to be based on a hands-on approach, which is often used during science outreach programs.

The population targeted by science outreach may be students in a K-12 classroom, or community members. Elementary students have been the targeted audience for many science-outreach programs because they have not had enough experience to develop a dislike for science and have fewer misconceptions about science related topics than students in junior high or high school (Wilson & Chizeck, 2000). Younger students have less experience with science content and are more enthusiastic about science. These students have not had time to make up their minds about what they are going to be when they grow up, thus properly designed and executed science outreach programs may guide them into a scientific career (Wilson & Chizeck, 2000).

The elementary classroom is also an ideal location for outreach due to the general knowledge base of elementary teachers (Moskal & Skokan, 2011). They are educated in a broad band of subjects with few having a special interest in science. By allowing a

content specialist to teach science, the elementary teacher allows access to greater and more in-depth knowledge than the students would have experienced without the outreach opportunity.

The common purpose of science outreach programs is to enhance elementary science education and to give students a positive experience in science. Oregon State University conducted an outreach program with student fellows or student presenters. The student presenters were required to develop lessons that involved hands-on activities and were inquiry-based. The student presenters, whether high school students or college undergraduates, were in charge of preparing, executing, and evaluating the lessons delivered to the elementary students (Collay, Rao, & Shamah, 2007).

Inquiry-based science has been observed to include students planning and conducting science, asking questions, and receiving guidance more than traditional instruction (Institute for Inquiry, 1995). The National Science Teachers Association, NSTA, recommends science inquiry as a way to engage students in science learning resulting in students with a greater understanding of the underlying concepts in science (National Science Teachers Association, 2004).

The benefits observed during science outreach not only affected the students being taught but the student presenters as well. The student presenters who taught the lessons were rewarded with a deeper understanding of their content, more confidence in their teaching abilities, team work, experience with scientific communication, and time-management and presentation skills (Hatcher-Skeers & Aragon, 2002; Collay et al., 2007; Gutstein, Smith, & Manahan, 2006). The student presenters were given a sense of ownership for the topics they taught. They spent extra time rehearsing and preparing

before performing their lessons in front of peers and teacher facilitators. This process gave the student presenters a reason to study for deeper understanding (Hatcher-Skeers & Aragon, 2002). The elementary students also benefitted through the outreach programs initiated at both the secondary and university levels. The targeted students received science lessons from role models, and science lessons that expanded their traditional content (Collay et al., 2007).

With any program, there are some limitations that have been encountered by participants in outreach programs. The most common concern with science outreach is scheduling. It is difficult to line up the schedules of the student presenters with the classrooms that received the science outreach (Collay et al., 2007). In order to compensate for seeing the outreached students periodically, student presenters created worksheets that reinforced the content taught and created kits for teachers to use when student presenters were unavailable (Hatcher-Skeers & Aragon, 2002; Wilson & Chizeck, 2000). Another concern was the inability to reach a larger number of elementary students. To compensate, high school students were trained in the outreach process and became student presenters under the direction of their classroom teacher (Voegel, Quashnock, & Heil, 2005).

Swim (1999) reviewed a program entitled “Have Demo Will Travel” in which high school level students presented various science lessons to elementary students under the direction of the high school teacher. The student presenters used hands-on activities and inquiry-based lessons to present a wide array of chemistry topics including the scientific method. It was the teacher’s responsibility to ensure that the student presenters were knowledgeable about the content to be presented. The student presenters worked in

teams of three to five and practiced the demonstration before they shared it with the elementary students. The results of this program gave the student presenters improved skills in communication and confidence while presenting (Swim, 1999). A similar outreach program noted that both the student presenters and the students who received the instruction benefitted from the program as the student presenters gained further confidence in their presentation skills and the students were presented with science demonstrations not normally observed in the classroom (Hatcher-Skeers & Aragon, 2002).

Voegel and colleagues (2005) developed a program that integrated college and high school students into science outreach which targeted elementary students. This program initially began strictly with college-level students, but with an increased demand, the program trained high school students in the outreach process. High school students and their teachers attended training put on by the college before they participated in the outreach program. The college provided all the materials necessary for the high-school students to conduct the science outreach program for area elementary students.

The results of this program showed a positive response from both the high-school level student presenters and the increased number of elementary students that were reached by the program. The students who received the instruction from student presenters gained a greater interest for science upon completion of the program (Voegel et al., 2005).

These are just a few examples of how science outreach has been used to complement the science curriculum in K-12 schools. There were both benefits and

concerns identified with the science-outreach programs. As described by Jean-Pol Martin, teaching is learning (Grzega, 2005).

METHODOLOGY

The purpose of this research was to determine if science content knowledge would change among high school or elementary students during science outreach. My secondary question was to determine how each student's, high school and elementary, perception of science changed after participating in this cross-age science outreach program.

Advanced biology students from Powder River County District High School were selected to participate as cross-age science teachers in science outreach for first grade elementary students at Broadus Elementary. The term "cross-age" is a term used within PRCDHS where high school students work within elementary classrooms as teacher aides. These selected students consisted of all seven students enrolled in advanced biology, 85% female and 100% Caucasian. Students were allowed five days to prepare their lessons on the designated topic. Students used computers and classroom resources to develop five to seven minute lessons that were taught in a round-robin session during a 50 minute period for each science outreach session.

Elementary classroom teachers completed the Elementary Teacher Interest Survey in November 2012 to determine which classrooms would be compatible and willing to allow high school students to bring science lessons into their classrooms (Appendix A). This survey collected data on classroom demographics, the time of day science was taught, and the current teaching strategy used in the classroom for science content, as this

information determined the classrooms used for science cross age outreach. Teachers were asked to explain how they currently use science in their classroom and to describe their classroom demographics, as well as any accommodations that would be necessary during a science lesson. When all surveys were returned, personal contact with each teacher was made to determine the science content that each class would be interested in from the outreach students, as well as an estimated time for the first lesson presentation. Elementary teachers were given the opportunity to decide at any time to discontinue participation in the outreach program.

Upon analyzing the available classrooms from the Elementary Teacher Interest Survey, the first grade was selected as our target recipients of the outreach program. The selected elementary classroom consisted of 15 students, 40% female and one student who required additional help and an aide due to learning and behavioral disabilities. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

The two student groups, elementary and high school, received pre and post interest surveys. High school students completed the Science Outreach Survey for High School Students prior to beginning the science outreach program and upon completion of the final outreach lessons to the first grade class (Appendix B). Students received the same survey both prior to the outreach and upon completion. The Science Outreach Survey for High School Students was scored using a Likert Scale of *strong* (5), *moderate* (3), *weak* (1). This survey also provided data on students' preferred career paths. The elementary students completed the Elementary Student Science Interest Survey both prior

to receiving instruction from the high school students as well as the conclusion of the outreach program (Appendix C). This survey contained statements that were used to determine if each student was interested in science prior to beginning the outreach program and to determine if each student liked to study science during school. The Elementary Student Outreach Science Interest Survey asked students to circle an answer for each statement: *not at all*, *a little bit*, *most of the time*, *all of the time*, or *not sure*. The responses for both interest surveys, high school and elementary, were evaluated for themes of common interests before and after the science outreach was conducted. Both surveys were kept anonymous.

In order to measure the content knowledge gained by the high school students during the science outreach, they were given pre and post tests about the content they were teaching. The high school students took the High School Student Content Test prior to beginning researching and preparing their lesson for the first grade class and once again upon completion of teaching (Appendix D). The questions on the content test were all short answer questions to assess higher order thinking and were based on the same topic that was presented to the first graders, but at a higher order of thinking. Answers were compared on the pre and post tests and analyzed for themes of content knowledge changes due to the science outreach.

The advanced biology high school students received instruction on preparing, executing, and evaluating lessons. Next, they worked on approved lessons geared towards first grade Montana State Science Standards (Montana Office of Public Instruction, 2006). Each lesson that was prepared by the advanced science students was presented to peers prior to being presented to the first grade class. High school students

presented lessons on two different topics. The first topic was animal symmetry with three subtopics of bilateral, radial, and spherical symmetry. The second topic was animal taxonomy with three subtopics of mammals, amphibians, and fish.

Throughout the process of creating, teaching, and reflecting about each lesson, the high school students wrote about their experiences using the Science Outreach Journal (Appendix E). The journal allowed students to reflect on each part of the outreach process to include personal feelings, observations, and perceived success of each lesson. Students described each lesson they taught using the following categories: *Engage*, *Explore*, *Explain*, *Elaborate*, and *Evaluate*. Upon completion of the lesson, students reflected on the lesson and how their content knowledge changed during the outreach experience. Journal data were used to evaluate how the high school students' perceived their content knowledge to change or grow over time due to the outreach process.

Each lesson was based around Montana State Science Content Standard 3 which stated "students, through the inquiry process, demonstrate knowledge of characteristics, structures and function of living things, the process and diversity of life, and how living organisms interact with each other and their environment" (Montana Office of Public Instruction, 2006, p. 11). Lessons were taught in the elementary classroom using a round robin approach. For each lesson taught, advanced biology students were divided into three groups and each group prepared a five to seven minute lesson. Elementary students were also broken into three different groups that the elementary teacher decided prior to each lesson. During the outreach experience, each group of elementary students visited each of the three groups and received a pre-test, instruction, and a post-test.

Elementary students were given Elementary Content Pre and Post tests in order to determine the content knowledge gained from each lesson (Appendix F). The pre and post tests consisted of a combination of questions created by the high school students prior to teaching each lesson. Students answered the pre and post questions at the beginning and end of each respective lesson. The results of the pre and post tests were compared and evaluated for content knowledge gained from the lesson presented to the elementary students by the advanced biology students.

One final measurement of this research was the observations of both the elementary classroom teacher and me. I made observations concerning the content knowledge learned by the high school students during this process using the High School Teacher Observation Form (Appendix G). The elementary classroom teacher made observations on the content knowledge of the elementary students we worked with using the Elementary Teacher Observation Form (Appendix H). The data collected from the observations were first used to develop the next lesson presented to ensure any issues and all comments were considered in the planning of each subsequent lesson taught by the high school students. The observations were also used to identify areas of content knowledge changed during the process in the short-term memory of the elementary students. Long-term memory of the elementary students was not part of the scope of this project. By using all of the data tools described above, the effectiveness of increasing content knowledge and science perception was determined (Table 1).

Table 1
Data Triangulation Matrix

Research Questions	Data Source 1	Data Source 2	Data Source 3
How does participating in science outreach increase high school student science content knowledge?	Journaling	Pre/Post Content tests	High School Teacher Observations
How does participating in science outreach affect high school students' interest to pursue science and/or teaching as a future career?	High school student pre and post student surveys		
How did elementary students respond to science outreach in terms of science content knowledge?	Pre and Post content tests	Elementary classroom teacher observations and comments	
How did elementary students respond to science outreach in terms of science perception?	Elementary student pre and post student surveys.	Elementary classroom teacher observations and comments	

DATA AND ANALYSIS

The results of the Pre-Science Outreach Interest Survey for High School Students indicated that 86% of the high school students had an interest in teaching younger students ($N = 7$). Only one high school student indicated a weak interest in teaching younger students.

Of the high school students surveyed, 43% had taken three years of high school science including physical science, biology, and advanced biology. The other 57% had four years of high school science including physical science, biology, advanced biology,

and chemistry. The students with four years of science indicated having a moderate understanding of cellular biology. The data indicated 86% of the students have a moderate background in biology. Fourteen percent of the students have a less than moderate understanding of cellular biology. Students indicated their understanding using the Likert Scale of *strong* (5), *moderate* (3), and *weak* (1) (Figure 1).

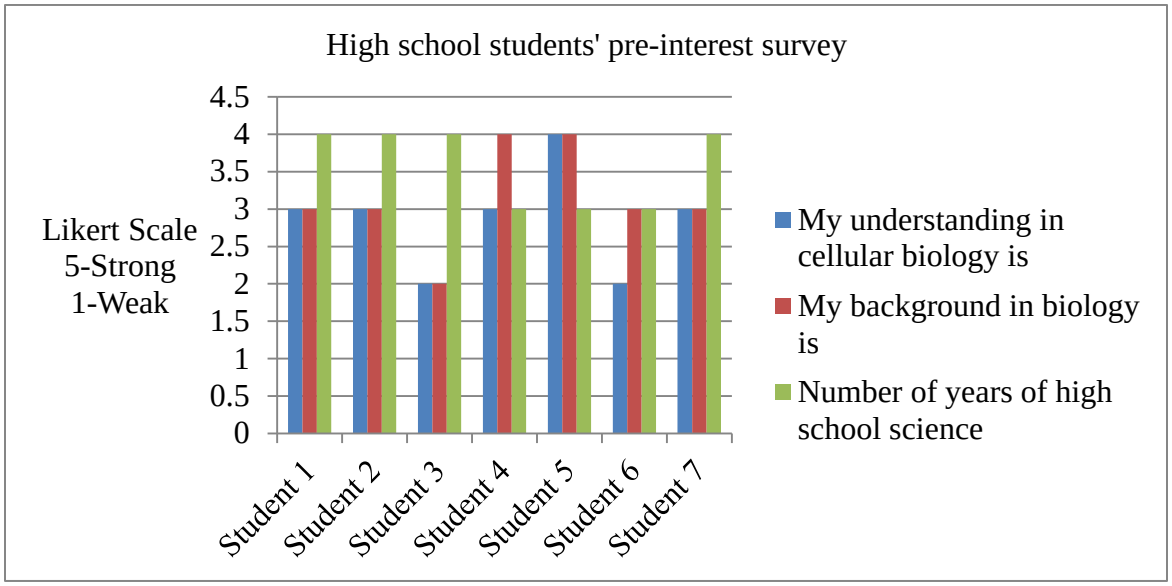

Figure 1. Student responses to pre-interest survey, (*N* = 7).

After analyzing the data from the pre and post interest surveys, the high school students indicated an overall decrease of interest in teaching younger students. There was an increase in interest of teaching younger students in 29% of the high school students, 29% remained unchanged, and 43% of the high school students' interest decreased. Of the high school students with a decreased interest, there was a one point decrease seen in all 43% from a five to a four (Figure 2).

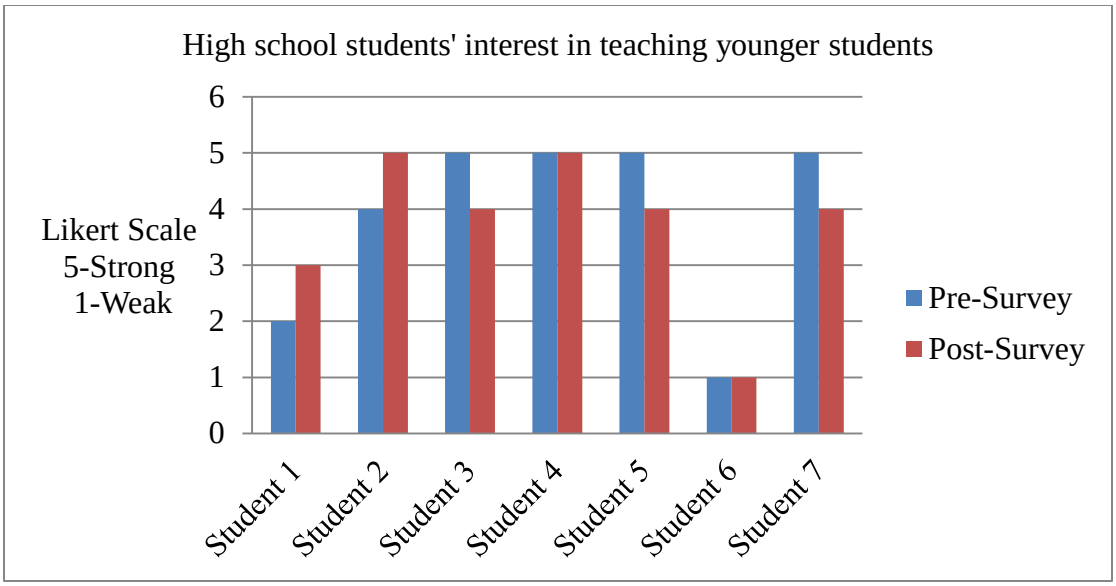

Figure 2. Student interest in teaching from post survey, *(N = 7)*.

High school students' perception change was also observed by reviewing their potential career choices on the pre and post interest survey. One student had written "engineering" on the pre-Science Outreach Survey but it changed to "chemical engineering" on the post survey. Another student had written "athletic training" on the pre survey and it changed to "sports medicine or animal science" on the post survey. A third student had written "speech pathologist" on the pre-survey but changed it to "elementary education" on the post survey. This indicated that 43% of the high school students had changed their career of choice to an educational or scientific field following the completion of the science outreach.

High school students showed an overall increase of understanding cellular biology upon completion of the science outreach. Of the students who participated, 29% showed a regression in their understanding of cellular biology and 14% maintained the same level of understanding from the pre-survey to the post-survey. The remaining 57% illustrated

an increase of understanding in cellular biology over the duration of the science outreach (Figure 3).

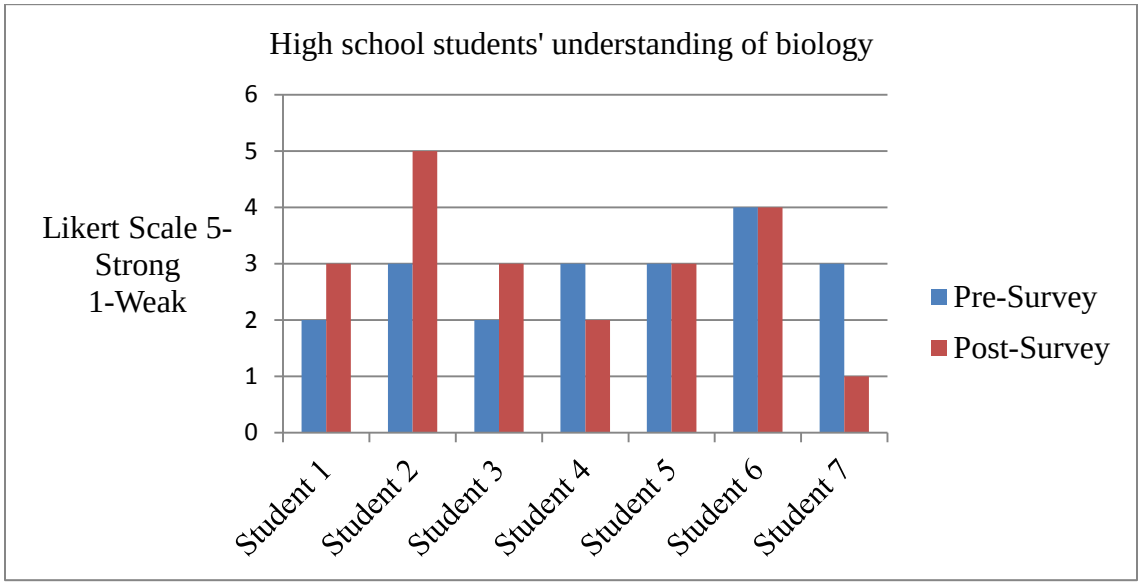

Figure 3. Student understanding of cellular biology, (*N* = 7).

Of the seven high school students who participated in the science outreach, 86% showed an increase in their interest level in biology. There was a 40% increase in two of the students' interest in biology from before the science outreach to after. One student had a 20% decrease in biology interest. Another student's interest and career choice stayed the same. However, all of the students' interest in biology was at or above the moderate level of interest upon completion of the science outreach, whereas, prior to the science outreach, one student had a less than moderate interest in biology (Figure 4).

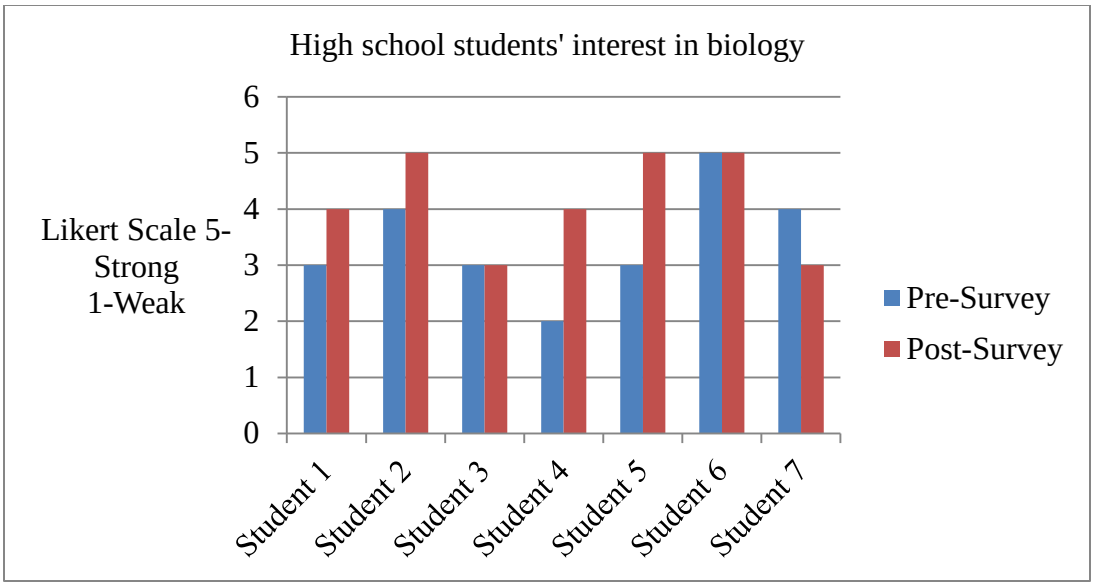

Figure 4. Student interest in biology, (*N* = 7).

The results of the Elementary Interest Surveys indicated that the first grade students increased their perception of science following the completion of the science outreach. Prior to the science outreach, 15% of the elementary students responded to the statement, *I like science*, with "not at all," 38% responded with "a little bit," and the remaining 46% responded with "most if not all of the time" (Figure 5). Following the science outreach, 47% of elementary students responded to the statement, *I like science*, on the post survey with an increased interest in science.

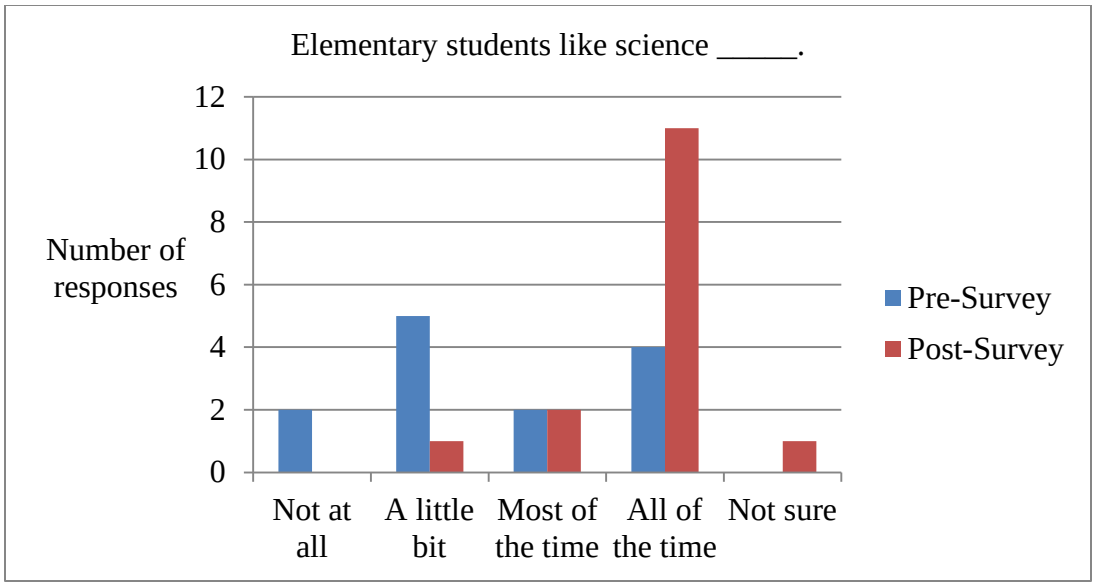

Figure 5. Elementary interest survey response to: *I like science*, (*N* = 15).

Elementary students showed an increase in liking to learn about science. There was a 53% increase in students liking to learn science all of the time. The students who replied with "not at all" on the pre-survey had an increase in their desire and liking to learn about science on the post survey and students with the response of "not sure" gave an affirmative answer on the post survey (Figure 6).

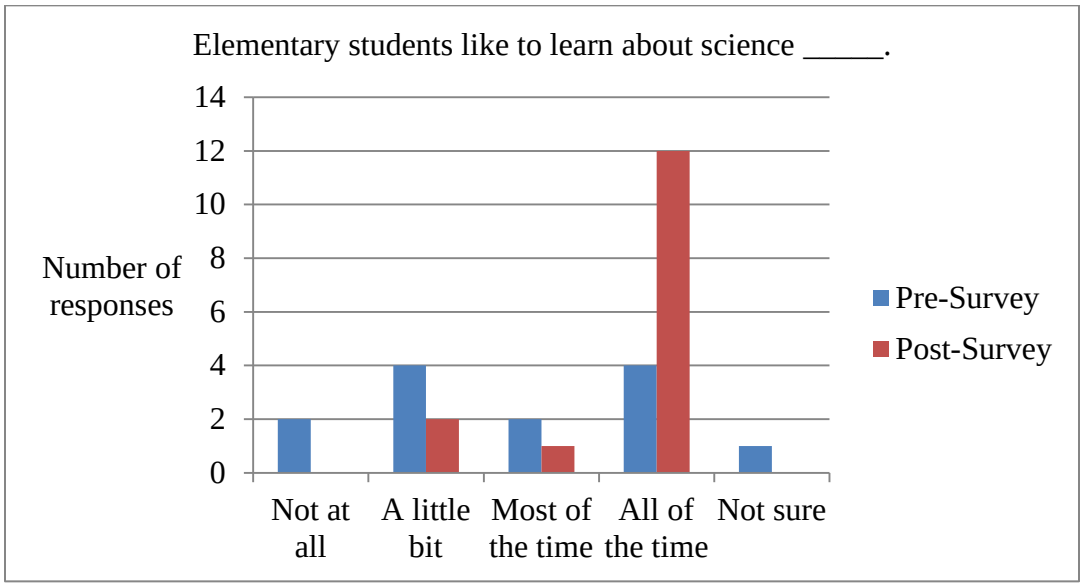

Figure 6. Elementary interest survey response to: *I like to learn about science*, (*N* = 15).

Ninety two percent of the elementary students stated they liked to watch science shows on the pre-interest survey. The most popular choice with 31% of the elementary students was Animal Planet, while 23% of the students selected shows about penguins, 23% selected shows about cats, 8% selected National Geographic and the final 8% of respondents to this question selected Agents (N = 12). In the post survey, the most popular science show was still Animal Planet for 33% of the students (N = 15).

The results of the High School Student Content Knowledge Tests showed an increase in the depth of knowledge obtained from the science outreach. The pre-content knowledge test on animal symmetry had a class average of 65%. The most common questions on the pre-content test that were missed were the questions that asked for specific examples of animals displaying various types of symmetry. Eighty-six percent of the students were unable to state the significance of metamerism, the repetition of parts, or cephalization, the centralization of sensory organs towards one end of the organism, on the pre-content test. The post-content knowledge test had a class average of 92%. The questions about metamerism and cephalization were correctly answered by 71% of the students on the post-content knowledge test, indicating a 57% improvement rate from the pre to the post content knowledge animal symmetry test.

The pre-content knowledge test on animal taxonomy revealed similar results. The advanced biology students had already received instruction about animal taxonomy in their sophomore biology class the year prior as well as earlier in the year. This resulted in a higher class average than for the animal symmetry content test. However, the results still indicated a class average of 74% on the pre-content knowledge test and a class average of 96% on the post-content knowledge test. The most missed questions on the

animal taxonomy pre-test were the two questions that asked for the specific categories in which plants and animals are classified. The content knowledge test asked for at least five categories for animal classification, whereas the students only discussed three with the elementary students. On the post content knowledge test, all students were able to list the three categories that were taught to the elementary students during the science outreach but only 57% of the high school students were able to correctly identify five categories in which animals may be classified.

During the science outreach lessons, one high school student commented that "teaching the material really gets it in your head." Another student stated, "This stuff is easier to remember after repeating it and explaining it to others." I observed that high school students gained more confidence in their understanding of the material each time they presented it. In their Science Outreach Journals, one student wrote "Teaching is the best way to learn something." Another student wrote, "For the most part I knew what a mammal was, but after doing some research I found out some things that I didn't know. I felt that after teaching our lesson on mammals I had a solid base on what a mammal was." A third student wrote, "I as well as the first graders learned something new." This student summed it all up with "You can only truly understand what you know once you explain it to someone else."

The elementary students showed an increase in content knowledge based on their content knowledge tests. During the amphibian pre-test, 27% of the elementary students agreed that snakes were amphibians. The post-test indicated that 100% of the students were able to correctly identify that snakes were not amphibians. During the lesson I observed an elementary student share "slippery and slimy" when giving characteristics of

amphibians. During the mammal's presentation, one elementary student stated that "a fish is an amphibian" and another student responded "boy ones are mammals." This sharing of ideas early in the lesson allowed the student teachers to address misconceptions and help increase content knowledge among the elementary students.

Of the 14 students present during the animal symmetry science outreach, 93% could correctly state what symmetry was, but none of them knew what bilateral symmetry was on the pre-test. The post-test results showed that 93% correctly described bilateral symmetry following the science outreach lesson. In her observations, the elementary classroom teacher wrote, "Science content was good. I learned something about symmetry along with the 1st graders." In both lesson observations she wrote, "high school students were positive." In response to the overall experience she wrote, "Positive all the way around in my view."

No disruptive behavior was observed in the elementary or high school students during the science outreach and all students were actively engaged in each of the three lessons taught for each topic, animal symmetry and animal classification. Both the elementary teacher and I observed a positive learning environment with the high school students facilitating engaging lessons.

INTERPRETATION AND CONCLUSION

The two areas I hoped to address with this action research based project for both elementary and high school students was the content knowledge gained and change in students' perception of science following science outreach. The science content knowledge changed was measured primarily through pre and post content tests for both

groups of students, elementary and high school. High school students also journaled pre and post the science outreach which displayed growth in content knowledge. The results indicated that high school students were able to gain a broader, but deeper understanding of the science content they were preparing to teach. The high school students became experts of the lesson they were teaching but also deepened their understanding by researching further into the content than what they had planned on teaching. By doing this, the high school students learned more "cool facts" and were able to add more depth to their originally planned lessons.

Elementary students demonstrated short term science content knowledge increase based on the pre and post content knowledge tests. All of the elementary students showed an increase of science content knowledge immediately following the lesson. However, there were no post content knowledge tests administered past the immediate conclusion of each lesson. These results do not show how much content knowledge was stored in the long-term memory for the elementary students, but rather just assessed the short-term learning for the elementary students.

The students' perception of science was measured using pre and post interest surveys as well as science journaling for the high school students. The high school students overall perception did not change, however, one student's perception of teaching younger students was influenced. This student wrote "it wasn't as bad as I thought it would be." Granted, the advanced biology class is an optional science class and students who do not have an interest in biology would not choose to take this course.

Elementary student perceptions of the science outreach experience were positive. Upon arrival of the high school students, the elementary students were eager to get

started and disappointed when time was up. When the elementary teacher asked the students to raise their hands if they like learning science from the high school students, 100% of the elementary students raised their hands. The students asked us to come again, however, the high school students were only available to come twice during the span of the project.

VALUE

"Practice makes perfect" is often heard on the sports field or in the mathematics classroom during practice sets. This idea may also be applied in other areas such as the science classroom. The more a student is exposed to material, the more likely it is that the student will grasp the concept being studied. As an educator early in her career, I have often found myself learning alongside my students. My first time teaching anatomy and physiology was just that. I took my basic knowledge and as I taught it to my students, my content knowledge became broader and deeper. This is what I wanted my advanced biology students to experience, a deeper understanding of a topic developing as they prepared to teach others.

I found that the two trials of the science outreach was a success. The high school students were able to teach the elementary students and the elementary students gained science content knowledge. As a program like this develops, I believe it can be a science elective for high school students. These students would not have to be science scholars but have an interest in science and in education. This would enable students who were not as successful in science but still interested a science elective and the opportunity to expand their science knowledge in areas that are of interest to them. Elementary students

benefit by having student teachers with an enthusiasm for science and allow the elementary teachers an opportunity to learn more depth of science as well.

When I am offered a full-time teaching position and the opportunity to bring more electives to the science department, I will bring this idea forward. I have found that this experience has the potential to change students' perception of science and education in a positive way. In fact, I am a product of a course similar to the one I have described where I worked on lessons and then taught third grade students. That experience, in combination with another non-traditional science elective, has brought me to where I am today, teaching science. Prior to those two science elective classes, I was going to college but unsure of what I would become. If I reach only one student by offering this science elective, then it was a success.

Some areas of improvement for this action research based project would be (1) a larger sample size, (2) reaching more elementary students, and (3) more sessions with the elementary students. Due to the isolated nature of my study area, I was unable to have a larger sample size. Class sizes in both the high school and elementary school are very small. However, in the future, since I am currently a part-time employee, I could reach out to the one-room schoolhouses in the area. The downside to this is that the administration did not want students missing school. This restricted my high school students to a 50-minute period first thing in the school day. The idea of more sessions with the elementary students was appealing to both the elementary classroom teacher and me. I have actually shared my idea of science outreach with the elementary teachers a year ago and most of them were on board with the idea. In fact, 86% of them volunteered their classrooms for this project, but due to the time of day restrictions, we were able to

only work with one classroom: the first graders. Our class was only able to make two visits with the first graders during the span of this project due to the course content that needed to be covered with the advanced biology students. This is another reason why a separate science elective course would be beneficial to add to any science department.

Through this action research based process, I have learned that education is not black and white, and there is not just one way to do things. If you want to try something new and truly determine if it is in fact successful, use it as an action research based project and get the facts. Do not just assume that it will be easy to determine your success or failure as often it is not without some documentation and written observations.

As an educator, I have found that collaboration between educators is priceless. I observed different environments and teaching skills by working with the first grade teacher. It was beneficial to share my knowledge of science with the first grade teacher and to observe her sincere interest in the learning of each and every one of her students. Teachers are often secluded to their subject area, and even to their individual classrooms. Collaboration can be seen between teachers with similar subject matter expertise, but rarely observed between teachers of different grade levels or locations. I think it would be beneficial for teachers of different grade levels to share their knowledge and teaching strategies. Not only to see new ideas, but to help in the transition of younger students into the next grade levels.

I felt I grew as an educator in my ability to try new things. This approach to teaching and learning had not been done in my school. It took the elementary teacher and myself working together to make this experience successful.

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APPENDICES

APPENDIX A

ELEMENTARY TEACHER INTEREST SURVEY

Elementary Teacher Interest Survey

Directions: The purpose of this survey is to determine your interest in having your students participate in science outreach led by high school advanced science students. This would require a minimum of one 45-minute session per week with your students for a four to six week period throughout the 2012-2013 school year. You may choose to cancel your participation in the outreach program at any time. Please answer each question fully in order for us to match your students with the best student teachers and lessons.

1. What is your name and what grade(s) do you teach?

2. Please describe your classroom demographics.

3. How do you currently teach your students science?

4. Do you feel comfortable teaching hands-on science? Why or why not?

5. Would you like to add more science to your classroom teaching? Why or why not?

6. How often do guest teachers currently interact with your class?

7. Would you be interested in participating in a science outreach program with high school advanced science students? Why or Why not?

8. Do you have any students with special needs that would need accommodations during science lessons? If so, please explain the accommodations necessary so we can plan accordingly.

9. Is there anything else you would like me to know?

Thank you for taking time out of your day to complete this survey. Please return it to the front office by November 21, 2012. Your prompt response is appreciated!

APPENDIX B

OUTREACH SURVEY FOR HIGH SCHOOL STUDENTS

Outreach Survey for High School Students

Purpose: This survey is to be completed by all students that intend on teaching science in the elementary classrooms as part of Mrs. Hinck's Advanced Biology class. Participation in this research is voluntary. Your participation or non-participation will not affect your grade in any way.

Student ID: _____

Year of expected graduation: _____

Number of years of high school science: _____

Potential job or college degree: _____

For each question below select a number based on the key below:

5-Strong 3- Moderate 1-Weak

My background in cellular biology is: 5 4 3 2 1

My understanding in cellular biology is: 5 4 3 2 1

My interest in cellular biology is: 5 4 3 2 1

My background in biology is: 5 4 3 2 1

My interest in biology is: 5 4 3 2 1

My background in cross-age tutoring is: 5 4 3 2 1

My interest in cross-age tutoring is: 5 4 3 2 1

My background in teaching younger students is: 5 4 3 2 1

My interest in teaching younger students is: 5 4 3 2 1

My level of comfort performing science experiments is: 5 4 3 2 1

In the space on the back, please provide any additional information you'd like to share about your interests, understanding or background relevant to teaching science to elementary students.

Adapted From: (Whitlow and Hoofingale, 2011)

APPENDIX C

ELEMENTARY STUDENT SCIENCE INTEREST SURVEY

Elementary Student Science Interest Survey

Participation in this survey is completely voluntary. You may stop at any time and your choice will not affect your grade or class standing.

Directions: Read each question fully. Circle the best answer. If you need help reading a question or do not understand what it is asking, you may ask for help by raising your hand.

1. I like science.
   Not at all A little bit Most of the time All of the time Not sure

2. I like to do science experiments.
   Not at all A little bit Most of the time All of the time Not sure

3. Science is easy for me to understand.
   Not at all A little bit Most of the time All of the time Not sure

4. I like to learn about science.
   Not at all A little bit Most of the time All of the time Not sure

5. I like to read about science.
   Not at all A little bit Most of the time All of the time Not sure

6. If you like to read about science, what books do you read about science?

7. I like to watch shows about science.
   Not at all A little bit Most of the time All of the time Not sure

8. If you like to watch shows about science, what shows do you watch?

9. I talk about science to my family and friends.
   Not at all A little bit Most of the time All of the time Not sure

APPENDIX D

HIGH SCHOOL STUDENT CONTENT TESTS

Name: _____

Advanced Biology: Animal Symmetry Content Test

1. Define symmetry.

2. Define radial symmetry and list three characteristics of organisms that display radial symmetry.

3. Define bilateral symmetry and list three characteristics of organisms that display bilateral symmetry.

4. Define spherical symmetry and list three characteristics of organisms that display spherical symmetry.

5. What is the significance of metamerism?

6. What is the significance of cephalization?

Name: _____

Advanced Biology: Animal Taxonomy Content Test

1. Who developed taxonomy?

2. Why do we use taxonomy today?

3. Explain how taxonomy can be helpful in science?

4. How can animals be classified?

5. Name five categories animals are classified into and describe characteristics that are unique to each classification.

6. What are some classifications used for plants?

APPENDIX E

SCIENCE OUTREACH JOURNAL

SCIENCE OUTREACH JOURNAL

Directions: Upon completion of each outreach lesson, you need to complete this form and include it in your lessons binder. It is best to complete this journal immediately after presenting your lesson to the elementary students.

Name of lesson: _____

Grade of students you presented to: _____

Number of students present for lesson: _____

Give a written description of how you felt each part of the lesson went. Include observations of how you feel you performed and how well the students were able to understand what you were teaching. If you need more space, attach another sheet of paper.

Engage:

Explore:

Explain:

Elaborate:

Evaluate:

Reflect on how you feel you may have increased your knowledge through this outreach experience. Be specific. You may address the process of learning the material, the process of preparing a lesson, and/or the process of teaching the lesson.

APPENDIX F

ELEMENTARY CONTENT TESTS

Elementary Content Knowledge Test: Animal Symmetry

Directions: Your high school student teachers will help you with each question before they teach you their lesson. After your lesson, you will be asked the same questions to see how much you learned from today's science outreach.

Bilateral Symmetry

1. What does bilateral symmetry mean?

2. Which pictures have bilateral symmetry? (Teacher holds up pictures of dog, star fish, amoeba, human, and tree).

Spherical Symmetry

1. What is symmetry?

2. What is a sphere? Name one example.

3. Which objects have spherical symmetry? (Teachers show pictures of ball, ocean, tree, and apple).

Radial Symmetry

1. What is radial symmetry?

2. Which objects have radial symmetry? (Teachers show pictures of star fish, ball, human, dog, and a flower).

Elementary Content Knowledge Test: Animal Classification

Directions: Your high school student teachers will help you with each question before they teach you their lesson. After your lesson, you will be asked the same questions to see how much you learned from today's science outreach.

Fish

1. What makes a fish a fish?

2. Which of the following pictures are of fish? (Teachers show pictures of shark, whale, dolphin, and goldfish).

Amphibians

1. What is an amphibian?

2. Where do amphibians live?

3. Do amphibians lay eggs?

4. Which of the following pictures are amphibians? (Teachers show pictures of salamanders, snakes, cows, lizards, toads, and frogs).

Mammals

1. What are some characteristics of mammals?

2. Which of the following pictures are mammals? (Teachers show picture of cow, fish, frog, whale, dolphin, and platypus).

APPENDIX G

HIGH SCHOOL TEACHER OBSERVATION FORM

HIGH SCHOOL TEACHER OBSERVATIONS

Date: Grade level for lessons:

Lesson(s) being presented:

Number of high school students present:

Number of elementary students present:

Are students introduced to the lesson topic?

Yes No

Are students actively engaged during the lesson(s)?

Very Engaged	Somewhat Engaged	Not Engaged	Not Observed
3	2	1	0

Do the elementary students behave appropriately during the lesson(s)?

Always	Mostly	Rarely	Not Observed
3	2	1	0

Do the high school students have age appropriate science content?

Always	Mostly	Rarely	Not Observed
3	2	1	0

Are one or more students distracted or not paying attention to the lesson?

Rarely	Mostly	Always	Not Observed
3	2	1	0

What are some good things noted throughout the lesson? Note interactions between students, between high school students and elementary students.

What are some things that should be improved prior to the next outreach?

Any additional observations and/or comments?

APPENDIX H

ELEMENTARY TEACHER OBSERVATION FORM

ELEMENTARY TEACHER OBSERVATION FORM

Participation in this survey is completely voluntary. You may stop at any time and your choice will not affect your grade or class standing.

Directions: Please complete the questions below during each visit from the high school science outreach program and return this form to Mrs. Hinck after each visit.

1. Name and position:_____

2. Today's Date: _____

3. How many students participated in science outreach today?

4. Prior to today's lesson, what is the overall attitude of your students towards science?
   Positive Neutral Negative Not Sure

5. What impact do you feel the high school students had on the learning of science content today?
   Positive Neutral Negative Not Sure

6. Did you observe any disruptive behavior today that is unusual for this class?
   Yes No

If yes, please explain.

7. What would you like to see stay the same for the next outreach?

8. What would you like to see changed for the next outreach?

9. Please give an overview of what you observed today during the science outreach lesson. You may address any of the following: interactions between elementary students, interactions between elementary and high school students, correct and/or incorrect science content or teaching strategies, etc. Please include specific examples of anything positive, neutral, or negative that you observed.