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The Relationship Between Attitude and Anxiety Toward Teaching Science in Pre-Service Elementary Teachers and the Use of Science Olympiad Events

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The University of Southern Mississippi

THE RELATIONSHIP BETWEEN ATTITUDE AND ANXIETY TOWARD
TEACHING SCIENCE IN PRE-SERVICE ELEMENTARY TEACHERS AND THE
USE OF SCIENCE OLYMPIAD EVENTS

by

Allison Armstrong Downing

A Dissertation

Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

December 2011

ABSTRACT

THE RELATIONSHIP BETWEEN ATTITUDE AND ANXIETY TOWARD TEACHING SCIENCE IN PRE-SERVICE ELEMENTARY TEACHERS AND THE USE OF SCIENCE OLYMPIAD EVENTS

by Allison Armstrong Downing

December 2011

The purpose of this study was to examine the relationship between the anxiety and attitudes of pre-service elementary teachers toward teaching science and the use of Science Olympiad events in an elementary science methods course. The participants were 34 pre-service elementary teachers enrolled in the Winter 2010 and Spring 2011 trimesters in the course Science in the Elementary School at a private university in south Mississippi. Attitude toward teaching science was measured using the Revised Science Attitude Scale. Anxiety was measured using the State-Trait Anxiety Inventory (Form Y). Data collection involved participants taking pretests for attitude and state anxiety on the first class meeting and then posttests for attitude and anxiety on the last class meeting of the course. The collection of qualitative data occurred throughout the classes through video recording groups of participants while they were engaged in Elementary Science Olympiad events. Dependent t-tests were used to compare preattitude and postattitude as well as prestate anxiety and poststate anxiety. Results of the statistical analysis of pre- and postattitude scores indicate a statistically significant difference in students' attitudes toward teaching science. Students had significantly higher attitude scores upon completion of the course. Results of the statistical analysis of pre- and poststate anxiety scores also indicate a statistically significant difference in students' anxiety toward

teaching science. Students had significantly lower anxiety scores upon completion of the course. These results suggest that the use of Science Olympiad events in an elementary science methods course is beneficial to promoting science teaching in the elementary classroom.

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December 2011

DEDICATION

This dissertation is dedicated to my family whom I love dearly. To my parents, thank you for the time, patience and assistance you have given in order for me to reach this goal. You are the ones who supported me through all my interests over the years and helped me become the person I am now. There are no words to express my sincere love and gratitude for all you have given to me over the years. To my husband, Jeff, thank you for the patience, understanding and sacrifices you had to make so I could go back to school. I could not have finished without the support you gave me. To my children, Tyler and Coleman, I know I have had to sacrifice coveted family time with you and now that I have completed this degree I will try my best to make it up to you. I hope that with my example you will always strive to take advantage of the talents God has blessed you with and take joy in learning new things. Finally, I promise to all of you this is the last degree. I love you!

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CHAPTER I

INTRODUCTION

Background of the Study

The foundations for secondary educational success, educational interests, and the groundwork for career paths are established during a child's elementary school years. It is the opinion of the researcher that the elementary teacher is the primary person who influences his or her students and helps teach them how to learn. Unfortunately, elementary teachers may lack experience using inquiry teaching methods, and they may also lack the exposure to those methods within their own educational process (Palmer, 2004; Westerback, 1982). Therefore, educational reform should begin within teacher education programs. Past pedagogical practices are adopted by pre-service and new teachers, and the cycle of teaching as these teachers were taught continues, but this must change. If the purpose of science teacher preparation at colleges and universities is to produce future teachers who use inquiry-based methodology in cooperation with their constructivist classrooms, then should those professional educators not use the same methods in teaching their science methods courses? The outcome that is intended should be modeled for the learners in their pedagogical training. Additionally, as the world and society become more centralized in science, technology, engineering, and mathematics (STEM) fields, the way children are educated should reflect these world changes (Chen & Weko, 2009; Loucks-Horsley, et al, 1990).

By incorporating the constructivist approach to learning, classrooms become more student centered. Through constructivism the learner is able to be more active in the learning process and therefore become more interested and retain the information longer.

Through this learning process, the student is able to construct meaning and grasp the understanding of scientific concepts rather than through rote memorization of facts and definitions. From a constructivist viewpoint, students should be actively engaged within the classroom and have interactions with events, objects, and peers (Koballa, 1989). The use of inquiry learning coincides with the constructivist theory of learning. There are five features associated with the inquiry-based classroom environment:

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
3. Learners formulate explanations from evidence to address scientifically oriented questions.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations. (NRC, 2000, p. 25)

The interaction with peers supported by constructivism is described within cooperative learning. Cooperative learning allows students to work through problems in groups to achieve a common goal (Gillies, 2007; Johnson & Johnson, 1995; Kagan, 1994). The goal achieved through the use of cooperative learning groups may be an academic learning outcome, conflict resolution, or working towards building a classroom community of learners (Johnson & Johnson, 1995; Kagan, 1994). There are 3 major positive outcomes for students involved in the cooperative learning structure: increased academic achievement, improvement of race relations within diverse classes, and support

for social and emotional wellbeing of students (Kagan, 1994). Within the cooperative learning groups, students are given the opportunity to learn how to listen to the ideas of fellow classmates while also giving constructive feedback (Gillies, 2007).

According to The Nation's Report Card of 2005, 74% of American 4th graders fell below the proficient level on the National Assessment of Educational Progress (NAEP) science assessments (NCES, 2006). This is unacceptable for those who realize the importance of a good science education as well as the impending need for science education in relation to homeland security and economic leadership on the global level (NSTA, 2002; USDE, 2004).

Since the 1980s many published reports have called for a reform in America's science education. The focus of most of these publications is multifaceted. One is economic decline in the United States. What was once a strong scientific and technological entity in the global economy is now an entity that has been surpassed by nations such as China and Japan (AAAS, 1990; Walsh, 2010). Others include the various trends occurring in United States education: low test scores, student avoidance of science and mathematics courses and majors, a weakened teaching staff in many schools, lowered learning standards compared to advanced nations and while the U.S. is not ranked near the bottom in international studies of science and mathematics knowledge anymore, it is holding at an average ranking and not progressing at a significant rate (AAAS, 1990; U.S. Department of Education Institute of Education Sciences, n.d.).

Educational reform takes time and must begin with the human resource. Changing attitudes and behaviors is a slow process. An effective way to motivate a change in teaching is by introducing exciting new methodologies to alleviate boredom

that some teachers may experience with more traditional teaching methods. Within an educational setting, newly trained teachers can introduce innovative ideas, attitudes and teaching strategies to veteran teachers and administrators who may need a fresh approach and new motivation in order to teach children more effectively. Based on this ideology, reform in teacher education must also be closely examined to ensure those who are engaged in teacher education preparation programs are attaining new, up-to-date, empirically supported ideas, strategies and ideologies, and are excited about implementing all these innovative teaching strategies into the classroom (AAAS, 1990). Empirical studies suggest teachers who exhibit poor attitudes and high anxiety toward teaching science will choose not to teach science. Attitude and anxiety are predictors of behaviors. Attitudes are learned behaviors (Koballa, 1989); therefore, uninspired teachers may pass their prejudices toward science on to their students (Bratt, 1977).

In the late 1970s Science Olympiad style events were being held in Pennsylvania and North Carolina. This soon spread to Delaware, at which time Dr. Gerard Putz of Michigan read an article about the Delaware Science Olympiad. He brought the Science Olympiad program to two schools in his state. After two very successful competitions in the early 1980s, it was decided that the program should be introduced to the rest of the country. Science Olympiad was presented during the 1984 National Science Teacher Association conference in Boston, Massachusetts. Only 17 states participated in the first Science Olympiad National Tournament in 1985. Twenty-six years later, the National Tournaments each year have 49 states participating, indicating the popularity it is gaining among America's middle and high school students (Science Olympiad, n.d.b).

Statement of Problem

The problem of this study was to explore the use of Science Olympiad events in relation to attitudes and anxieties toward teaching science in pre-service elementary teachers. Specifically, the following questions were studied:

1. Is there a relationship between the participation in Science Olympiad events and pretest and posttest means on the variable of state anxiety toward teaching science?
2. Is there a relationship between the participation in Science Olympiad events and pretest and posttest means on the variable of attitude toward teaching science?

Purpose of the Study

The purpose of this study was to examine the relationship among the anxiety and attitudes of pre-service elementary teachers toward teaching science and the use of Science Olympiad events presented using the 5E Instructional Model and cooperative learning groups in an elementary science methods course at a private university in southern Mississippi.

Theoretical Framework

Learning was described by Piaget, as quoted in Thompkins (2001), “as the modification of students’ cognitive structures, or schemata, as they interact with and adapt to their environment” (p. 12). The schemata are comparable to an organizational system used to departmentalize the knowledge we currently have and are obtaining (Thompkins, 2001). Jean Piaget studied how children make sense of the world (Howe, 2002; Marek, 2008). He found that children do not reason the way adults do and must construct meaning based on their own reality. Children must gain understanding by

gathering the bits of information and putting those pieces together themselves (Howe, 2002). According to Piaget's research, cognitive development occurs when an individual must mentally find an organization for newly acquired knowledge within that which already exists. This is known as assimilation. Once assimilation occurs, the individual must change the existing knowledge in order to interconnect with the new. This process is accommodation (DeBoer, 1991; Von Glaserfeld, 1993). Piaget's work became known as the theory of cognitive development and provides the basis for the constructivist learning theory (Howe, 2002).

Lev Vygotsky studied learning in relation to a child's social interactions. Children are able to learn new concepts by observing and discussing those concepts with their peers, older children, and even adults (Ruddell, 2002). According to his research, children use language to organize their thoughts and therefore communication and the sharing of experiences is important in an educational setting (Thompkins, 2001). Through socialization, modeling of behaviors is used to transfer knowledge from one person to another. Vygotsky developed the concept of the Zone of Proximal Development (ZPD) which points out how children have a certain amount of knowledge and skills. These knowledge and skills are achievable by themselves but there are more possible achievements when assisted by peers and the teacher (Bruning, Schraw, Ronning, 1999; Daniels, 1996; Graves et al, 2007). Lessons should be developed to occur within students' ZPD in order to make the most of a learning situation.

Constructivism, based on the work of Piaget and Vygotsky, is the theory that information cannot be passed from one individual to another but rather must be experienced and constructed by the learner (Sadker & Sadker, 2003). The constructivist

learning theory suggests meaning is constructed from within due to social and environmental interactions (Vacca et al, 2006). Constructivism is a multidimensional term that places emphasis on the meaning and learning created by a student based on individual and social activity. The learner uses experiences with various phenomena in order to construct meaning of new information (Bruning, Schraw, Ronning, 1999). Constructivism is derived from these social constructs and various experiences of the students. It is an active process which allows the learner to create meaning of a concept that is individualized based on the individual's previous experiences and prior knowledge (Graves, Juel, & Graves, 2007). Within a constructivist's classroom, the teacher evaluates the prior knowledge of the students and creates a student-centered lesson based on the information collected. Throughout the lesson the teacher uses scaffolding techniques such as probing questions, clues, or suggestions to assist the learners in linking their prior knowledge to the new information they are gathering. Constructivism has gained in popularity among education reformers due to its coinciding nature with authentic learning, critical thinking, and project-based learning (Sadker & Sadker, 2003). The key concepts to the constructivist learning theory are that children are active learners, they relate new information to their previous knowledge base, and they organize and integrate information in their schemata (Thompkins, 2001).

The 5E instructional model was created based on the constructivist learning theory (Bybee, Powell, & Trowbridge, 2008). The model consists of five phases: engage, explore, explain, elaborate, and evaluate. The engage phase allows the teacher to introduce the lesson to the students by presenting them with a problem or event that causes the student to ask a question and simultaneously pique their interest. The explore

phase gives students the opportunity to investigate a scientific concept through hands on experiences. The explain phase offers the teacher the opportunity to get feedback from students as to what they discovered during the investigation as well as explain certain concepts and introduce new vocabulary. The elaborate phase allows students to further investigate or discuss the new concepts and terminology and apply this new concept to real life and other lessons. The evaluate phase, which may take place throughout the lesson, allows the teacher an opportunity to gather data based on individual student performance and skill (Bybee, Powell, & Trowbridge, 2008).

Hypotheses

H₁: There is significant difference in pretest and posttest means on the variable of state anxiety toward teaching science.

H₂: There is significant difference in pretest and posttest means on the variable of attitude toward teaching science.

Assumptions

The researcher assumed the participants responded to survey questions honestly without intimidation of any form.

Delimitations

The subjects for this study consisted of 34 students enrolled in the elementary science methods course over the Winter 2010 and Spring 2011 trimesters at a private university in southern Mississippi. These students were limited to pre-service elementary teachers.

Definitions

The following are definitions of terms in the context of how they are used in this study:

1. Constructivism: Colburn (2003) describes constructivism as a method in which “learners test new ideas against that which they already believe to be true” (p. 59). This theory contradicts the notion that students are “blank slates” but rather are able to build new knowledge based on prior knowledge and experiences (Colburn, 2003).
2. 5E Instructional Model: A version of the learning cycle involving the steps engage, explore, explain, elaborate, and evaluate. This model is derived from the constructivist learning theory which is based on the work of Piaget. This suggests students will gain a deeper understanding of various concepts which is meaningful to the learner by constructing their own understanding by developing their learning on their previous knowledge and experiences.
3. Anxiety: As described by Spielberger et al, anxiety is an emotional state existing at a particular moment in time at a certain level of intensity. Anxiety can be characterized by “feelings of tension, apprehension, nervousness, and worry, and by activation or arousal of the autonomic nervous system” (1983, p.4).
4. Attitude: Fishbein and Ajzen (1975) describe attitude as “a learned disposition to respond in a consistently favorable or unfavorable manner with respect to a given object” (p.6). The object in reference to this study will be teaching

science. Attitude will be measured using the total score on the Revised Science Attitude Scale.

5. Inquiry: Interrelated processes used by students and scientists to pose questions about the world around them and investigate natural phenomena. Through this process students are able to attain a deep knowledge base and understanding of various scientific concepts (NRC, 1996).
6. Science Olympiad: A national non-profit organization committed to improving science education by piquing interest and providing recognition for achievement. It is designed to encourage teachers to find new and challenging ideas to utilize within the science classroom (Science Olympiad, Inc., 2004).
7. Student engagement: Tyler (1949) describes student engagement as the “active behavior of the student” (p. 63).
8. Cooperative Learning: Johnson, Johnson, & Holubec (1993) describe cooperative learning as using small groups in an instructional setting in order to take full advantage of learning opportunities for the individual and the group.

Justification

The purpose of this research was to examine if participation in Science Olympiad events relates to statistically significant improvement in attitudes and anxiety toward teaching science. This examination was based on the premise that inquiry-based instruction during teacher training will improve the attitudes and anxiety toward science and the teaching of science held by many pre-service elementary teachers. Researchers

believe it is the current attitude and anxiety state of elementary teachers which results in a reluctance to teach science.

America's inventors have always used a trial and error, hands-on method for creating new inventions. Inventors such as Thomas Edison made the United States a highly respected nation among the scientific world. More recently, this great scientific nation has not maintained the hold on cutting edge science and technologies as it once did. The amount of money invested in research and development by the U. S. federal government has steadily declined since the mid-1980s (Walsh, 2010). At the same time, countries such as China have increased their investments by 20% each year from 1996 to 2007 (Walsh, 2010). The numbers of students we produce in the United States in science and engineering are also decreasing. Of the bachelor's degrees awarded in the United States, only one-third of them are in science or engineering. There were 22,500 doctoral degrees awarded in 2007 in science and engineering and over half of those went to students from other countries. If America does not increase investments in education and research, the result will surely be a decline from the prosperous nation that once existed (Walsh, 2010).

Providing opportunities for students to be successful in science and celebrating those achievements increases student motivation to continue striving toward achievement goals. Science teachers not only support and encourage students within the classroom but also in science-based extracurricular activities (Harrison & Mannion, 1997). Through the use of Science Olympiad events, the pre-service teachers found inquiry-based activities to use in their future classrooms, build on their science content knowledge and find that science is a subject that does not have to be intimidating. The Science Olympiad events

spanned various content strands and interest areas as well as various grade levels and abilities so students will accomplish goals and take pride in their achievements (Science Olympiad, Inc, 2004).

Pre-service teachers experienced these activities within the learning cycle. Through the use of the learning cycle, more specifically the 5E Instructional Model, the pre-service teachers experienced the method of learning researched by Piaget intertwined with cooperative learning researched by Vygotsky as they experience Science Olympiad. This theory-based method of instruction has been proven successful over time and continues to be used throughout the world in science instruction (Bybee, Powell, & Trowbridge, 2008; Hanuscin & Lee, 2008; Marek & Cavallo, 1997).

Improving the attitude and anxiety of pre-service teachers who participate in Science Olympiad events indicates an effective strategy to incorporate into science methods courses to help teachers feel more comfortable teaching the sciences. The use of cooperative learning within the 5E Instructional Model while engaging students in inquiry based activities such as the Science Olympiad events offers an opportunity to reach whole learner to create a meaningful and effective learning experience.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Good science education allows children to become engaged in studying the natural world and its phenomena. This allows for links between science concepts covered in the classroom to real world technologies and ways those technologies help solve societal and personal issues. According to Loucks-Horsley, et al (1990), adults who are scientifically literate were actively engaged in science as children. These authors also maintain that children involved in science early in education will have the problem-solving skills to be better prepared for the world once they leave their educational institutions. They will be prepared for voting, be marketable as competitive employees and make sound personal decisions in areas such as finances and family issues (Loucks-Horsley, et al, 1990). The average elementary school has few teachers who are well versed and successful in science instruction, and they tend to have smaller numbers of students in their classrooms, thus leaving the majority of students uninfluenced by their effective instructional methods (Nelson & Landel, 2007).

The United States Department of Education (USDE) national education goals include the redesigning of American high schools into workplace and career academies. All graduating students entering the workforce or career training will graduate from one of the 19 academies established within every high school in the nation. The high school academies are developed from Mississippi High School Redesign which is a reflection of the federal *Race to the Top* initiative. *Race to the Top* was developed under the current

federal administration to allow states to compete for federal grant money by pursuing educational reform. Schools within participating states are to show reform in four areas:

- Adopting standards and assessments that prepare students to succeed in college and the workplace;
- Building data systems that measure student growth and success, and inform teachers and principals how to improve instruction;
- Recruiting, developing, rewarding, and retaining effective teachers and principals, especially where they are needed most; and
- Turning around their lowest-performing schools. (USDE, 2010)

The 19 academies are embedded within seven career tracks: agricultural sciences; business; construction and manufacturing; health sciences; human sciences, art, and humanities; science, technology, engineering and mathematics (STEM); and transportation. High school students are able to choose the career training matching their interests. High School Redesign is developed to be an exploratory curriculum in which the students are able to move throughout various training programs to find one that best suits their interests (USDE, 2010). By intriguing students in the sciences through their involvement in Science Olympiad, these students may be more likely to become involved and trained in the STEM fields while in high school. This would result in more trained individuals ready to enter postsecondary education or the workforce in these fields. Through the use of the 5E instructional model students progressing through their science courses will gain higher order thinking skills making them more competitive in their education and the workforce.

In reference to lower and higher order thinking skills, one is typically indicating the cognitive level needed to perform certain learning requirements. The cognitive levels currently used in education today typically refer to the cognitive taxonomy developed and published in 1956 by Bloom et al. There are 6 taxonomic categories, consisting of Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation, ordered from simple and concrete to more complex and abstract (Krathwohl, 2002). Examples of abilities classified in the Knowledge category would be memorization of symbols, classifications, and procedures or methods. In contrast, the Evaluation category encompasses critiquing an idea or issue and supporting the argument with well thought out justifications (Colburn, 2003). As the usefulness of the cognitive taxonomy spread through the nation and the world, it has become frequently utilized in the creation of learning outcomes for students as well as test items (Krathwohl, 2002).

Elementary science programs are the foundation to science education within the K-12 system and into adulthood science literacy. Some schools not meeting Adequate Yearly Progress (AYP) require their teachers to teach only reading and mathematics and not focus on the content areas not being tested. When National Assessment of Educational Progress (NAEP) scores are released indicating students are scoring below average in science, it is due to a lack of science instruction beginning in kindergarten. NAEP scores provide evidence that administrators at the school and district levels are allowing science education to become an endangered species in the elementary schools. In schools where accountability surpasses curriculum and test scores override instruction, time during the school day originally allotted for science instruction is being replaced with additional language arts and mathematics instruction. If students are to be

adequately prepared for high school, an effective education must have begun in the early grades.

The optimal time to teach science to children is during the elementary grades. Children have an innate sense of curiosity and are eager to participate in learning about the world around them. By putting off this natural excitement and hands-on opportunities to construct their view of the phenomena until the students enter into formal science classes takes away from part of the foundation necessary for students to be successful in secondary science courses (Keely, 2009). Children naturally absorb information around them at home, from television and movies and other natural exposure to learning experiences. Educators can take advantage of these natural occurrences as a way to introduce scientific concepts (Lamanauskas, 2009).

The United States Department of Education (2000) provides four primary reasons children need to become competent in math and science:

- the need for skills required by the economy and workplace are changing;
- the need for well-educated U.S. citizens;
- the necessity of math and science in regards to national security; and
- the increasing value of math and science as it relates to individuals.

When students are not provided with the skills needed to be competitive within a changing economy, these students are ultimately being set up for failure in their future learning endeavors. Students are being taught math and science by teachers who are poorly equipped for teaching these subjects, who have little or no training in the subject matter, and little or no mentoring from experienced and qualified colleagues (United States Department of Education, 2000).

In order to best serve the students in our schools, we must demand a high quality of teaching from our science teachers. High quality teaching is comprised of several aspects: the ability to teach, a good understanding of the subject matter, the use of inquiry, being insistent to learning, focusing on science process skills, encouraging questioning, possessing the ability to recognize and utilize the various learning styles represented in the class, preparing lessons which are grounded in well-structured curriculum and assessments, lessons and teaching styles always being modified, and constantly self-evaluating based on student performance (USDE, 2000; NSTA, 2002). Reflecting upon these issues within science education, educators must find a way to rejuvenate meaningful science instruction in the elementary classroom.

Science Olympiad

Science teachers should be willing to use a diversity of teaching approaches to make lessons relevant to the students (Harrison & Mannion, 1997). One strategy which is now used more often in schools and incorporates many of the characteristics of high quality teaching is Science Olympiad, a national non-profit organization that commits itself to improving science education by developing a greater interest in science and providing recognition for science achievements. The organization is designed to assist teachers in finding new and challenging ideas to use within the science classroom (Science Olympiad, Inc, 2004).

State competitions consist of teams from schools around the state converging on a single competition site to vie for Olympic-style medals and the state championship trophies. More than 26 years ago a group of Delaware science teachers engaged their students in a team-oriented science challenge. Today, 6000 secondary schools across 49

states participate in that science challenge now known as Science Olympiad (Science Olympiad, n.d.a). Originally for secondary students, approximately 10,000 elementary schools are currently participating in tournaments or events across the country. The secondary schools receiving first place medals in the state level Science Olympiad also win the chance to compete at the National Science Olympiad held in various places throughout the country (Science Olympiad, n.d.a). Science Olympiad is not only for middle and high school students, but elementary as well. The Elementary Science Olympiad can be held as a tournament, a Fun Day filled with hands-on science competitions, or a Fun Night which includes parents and community members (Science Olympiad).

One Science Olympiad event for elementary students is Mystery Powders. In this event, teams of students are given four unlabeled white powders (sugar, baking soda, cornstarch and plaster of Paris) and must use various observations and tests to determine what each powder is out of several choices given. The students use their senses to observe characteristics of each powder and record how the powders look, smell, sound, and feel. They then make a prediction of what each powder might be. Next, each powder is tested for a reaction with water, iodine, vinegar and heat. Then the teams make another prediction as to what each powder may be (Science Olympiad, Inc, 2004). Through this event inquiry and science process skills are utilized such as observing, inferring, and communicating. This particular event is designed for grades four and five and corresponds to the National Science Education Standards for physical science in those grade levels. The physical science content standards call for an understanding of the properties of matter and changes in those properties (National Research Council

(NRC), 1996). Using Science Olympiad in conjunction with the regular curriculum will develop these skills further within the students which will benefit them in future science courses, interests, or career paths.

The Science Olympiad mission states the organization is dedicated to stimulating scientific interest in all students, regardless of gender or ethnicity. More than 50% of the expenses are dedicated to the national tournament costs and toward scholarships for student participants, indicating the dedication this organization has toward the science education of students of the nation (Science Olympiad, Inc., 2008).

By participating in the Science Olympiad events, students are able to use and expand their ability to learn through trial and error, improve their problem solving skills and use these developing skills to address social issues within their teams. Through the various events offered by Science Olympiad, students are able to find a subject matter that interests them and become more specialized in that area or field. The opportunity to perform well at these competitions gives the students as well as the team and the school a sense of pride in their accomplishments. According to McGee-Brown (n.d), parents of Science Olympiad participants noticed the increase in scientific knowledge and skills, improved problem solving skills, critical thinking and creativity in their children.

Science Olympiad is a team-oriented science competition. Through this teamwork students are able to use and build process skills for problem solving while gaining content knowledge and increasing interest in science. Science Olympiad also allows for the opportunity to gain recognition in science achievement outside the traditional classroom setting (Abernathy & Vineyard, 2001). Teachers may utilize Science Olympiad to challenge their students' knowledge and skills by either beginning

the competition as an extracurricular activity or incorporating the events within the regular science class (McGee-Brown, n.d.).

A study by Abernathy and Vineyard (2001) found that high school students participating in Science Olympiad were generally repeat competitors and were taking or had taken a fourth year science class. They also found both males and females enjoyed Science Olympiad because it was fun and they were offered the opportunity to learn new things. However, males got more enjoyment from the competition aspect than females, while females liked being on a team more than males.

Many teachers use external motivators such as grades and extra credit as a means to increase student participation in these competitions. Anderman and Maehr (1994) note that motivation declines in the junior high years and the external motivators utilized by teachers puts the students into a content area where they gain a lot educationally and have a positive experience in the process. Future entries in competitions then come from more intrinsic factors (Abernathy & Vineyard, 2001). Because Science Olympiad is primarily participated in on a voluntary basis, incorporating the events within the classroom and integrating Elementary Science Olympiad as a school-wide function gives students who otherwise may not have had the opportunity to participate have the same opportunities as everyone else. Middle and high school students who did not experience elementary science have gaps in their understanding of basic science concepts. Many have misconceptions of scientific ideas which were never addressed early in their education (Keely, 2009). Delaying science education can be detrimental to the future science education of students.

The National Science Teacher Association (NSTA) (1999) supports the use of science competitions such as Science Olympiad in schools, provided certain aspects are taken into consideration. All students should have the opportunity to participate in the competition but on a purely voluntary basis. The emphasis of the competition should not lie within the competition but on learning the process, content, or application of the event. The competition should act as a supplement of the current curriculum, not replace it. Lastly, the events should display the time, effort, and work the students have invested in the competition while still giving appropriate credit to coaches, trainers, or other contributors (National Science Teacher Association, 1999).

The National Science Education Standards support Science Olympiad as a developmentally appropriate form of assessment for physical skills and cognitive abilities alike and should be considered as assessment tools by science educators. According to Teaching Standard C, science teachers are to take part in an ongoing assessment of their teaching as well as student learning. Science Olympiad utilizes various forms of assessment such as performance, authentic and individual assessments. During the events, students make and record observations, allowing the teacher to gather achievement data on each student (NRC, 1996; NSTA, 2002).

Making science a basic educational need such as reading and mathematics begins by including not only students and teachers but also parents, the school and the community. Involving all stakeholders creates a viewpoint that science is useful and necessary to everyday life (Loucks-Horsley, et al, 1990). Project 2061 supports the involvement of parents, community members, and other stakeholders as resources in the science classroom (American Association of the Advancement of Science (AAAS),

1990). In elementary grades, community members and family members may be used as judges for the events (McGee-Brown, n.d.). By involving various stakeholders, the community's awareness and support of school science programs increases. While a good deal of planning is involved in organizing a Science Olympiad, the school science program and students benefit greatly (NRC, 1996; NSTA, 2002).

Science Olympiad teaches students how to use scientific inquiry in problem solving, one of the characteristics of high quality teaching (NRC, 1996; USDE, 2000). Inquiry is described by the National Science Education Standards (1996) as “the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” (p.23). The use of inquiry within the learning cycle creates an instructional model conducive for learning and increasing student motivation in science. The use of inquiry in the classroom allows students to use scientific methods to find information just as scientists do. Exploratory investigations may range from structured investigations to free exploration (NRC, 2000).

Children are able to construct meaning about the world around them through observation, manipulation, and experimentation. This is best accomplished by allowing students to play in the classroom. Many of the inventions used today came about through play. Students not experiencing fun in the classroom tend to get bored and take part in disruptive off-task behaviors. Play during the learning experience invites students to take more risks in their learning which opens them to new learning experiences, encourages new ideas and thought processes, as well as inventing. Play gives the students ownership in their learning and a sense of control (Rea, Millican, & Watson, 2000). By creating a hands-on/minds-on experience for students, they are able to build cognitive development,

cultivate language arts skills, and social skills. By offering these opportunities early in the educational career, students will be more likely to pursue these experiences as they move into their high school years. The amount and level of play can be easily adjusted to the age level, abilities and maturity of the students. Play geared towards learning is offered through the use of the learning cycle (Rea, Millican, & Watson, 2000). Through the use of play students are able to better understand the inner workings of many concepts. Using Science Olympiad events in conjunction with the learning cycle offers students a time to explore science and develop more self-confidence in their science achievements.

The Learning Cycle and the 5Es

The learning cycle was developed in the 1960s by Robert Karplus and his colleagues for the Science Curriculum Improvement Study (SCIS). This learning cycle follows the constructivist learning theory which is based on the works of researchers such as Jean Piaget and several others (Marek & Cavallo, 1997; Bybee, Powell, & Trowbridge, 2008; Hanuscin & Lee, 2008). Constructivism is a learning theory explaining how people know what they know and is used as a basic principle for teaching (Lorsbach et al, 1990). One goal of many teacher education reform programs is to provide pre-service teachers with active hands-on investigations within the classroom setting. This goal can be successful in a setting where constructivism is used (Koballa, 1989). Science learning is most effective when using hands-on and minds-on methods, which is the basis for constructivism (Loucks-Horsley, et al, 1990).

The version of the learning cycle developed by Karplus and colleagues consisted of only three phases which became known as exploration, concept introduction and

concept application (Bybee, Powell, & Trowbridge, 2008; Marek, 2008). The learning cycle is a theory-based design for inquiry learning that has been shown to work when used properly. This model for learning assists students in making sense of scientific concepts, improving their science reasoning skills and increasing engagement in science class. Using the learning cycle allows teachers to offer a way to structure inquiry learning so that children are able to be guided through an investigation by exploring a concept, developing the concept and applying the new concept to various situations (Bybee, Powell, & Trowbridge, 2008). While many versions of the learning cycle have been developed, each one holds to the basic model of the original learning cycle. Hanuscin and Lee (2008) state the use of the learning cycle allows students to have “greater achievement in science, better retention of concepts, improved attitudes toward science and science learning, improved reasoning ability and superior process skills than would be the case with traditional instructional approaches” (p. 52). The model allows teachers to plan science instruction into a conceptual sequence which helps to avoid infrequent bursts of science activities disconnected from each other but rather allow them to flow as if part of a story with the concepts being presented in a manner so as to understand the connectedness (Hanuscin & Lee; Lamanaskas, 2009).

Students must be provided a combination of exploration and instruction, as is available through the learning cycle. Exploratory learning is useful when allowing children to construct meaning about a concept through investigative means; however, if the concept is not explained then comprehension may not occur, especially in elementary age children (Crane, 2005). The learning cycle also corresponds to the goals set by the

National Science Education Standards (Hanuscin and Lee, 2008). Goals for school science are to provide a science education to children who are able to:

- “experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers”
(NRC, 1996, p. 13).

The teacher and student each have roles to play in the learning cycle. Bybee et al (2008) describe the teacher’s role as preparing the materials for the exploration, providing students with instructions on how to complete the investigation and collect their data, guiding the students on safety and gathering data correctly, and checking for students’ accuracy. The teacher may offer guidance through appropriate questioning as well as teaching the students how to collect data properly rather than telling them what the correct data should be. The teacher acts as a guide and facilitator rather than an information delivery system. The students’ role in the learning cycle is to participate in the investigation and record data, answer questions and assimilate the data collected with all of this guided by the teacher (Bybee, Powell, & Trowbridge, 2008). Concept introduction is a phase of the learning cycle for the teacher to guide a discussion which will engage students in the development or construction of the scientific concept at hand. The meaning is developed from the experiences, observations, and data associated with

the exploration. The intention of concept application is to have students apply the new concept to other situations. This may be done through further experimentation, working on certain problems, or even reading related information. During this phase students are encouraged to use the new terminology associated with the concept. Application is very similar to exploration except that students now have the terminology to apply to the concept (Bybee et al, 2008).

One reason the learning cycle is not used often in science classes is because it is misunderstood by many in-service and pre-service teachers. The phases of the learning do not follow teachers' beliefs on teaching and learning and do not coincide with the pedagogical approaches taken by their own science teachers (Hanuscin and Lee, 2008). By allowing the pre-service teacher to experience the learning cycle in the aspect of the student rather than the teacher, the pre-service teacher is able to gain a better understanding of and improve attitudes toward the learning cycle as well as science instruction. By using the learning cycle in teaching about the learning cycle, Hanuscin and Lee found pre-service teachers were more excited about teaching science and gained a better understanding of the concept they were intended to learn.

The learning cycle supports the use of inquiry in teaching science and this ideology is gaining more and more popularity. Currently, the learning cycle is being used throughout the world to teach students of all ages. Using inquiry in science instruction allows the teacher to focus students on certain concepts while still allowing those students to experience an individualized instructional time (Tessier, 2010). Students benefit in various ways due to this type of instructional method. Those students benefit by increasing cognitive development, improving science process skills, and by gaining a

fuller understanding of scientific concepts. Use of inquiry with pre-service teachers has been found to result in higher confidence levels for teachers in teaching science. Tessier (2010) found that students had better attitudes toward science and teaching science when using the inquiry format within a general biology laboratory developed for pre-service elementary teachers. He suggests by using inquiry to teach science to these pre-service teachers, the quantity as well as the quality of science lessons within the elementary school will increase (Tessier). This in turn could very well spark an interest in more children who may proceed to careers in the science, technology, engineering and mathematics (STEM) fields.

The 5E instructional model created by the Biological Sciences Curriculum Study (BSCS) includes two additional phases to the previous cycle and a new name was created: Engage, Explore, Explain, Extend, and Evaluate, hence the 5Es. The 5E instructional model has been used in the BSCS curriculum since the late 1980s. The model evolved directly from the learning cycle developed by Karplus and colleagues (Bybee, et al, 2006). Through this cycle, as with the previous three-phase learning cycle, students are able to experience a conceptual change (Bybee, Powell, & Trowbridge, 2008). The 5E instructional model (see Figure 1) was developed from reliable educational theory and has increasing amounts of research to support its efficacy (Bybee, et al, 2006).

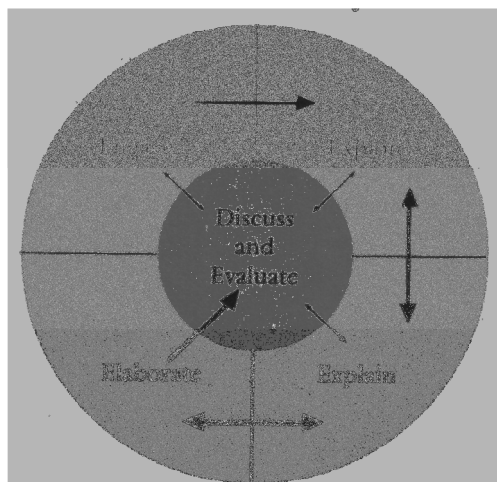


Figure 1. 5E Instructional Model from Ansberry & Morgan Picture-perfect science lessons, expanded 2nd edition (Ansberry & Morgan, 2010, p. 29).

Engagement consists of students being introduced to some type of problem, discrepant event, or question in order to identify prior knowledge, generate interest in the upcoming investigation and create motivation in the lesson (Hanuscin & Lee, 2008; Bybee, Powell, & Trowbridge, 2008). Disequilibrium tends to occur at this point, causing the students to feel the need to rectify this mental discomfort and understand the problem with which they were presented (Bybee, Powell, & Trowbridge, 2008).

Once students are actively engaged, the teacher will introduce the exploration phase. Activities within this phase of the learning cycle should be hands on and utilize concrete materials. At this point the teacher is only a guide through the investigation; the students are the ones who act as the primary investigators (Bybee, Powell, & Trowbridge, 2008).

At the end of the investigation, students are given the opportunity to provide explanations for the observations made. Students receive technical explanations and content-specific terminologies and then reflect on experiences from the engagement and

exploration during the explanation phase. At this point, the teacher delivers content through a variety of instructional strategies: media, discussions, interactive board presentations, textbook readings, etc. This is a time for students to make sense of what they have observed throughout the lesson up to that point (Bybee, Powell, & Trowbridge, 2008; Hanuscin & Lee, 2008).

The elaboration phase allows students to interact through discussion or further investigations using the new concepts and terms they have learned and connect them to other concepts and real life situations. This is a time when misconceptions may be resolved through teacher guidance, peer assistance, discussions, or further practice (Bybee, Powell, & Trowbridge, 2008).

Because most students want feedback on their performance and accomplishments and the teacher must gather student data for record keeping and future lesson planning, the evaluation phase was added to the original learning cycle. While the evaluation phase generally occurs after the elaboration as a paper and pencil test, performance assessment, or other type of assessment, it may be embedded throughout the various phases of the learning cycle. The evaluation of students and the lesson is a very important part of the inquiry learning process. The teacher must evaluate the students' conceptual knowledge as well as their science processing skills (Bybee, Powell, & Trowbridge, 2008; Bybee, et al, 2006). Formative assessments may be used in the engagement phase to determine prior knowledge, during the exploration phase to observe development of process skills and level of conceptual understanding, in the explanation phase for misconception clarification, and in the elaboration phase for student demonstration of depth of understanding obtained (Bybee, Powell, & Trowbridge; Hanuscin & Lee, 2008).

During a 5E instructional model lesson, one can witness evidence of the research on which the model was based. Piaget's work with cognitive development and how people learn new information is observed through the phases of the 5E model and order of each phase within the learning cycle. Vygotsky's research on the use of teacher and peer interaction for scaffolding purposes to assist in conceptual change is seen through the use of cooperative learning and class discussions (Bybee, Powell, & Trowbridge, 2008; Daniels, 1996).

Because many elementary teachers are responsible for teaching all subjects within the day, use of the 5E model easily allows other content areas to be integrated within the science lesson. Reading and language arts are subject areas that monopolize a lot of the time in an elementary class. The use of trade books in the science class is becoming more popular due to their availability. The trade books are up-to-date, contain high quality content, and are more engaging to students (Rice, 2002). Resources are now supporting and incorporating the use of trade books in science, i.e. *Science and Children* from NSTA. Science trade books are very diverse. They cover a variety of content strands, national standards, and age levels. They focus on every topic imaginable, from life sciences to science history. Using trade books can increase literacy skills, build content knowledge, and identify and address misconceptions (Rice, 2002). Science trade books address the various areas discussed in *Project 2061: Science for All Americans* (AAAS, 1990). The use of trade books is appropriate in various phases of the learning cycle and the 5E model. Trade books should supplement science texts rather than replace them and should be carefully chosen by the teacher. The teacher should be knowledgeable enough to choose books based on content and accuracy, determine how to

best use the book within instruction, determine how to alleviate misconceptions associated with the reading, and to teach students how to discern fact from fiction (Rice, 2002).

The National Research Council supports the use of the 5E instructional model as a means to learn the inquiry process as well as the conceptual knowledge associated with the process (Bybee, et al, 2006). Studies have found that students participating in science instruction via the learning cycle gained more science knowledge than those taught using more traditional approaches. Research has also found that use of the learning cycle will increase motivation in students and promote positive attitudes toward science. One particular study compared fifth-graders' performance on an end-of-year test. One group was taught using the *BSCS Science for Life and Living* 5E instructional model, and the other group was taught using a more traditional but activity centered program, referred to in the study as ACTS (Activity Centered Traditional Science). The ACTS program consisted of the teacher presenting information and then allowing the students to participate in an activity which was designed to reinforce the previous information. Data collected from the end-of-year test showed students using the BSCS curriculum scored significantly higher overall than the ACTS group. The scores were also higher for the BSBC curriculum group than that of the ACTS group on each of the four subscales as well as in higher-order and lower-order thinking skills (Bybee et al., 2006). Based on these studies, the 5E model is a key component to the development of teacher candidate professional dispositions in science education.

Cooperative Learning

Evertson, Emmer, & Worsham (2003) describe cooperative learning groups as “organizing students into small groups in which students complete assignments cooperatively, assist each other, solve problems, share materials, and participate in discussions” (p. 112). Today’s educators have a responsibility to train students in a manner that will prepare them for the workforce in the future. By taking into account the future societal and economical skills needed to be successful this can be accomplished. Incorporating cooperative learning into the classroom will assist in preparing students to be successful in a workplace where interaction is not only necessary, but required (Kagan, 1994). According to Kagan (1994), the current state of the nation is rapidly changing in the aspect of society, economy, and demographics. By adjusting educational practices such as, the use of cooperative learning, educators can assist students in meeting future needs now by developing communication conflict resolution skills (Kagan, 1994).

In cooperative learning situations, students are able to assist one another in the learning process rather than hinder others’ learning as observed in a more competitive environment (Johnson & Johnson, 1989). Not only will cooperative learning strategies improve academics but also social skills, student motivation for learning, classroom management and success for all types of learners (Orlich et al., 2004; Evertson, Emmer, & Worsham, 2003). Opportunities for developing and improving communication skills of students are presented within a cooperative setting because students are taught to talk about their personal ideas as well as listen to the ideas of their group members. They are also given more opportunities to participate actively which adds to student engagement in the lesson and the learning process (Christie, Enz, & Vukelich, 2007; Evertson, Emmer,

& Worsham, 2003). Utilizing cooperative learning techniques allows the teacher to teach to all students within a heterogeneous class, reaching all multiple intelligences, all ability levels, and increasing cognitive levels for all students involved (Kagan, 1998). The use of cooperative learning groups has been found to improve the attitudes of students, especially of low performing and minority students (Johnson & Johnson 1989; Kagan 1994; Vaughn, 2002). Through this research it is suggested that similar results would occur within the science classroom. By incorporating cooperative learning, Science Olympiad, and the 5E Instructional Model, students are offered opportunities to study science through inquiry-based experiences that reach the epitome of effective learning.

Anxiety and Attitude towards Science Teaching

Yürük (2011) found that pre-service elementary teachers who had a strong background in science content had less anxiety toward teaching science and more personal science teaching efficacy when compared to those who did not have a strong science background. It has also been noted that many secondary teachers are not suitably prepared for the subjects they teach either (AAAS, 1990; Wenglinsky & Silverstein, 2006). This lack of science education creates a source of anxiety within teachers. Even teachers who have a good science background need ongoing professional development. In 1990, Columbia University began holding the Summer Research Program for Secondary School Science teachers. This program selects 10-12 teachers to participate each summer. Selection is based on a demonstration of the teacher's commitment to teaching, creativity, and resourcefulness. Participating teachers receive a stipend for the eight weeks during which they conduct laboratory research at Columbia under the mentorship of university faculty members (Wenglinsky & Silverstein, 2006). All

university science departments participate in working with the teachers. Each teacher works in one laboratory as a means of becoming more knowledgeable in that particular field of study and familiar with the associated equipment. Seminars and professional development tasks are conducted weekly to assist the teachers in finding ways to incorporate the knowledge, skills, and technology being used into their individual classrooms. Throughout this program a professional learning community is forming. During the school year after the research program, the teacher receives \$1000 for science classroom use and help from a support person who is a graduate student or postdoctoral fellow. This support person makes monthly visits to the teacher's school and collaborates via phone and email to continue assisting the teacher in developing hands-on activities to use in the classroom (Wenglinsky & Silverstein, 2006). The Summer Research Program for Secondary School Science Teachers has resulted in three major positive results:

- 1) Participating teachers use constructivist practices more often upon return to their classrooms.
- 2) Participating teachers are less likely to leave the teaching profession.
- 3) The students in the classes of participating teachers are more likely to be involved in science competitions at the national level and in school science clubs/organizations, and they score higher on science standardized tests as compared to students of nonparticipating teachers in the same school (Wenglinsky & Silverstein, 2006).

While many schools use funds to purchase good, effective instructional materials for science classes, many of the same schools do not invest in appropriate professional development or training on using these materials in the classroom (Nelson & Landel,

2007). This indicates all science teachers, elementary as well as secondary, need effective, research-based professional development throughout their teaching careers (NSTA, 2002).

Upon reflection of her own science education, Jesky-Smith (2002) decided to give an informal survey to the students enrolled in her science methods course for pre-service elementary teachers. She found that while this group of pre-service elementary teachers did view science as an important part of an elementary education, they also had very poor attitudes toward science. Research supports similar findings that many pre-service elementary teachers have poor attitudes toward science and are anxious about teaching science (Sherwood & Westerback, 1983; Westerback, 1984; Cox & Carpenter, 1989). Education researchers suggest college and university instructors follow the practices they teach to their students. These are practices such as the use of learning strategies, modeling inquiry-based science and questioning skills, and being lifelong learners. One student involved in Jesky-Smith's course expressed excitement for being able to do science rather than just learn about science (Jesky-Smith, 2002).

Research indicates elementary education teachers as well as pre-service elementary education teachers usually attribute their dislike for science to previous experiences with the subject (Palmer, 2004). These poor attitudes toward science tend to inhibit potential learning during the teacher education training. The negative attitude also affects the teacher's self-confidence in his or her ability to teach science. This leads to little or no science instruction in the elementary classroom. Those who do teach tend to use more lecture-based approaches rather than inquiry or hands-on methods (Palmer, 2004). Using inquiry-based science methods courses in teacher education programs has

been successful in improving attitudes of pre-service elementary teachers. One study by Koballa (1986) examined the impact of attitudes of pre-service elementary teachers on behavioral intentions (what they intend to do). Within this study, 76 pre-service elementary teachers completed instruments on their attitudes toward science, toward teaching science and with respect to behavior and behavioral intentions. Koballa's research found attitude cannot predict behavior; however, intentions are predictable based on attitude, and pre-service teachers are more likely to exhibit a positive behavior and behavioral intentions when attitude improves. Inquiry-based teaching methods have shown to increase confidence levels along with using peer teaching, practicum experiences, hands-on investigations and technology. According to the research, elementary education teacher candidates improve when participating in content area courses such as biology or physical science that are designed specifically for teacher candidates. These courses give applicable experiences which can be transferred to use in the elementary classroom (Palmer, 2004). Palmer indicates sustained situational interest was also found to improve attitudes toward science. Professors must realize that teacher educators are able to change the negative attitudes of their students (pre-service teachers) through the use of simple teaching strategies: novelty, meaningfulness and involvement. “. . . if we are interested in the development of high quality science teaching in primary schools then attitude change is a logical first step” (Palmer, 2004, p. 905).

Problems teachers have faced in utilizing new science curricula include a lack of understanding, a lack of effective training, and an inadequate science background. While there has been no agreement on how to adjust the curricula, there is an agreement that teachers tend to have negative attitudes toward science as well as toward teaching

science. This attitude in turn deters teachers from teaching science in their classes and embeds a negative attitude in their students. Research found that students entering into college level science courses with a negative attitude will have that attitude reinforced through exposure to science courses where they do not do well due to poor preparation. Poor science academic performance correlates with high anxiety levels toward science. Because all students do not learn in the same manner, a differentiated learning environment should be created within the classroom so all students may be successful. Westerback (1982) found through participation in nontraditional lecture-based science content courses which focus on a more humanistic approach to teaching, pre-service elementary teachers showed a positive change in attitude and anxiety. Research indicates that once attitudes toward teaching science change, they remain fairly stable over time. Pre-service teachers tend to be more comfortable with the biology portion of the science courses, thinking physical science is more difficult because they associate it with math, space science, and other unfamiliar subject areas. There is a correlation between attitude and anxiety found within this research which was previously hypothesized. Demographic variables do not appear to have an effect on attitude and anxiety toward teaching science. The pre-service teachers were asked to complete the survey again following their enrollment in the science methods course and student teaching. Data showed the attitudes and anxieties of these students continued to move in a positive direction (Westerback, 1982).

West, Thomson, Watson, & Parke (1993) found that during the student teaching process, attitude toward science and teaching science improved while anxiety decreased. The research conducted showed that the attitude and anxiety of the in-service teacher

affects the way those teachers teach and how often they teach science. Also, pre-service teachers tend to have negative attitudes and high anxiety toward science. The researchers found that the pre-service teachers involved did not think that science had a very high importance. The implications identified by this study suggest that college and university faculty should be cautious in providing positive examples of science education to pre-service teachers. Colleges and university faculty should also be cautious in the placement of pre-service teachers to help ensure they have a positive public school experience (West, Thomson, Watson, & Parke, 1993).

Duschl (1983) found elementary teachers give their students a science education which is poor in quality and what is provided is done so infrequently. This may be due to not only the teacher's anxiety toward teaching science but also toward learning science. Pre-service teachers entering a science methods course at the collegiate level have only taken introductory level science courses. Within these courses the students are taught science as predetermined knowledge and not as a process for finding answers. When entering the methods course, the students are taught to use science as a means for finding answers to questions. The difference in this pedagogy tends to increase the anxiety of pre-service teachers. Another reason for increased anxiety is that the pre-service teachers have poor conceptions of the nature of science. Knowing how to use science as a means for finding information and being well versed in scientific language and thought processes well enough to direct students through a science lesson tends to be very intimidating to a pre-service teacher. Some alternatives suggested to help ease the anxiety were to have student take a methods course prior to the content courses, have science content courses taught by science education faculty, have the pre-service teachers

participate in semester-long independent research, and to have pre-service teachers take a history/philosophy course on science courses (Duschl, 1983).

Barrow, Holden, Bitner, Kane, & Nichols (1986) suggest creating on-campus facilities to assist students who have low levels of confidence in the sciences. The implementation of these facilities includes involving various groups around campus and assisting the students in improving their science skills. The facilities would include strategies such as science education courses focusing on science skills, math/science labs allowing students to drop in for assistance, and the advisors of these students being informed of the needs of their advisees. The authors suggest personal support would help the student with low science confidence levels in the way of compassionate instructors, peer tutors and study groups, and even counseling services (Barrow, Holden, Bitner, Kane, & Nichols, 1986).

The attitudes of elementary students toward science are strongly influenced by the attitudes exhibited by their teachers. The negative attitude expressed by elementary teachers also tends to cause them to avoid teaching science as frequently as other content areas. This can affect their students' ability to become scientifically literate and cause them to be improperly prepared for future science classes. One source of elementary teachers' negative attitude is the self-perception the teachers have on their ability in science which has been found to correlate with academic achievement, attitude and interest, and the usefulness and enjoyment of science (Cavallo, Miller, & Saunders, 2002). Research shows teachers spend less time teaching science than any other content area and those who have lower academic performance in science will exhibit more anxiety (Sherwood and Westerback, 1983). Westerback's (1984) research shows that

teachers feel unprepared to teach science, and findings indicate that by using a sequence of science content courses designed specifically for elementary education students, anxiety about teaching science decreased significantly.

Teachers tend to be the most influential on science attitudes of pre-service teachers (Cox and Carpenter, 1989). Elementary school teachers tend to have a negative perception of their own science teaching ability which leads to the negative attitudes and high anxiety toward teaching science. Many in-service programs deal with learning science rather than assisting teachers in reducing their anxiety and improving attitudes (Cox and Carpenter, 1989). Cox and Carpenter (1989) show that increasing only science content knowledge will not improve attitude or anxiety. The attitude and anxiety levels may interfere with the ability to learn science content. While research indicates the use of inquiry-based learning improves students' academic performance, many teachers still approach science teaching as a lecture or reading course. One study showed an introductory science course that integrates teaching methods, nature of science and science process skills while deemphasizing content knowledge can improve attitude and anxiety levels. The researchers found that during a methods course in elementary science teaching, emphasis should be placed on teaching methodology and participation in inquiry-based activities rather than focusing on teaching copious amounts of content (Cox and Carpenter, 1989). Elementary teachers and the school science programs should create and maintain positive attitudes toward science in the students (Loucks-Horsley, et al, 1990).

Learning anxieties appear to often stem from the subject matter being taught and the way it is taught. Attitudes are learned from parents and teachers who are also

uncomfortable with the subject. When teaching science, teachers should show evidence of student successes, and be encouraging toward their students in relation to their science accomplishments. Teachers should allow all students to have multiple opportunities to use tools and instruments in the laboratory setting. One should impress upon students that science is not just a subject for white males as commonly thought, but important contributions have come from women and minorities as well (AAAS, 1990). By addressing teacher attitude and anxiety through teaching inquiry methods such as those used within the Science Olympiad events and through the use of the 5E Instructional Model and cooperative learning groups, students will benefit as much as or more than the teachers.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to examine the relationship among the anxiety and attitudes of pre-service elementary teachers toward teaching science and the use of Science Olympiad events set within the frameworks of the 5E learning cycle and cooperative learning in an elementary science methods course at a private university in southern Mississippi. The methods used in collecting and analyzing the data within this study are described in this chapter.

Research Questions

1. Is there a statistically significant difference in the pretest and posttest means on the variable of state anxiety toward teaching science in a group of pre-service elementary teachers participating in Science Olympiad events?
2. Is there a statistically significant difference in the pretest and posttest means on the variable of attitude toward teaching science in a group of pre-service elementary teachers participating in Science Olympiad events?

Hypotheses

1. There is a significant difference in pretest and posttest means on the variable of state anxiety toward teaching science.
2. There is a significant difference in pretest and posttest means on the variable of attitude toward teaching science.

Research Design

This research study was a pretest-posttest design and also included a descriptive factor. During the first class meeting students were informed about the study and signed permission forms if they agreed to participate in the study as well as if they agreed to be video recorded as part of the study (see Appendix A). They also completed the pretests (Revised Science Attitude Scale and STAI) during this time. The researcher had another professor administer the instruments both at the beginning and end of the course. The participants were asked to include their names on the test, but it was stressed that their grades would not be affected by their responses. Responses were not seen until the course ended and final grades were submitted.

Throughout the 10-week course, the researcher modeled the 5E Instructional Model, a five-phase learning cycle based on the constructivist learning theory. Students participated in Elementary Science Olympiad events as the inquiry-based exploration phase of the 5E Instructional Model and worked in groups of four or five students. Throughout the course, the researcher and students were video-recorded during presentation of the lessons within the 5E model and engagement of Science Olympiad events within cooperative groups. The researcher compiled a descriptive analysis including the amount of engagement displayed by each participant and a transcription of group discussions. The time and effort displayed by the researcher and the students were documented. The results of the pretest-posttest on attitude and state anxiety were compared to the amount of engagement documented in the video. Groups were video-recorded one at a time in order to document participation and engagement by group members effectively.

Participants

The population consisted of 34 pre-service elementary teachers attending a private university in the southeastern region of Mississippi during the Winter 2010 and Spring 2011 trimesters in the course EDU 346 (Science in the Elementary School). Appendix B provides a course description and an annotated syllabus. The student population is composed of approximately 65% females and 35% males. The ethnic populations are approximately 69% white and 25% black with the remaining 6% composed of international students, American Indian, Asian, Hispanic and others.

Instrumentation

State-Trait Anxiety Inventory (Form Y)

Scores for each STAI item range from 1 to 4, with 4 indicating the presence of a high anxiety level for ten state anxiety (S-Anxiety) items and eleven trait anxiety (T-Anxiety) items. Trait anxiety (STAI statements 21-40) measures the normal anxiety level of a participant. Students responded to the trait anxiety questions but these items were not included in the statistical analysis. State anxiety (STAI statements 1-20) measures the anxiety level of a participant when considering a certain situation. For this study, students were asked to respond to the statements when imagining that they were instructed to teach science to elementary students. Ten items on the state anxiety portion of the STAI were denoted as anxiety-absent statements and were reversed in scoring for statistical analysis. Examples of the statements are as follows: I feel calm, I feel frightened, I am worried and I feel at ease (Spielberger, et al., 1983). Scores for each scale, S-Anxiety and T-Anxiety, ranged from 20 to 80. Due to the transitory nature of anxiety states, use of the alpha coefficient will provide a more meaningful reliability

index of the S-Anxiety scale. Using the Formula KR-20 (Kuder-Richardson formula 20 for internal reliability) as modified by Cronbach, the alpha coefficients for college females for Form Y S-Anxiety is .93 and for Form Y T-Anxiety is .91 (Spielberger, 1983). Similar to the Cronbach alpha, reliability coefficients for KR-20 range from 0 to 1. The closer the coefficient is to 1 the higher the reliability. Therefore, the reliability coefficients for this instrument are considered excellent due to the close proximity to 1. The norms for anxiety levels for female college students, which made up the participants for this study, were 38.76 for mean state anxiety and 40.40 for mean trait anxiety. Permission was granted by the company Mindgarden through the purchase of the right to copy the STAI instrument for this study (see Appendix C). A sample of the STAI instrument can be found in Appendix D.

Revised Science Attitude Scale

This instrument used a Likert-type scale to measure the attitude of pre-service elementary teachers' attitudes toward teaching science. Participants responded to statements on the attitude scale by indicating one of five choices ranging from strongly agree to strongly disagree. The response choices were assigned a number 1-5 before data analysis occurred: 1 for strongly disagree, 2 for disagree, 3 for neutral, 4 for agree, and 5 for strongly agree. The statements were positive and negative and positive in nature. Ten of the 22 statements on this scale were negatively stated and reversed for statistical analysis. The following are examples of statements on the Revised Science Attitude Scale: I will feel uncomfortable teaching science, I have a difficult time understanding science, The teaching of science processes is important in the elementary classroom, and I plan to integrate science into other subject areas (Thompson & Shrigley, 1986).

The authors report this instrument to be reliable with a Cronbach alpha coefficient of .92. The instrument is composed of four subcomponents: comfort, need, time and equipment. For the scope of this study only the composite score was utilized (Thompson & Shrigley, 1986). Permission was granted by School Science and Mathematics to use the Revised Science Attitude Scale for this study (see Appendix E). A sample of the Revised Science Attitude Scale can be found in Appendix F.

Cooperative Learning Rubric

The Cooperative Learning Rubric (see Appendix G) was used to support data collected through the STAI and Revised Science Attitude Scale. The Cooperative Learning Rubric was provided by ReadWriteThink.org, a Thinkfinity website developed by the International Reading Association, the National Council of Teachers of English, and in partnership with the Verizon Foundation. During video analysis, each student in each group was given a score between 1 and 4 in each category: contribution to group goals, consideration of others, contribution of knowledge, and working and sharing with others. Composite scores ranged from 4 to 16. Scores were then categorized as low, mid, or high cooperative learning behaviors: low = 4 - 7, mid = 8 -12, and high = 13 – 16. Each student's pre and post state anxiety scores and pre and post attitudes toward teaching science scores were recorded, along with each student's cooperative learning score.

Procedure

Approval from the Human Subjects Review Board (see Appendix H) was obtained. At the first class meeting the researcher explained the study being conducted and students were asked for their participation in the study. Students had the option of

participating in the test portion of the study without being video-recorded. Students agreeing to participate completed a state anxiety pretest and attitude pretest. The participants were asked to put their name on the pretests in order to match the instruments with the qualitative data. A strong emphasis was placed on the fact that data collected was not looked at until grades were submitted and data analysis began. These precautions were taken to reduce any anxiety in participating or answering in a biased manner. All students were asked to sign the consent form to be video recorded. The attitude and state anxiety pretests were collected by a professor other than the researcher, sealed, and placed in a locked area until final grades were turned in and data analysis began.

Thirty-five students consented to participate in the study; however, 1 student withdrew from the course during the winter trimester and was therefore excluded from the data collection. A total of 34 students completed the study. All students chose to participate in the study itself and in the video portion of the study. Throughout the course the students participated in a variety of Elementary Science Olympiad events within groups of 4 or 5 presented by the researcher using the 5E Instructional Model. Write It/Do It required students be in groups of 2 or 3.

Six Elementary Science Olympiad events were used in this study: Marshmallow Towers tasks the students with building a tower as tall as possible using only miniature marshmallows and toothpicks; in Fill the Bill, students used various devices representing different shapes of bird beaks to pick up toothpick worms from the carpet environment; Owl Pellets had students dissecting real owl pellets to discover what bones were present within them in order to determine what constitutes an owl's diet; in Mystery Powders, students used different tests to determine the identity of four unknown white powders; As

the Worm Turns allowed students to participate in descriptive and experimental investigations to learn more about worms as organisms and appropriate scientific techniques; and in Write It/Do It, students wrote a description of an object built from blocks so their partners could reconstruct the object using only the written description.

During the activities, the researcher accessed the students' prior knowledge through the engage, the explore phase was the Elementary Science Olympiad event, the explain took place through class discussions and explanations by the researcher, the elaborate expanded on the topic presented in class, and the evaluation consisted of a reflection by the student answering specific questions or a rubric to evaluate the student (see Appendix I). One example of the lessons was As the Worm Turns. The class was engaged by the researcher holding live worms and asking the class what they knew about worms and what purpose they served in the environment. Next, each group received a live worm, a packet with directions and data sheets, and materials to complete each part of the investigation which included descriptions of the worms, testing if the worm preferred light or dark environments, testing if the worm preferred moist or dry environments and testing if and where the worm was ticklish. During the explain phase, the class shared their findings and the researcher shared a website that was fun and informative about earthworms called The Adventures of Herman the Worm. The elaborate phase allowed students to use what they knew about worms to work in their groups and think of another investigation that could be done with the worms. Students were evaluated through a written reflection submitted at the next class meeting.

The researcher and students were video-recorded for qualitative analysis during the activity portion of the class. During the review of videos, the Cooperative Learning

Rubric was used to maintain objectiveness when assessing student participation and engagement. The video analysis allowed the researcher to make inferences on the quantitative data collected to obtain a better understanding of the effectiveness of the use of Science Olympiad events when utilized in conjunction with cooperative learning and the 5E Instructional Model. The dissertation committee chairperson reviewed the videos to ensure the 5E Instructional Model was implemented correctly. During the last class meeting, the research participants completed the posttest for state anxiety and the posttest for attitude.

Data Collection

Upon approval from the Human Subjects Review Board, the following data was collected:

1. The State-Trait Anxiety Inventory (Form Y) was administered during the first and last class meetings of the trimester in order to provide pretest and posttest scores for state and trait anxiety in regards to teaching science.
2. The Revised Science Attitude Scale was administered during the first class meeting and repeated during the last class meeting of the trimester as a posttest measure.
3. During the course, the presentation of Science Olympiad events using the 5E instructional model and the participation and engagement of the subjects in these events/lessons was video-recorded and documented. All 34 students were consenting participants and were video recorded.

Data Analysis

Test score data were entered and analyzed in SPSS version 18. Alpha was set at .05 to determine significance of the tests. To examine the first hypothesis, there will be a

significant difference in pretest and posttest means on the variable of state anxiety toward teaching science, a dependent t-test was used to determine a significant difference.

To examine the second hypothesis, there will be a significant difference in pretest and posttest means on the variable of attitude toward teaching science, a dependent t-test was used to determine a significant difference.

The researcher viewed the video-recordings made during the class participation in the Elementary Science Olympiad events. Observations of the researcher's presentation of the lesson using the 5E instructional model, student participation and engagement in the activities, and any noteworthy occurrence within the classroom were recorded. The level of engagement was assessed for each participant based on these observations and using the Cooperative Learning Rubric. These observations were compared to the test scores to determine if lack of participation or engagement in the activity caused the individual's pretest and posttest scores for attitude and state anxiety to not show significant differences. Making comparisons between the posttest scores and the video observations allowed the researcher to obtain a better understanding and make more accurate inferences of why participants received the scores they did. Participants were assigned an identification number known to the researcher only.

In addition, a transcription of group discussions and a descriptive analysis of the amount of engagement displayed by each participant were compiled. Group interactions evident in the videos were coded by the researcher using the Cooperative Learning Rubric as previously described.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to examine the relationship between the anxiety and attitudes of pre-service elementary teachers toward teaching science and the use of Science Olympiad events in an elementary science methods course in order to make data driven decisions on how to better educate pre-service elementary teachers. In addition to analyzing quantitative data collected, student engagement within cooperative groups through video recordings of students involved in the Elementary Science Olympiad events during class meetings were also analyzed. This chapter is comprised of a summary and the results of the study.

Summary

Two sections of the course Science in the Elementary School were used to collect data for this study; the researcher taught both sections. The participants were 34 pre-service elementary teachers at the undergraduate level.

Attitude toward teaching science was measured using the Revised Science Attitude Scale by Cathy L. Thompson and Robert L. Shrigley (1983). The survey instrument consisted of 22 items, with 14 positive and 9 negative statements, based on a 5 choice, Likert-type scale; the options range from strongly disagree to strongly agree. Anxiety was measured using the State-Trait Anxiety Inventory (STAI) (Form Y) by Charles D. Spielberger, et al. (1986). Data collection involved participants taking pretests for attitude and state anxiety on the first class meeting. Data collection also involved participants taking posttests for attitude and state anxiety on the last class

meeting of the course. The collection of qualitative data occurred throughout the classes through video recording groups of participants while they were engaged in Elementary Science Olympiad events. For the purposes of data analysis and to ensure anonymity of the participants, each student was assigned a number 1-34. The results of the pre- and post- scores on state anxiety and attitude toward teaching science were then analyzed with respect to the category of group engagement attained by each student as determined by coding using the Cooperative Learning Rubric (CLR).

Results, Analysis, and Interpretation

Quantitative

Hypothesis 1 for this study is stated as: There will be a significant difference in pretest and posttest means on the variable of state anxiety toward teaching science. Hypothesis 2 for the study is stated as: There will be a significant difference in pretest and posttest means on the variable of attitude toward teaching science. Both hypotheses were tested by running paired sample *t*-tests. Results from the *t*-test for state anxiety were $t(33)=3.876, p<.001$, indicating a statistically significant difference in the pre-state anxiety and post-state anxiety means. Results from the *t*-test for attitude were $t(33)=-5.648, p<.001$, also indicating a statistically significant difference in the pre-attitude and post-attitude means. The mean and standard deviation values for anxiety and attitude can be found in Table 1. A lower number for anxiety indicates a lower anxiety level. A lower number for attitude indicates a lower or poorer attitude level. The post-state anxiety mean was lower than that of the pre-state anxiety mean indicating participants achieved a lower anxiety toward teaching science as seen in Figure 1. The post-attitude

mean was higher than the pre-attitude mean indicating participants achieved a higher or better attitude toward teaching science as seen in Figure 2.

Table 1

A comparison of means for anxiety and attitude

Variable	Mean	Standard Deviation
Pre-state	44.71	13.52
Post-state	36.59	10.10
Preattitude	3.65	.49
Postattitude	4.01	.43

Note. Pre-state and post-state are variables for state anxiety and measured on a 4 point Likert scale and were summed and possible scores range from 20 - 80. Preattitude and postattitude are variables for attitude and measured on a 5 point Likert-type scale.

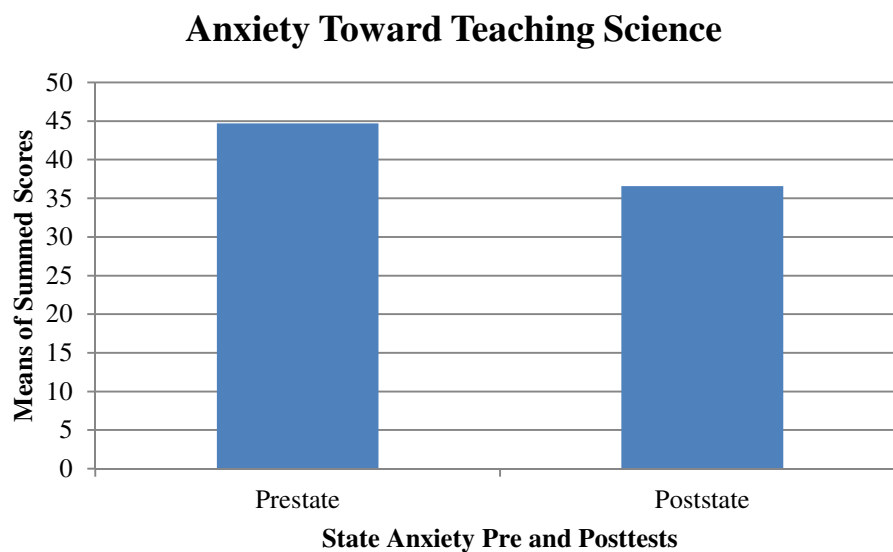


Figure 2. Means of State Anxiety Pre- and Posttest Scores. Pre-state represents the state anxiety pretest and post-state represents the state anxiety posttest. Pre-state has a mean of 44.71 while the post-state has a mean of 36.59.

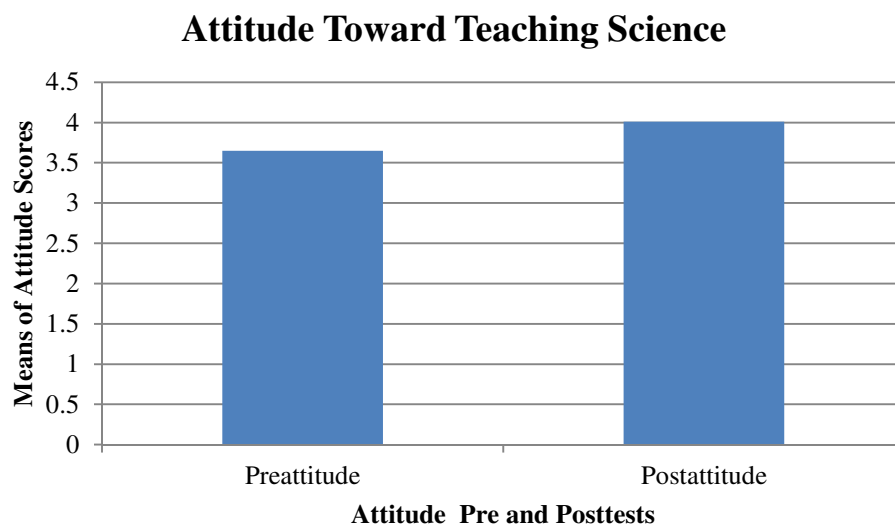


Figure 3. Means of Attitude Pre and Posttest Scores. Preattitude represents the attitude pretest and Postattitude represents the attitude posttest. Preattitude has a mean of 3.65 while the Postattitude has a mean of 4.01.

Qualitative

Twenty students demonstrated behaviors supporting the hypotheses (students 1, 2, 3, 4, 6, 7, 8, 11, 12, 14, 15, 22, 23, 25, 26, 27, 29, 32, 33, and 34). Each one showed a decrease in anxiety, an increase in attitude toward teaching science and rated high on the CLR. Student 1 was representative of this group. She was positive and upbeat, always willing to participate in the activities and to perform tasks within class. Students 17 and 30 only partially supported the anticipated outcomes. Student 17 showed a decrease in anxiety and rated high on the CLR, but received the same pretest and posttest score for attitude toward teaching science. With a score of 4.18 out of 5.0, she came into the course with a good attitude toward teaching science and kept the good attitude. The state anxiety score for student 30 did not change from pretest to posttest, but her attitude toward teaching science went up and her CLR score was high. With anxiety scores ranging from a low of 20 to a high of 70 in the class, her anxiety score of 29 was low even at the

beginning of the course. Therefore, the behaviors of 22 of the 34 students clearly supported the anticipated outcomes.

The majority of the participants in the study reacted positively toward the activities in which they were involved. Based on their responses to one another, to the researcher, and within the written reflections, the majority of the participants seemed to have a different outlook at the meaningfulness of science in the classroom as well as how to teach science in the elementary setting. Fewer than 10 of the students reacted negatively or neutrally to the activities in which they participated. Those who were interested in science seemed to revalidate that interest. Many of the participants who had no interest in science seemed to be more open to participating in and comfortable with the science activities in which they were engaged. The following comments from video transcriptions and within the written reflections are examples of positive remarks from thirteen students across the two trimesters:

3: This activity was fun and I am constantly reminded of how much I love hands on activities every time we are allowed to experiment in this science class.

4: A beak!! Look! That is so cool! Look how cool!

17: I learned a lot of information about birds that, for the most part is common sense, but are things I have never thought about.

3: I don't think students should be kept from learning about our environment just because the teacher is afraid to touch worms.

4: Neat! Oh this is cool! They think it's gross. I don't!

8: I really enjoyed this activity; I thought it was very fun and was definitely a 5E lesson plan I will use in the future. (personal communication, February 2011)

21: I always wonder what the significance of some creatures are and I'm learning that everything has a purpose.

27: I like experiments where you have to figure out what an item is, not just whether or not something works.

31: My school didn't teach science in the elementary. . . I feel cheated.

32: Learning about owl pellets was very neat . . . By talking about it as a class it helped me understand more about the food chain.

29: Doing this [food] web gave me a good resource to do with my future classes. Now that I know how to do the webs, I can show my students how to [do] them as well.

27: Having these hands on experiences will be something that I never forget.

18: I really enjoy doing stuff like this. I'm going to finish getting my science endorsement this summer. . .

33: I thought today's activity was a lot of fun, and I really think that kids in the classroom would enjoy it.

26: Everyone in our group added to the knowledge of the animals in the food web, which helped us to get the web correct (except for the fox).

31: I feel as though I learned a lot from the experience.

30: I don't think the worm liked being poked and touched but I know we had fun as a group doing these experiments! (personal communication, May 2011)

The overall conclusion was that the Elementary Science Olympiad activities as presented in the 5E instructional Model within cooperative groups did indicate a positive change in the pre-service teachers' attitude and anxiety toward teaching science.

Participants mentioned within their groups, to the researcher, or within their written reflections that they viewed the activities and experiences as fun, interesting, and informational. One participant, as quoted above, mentioned her elementary school never taught science and she was disappointed in the fact that she missed the experiences she was never allowed to have.

Through video analysis, the researcher was able to determine that different Science Olympiad events were found attractive by different students. By allowing for a variety of Science Olympiad events, students were offered learning opportunities that met various personal interests. All of the students appeared to enjoy Mystery Powders. Using different tests to discover the identity of each white powder appealed to the majority of the class. One participant did not react favorably to the activity noted within her reflection, “Had we known what iodine was used for we probably could have gotten the other two right based on that one test” (personal communication, May 2011). Another participant became distracted by the consistency of the vinegar and cornstarch mixture. Her engagement and discussions were more focused on the mixture rather than assisting with the rest of the tests being conducted. This appeared to frustrate one of her group members and distract another.

33: What’s the stuff you use to make the gook? You know when you move it . . .

18: Cornstarch.

33: I think this is cornstarch. Because look.

18: Let me see. I don’t know because it’s still . . . If we could touch it we would know if it’s gook or not. Can I touch it? (personal communication, May 2011)

As the activity progressed, the one student continued to play with the new mixture that had formed and did not assist much with the testing process. Nonverbal cues indicating frustration such as, facial expressions, eye rolling, and sighing, from other group members were noted by the researcher upon reviewing the videos while assessing engagement and cooperation using the Cooperative Learning Rubric. The rubric measures four categories consisting of contribution to group goals, consideration of others, contribution of knowledge and working and sharing with others; the scores for each category range from 1 to 4. Three of the eight students recorded during Mystery Powders received scores of all fours. Of the remaining five students, two lost points for their lack of consideration of others. Two did not contribute to the group goal without prompting from group members. Student 24 contributed very little to the group in the way of completing the assigned tasks and contributing to group discussion.

As the Worm Turns was one that made several participants hesitant. When the live worms were first brought out, the researcher asked the participants, "Do you know what these are?" (personal communication, February 2011) One participant commented, Nasty. As they watched the worm move and fellow group members touch the worm, some of the participants who were nervous in the beginning began to feel more at ease and even touch the live worms, with or without gloves. Less than 5 students refused to have anything to do with the activity and just recorded data for the group. Students video recorded were assessed using the Cooperative Learning Rubric. Of the two groups video recorded for As the Worm Turns, six of the nine students received a score of all fours on the Cooperative Learning Rubric. The other three received scores of three due to lack of

knowledge contribution and work effort to the group goal and lack of encouragement towards group members.

All of the participants appeared to be accepting of Fill the Bill. The videos and reflections revealed the participants learned a lot from the lesson. Twelve students commented in their reflections how they learned a lot of things about birds they had not known before and things that seemed to be common sense but they had never been given the opportunity to consider them before. When assessed with the Cooperative Learning Rubric, only two students received scores of all fours. The other six students lost points because they needed to be prompted to participate or did not contribute to the group consistently and actively. One student did not demonstrate appropriate sensitivity to her group members and lost points for consideration of others.

During the Owl Pellets lesson, most of the participants were open to trying to dissect the owl pellet even though they viewed it as nasty or unsanitary. Most became excited as they found multiple types of bones from a variety of animals within one pellet. The majority of the comments made and statements within the reflections showed almost all students enjoyed the activity. Ones who did not enjoy the lesson as much did not want to touch the owl pellet and viewed it as disgusting. Others may have not been as interested when their owl pellet did not contain a large assortment of bones. Although the assembling of the food web during the elaborate phase was difficult, many of the reflections revealed the participants gained a lot of necessary information as they worked in groups to compile the web correctly. Of the seven students video recorded throughout the Owl Pellets lesson, none of them received the highest possible score on the Cooperative Learning Rubric for various reasons. Student 4 dominated her group so that

participation by the other members was inhibited. In another group, each student was working on dissecting the owl pellet but it did not appear that they were working together. For example, student 24 assisted in the dissection but had very little interaction with the rest of the group.

Write It/Do It allowed participants to interact with one another while learning the importance of specificity in scientific communication. When the time came for participants to build a model of connecting blocks based on a written description by their partner, frustration became more evident. Several participants revealed they did not understand the written descriptions they were given. There was only one incident of group members appearing to be rude due to the inaccuracies in the written description by describing one partner as not being smart. The other participants tried their best to complete the lesson and worked cooperatively in order to correct the first writing, making it easier to understand and follow the directions given. The majority of the participants appeared to enjoy the activity and lesson through nonverbal communication as noted by the researcher when assessing levels of engagement with the Cooperative Learning Rubric. Students in the Winter 2010 trimester class received scores of all fours except for Student 8 who received a score of two for her consideration of fellow classmates as she had done throughout the course. Students in the Spring 2011 trimester class received scores of all fours as well with the exception of Students 19, 21, and 24 who lost points for lack of consideration for classmates, contribution of group goals, and working and sharing with others. These students were not supportive of the learning process for one another. Student 21 was more concerned with the competitive nature of the activity rather than the learning process.

Ancillary Findings

The state anxiety towards teaching science decreased for all but 8 of the 34 participants. Attitude towards teaching science increased for all but 9 of the 34 participants (see Table 2). Four of the participants are included in both of these groups, meaning they did not experience a desired change in attitude as well as anxiety. Attitudes expressed by some of these individuals during the video recordings and in the reflections were negative toward the activities in which they participated. Some comments made by them were, “Let’s just call it a day” (personal communication, May 2011), “This activity [owl pellets] was rather unusual and just seemed nasty . . . I still don’t think I’d let kids do that in my classroom” (personal communication, May 2011), and “The concept seems unsanitary” (personal communication, May 2011). The participants not exhibiting the positive change did not fully participate in the activities but rather allowed their group members to engage more in the activities.

Table 2

Individual student scores for pre- and post-state anxiety with direction of change, pre and post attitude toward teaching science with direction of change, and Cooperative Learning score and category

Participant	Pre-State Anxiety	Post-State Anxiety	Direction of change	Pre Attitude	Post Attitude	Direction of change	Cooperative Learning Rubric	CLR category
1	37	28	+	3.14	3.82	+	16	high
2	70	40	+	2.73	3.82	+	15	high
3	44	30	+	3.50	3.77	+	14	high
4	53	40	+	4.09	4.41	+	15	high
5	50	48	+	3.59	3.45	-	16	high
6	47	38	+	4.14	4.41	+	14	high
7	29	25	+	4.14	4.59	+	15	high
8	44	36	+	4.05	4.91	+	14	high
9	47	51	-	3.18	3.50	+	15	high
10	40	37	+	3.50	3.45	-	14	high
11	48	38	+	3.68	4.23	+	16	high
12	46	36	+	3.64	4.14	+	15	high
13	37	32	+	4.59	4.45	-	16	high
14	51	49	+	3.36	3.45	+	16	high
15	45	37	+	3.41	3.73	+	16	high
16	42	48	-	3.73	3.55	-	15	high
17	67	40	+	4.18	4.18	NA	16	high
18	33	40	-	3.77	3.73	-	12	mid
19	34	41	-	3.64	3.50	-	8	mid
20	29	26	+	4.59	4.45	-	14	high
21	36	40	-	3.09	3.82	+	10	mid
22	73	68	+	3.64	4.05	+	16	high
23	74	33	+	4.00	4.68	+	15	high
24	57	30	+	2.55	3.68	+	7	low
25	40	37	+	3.50	4.27	+	16	high
26	54	25	+	3.45	3.59	+	16	high
27	33	29	+	4.45	4.50	+	16	high
28	31	33	-	3.77	3.68	-	9	mid
29	26	25	+	3.14	3.95	+	16	high
30	29	29	NA	3.59	4.18	+	15	high
31	20	23	-	4.23	4.77	+	15	high
32	41	36	+	3.05	3.55	+	15	high
33	53	20	+	3.86	4.27	+	13	high
34	60	56	+	3.29	3.91	+	13	high

Note. Pre- and post-state anxiety are variables for state anxiety and measured on a 4 point Likert scale and were summed and possible scores range from 20 - 80. Pre-attitude and post-attitude are variables for attitude and measured on a 5 point Likert-type scale. Scores in bold print indicate those not exhibiting the desired change.

There were two participants who attempted to complete the activity and participate fully, but due to actions of one or more group members, i.e. off topic discussions, negative attitudes, or disinterest in the lesson, they appeared to become a bit frustrated at times themselves. Student 30 increased her attitude score but the state anxiety score remained exactly the same. Student 17 decreased her state anxiety score but the attitude score remained exactly the same. Both of these participants were engaged in the activities, but appeared to be somewhat withdrawn as though slightly intimidated by working in a group. Each of these participants would speak freely and laugh with several different class members but when it came time to work in groups they did not speak up as much and would participate more when other group members encouraged them to participate more. Nonverbal cues observed by the researcher during video review indicated a nervousness or shyness about the individual.

CHAPTER V

DISCUSSION

Discussion of Major Findings

Anxiety Findings

Hypothesis 1: There will be a significant difference in pretest for state anxiety and posttest for state anxiety means on the variable of anxiety toward teaching science. The results of this study found a statistically significant decrease ($p < .001$) in anxiety toward teaching science, which supports this hypothesis. Results from other studies also have shown that science methods courses designed for pre-service elementary teachers, especially those designed around the constructivist learning theory, have provided empirical support in showing a decrease in anxiety toward teaching science (Barrow, 1986; Cox and Carpenter, 1989; Duschl, 1983; Mallow, 1986; Westerback, 1984). This study produced similar findings. This study supports previous studies that teaching science content through science methods creates a learning climate in which anxiety toward teaching science can be reduced (Westerback, 1982; Westerback, 1984; Yürük, 2011). Only 8 of the 34 participants did not exhibit a desired change in their state anxiety throughout the course.

Attitude Findings

Hypothesis 2: There will be a significant difference in pretest and posttest means on the variable of attitude toward teaching science. The results of this study found a statistically significant increase ($p < .001$) in attitudes toward teaching science which supports this hypothesis. Various studies on the attitude of teaching science indicate that purposefully designed methods courses are successful in improving the attitude of pre-

service elementary teachers toward science (Cavallo, Miller, and Saunders, 2002; Hanuscin & Lee, 2008; Jesky-Smith, 2002; Koballa, 1986; Koballa, 1989; Palmer, 2004; Tessier, 2010; West et al., 1993; Westerback, 1982). The results of this study support such findings. This study supports the findings of previous studies that providing a variety of teaching strategies and presenting activities and strategies directly related to elementary education can improve the attitudes toward teaching science of pre-service elementary teachers (Cavallo, Miller, and Saunders, 2002; Lucas and Dooley, 1982; Shrigley, 1977). Only 9 of the 34 participants did not exhibit a desired change in their attitude throughout the course. Introducing elementary science concepts through informal activities is a method in which anxiety of pre-service elementary teachers can decrease and attitude can improve. The activities they participated in and the method in which they were presented can be taken to the participants' future classrooms to engage their students in scientific investigations.

Qualitative Findings

Through viewing the recordings of participants engaged in the various Elementary Science Olympiad activities, it appears being able to learn more about science in a nonthreatening environment with the support of peers offers an opportunity unlike those of traditional science courses. Rather than being a part of a lecture based course, the participants of this study were immersed in a hands-on based format of learning within cooperative learning groups. Activities were viewed as fun and interesting by the majority of the participants. Five of the 34 participants submitted reflections on the lessons which were either negative towards the exploration activity or indifferent. Those that were indifferent to the activity answered the questions necessary but gave no

indication on whether they enjoyed the activity or not. One student was very verbal throughout the course of the various activities and course elements she did not like. In her reflections, however, she was very positive and stated she learned a lot from the lesson.

The participants who did not exhibit a desired change in attitude or anxiety may have had other situations affecting their perception of the science activities and course in general. Three of the participants appeared to react negatively toward the activities and sometimes toward their group members. Upon reviewing the reflections submitted, participants who did not exhibit a change in attitude or anxiety submitted reflections that were simply written and did not express much feeling about the lesson, positive or negative. The participants who did not exhibit a desired change in attitude or anxiety may have had other situations affecting their perception of the science activities and course in general. For example, five participants were pregnant and had to miss a class meeting or two for doctors' appointments. Another example was one participant from another country struggling with being away from her family.

Interestingly, student 24 exhibited positive changes in anxiety and attitude, but she scored low on the CLR. She would participate when given a specific task by group members, but she did not add to the group discussions. Her state anxiety and attitude scores surprisingly exhibited the desired change. Participant 1 was one of the students who scored highest on the CLR. Her behavior within class was very positive and upbeat. She was always willing to participate in various activities and tasks within class and was a valuable asset to her group.

Even though the attitudes towards teaching science of students 9 and 31 increased and their CLR scores were high, their anxiety levels also increased. The anxiety level of student 9 increased from 47 to 51 and the anxiety level of student 31 increased from 20 to 23. Alternatively, the state anxiety scores decreased for students 5, 10, 13, and 20 and they had high CLR scores, but their attitudes did not improve.

There were only four students, 16, 18, 19, and 28, who did not exhibit the desired changes for state anxiety nor attitude. Their anxiety levels increased and their attitudes towards teaching science decreased. However, one of these, participant 16, scored high on the CLR. She added to the discussions and participated in the activities. A possible explanation may be attributed to the observation that one of her group members appeared to be disruptive to the others in the group by making comments that were perceived to be rude. Participant 18, on the other hand, infrequently added to discussions and activities and appeared interested in the tasks at hand only sporadically. She was frequently distracted and attempted to distract others. Participant 19 would avoid the activities whenever possible. She contributed little to the group discussions and missed class frequently. Her behavior in class appeared negative towards the course in general, and she preferred to work with students who shared her negative feelings. Participant 28 was one of these students with whom she would interact. This student also exuded negativity toward the course but the activities presented as well. Comments made within group discussions were viewed as sarcastic by the researcher.

There were two participants who appeared to react negatively toward the activities and sometimes even toward their group members. One participant half-heartedly assisted her group members in the investigations. Her discussions were off

topic and she found things to occupy her that were not related to the lesson. Another participant avoided the class altogether. She missed five class meetings, was tardy to class five times, and even attempted to manipulate her seating arrangement at one point to avoid participation in the video recording. She, along with the rest of the class, was informed that their video participation was not required even though she had signed the consent form. Two students were negative toward the activities and assignments required in the class. One expressed her negative attitude in her writings as well as verbally on the videos. A few examples of some comments made by these participants are as follows: “Let’s do this and call it a day. Right there. Good. There. Our building. A big disaster, so. . . there, just leave it” (personal communication, May 2011). The participant making this comment was participating in the Marshmallow Towers activity. She was displaying a negative attitude from the beginning through frustrated sighs and groans, questioning the purpose of each aspect of the lesson, and giving up on building the structure at various times throughout the activity. The same student made the comment, “We were the smart ones, she was not” (personal communication, May 2011) during the Write It/Do It activity when her group member did not give a suitable written description of the object assigned to her. Only one block of the structure was out of place and it was only turned to face the opposite direction as it was in the original structure. Another comment from a different participant was, “Who has the job of going to find those [owl pellets] anyway” (personal communication, May 2011). She was obviously disgusted with the Owl Pellet activity and really had no intention of participating if she did not have to and will not use this activity in the future. During the Winter 2010 trimester one student began the course, consented to participate in the study, completed the pretest for state

anxiety and attitude, participated in one activity, and then withdrew from the course. Her participation in the activity was documented in the Winter 2010 *Mystery Powders* transcription; however, she was not included in any other data collection or reporting.

The group video recorded for the Fill the Bill activity during the winter trimester worked well together and appeared to have fun while completing the lesson. Through the following portion of transcript it is evident that the group members were working together and remaining positive about the task they had to complete.

8: Dang, look at those. Now you have to count those.

17: Oh Lord, now I'm glad I have the dropper.

9: She was the long beak?

1: She was the broad beak.

3: I was the broad beak

9: So who was the long?

1: Me

9: OK

1: Broad beak, more than half. Do you need the exact number?

3: Yeah, we're going to have to count how many I got and then go back and completely recount them.

17: Let's just all get a handful and count.

1: Do you need the exact number?

3: Yeah, we're going to have to count.

9: Why don't we just start counting and add our numbers together.

3: I don't think we have to know the start number do we?

9: We can just start counting.

1: (at researcher) Do we need to know the exact number, or do we need to say more than half, or . . .

R: You need to count them

3: Do we need to know how many we start with?

R: No, everybody got about the same.

9: We can just all count and then add our numbers together. Hers is the only one I think that will get that many.

1: Hand me some to count (personal communication, February 2011).

Within the same activity, the group members worked together to complete the task assigned. When they decided to help one another count worms during the data collection period, it appeared that another issue came to surface.

9: We can just all count and then add our numbers together. Hers is the only one I think that will get that many.

1: Hand me some to count.

17: How many did you have?

3: 40

17: 30 and 40, so that's 70?

9: Oh, I can't add in my head. I'm not a math person

3: 16

17: So, that's 86.

1: I have 34.

17: Oh, I can't do that in my head.

9: I'll do it. (writing) 86 plus 34, 120 (personal communication, February 2011).

The problem being solved in the previous situation involves the addition of double digit numbers. Two separate participants in the same group made the statement, "I can't do that in my head" (personal communication, February 2011). One of those stated that she is not a math person. The observation of these statements by the researcher was found to be interesting.

Following the interactive activity of testing different types of bird beaks, the participants were assigned different birds to research and identify the feeding habits of the assigned birds. By breaking each group of 4 or 5 into smaller groups of 2 or 3 in order to research their assigned birds, participants were able to work together on the small group research without the issue of leaving group members out of the research process. This allowed all students to be involved in every aspect of the lesson.

In the spring trimester lesson of Fill the Bill, the group observed discussed the activity in great detail. As a group they discussed the questions that were posed to the class. They talked about the data they collected and appeared to have fun while completing the task. Observations from this group included laughter, cooperation, and sharing of tasks.

22: I say tweezers. What do you say?

29: I say tweezers. I thought the tongs might because they are bigger.

22: So, tongs? Do y'all think tongs?

30: Is it all at one time? Do just keep using it to pick stuff up?

22: I guess. I think you would have more control with these {tweezers} but I think you said this {tongs} would get more. But the question is would you be

able to keep them {toothpicks}. You know what I mean? If you are able to pick up more {with the tongs} will you be able to keep them?

32: Which beak is that?

22: Broad beak. {holds up tongs} Long beak. {holds up tweezers}

29: So you want to say the broad beak?

22: So, broad beak.

R: Does everyone have a prediction? Not yet? Still deciding?

29: I wonder if she wants our name on it.

22: I want credit (personal communication, May 2011).

The discussion above occurred as the group made their predictions on which beak would perform the best at picking up worms. The group gave a rich discussion to determine a single group prediction. Student 22's comment about wanting credit indicates she may be a very grade conscious student. Upon review of this video recording it was a concern of the researcher that she may more concerned with her actual grade than she would with the lesson participation. According to the data collected through pre- and posttests, she experienced the desired change in attitude and anxiety. It was another group member, student 30, who did not add as much to the discussions as the others who did not experience any change in anxiety.

The research portion of the Fill the Bill lesson offers the opportunity to discuss adaptations to environments of birds in particular, but other organisms as well. This has been a concept that lends itself to misconceptions as observed by the researcher. Elementary students are developmentally ready to be introduced to the introductory concepts of evolution which include the effect of environmental stressors on an organism

or species and the adaptations that result, plant and animal development, diversity of organisms, and the structures necessary for survival in different types of environments. It is the experience of the researcher that many pre-service teachers and in-service teachers are uncomfortable with topics dealing with evolution. This could be due to multiple reasons; however, offering effective learning opportunities to discuss these topics in a nonthreatening environment can lead to a better understanding of the concept as a whole.

The group observed during the Owl Pellet lesson in the winter trimester worked well together and appeared to enjoy the lesson. While expressing an uncertainty about working with an owl pellet, the group remained positive and at times were very excited about what they found within the pellet.

4: Oh my, gosh look at the beak!

3: Oh my gosh! Oh my gosh!

9: Look how small it is!

3: Oh my gosh!

4: Yes, it is! We have a beak!

9: Oh, look! Oowee!

R: You got what?

4: A beak!! Look! That is so cool! Look how cool!

3: Yeah, I'm little squeamish over here (personal communication, February 2011).

Comparisons were made throughout the lesson to real life experience, television shows, and even other courses. These comparisons support the theory of constructivism in that

learners come into a situation with some prior knowledge on which to build future knowledge.

3: What's a mouse eat?

9: Anything

4: Yeah, a mouse will eat a dead rabbit, a mouse will eat a dead snake. It really will! Do y'all ever watch Animal Planet?

3: These are not dead though.

4: I know, but . . .

And

4: When you live in a field and you have a big shop you go down there and see those big long rats. They're nasty but we have 40 acres of land so they're on the back 40. Yeah, the shed. Be CSI: its initial cause of death, a gunshot wound!

3: Initial cause of death is going to be . . .

4: It got ate!

3: Food chain.

4: Optimal foraging theory. I'm bird watching right now, too. This one was dumb and went to the middle of the yard (personal communication, February 2011).

In the spring trimester of Owl Pellets, there was a mixture of attitudes within the group observed. One student, student 24, rarely participated in the discussions while another worked diligently on picking apart the pellet. Student 33 worked without fail and appeared to be engaged in what she was doing.

18: I don't know if there is any more bones in here.

31: It's really gross, I'm afraid I'm getting sick.

18: I think those are like ribs.

33: It's kind of like working with chopsticks.

24: Hmm.

33: I'm never going to be able to use chopsticks again. I really think we have a bird skull. I'm not kidding. Look, we do! We have a cool pellet.

18: Where?

33: Look, there's the beak and there's the eye.

31: Wow.

18: This right here is really hard to pick up and look at (personal communication, May 2011).

A third member of the group, student 31, said it was gross and thought she was going to be sick and then decided that what was being found in the owl pellet was of interest to her. Throughout the lesson she appeared to be frustrated with the situation of the group dynamics. This was observed through looks of frustration, a tense posture not usually seen in this person, and rolling her eyes while the others were not looking at her. When she tried to discuss things with her group members they would not participate in the on-task discussion she attempted to engage in with them. Her anxiety score did not achieve the desired change. The fourth group member seemed to be watching what others were doing in the group rather than fully participating herself. As the owl pellet dissection ended and the portion of the lesson in which the group had to construct a food web began, the group dynamic shifted only slightly. Students 33 and 31 began to work together more and the other two group members would assist sporadically but more so than during the dissection activity.

31: Does that look right now? Going up?

33: I think so.

31: Okay.

33: Much better than I did, sorry.

31: So

33: The bunny eats the plant. And the frog eats the-----

31: What, the frog?

33: No, frogs eat bugs.

31: Mice? They eat plants right?

33: My arrows were going not where they needed to, brain fart.

31: One more thing.

R: There's two pictures of plants. So something you say...

Group: Oh right

33: What every has two, like the bunny is the only herbivore.

31: So these are berries?

R: Yes.

31: The go with mice. Mice eat berries.

R: You can leave that one because they also eat seeds. So that would take care of those two lines.

31: Okay. So, that's right?

R: yeah

31: Wow. I can't believe I did that right when I didn't know what I was doing.

Okay, so we got the plants. The cricket (personal communication, May 2011).

All participants in the winter trimester had the opportunity for observation during the Write It/Do It lesson. Because the lesson required partners to depend on one another for accurate descriptions of the given objects, feelings were mixed throughout the activity. The following transcript depicts one student in the midst of frustration with her partner's written description and another's excitement that she was able to understand the description well enough to rebuild the object.

4: Hold the cross like it's a cross. And hold the green knob with 4 knobs facing you, attach the blue knob on the left, and she says it's supposed to look like an H. But that can't be . . . She's torturing me! This is not an H either.

8: Oh, [she] is good! She did good. We love her! And it's so neat.

9: She did good. Ok, she just reassured us.

4: Ok, I give up! I can't figure this out!

R: Is everyone else done?

Class member: She said just to be complicated, R, attach the five knob pink block to the orange block with four knobs.

9: R, did you do that?

11: This is fun! This has been the funnest class.

4: I give up before I get frustrated! How is this going to make an H (personal communication, February 2011)?

Whether students were or were not frustrated with the object description by their partner, all seemed pleased once they had the opportunity to collaborate with their partner to find more accurate descriptions of the given objects.

The group observed during the spring trimester lesson of *As the Worm Turns* offered an example of a student trying to participate more in the lesson and overcome her own discomfort. The live worms were unsettling to several participants. The researcher's participation in handling the worms and the opportunity to wear gloves when touching them, helped put some at ease but there were still some who refused to touch the worms.

26: Let me try. I'm going to have to close my eyes.

25: It feels sticky, don't it?

26: Oh, she's touching a worm.

27: Does it feel like a muscle?

23: Yeah.

26: Okay, I'm going to touch it. I can't. I can't handle it. I'm going to cry, I can't do it.

25: It's okay. Breathe, you don't have to.

26: Ooh! Okay, I touched it.

R: Good job.

25: It's sticky like, it's not...I thought it was going to be slimy.

26: I have a phobia of creepy crawly things.

R: Well, don't you feel like you've accomplished something? Now you can say you've touched a worm.

26: Yeah, with a glove (personal communication, May 2011).

As student 26 got the courage to touch a worm for the first time, her group members were very supportive of her efforts. She was obviously very hesitant about touching the worm

but watching her group members, along with the positive and encouraging comments offered to her, she was able to accomplish something she had never done before. She did not touch the worm again, but it was an accomplishment to overcome her fear to participate more in the lesson. It is the opinion of the researcher that this would not have been accomplished without the use of the cooperative learning groups.

In the spring trimester of Mystery Powders, began working well together. When one of the mixtures caught the interest of one of the group members she began to play with it throughout the rest of the activity period, adding to discussions periodically.

31: It's thick. It's thick and hard to get off the bottom now. Sticky. Y'all try and stir that.

33: So, is it changing into a solid?

31: You feel that? It's like hardening.

18: Let me see it. Oh, wow. You know what?

31: What?

33: Is that the plaster?

18: No, but this does what the gook does. Watch it. You move it and then it goes back.

33: It turns to a liquid. Then I bet B is the cornstarch.

18: Why did it do it with the vinegar and not the water? That's what you make it with.

33: With water? I don't think B would be powdered sugar if A doesn't do that.

18: It totally does it. Where's the vinegar? Yeah, because you move it and it moves but then it goes . . .

33: Liquidy?

18: Do it. You'll see it's thick and then it turns liquid.

33: Ah.

18: Have you seen the gook that we're talking about?

31: No.

18: It's made of cornstarch and water. When it's just sitting there it looks like a . . .

33: Solid.

18: A solid. Then you move it around and it looks like a liquid. If you hit it with force, it's solid but you can pick it up. It's like a solid and a liquid. It's weird and it looks just like that.

33: So I wonder if you make it with cornstarch if it's just another type of cornstarch.

18: It could be. That's what my science fair project is on.

31: Or maybe it could be made with another kind of powder with the vinegar.

18: Maybe. I've never felt cornstarch so I don't know (personal communication, May 2011).

The conversation about the cornstarch and vinegar mixture interjected periodically throughout the activity. It was then that student 31 began to get frustrated through tense posture, eye rolling, and sighs of frustration. Student 18 would allow others to look and touch the interesting mixture but would not put it down and continued to play with the concoction.

The Marshmallow Towers lesson elicited mixed emotions. The group during the winter trimester appeared to enjoy the lesson and seemed to have fun while completing the task at times. However, there was some sarcasm among group members noted but everyone seemed to work well together. Comments were made in a sarcastic manner and nonverbal cues, such as sighs and groans of frustration, rolling of eyes, shaking of heads in discouragement, and an obvious reduction in effort to complete a lesson to the best of one's ability, from the group members were noted by the researcher upon review of the videos while assessing engagement.

16: We had it neatly going at one time but not anymore.

8: That was so brilliant! It was too brilliant!

17: Well, you have to try stuff.

2: I could have told you that wasn't going to work.

17: You never know until you try.

8: Y'all aren't saying anything to do.

2: We are telling how to do this (personal communication, February 2011).

The discussion among these group members show that student 8 was beginning to become excited that the tower may come together. Student 17 expresses a positive outlook while student 2 gives discouraging comments.

8: After I work on a project for so long I just get messy and throw it together.

16: OK, note to self: don't work with [her] on a group project. What is going in there (personal communication, February 2011)?

These comments indicate to the researcher that student 8 was tiring of the activity and did not want to see it through to completion. Student 16's comment which followed seemed

somewhat rude and slightly sarcastic. As the group continues to work, the tower they are constructing begins to take a more favorable shape.

2: It's standing!

17: We just need to stabilize it over here because this is falling.

2: What is this one supposed to connect to?

17: We'll just fix this.

R: Just take a couple more minutes and try to finish up. It looks like almost everybody is close to a stopping place.

16: Except us! We'll go really tall with this one.

8: That'll be that tall.

17: Oh yeah we can connect off of that.

16: Go, go, go, go!

17: Come on, girls! We can do this! (personal communication, February 2011)

The group members became more positive and supportive of one another as their product became something suitable to them. While a different attitude is now expressed, possibly hurtful and discouraging words have already been said. Within the cooperative groups, participants must learn how to work toward a common goal and develop conflict resolution skills. From this group, three of the four participants lost points on the Cooperative Learning Rubric for not showing consideration to others in their group. Only one group member received a score of all fours.

The group during the spring trimester did not work as well together. Two members of the group complained throughout the lesson about the task at hand. One member attempted to assist group members in completing the assigned task but appeared

to get a little frustrated at the fact no one was working together. Her nonverbal cues were noted by the researcher upon review of the videos while assessing engagement of group members. The fourth group member took over and completed the majority of the tower building by herself, not wanting assistance from the two members behaving in a negative manner.

28: It's going to be sturdy, if she doesn't break it trying to get more in.

21: Don't put any more in, I'm freaking out.

34: Go take a toilet break (personal communication, May 2011).

And

21: This did not work.

34: We're not on the same page (personal communication, May 2011).

The three students noted above lost points on the Cooperative Learning Rubric for not showing consideration to their group members. The only group member showing any consideration for the group did not receive the full amount of points for contributing to the group goals and knowledge because she was intimidated by the strong negative personalities within her group. Throughout the course and getting to know the students, it came to surface that the three group members expressing these negative feelings toward the activity and each other also had intense personal struggles outside the classroom that may have caused increased anxiety and shortened temperaments. It is also evident through this that attitudes of some students can affect the performance levels of their classmates or group members.

By using a variety of Science Olympiad events within the study, participants with varying interests would assumedly find at least one activity they preferred over the

others. While participants interacted during the Marshmallow Towers activity, it was evident to the researcher the amount of frustration coming from the groups. Sighs and grunts of frustration were common as miniature marshmallows and toothpicks were assembled into weak structures. As the structures bent, swayed and leaned the participants became more and more frustrated with the activity and this could have been the reason for short remarks towards group members during the activity period as noted previously. Also noted, as the participants became frustrated with the activity, the researcher also began feeling frustrated. This is not an activity that will be used often in future courses. While the study focused on the attitude and anxiety of the participants, the researcher noted a change in personal attitude toward this particular activity due to the feelings expressed by the participants. While the sample size was rather small, the findings indicate that the combination of Science Olympiad events, cooperative learning, and the 5E Instructional Model is a useful teaching strategy for an elementary science methods course when addressing attitude and anxiety in pre-service elementary teachers.

Limitations

Participants in this study were limited to students enrolled in Science in the Elementary School (EDU 346) taught by the researcher at a private university in southern Mississippi. The study was limited to the Winter 2010 and the Spring 2011 trimesters. Participants were not randomly selected, but were enrolled in the course because it is a requirement for graduation in the Elementary Education program for this particular university. There were only 34 participants in the study. The small class sizes could have been a limiting factor in producing a small sample size. The participants were only exposed to six Elementary Science Olympiad events of the numerous ones available. The

events chosen by the researcher were designed for a range of age groups as well as a variety of content and skill areas. Because the university where the study took place is on a trimester system, the amount of time allowed for students to become exposed to the Science Olympiad events was restricted within a 10 week term.

Implications of Study

Based on the findings of this study, the following implications can be made:

1. The use of Elementary Science Olympiad events to teach elementary science methods is a very useful tool. Using inquiry-based activities within the 5E Instructional Model this demonstrated to students not only what an inquiry activity looks like but how to incorporate an inquiry activity into a 5E lesson. The variety of activities offered through Science Olympiad allows for more opportunities to engage students in their varying interests. In the video recordings of students and the written reflections submitted to the researcher, the students participating in the study indicated they learned a good deal in regards to the concept being taught through the activities. Future courses in this instructional sequence will continue to use the Elementary Science Olympiad activities as a means of modeling how to teach science to students and providing the resources to do so.
2. The results indicating Elementary Science Olympiad events assist pre-service elementary teachers in lowering anxiety and increasing attitudes toward teaching science suggest the use of these activities is an effective strategy to use in science methods courses. Observations by the researcher indicated some activities used in the study were better than others at improving anxiety and attitude than others. During the Marshmallow Towers activity, participants appeared more frustrated than during the other activities.

The other five activities appeared to be equal in terms of difficulty and effectiveness for the participants.

3. In future science methods classes, it is recommended by the researcher that students be informed about the components involved in organizing a Fun Day or Fun Night Science Olympiad. The positive implications associated with teachers organizing a Fun Day/Fun Night in elementary schools are wide ranged. Presenting inquiry-based science activities to children in an informal setting allows the children to feel less threatened in the relaxed environment. They are then given the opportunity to view the subject matter as something fun and interesting. Implementing these activities within a school-wide setting opens the opportunity to involve families and various school stakeholders. A requirement of school accreditation addresses the involvement of stakeholders within the community.

4. The use of activities within cooperative learning groups can assist in building confidence in science content material and the ability to teach that content. Cooperative learning groups can lead to increased science knowledge and cognitive abilities (Gillies, 2007; Johnson & Johnson, 1995; Kagan, 1994). Future courses can be taught how to utilize cooperative groups in the elementary science classroom through demonstrations, explanations, and modeling the use of cooperative learning groups while participating in group learning projects such as Science Olympiad activities.

Recommendations for Further Research

As the global economy moves in a more scientific and technology-based direction, it is important that teachers prepare students for a life where they can be productive citizens. In order to achieve this, further research in the area of anxiety and

attitude toward teaching science in elementary teachers is necessary. The current study was a single group design. One recommendation for further research is that in developing an experimental design one might want to determine if the group participating in the Elementary Science Olympiad events differs significantly from a group that does not receive the treatment. A second recommendation is to use a follow up session with the participants during their student teaching experience and in-service experiences. This could be used in order to observe how those teachers are teaching and/or integrating science into the elementary curriculum. Another recommendation is one could perform a longitudinal study to gather data on how the participants involve their students in Elementary Science Olympiad events. This would assist in determining the length of the effect on attitude and anxiety for teachers toward teaching science. Replication of the study using a larger population may allow for further validation of the results. Another recommendation is to compare past science content course academic achievement and any other predictor variables to teacher attitude and anxiety toward teaching science.

APPENDIX A

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Participant's Name _____

Consent is hereby given to participate in the research project entitled The Effect of Science Olympiad Events on Anxiety and Attitude Toward Teaching Science in Preservice Elementary Teachers. All procedures and/or investigations to be followed and their purpose, including any experimental procedures, were explained by Allison Downing. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected.

The opportunity to ask questions regarding the research and procedures was given. Participation in the project is completely voluntary, and participants may withdraw at any time without penalty, prejudice, or loss of benefits. All personal information and video recordings are strictly confidential, and no names will be disclosed. Any new information that develops during the project will be provided if that information may affect the willingness to continue participation in the project.

Questions concerning the research, at any time during or after the project, should be directed to Allison Downing at (601) 297-3407. This project and this consent form have been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

A copy of this form will be given to the participant.

Check the appropriate box(es), sign and return to the researcher.

- I agree to participate in this study by completing the pretest and posttest.
- I agree to being videotaped as a part of this study.

Signature of participant

Date

Signature of person explaining the study

Date

APPENDIX B

COURSE DESCRIPTION AND SYLLABUS FOR EDU 346

EDU 346. Science in the Elementary School: An integrated approach to teaching science through discovery and hands-on experiences. A field experience in an elementary school is a component of this course.

WEEK	CLASS ACTIVITIES
#1	Introductions Syllabus – Discuss all assignments Orientation to Room 109 Review Text and Science Frameworks Discuss Chapter 1- Children, Science, and Inquiry: Some Preliminary Questions Discuss Chapter 2- Processes and Strategies for Inquiring Science Olympiad: As The Worm Turns
#2	What Does an Inquiry Lesson/Activity Look Like? lesson Chapter 3- Learning Science with Understanding Science Fair topic due Science Olympiad: Mystery Powders
#3	Chapter 4- Teaching Science for Understanding: The 5E Model of Instruction Science Fair forms and research plan due Science Olympiad: Food Web (Owl Pellets)
#4	Chapter 5 – Planning and Managing Inquiry Instruction Discrepant Events Writing objectives
#5	Classroom lesson plan presentations Science Fair research paper due
#6	Classroom lesson plan presentations Discuss Chapter 6- Assessing Science Learning
#7	Discuss Chapter 7- Effective Questioning Science Olympiad: Fill the Bill
#8	Discuss Chapter 8- Technology Tools and Resources for Inquiry Science Science Olympiad: Marshmallow Towers
#9	Chapter 9- Connecting Science with Other Subjects Chapter 10- Science for All Learners Science Fair results and conclusions due Science Olympiad: Write It/Do It
#10	SCIENCE FAIR Judging and Ribbons for 1 st – 3 rd place

APPENDIX C

PERMISSION FOR USE OF STAI

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To whom it may concern,

This letter is to grant permission for the above named person to use the following copyright material;

Instrument: *State-Trait Anxiety Inventory for Adults*

Authors: *Charles D. Spielberger, in collaboration with R.L. Gorsuch, G.A. Jacobs, R. Lushene, and P.R. Vagg*

Copyright: *1968, 1977 by Charles D. Spielberger*

for his/her thesis research.

Five sample items from this instrument may be reproduced for inclusion in a proposal, thesis, or dissertation.

The entire instrument may not be included or reproduced at any time in any other published material.

Sincerely,

A handwritten signature in black ink, appearing to read "Robert Most", written over a horizontal line.

Robert Most
Mind Garden, Inc.
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APPENDIX D

STATE-TRAIT ANXIETY INSTRUMENT

Participant's Name: _____

INSTRUCTIONS – STAI FORM Y-2

Follow the directions at the top of the page and answer questions 21-40. Notice that these questions refer to HOW YOU GENERALLY FEEL on a day to day basis.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983).

SELF-EVALUATION QUESTIONNAIRE
STAI Form Y-2

Name _____ Date _____

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you generally feel.

ALMOST NEVER
SOMETIMES
OFTEN
ALMOST ALWAYS

- 21. I feel pleasant 1 2 3 4
- 22. I feel nervous and restless 1 2 3 4

- 40. I get in a state of tension or turmoil as I think over my recent concerns and interests 1 2 3 4

INSTRUCTIONS – STAI FORM Y-1

You are a classroom teacher in an elementary school. Among other duties, you are responsible for teaching science to your students. When answering the following questions, IMAGINE how you will teach science to your students with the knowledge and skills you possess right now.

Now turn the page and read the directions to yourself for the questionnaire:

HOW DO YOU FEEL ABOUT TEACHING SCIENCE?

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

Name _____ Date _____ S _____

Age _____ Gender (Circle) M F T _____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

VERY MUCH SO
MODERATELY SO
SOMEWHAT
NOT AT ALL

1. I feel calm..... 1 2 3 4

2. I feel secure 1 2 3 4

20. I feel pleasant 1 2 3 4

APPENDIX E

PERMISSION TO USE THE SCIENCE ATTITUDE SCALE

FW: request
Piper, Eric - Boston [epiper@wiley.com]
Sent: Monday, June 07, 2010 1:55 PM
To: Downing, Allison

Dear Allison (if I may),

I am an editorial assistant at Wiley-Blackwell. Gerald Kulm forwarded your email to me, as we handle rights requests for the journal. On behalf of the SSMA, we are happy to grant you permission to use the Science Attitude Scale for research purposes. If, in the future, you are also interested in obtaining permission to republish the table in a journal article or book chapter, please let me know and I will be happy to forward your request to the permission dept.

Thank you for your interest in School Science and Mathematics. Please don't hesitate to contact me if I can be of any further assistance.

Sincerely,
Eric

Eric Piper
Assistant Editor, SSH Journals
Wiley-Blackwell
350 Main Street
Malden, MA 02148
Phone: (781) 388-8471
Fax: (781) 338-8471
epiper@wiley.com

APPENDIX F

SCIENCE ATTITUDE SCALE

YOUR THOUGHTS ABOUT TEACHING SCIENCE

This is a questionnaire which helps us determine what different people believe about some matters related to teaching science. The questionnaire is composed of 22 statements with which you may agree or disagree. There are no “right” or “wrong” responses to these items.

Please indicate your response to each item on the response sheet provided. Circle one of the five choices on the response sheet next to the number for each item to indicate your agreement or disagreement.

Here is an example:

College students have too much free time. SA A N D SD

Circling **SA** means you “Strongly Agree” with the statement.

Circling **A** means you “Agree” with the statement.

Circling **N** means you have no strong opinion, or a neutral feeling.

Circling **D** means you “Disagree” with the statement.

Circling **SD** means you “Strongly Disagree” with the statement.

Thank you for responding honestly to this survey.

Thompson, C. L., & Shrigley, R. L. (1986).

Permission granted by *School Science and Mathematics*

1. I will feel uncomfortable teaching science.	SA	A	N	D	SD
2. The teaching of science processes is important in the elementary classroom.	SA	A	N	D	SD
3. I fear that I will be unable to teach science adequately.	SA	A	N	D	SD
4. Teaching science takes too much time.	SA	A	N	D	SD
5. I will enjoy the lab period in the science courses that I teach.	SA	A	N	D	SD
6. I have a difficult time understanding science.	SA	A	N	D	SD
7. I feel comfortable with the science content in the elementary school curriculum.	SA	A	N	D	SD
8. I would be interested in working in an experimental science curriculum.	SA	A	N	D	SD
9. I dread teaching science.	SA	A	N	D	SD
10. I am not afraid to demonstrate science phenomena in the classroom.	SA	A	N	D	SD
11. I am not looking forward to teaching science in my elementary classroom.	SA	A	N	D	SD

12. I will enjoy helping students construct science equipment.	SA	A	N	D	SD
13. I am willing to spend time setting up equipment for a lab.	SA	A	N	D	SD
14. I am afraid that students will ask me questions that I cannot answer.	SA	A	N	D	SD
15. Science is as important as the 3 R's.	SA	A	N	D	SD
16. I enjoy manipulating science equipment.	SA	A	N	D	SD
17. In the classroom, I fear science experiments won't turn out as expected.	SA	A	N	D	SD
18. Science would be one of my preferred subjects to teach if given a choice.	SA	A	N	D	SD
19. I hope to be able to excite my students about science.	SA	A	N	D	SD
20. Teaching science takes too much effort.	SA	A	N	D	SD
21. Children are not curious about scientific matters.	SA	A	N	D	SD
22. I plan to integrate science into other subject areas.	SA	A	N	D	SD

APPENDIX G

COOPERATIVE LEARNING RUBRIC

	1	2	3	4
Contribution to group goals	Works toward group goals only when prompted	Works toward group goals with occasional prompting	Works toward group goals without occasional prompting; accepts and fulfills individual role within group	Consistently and actively works toward group goals; willingly accepts and fulfills individual role within group
Consideration of others	Needs occasional reminders to be sensitive to the feelings of others	Shows sensitivity to the feelings of others	Shows and expresses sensitivity to the feelings of others; encourages the participation of others	Shows sensitivity to the feelings and learning needs of others; values the knowledge, opinion, and skills of all group members and encourages their contribution
Contribution of knowledge	Contributes information to the group only when prompted	Contributes information to the group with occasional prompting or reminding	Contributes knowledge, opinions, and skills without prompting or reminding	Consistently and actively contributes knowledge, opinions, and skills without prompting or reminding
Working and sharing with others	Participates in needed changes when prompted and encouraged; always or often relies on others to do the work	Participates in needed changes with occasional prompting; often needs reminding to do the assigned work	Willingly participates in needed changes; usually does the assigned work and rarely needs reminding	Helps the group identify necessary changes and encourages group action for change; always does the assigned work without having to be reminded

Signatures and comments:

APPENDIX H

IRB APPROVAL NOTIFICATION



THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
 Hattiesburg, MS 39406-0001
 Tel: 601.266.6820
 Fax: 601.266.5509
 www.usm.edu/irb

**HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
 NOTICE OF COMMITTEE ACTION**

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **10102131**

PROJECT TITLE: **The Effect of Science Olympiad Events on Anxiety and Attitude Toward Teaching Science in Pre-Service Elementary Teachers**

PROPOSED PROJECT DATES: **11/08/2010 to 06/18/2011**

PROJECT TYPE: **Dissertation**

PRINCIPAL INVESTIGATORS: **Allison Armstrong Downing**

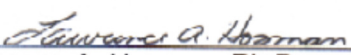
COLLEGE/DIVISION: **College of Science & Technology**

DEPARTMENT: **Center for Science & Math Education**

FUNDING AGENCY: **N/A**

HSPRC COMMITTEE ACTION: **Expedited Review Approval**

PERIOD OF APPROVAL: **10/26/2010 to 10/25/2011**



 Lawrence A. Hosman, Ph.D.
 HSPRC Chair

10-27-2010

 Date



October 7, 2010

Dr. Breland,

I am requesting permission from William Carey University to conduct research with my students on campus. This is a mixed methods research study which will hopefully improve attitude and lower anxiety toward teaching science throughout the Winter 2010 and Spring 2011 trimesters. As the activities involved with the research coincide with the topics to be studied as described in the EDU 346 syllabus, there will be no disruption of the normal class scenario.

Thank you,

Allison A. Downing

Allison A. Downing
Assistant Professor
School of Education

Approved: _____

Garry M. Breland

Dr. Garry Breland, Vice President of Academic Affairs

10/11/10

Date

APPENDIX I

5E SCIENCE OLYMPIAD LESSONS

Title: Marshmallow Towers

Intended Grades: K-1

NSES Content Standards:

- A: As a result of activities in grades K-4, all students should develop abilities necessary to do scientific inquiry.
- B: As a result of the activities in grades K-4, all students should develop an understanding of position and motion of objects.

Engage:

Has anyone ever been around a home or building construction site? On a sheet of paper draw a picture of a house or building you would like to build. What kinds of materials would you use to build it? After a few students are given the opportunity to share their own pictures, the teacher will show pictures of towers. What kinds of people are involved in building towers like these in the pictures? What kinds of materials do you think they use?

Explore:

The students will be given a space to work in, 1 bag of miniature marshmallows, and 1 box of toothpicks. They will be instructed that using only the materials provided, each team is to build a tower as high as you can.

Explain:

The class will discuss what they did to construct their tower. Did they have a plan? Did they start with a base? Did they find they had to make adjustments through the process? What could you do to make the tower taller? What would happen if you changed the width of the base? What are different types of materials that could be used to build a tower? Discuss the position of the highest tower. Discuss the force of gravity and how it acted upon their structures. Discuss the need for stability in buildings.

Elaborate:

Once questions have been addressed and students have a grasp of the concept, they will be asked to make any adjustments they feel are necessary to their towers to make sure it is sturdy. The class will test the sturdiness of each tower by placing a plastic lid on the tower and putting pennies on the lid. The tallest tower holding the most pennies WINS! The class will compare and contrast the marshmallow towers with the ones in the pictures.

Evaluate:

Students will write a reflection of the class activity addressing the following questions:

Did you begin building your tower with a plan? Can you describe what is wrong and right with the towers when they were finished? Were you able to make appropriate adjustments to the existing structure? How did you compare and contrast your tower with real towers? Discuss the types of towers you viewed in relation to position, force of gravity, and stability?

Title: As the Worm Turns

Intended Grades: K-1

NSES Content Standards:

- A: As a result of activities in grades K-4, all students should develop abilities necessary to do scientific inquiry.
- C: As a result of the activities in grades K-4, all students should develop an understanding of the characteristics of organisms and organisms and environments.

Engage:

Holding up a living worm, the teacher asks if anyone knows what the animal is and what it does. Today, the class will become “wormologists.”

Explore:

The students will use the data sheets provided to record their observations. The teacher will give oral instructions on how to make the observations, when needed. First the students will make general observations of the worms such as, its length and how it moves. The second data sheet allows the students to test whether the worm likes a dry or damp environment. Worms will be placed in a pan on paper towels. Paper towels on one half of the pan will be moistened with water while the paper towels on the other half remain dry. The worm will be placed in the middle and observed as to which side it moves. This is repeated 8 times. On the third data sheet the students will test if the worm prefers light or dark habitats. The worm is placed in the pan on moistened paper towels. Half the pan is covered by black construction paper and the other half is left open. The worm is placed in the middle and observed as to which side it moves. This is repeated 8 times. The final data sheet allows students to test whether the worm is ticklish and where. Students will use a cotton swab to gently rub the earthworm at its head, middle, and tail end. Observations will be made as to the amount of movement by the worm when touched in the different places on its body.

Explain:

The class will discuss their findings and the earthworm anatomy. The teacher will explain how the earthworms help our gardens. The class will discuss the types of investigations used in this activity: descriptive and experimental. A website called The Adventures of Herman the Worm (<http://urbanext.illinois.edu/worms>) to find more information about worms.

Elaborate:

The class will work in their groups to develop another investigation using worms. In their procedures they will identify a problem question, hypothesis, the variable being tested, and the basic experimental design for the investigation.

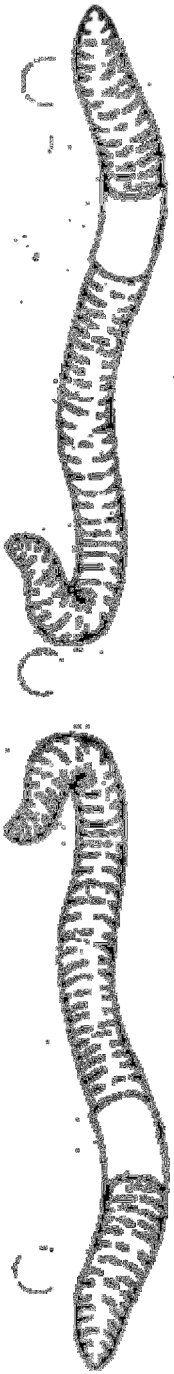
Evaluate:

Students will write a reflection addressing the following questions: Are you able to identify the parts of the worm? What do earthworms do in the environment? What was involved in the data collection?



As the Worm Turns

Name _____



Part I: Earthworm Observations



Draw a picture of your earthworm here.

Blank space for drawing a picture of the earthworm.

Which of these does your earthworm seem to have?

- Logs
- Eyes
- Nose
- Ears
- Mouth
- Teeth

Blank space for marking which features the earthworm has.

Measure your earthworm. How long is it?

Blank space for recording the length of the earthworm.

How does your earthworm move?

Does your worm ever move backwards?

Does your worm move fast or slow?

Blank space for describing the earthworm's movement.

What does your earthworm do when you hold it in your hand?

How does its skin feel?

Blank space for describing the earthworm's behavior and skin texture.

Is there a difference between the front end of the worm and the tail?

Look underneath your earthworm. Does it look different than the top?

Blank space for describing the difference between the front and tail, and the top and bottom of the worm.

Part 2

Do Earthworms Like a Wet or Dry Environment?

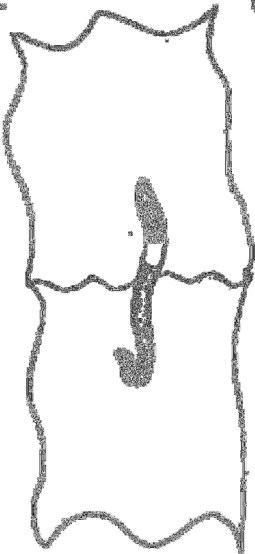
Materials

- * Flat pan
- * Paper towels
- * Water
- * Earthworms

Procedure

1. Wet a paper towel. Wring it out so it is still damp. Spread it on one half of the flat pan.
2. Next to it, spread a dry paper towel with the edges of the two towels overlapping.
3. Put a worm in the center of the pan. Where will it go?

Diagram



Data:

Worm	1	2	3	4	5	6	7	8
Lies wet								
Lies dry								

Predict Do you think the worms will like the wet or dry area better?

Additional Observations

Conclusion: What did you find out?



U

PAU3

Do Earthworms Like a Light or Dark Environment?

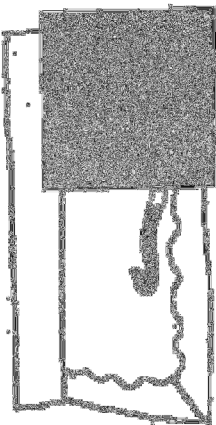
Materials

- * Flat pan
- * Paper towels
- * Dark paper
- * Water
- * Earthworms

Procedures

1. Line the bottom of the pan with damp paper towels.
2. Cover one half of the pan with dark paper. Leave the other half open.
3. Put a worm right in the middle of the pan. Where does it go?

Diagram



Data:

Worm	1	2	3	4	5	6	7	8
Likes light								
Likes dark								

Predict: Do you think the worms will like the light or dark area better?

Additional Observations

Conclusion: What did you find out?

Part 4 Are Earthworms Ticklish?

Materials

- Earthworms
- Paper towels
- Water
- Q-tips

Procedure

1. Put the worm on the moist paper towel.
2. Touch the worm VERY GENTLY on its tail, middle, and head.
3. If you don't want to touch the worm with your fingers, use the Q-tip.

Diagram



Data:

Response	Tail	Middle	Head
No movement			
Slight movement			
Great movement			

Predict Will the earthworms be ticklish?

Additional Observations

Conclusions What did you find out?

U

U

U

Title: Fill the Bill

Intended Grades: 2-3

NSES Content Standards:

- A: As a result of activities in grades K-4, all students should develop abilities necessary to do scientific inquiry.
- C: As a result of the activities in grades K-4, all students should develop an understanding of the characteristics of organisms and organisms and environments.

Engage:

Show the class pictures of different bird heads including toy birds. Allow students to give reasons why each bird is different.

Explore:

Each student is going to pretend to be a very hungry bird. Each member of the group will be a different species of bird:

- Long beak – tweezers
- Broad beak – kitchen tongs
- Short beak – clothespin
- Spoon bill – plastic spoon
- Hollow beak – medicine dropper
- Filter beak – aquarium fishnet

Each group will predict which “beak” will pick up the most worms. Taking turns, each student will have 30 seconds to collect as many toothpicks (worms) from a carpet square as possible using only their “beaks.” At the end of the 30 seconds, the toothpicks will be counted, recorded, and returned the “environment.” The process will be repeated until all “beaks” have been used.

Explain:

The teacher and class will discuss the following questions: What bird was the best at catching worms? What features gave that bird the best advantage? Where there any birds that did not catch any worms? What does this mean? Many birds have developed very specialized beaks, or beaks that can only eat one certain type of food. How can specialized beaks help some birds to survive? How might a specialized beak hurt a bird’s chance of survival?

Elaborate:

Students will graph the number of worms caught by each bird on the grid on the back side of their data sheet. Working in pairs using the resource books and computers, students will research an assigned bird. Describe its habitat, beak, food, and feeding habits. Does your bird have a specialized beak? If so, what is it used for?

Evaluate:

Students will write a reflection of the class activity addressing the following questions: What are some of the different characteristics of birds? Describe the adaptations of birds in relation to the habitat. How do the adaptations to environments result in specialization of beaks?

Fill the Bill

Data Sheet

What type of bird beak do you think will be the best at catching worms? _____

~~Record the number of worms each bird captured on the chart below.~~

	Long Beak	Broad Beak	Short Beak	Spoon Bill	Hollow Beak	Filter Beak
Number of worms						

Which bird was the best at catching worms?

What features of its beak help give it an advantage?

Fill the Bill Graph

>24						
23						
22						
21						
20						
19						
18						
17						
16						
15						
14						
13						
12						
11						
10						
9						
8						
7						
6						
5						
4						
3						
2						
1						
	Lang	Broad	Short	Spoonbill	Hollow	Filter

Title: Owl Pellets

Intended Grades: 2 and 3

NSES Content Standards:

- A: As a result of activities in grades K-4, all students should develop abilities necessary to do scientific inquiry.
- C: As a result of their activities in grades K-4, all students should develop an understanding of organisms and environments.

Engage:

At the beginning of class, the class will go to an area where the teacher has scattered paper “owl pellets” (cut out of construction paper) on the ground. The students will have 1 minute to pick up as many “pellets” as they can. Owl sounds will be played as the students collect their “pellets.”

Explore:

Students will work in pairs or threes to dissect real owl pellets. Each pair will need to use the key provided to determine what type of bones are found and to which animal each bone belongs.

Explain:





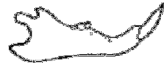







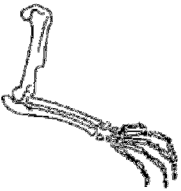




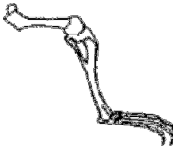


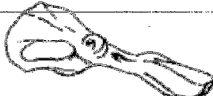











Students will share their findings with the class. The teacher will lead a discussion into food chains/webs and the flow of energy through the food chains/webs. The class will view examples of food webs in different ecosystems. Students will have the chance to practice assembling a food chain as a class to gain further understanding.

Elaborate:

Each group will receive an envelope containing pictures of different organisms within a food web. They will have to use critical discourse amongst themselves to place all the organisms into a food web, determine the flow of energy through the food web, and decide in what type of ecosystem that food web may be found.

Evaluate:

Students will write a reflection of the class activity addressing the following questions: Were you able to identify the different bones found? How did the use of class discussion assist in completing the food web?

Owl Pellet Bone Chart				
	Rodent	Shrew	Mole	Bird
Skull				
Jaw				
Scapula				
Forelimb				
Hindlimb				
Pelvic Bone				
Rib				
Vertebrae				

Title: Mystery Powders

Intended Grades: 4 and 5

NSES Content Standards:

- A: As a result of activities in grades 5-8, all students should develop abilities necessary to do scientific inquiry.
- B: As a result of their activities in grades 5-8, all students should develop an understanding of properties and changes in properties in matter.

Engage:

The teacher will blow bubbles and ask the students what the bubbles are made of. Create a chart for students to share ideas of how to identify a solid, liquid, and gas. What do these have in common? What is matter? What are some examples of how matter can change (use the solid, liquid, and gas for reference)?

Explore:

Students will follow the instructions in the data packet to make observations of the 4 “mystery powders” (sugar, cornstarch, baking soda, and Plaster of Paris) to make predictions as to the identity of each powder. There are 5 tests to complete: Basic observations, Water Test, Vinegar Test, Iodine Test, and Heat Test. The basic observations have students use their senses minus taste to describe each unknown powder. In the water test, a small amount of water is added to a spoonful of each powder and any reactions or changes are noted by the students on their data sheets. A small amount of vinegar is added to a spoonful of each powder in the vinegar test and any reactions or changes are noted by the students on their data sheets. In the iodine test a few drops of iodine are added to a spoonful of each powder and any reactions or changes are noted by the students on their data sheets. The heat test uses small cups made of aluminum foil. The students place a small amount of each powder in the cups and hold over a lit votive candle to heat. Any reactions or changes are noted by the students on their data sheets.

Explain:

Allow students to share their predictions and give them the correct answer to each powder identity. Discuss as a class the characteristics of each powder they observed as they progressed through the tests. Point out certain reactions such as the cornstarch during the iodine test and baking soda during the vinegar test. Take this opportunity to discuss the presence of starch in plants and the reaction of baking soda and vinegar.

Elaborate:

Now that students have been able to identify the various powders, they will be given a plastic bag with two of the powders mixed together by another group. Using the previously gathered data the students will have to identify the two powders contained in the mixture.

Evaluate:

The students will write a reflection on the lesson answering the following questions: are students able to identify the 4 original powders? Are students able to identify the powders in the mixture? Are students able to use scientific discourse using observations from the exploration?

Mystery Powders



Team Name _____

Name _____

Mystery Powders

If you know what the powders are before the end of the 5 tests, DO NOT CALL THEM BY NAME OUT LOUD!!!

Test #1 Observations

The first test will be to examine each powder using as many of your senses as you can. Since these powders are unknown, the sense of taste should NOT be utilized. Place one spoonful of each powder onto the black paper. Be sure to put powder A next to the A on the black paper, powder B next to B, and so on. Think of words to describe and compare the color, texture, and other properties of the powders. A magnifying glass can be used, and all observations should be recorded on the data sheet for Test #1.

Test #2 The Water Test

The second test is the water test. Here, each powder is tested for its reactions when mixed with water. The water is in a plastic container in your tray. Designate one plastic spoon for each powder. Take some of powder A and place it into a clear plastic cup. Use the eyedropper provided to add some water. The craft sticks may be used to stir each solution as you add the water. Be sure to record what happens on your data sheet. Does the powder dissolve? Does it become milky? Is the liquid thick or thin? What color is it?

Test #3 The Vinegar Test

The third test is the vinegar test. Each powder will be tested for its reaction when mixed with vinegar. Use the clear plastic cups and craft sticks for this test. The vinegar is in a plastic container in your tray. You may use the same eyedropper to add the vinegar to each cup. Be sure to record what happens on your data sheets. Remember to keep each spoon with the correct mystery powder!

Test #4 The Iodine Test

Next test is the iodine test. You can use the powders that are arranged on your black paper for this test. Carefully use the eyedropper in the iodine bottle to place one drop of iodine on each powder. Observe and record what happens.

Test #5 The Heat Test

The final test is the heat test. A piece of aluminum foil has been provided to make a small cup which will be held over a candle with a wooden pinch-type clothespin. The powder should be heated for several minutes until no more change occurs. Then repeat this experiment with a fresh foil cup for each powder. Please be very careful with the flame! The teacher will have a lighter, so raise your hand when you are ready for this experiment.

Mystery Powders Data Sheet

Test #1 Observations

Powder	How does it look?
A	
B	
C	
D	

Powder	How does it smell?
A	
B	
C	
D	

Powder	How does it sound?
A	
B	
C	
D	

Powder	How does it feel?
A	
B	
C	
D	

What I think each powder might be:

A _____ B _____
C _____ D _____

Mystery Powders Data Sheet

Test #2 The Water Test

Powder	What happens when the powder is mixed with water?
A	
B	
C	
D	

Test #3 The Vinegar Test

Powder	What happens when the powder is mixed with vinegar?
A	
B	
C	
D	

Test #4 The Iodine Test

Powder	What happens when a drop of iodine is added to the powder?
A	
B	
C	
D	

Test #5 The Heat Test

Powder	What happens when the powder is heated?
A	
B	
C	
D	

Conclusion: What I think each powder is after completing each test.

A _____ B _____
C _____ D _____

Title: Write It/Do It

Intended Grades: 4 and 5

NSES Content Standards:

- A: As a result of activities in grades 5-8, all students should develop abilities necessary to do scientific inquiry.

Engage:

The teacher will use news clippings similar to those seen on *The Tonight Show* for students to see how everyday people depend on specific communication. An example of these is “Jodie Berry of Panama City, FL, sits with her toy Yoda at her lawyer’s office. Berry, a former Hooter’s waitress, has sued the restaurant where she works saying she was promised a new Toyota for winning a beer sales contest in April. Berry believed she won a new car, but she was blindfolded, led to the parking lot, and presented a toy Yoda, the little green guy from Star Wars.” Another is “Reminder: Monday classes will be held Tuesday because Monday classes are canceled due to President’s Day. Tuesday classes will be canceled to make room for Monday’s Tuesday classes.”

How important is it for scientists to be specific in their writings and other forms of communication? Can you think of examples of time when it is helpful to be VERY specific?

Explore:

The teacher will construct an object using connecting blocks. The class will be divided into pairs. One person from each pair will be shown the constructed object and have 25 minutes to write a description of the object and how to build it. Once the first person finishes, the other person in the pair will be given the written description in another room with materials to construct the same object with a 20 minute time limit.

Explain:

Allow the partners to work together to determine a better way to write the description so that it is more precise. Discuss the importance of accuracy in scientific writings and how it is important for someone to recreate an investigation and be able to gain the same results.

Elaborate:

The “Explore” will be redone with the constructing partner now as the writer. A new object made of connecting blocks will be used.

Evaluate:

A rubric will be used to assess the construction during the “Explore” and “Elaborate.” Are students able to correct the accuracy of the object descriptions while working in pairs?

RUBRIC FOR EVALUATING WRITE IT/DO IT

	Excellent (5)	Average (3)	Poor (1)
Construction during Explore	Model was built completely correct based on written description	Model was built somewhat correctly based on written description	Model was not at all correct based on written description
Construction during Elaborate	Model was built completely correct based on written description	Model was built somewhat correctly based on written description	Model was not at all correct based on written description
Making Corrections	Students work very well in cooperative pairs to correct the accuracy of the writing.	Students work in cooperative pairs to correct accuracy of writing.	Students do not work together to correct accuracy of writing.

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