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Can Experiential Education Strategies Improve Elementary Science Teachers' Perceptions of and Practices in Science Teaching?

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By

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Declaration of Originality

I do hereby declare and attest to the fact that this is an original study based solely upon my own scholarly work here at Lindenwood University and that I have not submitted it for any other college or university course or degree here or elsewhere.

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Abstract

This study was prompted by the growing amount of research that is in support of science reform and from this researcher's personal experience and concern that science instructions is no longer a top priority in elementary schools nor are young scientists given the opportunities to act as scientists in a real world setting. This study uses experiential education strategies in a workshop format to try and affect change in the attitudes, behaviors, and perceptions of elementary science teachers.

Experiential education is not new, but the methods of teaching can span a wide range of topics. The main focus of the workshop featured in this study was a combination of outdoor education and inquiry. The format was Project WET, a program focused on the teaching and learning of water education.

The workshop was given to pre-service teachers enrolled in a science methods course at a local university. The workshop was held both in and out of doors and featured six lessons from the Project WET Activity Guide.

Data gathered offered insight into pre-service elementary teachers' attitudes, behaviors, and perceptions of science instruction, through the use of the Science Teaching Efficacy Belief Instrument. A z test for the difference in proportions for two sample means was used to analyze each statement on the STEBI, individually. A follow-up questionnaire, via an online survey instrument, provided feedback regarding the Project WET workshop.

Final analysis indicated no significant difference in the responses to 12 of the 13 individual questions, but follow-up survey questions indicate that there are definite advantages to further research.

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Chapter 1: Introduction

In less than 40 years, the world population is expected to reach an all time high of approximately nine billion people (Fetini, 2009). The struggle for water, food, and sustainable energy is already on the rise. By the year 2025, more than 50% of the world's countries will experience freshwater shortages and 75% by the year 2050 (Mongabay.com, 2008). Companies such as Monsanto, the world's leading seed producer, are working on the development of drought resistant crops that can withstand the unpredictable weather of the mid-western United States and in those countries where crop production is dependent upon the tolerance of high heat and little rain (Melcer, 2004). This development is reliant upon the knowledge and persistent research of life science specialists throughout the country, not the skilled labor of the ill-fated car manufacturing companies. Society has shifted from manufacturing to a more proficient technological economy, where it will take both science and technology to solve the sustainability issues of our global civilization. Only through the education of individuals can we meet this goal.

Background of the Study

Over the last several years, many factors have surfaced causing a need for changes in perception, instruction, and learning of science content. Since 1996, the National Science Education Standards (NSES) have been in place to guide curriculum design and bring science teachers and scientists closer together in science instruction. The *National Science Education Standards* were produced by the National Research Council in 1995 and published in 1996. The *Standards* were the result of four years of work by 22 scientific and science education societies and over 18,000 individual contributors (National Science Teachers Association, 2010).

During the summer of 2005, the United States Congress appealed to the National Academy of Sciences for an examination into concrete steps to enhance science and technology enterprises to ensure that the United States could prosper and be secure in the global community of the next century. This research was prompted, in part, by the call for a "vast improvement of K-12 math and science education…" presented among the final recommendations from the Academy (Committee on Science, Engineering, and Public Policy, 2007), as well as, the Nation's Report Card: Science 2000 (National Center for Education Statistics, 2003), and the Trends in International Mathematics and Science Study, known as the TIMSS (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008).

It has been three years since the Academy's recommendations, yet according to the Center on Education Policy's (CEP) February 2008 analysis of the No Child Left Behind (NCLB, 2001) initiative, classroom science has taken a back seat to increased instructional minutes for Reading and Mathematics. This loss of instructional time is causing many classroom teachers, even schools, to whittle the teaching of science down to virtually little or no instructional time (McMurrer, 2008). In that same study, out of 349 nationally represented and responding school districts, 58% had increased instructional time in English language arts and 45% increased time in mathematics for the 2006-07 school year. Of these same schools surveyed, 36% had decreased instructional time in social studies and 28% decreased time in science (p. 2). Thus, the average decrease of instruction for social studies and science was reportedly 75 minutes weekly, leaving 15% of those schools with less than 25 minutes per week of instructional time in science (p. 6). A related survey sampling approximately 6,000 self-contained elementary teachers, grades one through six, reported an "average of only about half an hour per day spent in science instruction…" (Plourde, 2002, p. 2). This makes it difficult to conduct experiments with so little time devoted to the subject.

With so little time, the teacher must be able to determine and effectively teach highly engaging content in order for students to get the most out of science instruction. In elementary school this is often difficult to accomplish, especially if the teacher's preference is for teaching communication arts, mathematics, or social studies. Not to mention the fact that, in many instances, elementary teacher certification requires only one course in science teaching methods and few in content. In many cases, teachers have little time to familiarize themselves with the science education standards and therefore may be uncomfortable in relaying the knowledge therein.

Fulp (2002) found the following:

> In 2002, the National Survey of Science and Mathematics Educators already reported 67 percent of elementary teachers in grades K-5 as not at all familiar with the National Science Education Standards set forth from the National Research Council. Only four percent of elementary school science teachers had undergraduate degrees in science or science education, less than 25 percent participated in in-service education in the three year prior to the survey, and less than eleven percent had taken a formal course in the teaching of science or

> science in general. Although more than 70 percent of the K-5 elementary teachers surveyed rated themselves as being well prepared in pedagogical styles, 18-29 percent of teachers had a perceived self- efficacy as ‘not well qualified’ to teach science concepts. (pp. 2-7)

The Compendium for Missouri Certification Requirements maintains that every individual pursuing a certification in elementary education must receive that certificate from an accredited teacher education program (Missouri Department of Elementary and Secondary Education, MODESE, n.d.) and have a minimum of 15 hours in methodology, of which only three credit hours may be given to science instruction. Major universities in Missouri offering elementary teacher education necessitate 12 hours of science within the general education requirements, typically taken within the first two years of undergraduate study, and only three credit hours of science methodology before student teaching and graduation (see Appendix A: MODESE certification requirements).

Considering a decrease in the number of minutes spent teaching science and a lack of teacher preparation in the content field, as well as, understanding concepts and methodology in the subject area, the implications for students are concerning. It is this researcher’s contention that the lack of teacher understanding may perhaps be the cause of avoiding the subject. Likewise, avoidance of the subject may possibly cause a teacher to skim over the concepts or use less effective modes of instruction such as lecturing.

Consider the possibilities of the following scenario. A teacher is uncomfortable teaching science because she did not do well in those courses in high school or college. Therefore, she skims over the topics and concepts when teaching her own class. The students sense the dislike and develop a lack understanding of the concepts due to ineffective teaching. The student receives poor grades which causes a lack in motivation to learn the content and possibly a dislike for the subject area. The student later chooses a career in elementary teaching and is comfortable teaching most subjects except for science, and the cycle begins again.

According to social cognitive theorist, Albert Bandura, whatever a person believes about his or her capabilities, self-efficacy, ultimately affects performance. "Unless people believe they can produce desired effects by their actions, they have little incentive to act" (Bandura, 1994, p. 3). Thus it is essential for professional development to focus on increasing teacher efficacy in the area of science, especially in elementary schools. Thus, if the teacher is uncomfortable with personal knowledge and understanding of science content, it is unlikely that the individual would seek out further opportunities to learn the content. If the teacher is uncomfortable with methodology in science instruction, it is unlikely that the individual would seek out further opportunities to learn new approaches to science instruction, but rather resort to the tradition of lecture and note-taking. Professional development to increase teacher efficacy and knowledge in science must demonstrate and incorporate more varied approaches to teaching this subject. Fortunately, although statistics illustrate in the previous paragraphs that instruction must change, new methods need not be created. Currently, teachers are continually searching for modern ways to connect student learning with real-life experiences. Yet, 'Outdoor Education' has been accomplishing this for almost a century with the opening of the Salem School in 1920 by Kurt Hahn (James, 2000). Hahn's achievements will be discussed further in Chapter 2: The Literature Review.

Real life learning, often called authentic learning, project-based or experiential learning, provides individuals with tasks that are authentic, that is, something that is true to life. Problem solving, analyzing, and understanding are products of the experience, not learned through books or lectures (Bird, 2000). A recent trend in education, encouraging use of the 'inquiry-based' model, have students asking essential questions and constructing personal understanding about experiences, but fails to go one step further by replacing prescribed experiences in the classroom with 'authentic' experiences outside of the four walls. Hammerman, Hammerman, and Hammerman (1994), internationally recognized outdoor education experts, are of the opinion that "learning, which traditionally has been limited to the four walls of the classroom, is for the most part highly verbal. All too often, concepts learned in school at the verbal level are merely words without meaning" (p. 12). Learning within the classroom cannot replace first-hand observations and experiences. When students interact with subject matter in a multi-sensory way, new perceptions can be derived from prior knowledge thus continually refining and reconstructing personal understanding of concepts.

Problem Statement

L.B. Sharp (1943) said, "That which can best be taught inside the school rooms should there be taught, and that which can best be learned through experience dealing directly with native materials and life situations outside the school should there be learned" (p. 363). Unfortunately, budgetary concerns, liability issues, and lack of teacher training seem to be some of the barriers causing experiential learning practices to appear impossible. Within the local school districts pertaining to this study, the monies for field trips are decreasing and many teachers do not know how to use the local environment for effective instructional purposes.

With the rationale in Sharp's commentary, this study will address elementary teacher perceptions on the use of experiential education practices as a viable instructional model for science. Using the natural environment surrounding students has proven to be an effective teaching strategy. The importance of using those areas where students are in constant contact helps to develop the relationship between school and community, as well as give purpose to the learning process. This is shown explicitly in the matter of Foxfire, a student publication that began in the Appalachian Mountains, with the purpose of breathing life into a communication arts curriculum. Foxfire (1966) will be discussed further within Chapter 2: the Literature Review.

Methodology

Although discussed at length in Chapter 3, the methodology for this study is founded upon the cross-sectional survey. The representation of data is from a sample of elementary pre-service and in-service teachers who may or may not lack personal confidence in teaching science effectively but who did participate in a one day experiential education workshop. I found that the best avenue for gauging the before and after perceptions of teachers, was to use the Science Teacher's Efficacy Belief Instrument-B (STEBI-A, B). The instrument was a pre and post survey that combined questions concerning teacher perception of science with teacher perception of science instruction and student achievement. It has a Cronbach's Alpha reliability score of 0.75 (Bleicher, 2004). I chose the Project WET format with ongoing verbal reflection as the vehicle for change. Project WET is a nation-wide curriculum on water education, and I am a trained Project WET facilitator.

As a public school middle level science teacher for eight years, this researcher has had many experiences in developing activities to reflect the goals and objectives of curriculum while still appearing attractive to students. These were developed to enable students to see the relationship between themselves and the learning in question.

Hypothesis

This study addresses the question, Can experiential education strategies improve elementary science teachers' perceptions of and practices in science teaching? The research collected is an attempt to better understand the relationship between teacher and practice.

$H_0$1: There will be no difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_1$1: There will be a difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_0$2: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

$H_1$2: There will be a difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

The following research questions defined the study:

1. What are the perceptions of elementary teachers in regard to science instruction?
2. If given the experiential tools to guide instruction, how will teachers change their perceptions of science instruction?
3. Can pre-service elementary education teachers be influenced to use experiential instructional tools as a result of personal experience?

Professional Significance of the Study

The implications of this study are far reaching. Prior research on the use of experiential education has been limited to the early work of such researchers as Dewey (1897) Hammerman and Hammerman (1968), Hahn (1936), and Sharp (1943) along with parcels of more current research that are restricted to curriculum and schools specializing in programs such as the National Outdoor Leadership School and Adventure Treks. More common are the notable research studies that are currently being conducted on science teacher efficacy detailed in the literature reviews of the upcoming chapter. What is less common is the research outlining how teacher perceptions can be positively influenced by using experiential education practices, to influence schools and districts to invest in outdoor classrooms, science materials, and professional development, hence the significance of this study. Other schools may want to incorporate similar workshops into their professional development requirements for elementary teachers. While the research indicates that a one-day workshop is not as effective as continuing and embedded professional development, a content area specialist in the area of science may not be available to work with teachers for this length of time.

Independent Variables

Content of the Workshop. Project WET is a nationwide integrated environmental curriculum for grades K-12 (Project Wet, 1984). The Project WET framework reflects national science goals and objectives, as well as the grade level expectations written by the Missouri Department of Elementary and Secondary Education. Project WET began in 1984 by the North Dakota State Water Commission, was adopted by Montana University in 1989, and has spread throughout the United States over the last 20 years. Missouri adopted the program in 1995 where it was sponsored by the Department of Natural Resources and today has several local communities that support the funding of the program, now housed at Missouri State University.

Participants. The Project WET workshop was limited to pre-service teachers, at one university enrolled in a science methods course. Chapter 1 noted that pre-service teachers often acquire little background in science content. The workshop and use of the STEBI-B was a unique opportunity to illustrate a need for change in pre-service teacher education, if in fact, the null hypothesis was rejected.

Dependent Variables

STEBI-A, B. The Science Teacher Efficacy Belief Instrument-A and B, using likert scale scores, were used to determine teachers' perceptions of science and science teaching. The STEBI-A, B have been used and validated in a variety of studies (Bleicher & Lindgren, 2005; Finson, 2001; Morell & Carroll, 2003; Riggs & Enochs, 1989;).

Delimitations

Restrictions imposed upon this study by the researcher include the following: The amount of time available for which to conduct the study.

The focus of the study is on pre-service. The researcher controlled the type of experience given to participants by using an experiential education workshop held on the Lindenwood University campus and open only to Elementary Science methods students.

Limitations

1. This study recognizes that there may be biases in self-reporting surveys in assuming that individuals will answer the questions honestly. However, survey has been validated by previous research, and self-perception is the main focus of the study.
2. The researcher did not control for the number of participants who had previous experience with experiential education activities.
3. Although it was not an issue on that day, the researcher could not control for the weather.
4. There was a lack of diversity in the sample.
5. Only pre-service rather than in-service teachers were available for the workshop.

Internal Validity

Mortality. Although the expectation was to have all methods students participate in the workshop, this researcher recognized there may have been students who were absent from class the day of the workshop. Because the workshop was only one full day, it was expected that all subjects would complete the workshop. Problems would have been in whether or not all participants completed the whole survey, affecting the number of participants needed to satisfy the numbers necessary for the study to be valid.

Location. In order to make sure the hypothesis was not jeopardized, all participants took the survey at the same time and in the same location. The researcher chose to use the classroom as the survey location.

Instrumentation. The data collector is the same throughout the time of taking the survey and the workshop. The STEBI- B is an instrument validated by the research of Riggs and Enochs (Riggs & Enochs, 1989, 1991).

Testing. The researcher recognized that taking the pre and post test may have alerted participants as to the content of the workshop and caused the participant to be sensitized to the subject.

Implementation. It is also recognized that the attitude of the principal investigator toward experiential learning may be perceived as a threat to validity. A preference from the researcher or to participants could account for higher performance. The course instructor did not provide any incentives for taking the workshop. The students chose to attend on their own.

Attitudes of subjects. The researcher recognized that teachers who knew they were participating in a study, may change their performance within the study, this is known as the Hawthorne effect. Merriam Webster defines the Hawthorne effect as the "stimulation to output or accomplishment that results from the mere fact of being under observation…" However, it is necessary that the teachers know about the study in order to fill out the general consent form for participation.

Definition of Terms

Adventure Education-"A variety of self-initiated activities utilizing an interaction with the natural environment that contain elements of real or apparent danger, in which the outcome, while uncertain, can be influenced by the participant and the circumstance" (Ewert, 1989, p. 6).

Cultural Journalism-"…interviewing community members to reconstruct history; gathering information about traditional cultural practices; and sharing knowledge about local life ways through the publication of articles, journals, and books" (Gibbs & Howley, 2000, ¶17).

*Environmental Education***-** Environmental education generally refers to curriculum and programs which aim to teach people about the natural world and particularly about ways in which ecosystems work (Wilderdom Environmental Education, n.d).

Experiential Education- "Experiential education is a process through which a learner constructs knowledge, skill, and value from direct experiences" (Association for Experiential Education, 2002, p. 5).

David Kolb defined experiential education as having the four following components: concrete experience, observation and reflection, forming abstract concepts and testing in new situations. Figure 1 is a model adaptation of Kolb's experiential learning theory (Exeter, 2001).

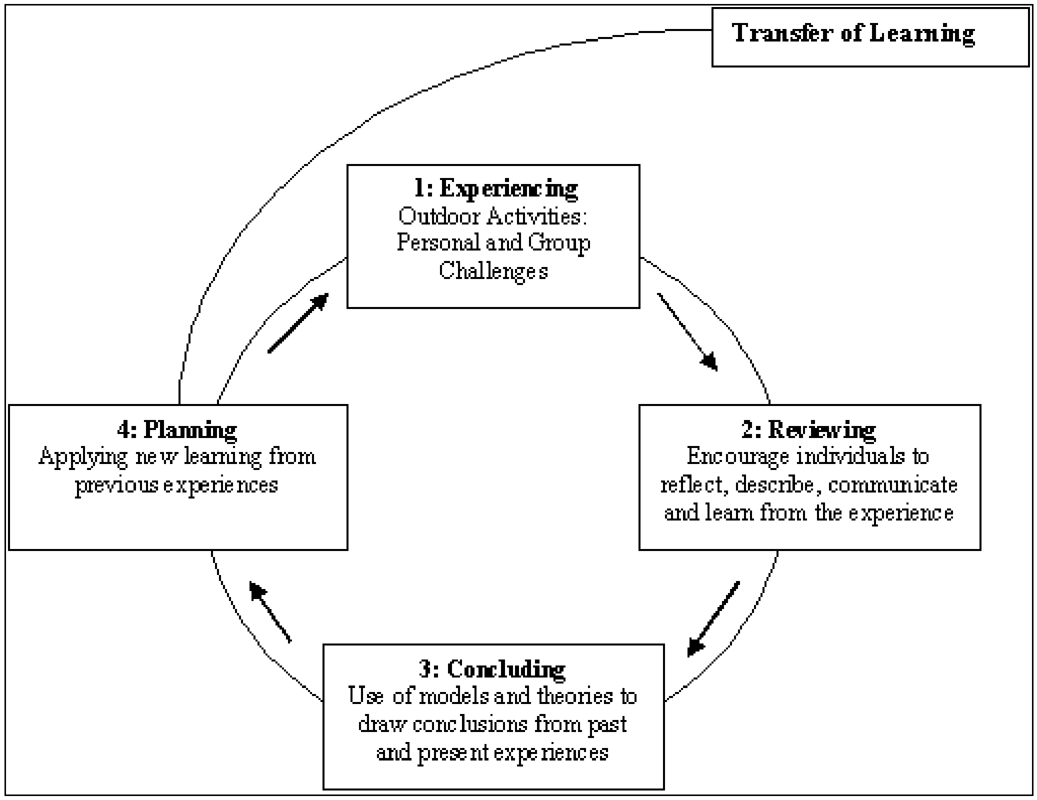

Figure 1. Kolb's experiential learning theory

Inquiry- The Exploratorium Institute for Inquiry (n.d) defines Inquiry as "an approach to learning that involves a process of exploring the natural or material world that leads to asking questions and making discoveries in the search for new understandings" (Exploratorium Institute for Inquiry, n.d., ¶1).

Outdoor Education- "is education 'in', 'about', and 'for' the out-of-doors" (Donaldson & Donaldson, 1958, p. 63).

Outdoor Education refers to experiential education done in the outdoors. Outdoor Education typically comprises residential, journey-based learning in which students participate in adventure-based activities, such as climbing, hiking, canoeing, kayaking, teambuilding, low ropes, high ropes, and group games. Outdoor Education usually has an environmental education component to it. For example, hiking may have an ecology lesson tied in with it, or canoeing may include discussion on pond life and habitats (Outdoor Education, n.d.).

Place-based Education-

> Place-Based education is the process of using the local community and environment as a -starting point to teach concepts in language-arts, mathematics, social studies, and other studies across the curriculum. Emphasizing hands-on, real-world learning experiences, this approach to education increases academic achievement, helps students develop stronger ties to their community, enhances students' appreciation for the natural world, and creates a heightened commitment to living as active, contributing citizens. Community vitality and environmental quality are improved through the active involvement of local citizens, community organizations and environmental resources in the life of the school. (Sobel, 2004, p. 6)

Teaching Efficacy- Teaching Efficacy represents a teacher's belief that teaching can overcome factors external to the teacher, such as the home environment. Personal Teaching Efficacy represents a teacher's belief that he or she can personally affect changes in students (Kang & Neitzel, 2005).

Summary

I am in hopes that this study will bring about much needed conversation on changes for science education. The National Academy Press, National Science Education

Standards, National Research Council and countless individual researchers cannot be wrong in finding that science has been pushed aside to accommodate mathematics and communication arts or that American students' are falling further behind in the race toward a more scientifically skilled community. Americans simply cannot meet the growing and changing needs of the global society without taking a hard look at the factors influencing science instruction.

In Chapter 2, the literature review will clarify current research outlining teacher perceptions of science and the use of experiential education as a vehicle for change. The chapter is divided into six sections beginning with a brief overview and followed by theoretical background, teacher perceptions, experiential education, experiential education methods, and finally, experiential education and student achievement.

Chapter 2: Review of the Literature

Overview

This research is based on results obtained after surveying pre-service and elementary school teachers on their use and understanding of experiential education practices and a one-day workshop focused on tools and strategies used in science classroom teaching. It is hypothesized that by using experiential education practices in teaching elementary science, teachers' perceptions as to the ease and understanding of science content and instruction will change. When designing the one-day workshop, I used effective practices in experiential education as demonstrated by the literature reviewed in this chapter.

Experiential education has a wide berth of meaning. It is typically inclusive of Outdoor, Adventure, Wilderness and Environmental Education, Place-Based Education, Cultural Journalism, and Inquiry practices and programs. For the purposes of this study each of these methods will be addressed separately in the literature review, and the aspects of these programs used in the one day workshop will be highlighted.

Much can be gleaned from the accumulation of experiential education research that has been conducted over the last 60 years. There have been many well known experiential education enthusiasts who have written about the inherent educational value in extending the school curriculum beyond classroom walls. Many have written about using experiential education with varying types of students in challenge by choice situations to enhance self esteem, cooperation, teamwork, and comfort level within a certain amount of risk taking for success. However, little research demonstrates the changes that take place in the minds and attitudes of those teachers who first engage in experiential learning and then introduce the theory into their personal teaching repertoire. Upon exhausting literary resources, it can be noted that primary writings divulging the perceptions of teachers prior to and after participation in personal or professional development activities grounded in experiential learning are almost nil. In order to set the stage to highlight the substantial need for further research in the use of experiential learning practices as a viable tool to positively increase teacher perceptions about science, this research will expound on a review of literature concerning teacher perceptions, science teaching, and experiential education methods.

Theoretical Literature and Historical Background

John Dewey and Progressive Education. The theory of education, first emphasized by John Dewey and widely known as progressivism, is the foundation of experiential education. Dewey's work stressed the importance of students engaging in real life experiences in the development of a cognitive construct. He viewed the end goal of learning, not to get the right answer, but rather to understand and use the experience (Warren, Sakofs, & Hunt, 1995). Dewey believed that people should investigate life as they experience it, not as they expect it should be.

Dewey believed that people are very social and learn through their interaction with others. In the 1920's and 1930's, Dewey posited, that the "strict, pre-ordained knowledge approach of modern traditional education is too concerned with delivering knowledge, and not enough with understanding students' actual experiences"(as cited in

Neill, 2005, ¶2) It is in those experiences that individuals learn from one another until knowledge becomes a common possession.

Progressive education reflects a commitment of values such as: attending to the whole child, community, collaboration, social justice, intrinsic motivation, deep understanding, and active learning (Kohn, 2000). Progressivism also has a long history of embracing the problem solving approach used in agriculture and industrial education (Columbia Encyclopedia, 2009). Prior to the writings of John Dewey in the early and mid-1900's, Land Grant institutions were established to implement programs that would take learning to the students because so many individuals could not attend collegiate institutions. The Land Grant colleges provided for demonstrations in new innovations to be taken out into the rural areas where farmers had no prior access and eventually developed paid positions for the hiring of county extension agents to rally farmers around new ideas soon available (Penn State College of Agricultural Sciences, 2009). Programs such as these, where the learner was central to learning, spurred Dewey's theories about progressive education.

Progressive education's idea of student-centered learning loosened the austere atmosphere of the classroom in the early 20th century. Traditionally, teachers viewed "…good pedagogy as drill and practice; their job was to hear recitations, not lead discussions" (Encyclopedia of Children and Childhood in History and Society, n.d., ¶2). Today, it is not uncommon to see student-led discussions and teacher as facilitator. The following table addresses the characteristics of a traditional versus progressive education classroom.

Table 1

A Comparison of Traditional vs. Progressive Education

	Traditional	Progressive
Classroom Environment	seats in rows	clusters
	teacher centered	student-centered
	authoritarian	facilitative
Assessments	standardized	authentic assessment
	multiple choice	open-ended questions
	true/false	
Division of Content	Intra-disciplinary	Inter-disciplinary

Constructivism

A key building block of Dewey's theory is the reconstruction of experience, because it gives the student the opportunity to apply what is known to new experiences. Progressivism is closely related to constructivism. "Understanding is in our interactions with the environment" (Savery & Duffy, 2001, p. 1). Constructivists, like progressivists, also see meaning as being attained as a person has experiences, reflects, and creates understanding; but central to constructivism is the focus on one's prior experiences as a catalyst for meaningful change in thought. Constructivists believe that one comes to a situation with a wealth of knowledge and skills that form perceptions. In an educational setting, the teacher would be responsible for assessing what the student knows and then building experiences that require students to reach past current knowledge toward the development of new understanding. Savery & Duffy concluded that understanding is particular to each individual, but cannot be understood without the 'context' of the content or the activity of the learner.

These ideas extend to teacher professional development. Posnanski (2002) pointed out that if positive changes are to be made in science teaching then teachers must be participants in professional development that is based upon the constructivist theory where they can learn about science and science instruction using the same methods that will be used to teach future students. With similar thoughts, Shymansky (1992) said, "…old teaching habits die hard…many teachers in pre-service and in-service programs are being schooled *about* models and methods…few are being schooled with those same models and methods" (p. 53). Research indicates that the greatest impact on student achievement comes from teacher effectiveness (Lumpe, 2007). If that is true, then pre-service training and in-service professional development, should focus on best practices in science teaching (Lumpe).

Professional Development

Smith and Gillespie (2007) outlined seven conditions whereas teacher professional development can be most effective. From those seven conditions, four have a direct relationship to the constructivist theory previously outlined. They are duration, connection, content, and emphasis on reflection. Smith and Gillespie saw that the length of professional development has a direct bearing on instructional change because duration gives the teacher time to reflect on their own practice, especially when there is follow-up to the professional development. Reflection is a direct component of constructivism and allows the teacher a chance to focus on problem-solving and process rather than technique and product. Many teachers receive the bulk of their professional development through one-time training seminars. Experts say that one-time seminars lacks continuity, does not regard how adults learn or appreciate the difficulty of the teaching profession (Little, 1994).

Constructivism emphasizes making connections. Although not necessarily a connection to prior knowledge, Smith and Gillespie (2007) believe that teachers need to be able to make a connection between the content of the professional development and the content they must teach, as well as, having intimate knowledge of content.

Chapter 1 identified lack of teacher understanding as a problem in science instruction that may cause avoidance of the subject in elementary school classrooms. Teacher preparation requirements for elementary school teachers are limited in science at best. Bandura (1994) suggested that self efficacy affects performance. If a persons' self efficacy is low, it is unlikely there will be an incentive to act. Thus, if a teacher has low self efficacy in teaching science, if they can, they will be more likely to avoid the subject. Thus again, as stated in Chapter 1, professional development should focus on increasing self efficacy in science instruction.

Teacher Perceptions about Science Teaching

Strategies for improving science teaching at the elementary level have been the focus of many studies (Bencze & Upton, 2006; Ellis, 2001; Lee & Krapfl, 2002; Morell

& Carroll). In fact, one concern of science educators is the attitudes of their elementary level colleagues toward the teaching of science.

> The negative attitudes and low comfort levels toward science and/or science teaching particularly at the elementary school level, tend to lead to the sporadic teaching of science, the teaching of science during inadequate blocks of time, or the omission of science instruction from the school day. (Finson, 2001, p. 1)

Koballa & Crawley (1985), supported by Tosun (2000), noted teacher attitudes as an area of concern as to whether or not poor attitudes would affect the teaching of science. Tosun's 2000 study concerning the beliefs of pre-service elementary teachers characterized personal feelings toward science with such negative descriptors as being unpleasant, stressful, frustrating, and full of dread. Waters and Ginns (1994) suggested these attitudes may come from the students' own schooling or have been influenced by their training experiences. Avoidance of science is now being reinforced by pressure on teachers to increase student achievement on mathematics and communication arts assessments.

A 2008 report issued by the National Governor's Association (NGA) and the Council of Chief State School Officers (CCSSO) recognizes the need for common assessments. The report, however, calls for those assessments to be in mathematics and communication arts. The NGA and CCSSO recognize that the Unites States, once the number one rated education system in the world, had dropped in 2006, ranking 18th out of 24th in the education systems of industrialized nations (Jerald, 2008). This is because our country has fast become a nation of automation, where computers now do the work of human labor.

Technology has changed how and where things get done. Now countries with a skilled labor force compete for jobs once held only by Americans. More and more, higher skilled jobs are being outsourced to other countries. In order for the United States to meet the growing demand of a skilled technological workforce, many believe that "…better education is the best tool we have to prepare the population for a rapidly changing job market" (pg. 10). That being said, I question how to better educate for a science and technology driven global market than by including science as a major educational effort? Instead, the incentive comes in reports such as Jerald's 2008 study "Benchmarking for Success: Ensuring U.S. Students Receive a World-Class Education" focusing only on the common assessing of communication arts and mathematics. If and when science becomes a part of this focus on common assessments, teachers should be prepared to provide effective instruction in the content, regardless of personal preferences and mandates toward other subject areas.

Measuring teacher efficacy is a difficult task. In the late 1980's Iris Riggs and Larry Enochs developed and validated an instrument to measure elementary science teacher efficacy beliefs. This instrument, known as the STEBI-A (an instrument for validating the science teaching efficacy of in-service teachers), and its counterpart, the STEBI-B (an instrument for validating the science teaching efficacy of pre-service teachers) has been used to substantiate much research in regard to science and efficacy (Bleicher & Lindgren, 2005; Cantrell, Young and Moore, 2003; Riggs & Enochs, 1989;

Smolleck, Zembal-Saul & Yoder, 2006). The STEBI-A is written in first person and the STEBI-B in third person. The first was written for teachers who are not yet in the field, and the second for those teachers already teaching. Results of the original STEBI-A indicated that the instrument could be a "tool used in further understanding of teacher behavior, which in turn can facilitate the development of strategies which may assist in teacher preparation and teacher in-service designed to improve elementary science teaching" (Smolleck et al., 2006, p. 143) provided important information regarding education reform. The idea that these negative outcomes can be prevented prior to in-service teaching has been supported by various studies regarding the self efficacy of pre-service teachers (Bleicher & Lindgren, 2005; Cantrell et al., 2003; Finson, 2001; Morrell & Carroll, 2003).

After using the STEBI-B to study the possible effects on efficacy at three different successive levels of coursework, Cantrell et al. (2003) postulated that efficacy changes as pre-service teachers participate in coursework. If variables affecting those changes were known, college administrators could better plan for future coursework and practicum that enhance teacher efficacy. For example, research has shown that teachers who are weak in content typically have low self efficacy, causing a more teacher-centered and authoritarian approach to instruction (Rubeck & Enochs, 1991) that in all likelihood was much the same as that individual's grade school experience. Consequently a teacher with higher self-efficacy is more likely to use a more student-centered approach to learning.

Finson (2001) hypothesized that "pre-service teachers who can view themselves as a scientist, without stereotypes, will also develop higher levels of self-efficacy" (p. 35). Finson used both the STEBI-B and the DASTT-C (Draw a Science Teacher Teaching Checklist) as a pre and post test to assess pre-service teacher's self efficacy in teaching science. Results indicated a definite connection between how pre-service teachers view themselves as science teachers and self-efficacy. Like Rubeck & Enochs (1991), Finson found that those teachers with a low self-efficacy tended to see themselves as a more authoritarian figure in the classroom. Classroom structure offered less hands-on, student-centered activities showing a propensity for a more teacher-centered approach to instruction. The DASTT-C was not a part of this study because the research on the use of the DASTT-C was limited in comparison to that of the STEBI-A and B.

Experiential Education: A Catalyst for Science Reform

Recognizing and understanding the various methods of experiential education provide a foundation in the efforts of science reform. Each of the methods has a direct relationship with 'hands-on, minds-on', authentic instruction. Consider Figure 2.

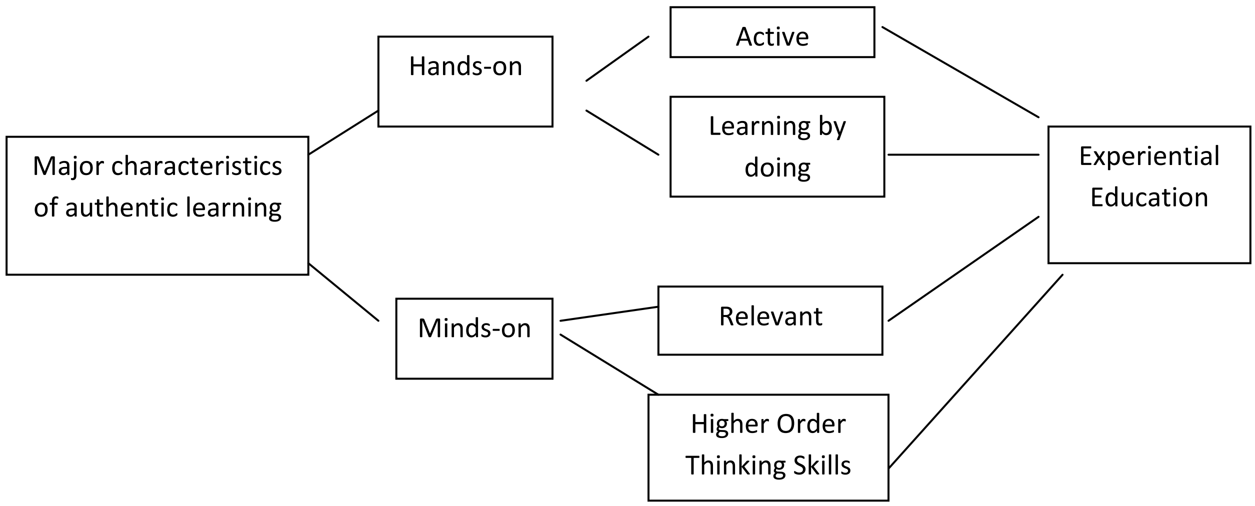

Figure 2. The relationship between authentic learning and experiential education.

According to the Council for Exceptional Children, CEC (Council for Exceptional Children, 2009), active learning, hands-on experiences, higher order thinking skills, real-time data collection, and real world topics are but a few of the major characteristics of authentic learning (CEC). Each of these characteristics is also one of the components of experiential education. This study was conducted to see if experiential education practices could cause change in the efficacy and instruction of elementary teachers. The components of quantitative research suggest measureable tests to determine an outcome. This researcher chose the STEBI-A,B as the pre and post test, used by Riggs & Enochs, 1989, Rubeck & Enochs, 1991, along with the development and presentation of a workshop component to test the hypothesis.

This literature review establishes the basis for using experiential education in the approach to the workshop. As a facilitator for training others in a nationally recognized experiential learning curriculum, Project Learning Tree, WET, and WILD, this researcher chose to use Project WET as the catalyst for the study. Project WET has the components necessary to see that participants have the opportunity to engage in the major characteristics of authentic learning listed above. Each plan within the curriculum requires the participant to place themselves in the role of learner as when addressing one or more specific parts within a problem to solve.

Experiential Education

The Association for Experiential Education (AEE) defined experiential education as "a philosophy and methodology in which educators purposefully engage with learners in direct experience and focus reflection in order to increase knowledge, develop skills, and clarify values" (AEE, 2002 ¶2). The AEE offers 12 principles to support the practice of experiential education. Although expanded, these 12 principles are in alignment with those objectives outlined by Gilbertson, Bates, McLaughlin, and Ewert (2006), in the preceding paragraph (See Appendix B).

Experiential learning is a cycle in which the learner engages in concrete experiences, reflection, conceptualization, and experimentation. Kolb developed the experiential learning model in 1984. In this model the learner engages in a specific situation or experience in which afterwards, there will be an extensive amount of reflection and questioning from all possible angles of the experience. Upon reflections, the learner gives thought to any established patterns or theories that might be derived from the experience and finally anticipates the application of the new construct (Shields, Aaron, & Wall, 2001). Kolb (1984) believed "learning is the process whereby knowledge is created through the transformation of experience" (p. 38). Like Kolb, Joplin (1995) viewed experiential education as having an action-reflection cycle. In Joplin's view, it is not the experience that makes experiential education; it is the addition of reflection that makes it so. Participants in this research study participated in ongoing verbal reflection while interacting with other participants and the instructor.

Even labeling a program with the term "experiential" does not mean that it meets the 12 principles of the AEE. In 1980, Gibbons and Hopkins noted that there had become "…so many experiential programs, that the very term 'experiential' seemed to lack meaning" (as cited in Neill, 2005, ¶2). To determine whether there seemed to be degrees of experiential learning, Gibbons & Hopkins developed a scale of experientiality, which Neill noted as flawed from the outset because life, in general, is experiential. The scale of experientiality was created to define the different ways in which people engaged in experiential learning. Based on the degree of experiential learning within a situation, Gibbons & Hopkins identified five different modes of experientiality: receptive, analytic, productive, development and psychosocial modes with each stage having two subcategories as illustrated in Figure 3.

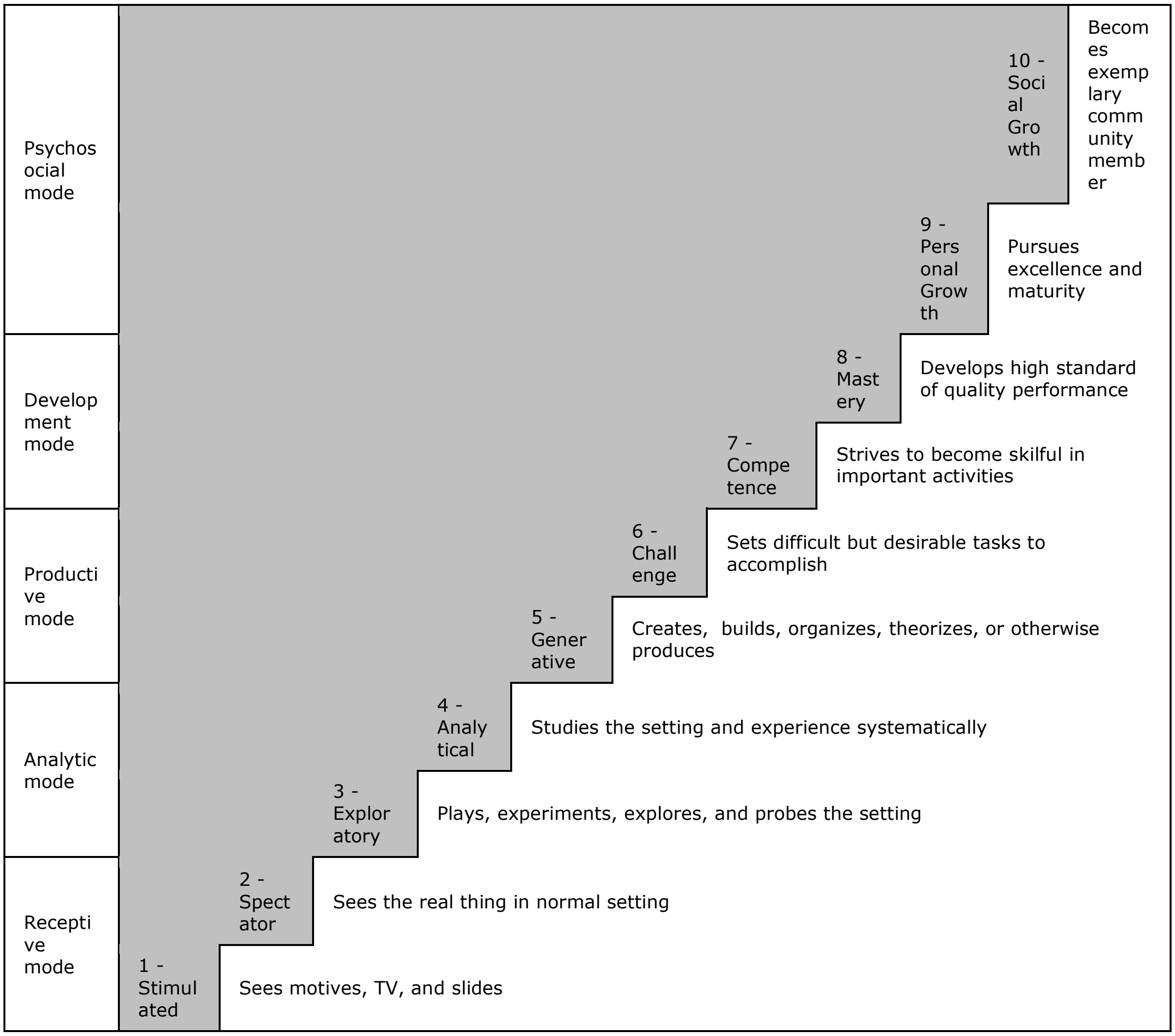

Figure 3. Gibbons and Hopkins (1980) scale of experientiality

According to the scale, as experientiality grows, so does the student's responsibility for learning. An individual operating in the receptive mode is simply observing an activity happening while another person in the development mode is working on becoming skilled in the activity. The modes of experientiality use an individual's prior knowledge to determine where they fall within the scale. This is especially good for curriculum designers who can then write goals and objectives based on the student's level of learning.

Gibbons and Hopkins' (1980) intent was to develop a scale to demonstrate that a person can engage in a variety of experiences and the more experiential the learning activity, the higher the mode of learning. This developmental model is similar to Bloom's taxonomy (n.d.) where learning is more likely to occur when students engage in higher level thinking skills. The experiential education workshop for this study uses Bloom's taxonomy in each individual lesson. The Project WET Curriculum and Activity Guide details, by grid, each level of the taxonomy and which lessons within the guide fit that level of learning.

Many of the methods and programs associated with experiential education so closely overlap that it is often difficult to illustrate any one without the other. Undoubtedly, as shown by the quantity of available research and programs in place today, the method of instruction with the largest breadth is that of outdoor education.

Outdoor Education

By nature, outdoor education is experiential, as often just the experience of being outside of the classroom walls may stimulate students to learn in new ways. Outdoor education developed slowly over time and is largely attributed to L.B. Sharp, a doctoral student under the supervision of Dr. John Dewey at Columbia University. Sharp built extensively on Dewey's philosophies, but focused his attention on education in the out of doors, using components of Dewey's philosophy in his work with youth camping programs (Carlson, 2009). Like Dewey, Sharp believed an individual's understanding is enhanced by those situations that provide some familiarity in an authentic learning experience.

The key components in Dewey's work parallel the primary objectives in outdoor education, outlined by Gilbertson et al. (2006) in *Outdoor Education Methods and Strategies*. It is a method of teaching and learning that emphasizes direct, multi-sensory experiences, takes place in the outdoor environment, and uses an integrated approach to learning by involving the natural, community, and individual environments (Gilbertson et al.). Direct, multi-sensory learning stimulates the natural curiosity of the learner, making available the readiness to learn. The outdoor environment and natural community provide a setting for drawing from prior experiences to construct meaning and the transfer of that knowledge to new situations. By using the natural environment to engage learners in practical applications, instruction becomes driven by what motivates individuals to learn.

Outdoor education "is education 'in', 'about', and 'for' the out-of-doors" (Donaldson & Donaldson, 1958, p. 63). Although hard to describe, there is a definite 'intensity' experienced while participating in outdoor learning. Taylor (1989), described 'intensity' as experiences that are distinguished by degrees of separation from everyday existence and suggested that this is best understood as an inward experience (p. 301). In outdoor education, there is often an intensity that can be gained only when a student actively reflects and tries to capture a particular moment. For many outdoor educators, intensity falls outside of normal experiences, instead, magnifying the experience to focus in on being-in-the-moment (Foran, 2005). Individuals experience many different emotions and outdoor education experiences can rejuvenate in ways that are difficult to duplicate.

According to a 2004 Review of Research on Outdoor Learning, "there is substantial evidence to suggest that outdoor programs can impact positively on people's attitudes, beliefs, and self-perceptions…', as well as, 'individual interpersonal and social skills…" (Rickinson, Dillon, Teamey, Morris, Choi, Sanders, & Benefield, 2004, p. 6). A previous survey by McRae (1990) found broad objectives in outdoor education to develop positive attitudes toward physical fitness, and enhancing personal qualities and relations with others. While studies show these things to be true, other variables affect the practicality of using outdoor learning. Certainly it is difficult to have a progressive outdoor education program without the cooperation of climate and weather, but these factors can be overcome with variety of skill and character building lessons and activities. More difficult to overcome are the monetary obstacles that can often plague schools and districts. Outdoor classrooms, gardens, and prairie habitat rely on a budget to be maintained. Still yet, are those areas where the very idea of children spending time outdoors gardening or going on nature walks is crushed by the environment in which they live. Large urban areas often have little acreage for outdoor learning and are often situated in areas where the safety of the students is a concern.

From the 1940s to the 1970s, outdoor education had a significant place in school curriculum. Unfortunately, the move from a rural society to a more urbanized setting has placed many people in situations far removed from nature. On the other hand, the current concern for the environment has many schools examining curriculum reform with an environmental emphasis.

Environmental Education

The term *outdoor education* denotes a need to become better acquainted with the environment. Environmental education has a long standing connection to outdoor education, but in its own right is considered a distinct field (Education Encyclopedia, 2009). The following excerpt from the Tbilisi Declaration (1977) defined the goals of environmental education.

According to the 1977 Tbilisi Declaration, "the *goals* of environmental education are:

1. to foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
2. to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
3. to create new patterns of behavior of individuals, groups, and society as a whole towards the environment." (p. 15)

Although environmental education can take place in doors, as well as out-of-doors, the focus is usually on those issues that have a direct effect on our environment, for example, pollution. Research shows that environmental behavior is a learned response or action and that an increase in awareness of strategies for ways to participate in being environmentally conscious, increased the motivation to do so (Palmberg & Kuru, 2000). A perfect example of this is recycling. Recycling in the classroom and school easily motivates students to recycle in the home.

Traditionally, environmental education has focused on the affective domain rather than on environmental content knowledge within the cognitive domain. According to Ballantyne and Packer (1996), many teachers believe that environmental change takes place through the modeling and teaching of attitudes and behavior rather than by factual information. This workshop study is a good example of modeling and teaching of attitudes and behavior. The workshop design was environmental in nature. It was based on Project WET (Water Education for Teachers), a not for profit, nationally renowned curriculum and activity guide to “facilitate and promote awareness, appreciation, knowledge, and stewardship of water resources…” (Project WET, 1995, i). The lessons within Project WET nurture attitudes committed to lifelong responsibility and positive community participation, characteristics valued by character education and implemented in many schools across the country.

Regardless of the reasoning behind the motivation for environmental change, the effort to make environmental education a recognized form of conventional education still lacks implementation. For example, in the 2004-2005 report from the North American Association for Environmental Education indicated that several states, including Missouri, had no plans to develop state by-law requirements for K-12 environmental education instruction. This does not mean there are no environmental education state curriculum objectives. It does mean those standards are not required. For example, in Missouri, only grade five is assessed in science on the Missouri Assessment Program (MAP) test. There are no grade level expectations for Kindergarten-third or fifth grade on strand four of the Missouri standards: “Changes in Ecosystems and Interactions of

Organisms with their Environment" (MODESE, n.d.), with the exception of concept A, "As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use" (MODESE), which is listed as a third grade expectation. Thus, fifth grade students are assessed on grade level expectations that are only taught in one elementary academic year: fourth grade.

Apart from academia, as the public leans toward sustainability, so do schools. The 2004 Green Schools Initiative (GSI) was created by parent environmentalists who were concerned about the health of school children (Green Schools Initiative, 2009). Since its inception, the GSI has lobbied supporters to aid in the elimination of toxins, use resources sustainably, create green spaces, serve healthier foods, and teach stewardship to the community. Rallying of community residents to educate one another can be a powerful source of motivation for student learning.

Cultural Journalism

Experiential education is not confined to science classes. In fact, in the mid 1960's teacher educator, Eliott Wigginton, found it difficult to engage high school students in language arts class. To breathe life into the curriculum, Wigginton challenged high school students in Rabun County, Georgia to get in touch with the local history. The idea was to engage students in an authentic experience by documenting the lifestyle, culture, skills, and talents of families living in the southern Appalachia area. The students chose to create and produce a magazine detailing the articles and stories that had been written. Foxfire is the name the class chose as title to the publication (Foxfire Fund, Inc., 1996).

The term cultural journalism came about after the first publication of the Foxfire magazine sparked schools across the country to emulate the style (Smith, 2002). "In cultural journalism authors chronicle the traditional skills and values of many different groups, defined perhaps by ethnic origin, occupation, or environment" (Olmstead, 2000, ¶1). It is related to other forms of experiential education through the learning by doing concept, as well as, immersing students into the surrounding culture.

Although cultural journalism seems to apply solely to a communication arts classroom, the implications for science and other content areas are far reaching. Just as L.B. Sharp (1943) held that education should be taught in context, so does cultural journalism. To date, Foxfire has published 43 volumes based upon the history and lives of those living in Rabun Gap (Foxfire Fund, Inc., 1996). Among the various articles on labor, cooking, and crafting, is such science oriented themes as the crafting of various tools, the structure of dams, local pond life, and gardening.

Originally there were three driving factors to the Foxfire model, the key factors being student-choice, community resource and an audience for completed student work (Foxfire Fund, Inc., 1996). Those three components are the foundation of the 12 core practices in effect today. Cultural journalism takes students out of the classroom setting to inquire and investigate life outside of the classroom door.

Place-based Education

Place-based education has many of the characteristics found in environmental education and cultural journalism. Like cultural journalism, place-based education uses the local culture as a guiding focus for real life problem solving, and just as in environmental education, place-based experiences use local nature as a part of the investigation.

Critics of place-based education believe education should prepare students to work and function in a technological society. Place-based educators, however, believe that education should prepare people to live and work toward a sustainable future (Woodhouse & Knapp, 2000). Many place-based educators believe every district should be able to design and offer a curriculum that reflects the lives of those children being taught (Gibbs & Howley, 2000).

Recent findings by Meichtry and Smith (2007) indicated that after a six-day summer workshop and two follow-up visits, teachers who participated in a place-based professional development program on local watershed "…experienced a positive impact on teacher confidence level to use community resources in teaching, conduct field investigations with students and the ability to teach watershed topics and connect that teaching to society and life" (p. 22) These teachers could better understand the watershed topic because they had lived the experience. The six-day workshop accommodated 20 participants from 19 counties within the watershed. Two participants were from elementary schools, seven intermediate or middle, and 10 taught high school, while one was a retired teacher and one was a school support staff member. The study began at the headwaters of a 310 mile river and continued downstream to its confluence. Follow-up sessions were held in September and the following March and focused on classroom application of the workshop training. The training involved a comprehensive set of place-based education strategies that positively impacted the confidence levels of teachers to use the strategies within the classroom. Teachers who used what was learned during the place-based education professional development, have noted improved student achievement, a reduction in discipline issues, increased enthusiasm for learning and greater pride in accomplishments (Meichtry & Smith).

Adventure Education

Ewert (1989) defined adventure education as, “A variety of self-initiated activities utilizing an interaction with the natural environment, that contain elements of real or apparent danger, in which the outcome, while uncertain, can be influenced by the participant and the circumstance” (p. 6). Adventure programs, typically held in a wilderness-like setting, offer participants the opportunity to enhance personal growth while honing physical skills. These programs exist on a continuum that blends recreation, education, and personal development (Haluza-Delay, 2001). Adventure education is unique in that there is a certain amount of perceived risk-taking involved in the activities, while still providing a level of excitement that is appealing to participants.

Adventure education tends to influence the awareness of oneself and/or the group. Program characteristics are often centered on developing positive behaviors and self esteem while developing interpersonal relationship skills among participants (Goldenberg, McAvoy, & Klenosky, 2005). Perhaps the most well known adventure education program is that of Outward Bound. Outward Bound was founded in 1941 and was originally focused on teaching young sailors how to survive at sea during World War II. Co-founder and educator, Kurt Hahn believed education should be a mix of personal character and understanding. With the first Outward Bound School, Hahn broadened the notion of experiential learning to include authentic experiences which would encourage positive self-esteem, develop one's natural abilities and impart a certain sense of responsibility toward fellow mankind (Outward Bound, 2009). Today, Outward Bound is the largest adventure education program in the world and continues to develop participant character and self-efficacy. Those who participate in the Outward Bound program range from military veterans and fortune 500 groups to school programs and at risk youth. Participation in the programs can be funded through scholarship and other forms of financial assistance.

Similar to Outward Bound is the National Outdoor Leadership School (NOLS), founded in 1965. NOLS attracts highly motivated students that want to learn to lead. Although not a traditional classroom setting, NOLS teaches character education, skill development, risk taking and safety (National Outdoor Leadership School, 2009). NOLS differs from Outward Bound in that the programs are all wilderness-based and focus on bringing about the leadership qualities within an individual. The programs range from 10 day to full year explorations.

Goldenberg and Pronsolino (2006) studied the outcomes associated with the NOLS and Outward Bound programs, using a means-end theory. The means-end-theory links the physical objects or service (the means) with the outcomes and the personal values of the individual (the ends). Like classroom teaching, the features of the NOLS and Outward Bound programs can be considered 'methodology', while the consequences of the programs are the student outcomes.

Data were collected from 510 individuals participating either in the NOLS or Outward Bound programs. Participants were questioned as to what method (feature) of the program was most meaningful. More than half of the Outward Bound cluster indicated that working in a ‘group’ was most meaningful, while more than 30% of the NOLS cluster agreed. Expedition, or adventure/experiential education, was the second most cited attribute of both programs (Goldenberg & Pronsolino, 2006).

The most frequently cited outcomes (consequences) for the programs were skill development for NOLS, and awareness, personal challenge, new perspectives, and new experiences for Outward Bound (Goldenberg & Pronsolino, 2006). So it could be said then that, authentic experiences often include group interaction and some form of experiential education, and the outcomes associated with such learning are skill development, awareness, personal challenge, and new perspectives. This sounds very much like teaching. What might the outcomes be if teachers integrated group interaction and experiential learning into the school curriculum?

Inquiry

Inquiry has become a term that is popular to use, but complex to understand. The Exploratorium Institute for Inquiry (n.d.) defined inquiry as an approach to learning that involves a process of exploring the natural or material world that leads to asking questions and making discoveries in the search for new understandings (Exploratorium Institute for Inquiry, ¶1). “Students need to learn scientific concepts by doing the same things that scientists do when they practice science: pose questions, gather evidence, formulate explanations, compare with existing knowledge, and communicate their ideas”

(Cooperative Institute for Research in Environmental Sciences, 2009, ¶11). When students are given experiences that place them in the role of scientist, where they can effectively ask their own questions and develop their own answers, they are participating in experiential education. Participants in the Project WET workshop, for this study, had a unique opportunity to role play and ask questions. The experience required cooperation and collaboration between participants and the reflection during and directly after the process was crucial to the learning. The instructor was facilitator and did not presume to direct the participants into right or wrong situations. Thus, students were required to ask pertinent questions to help direct the learning process.

It is difficult for students to practice inquiry if the teacher is not familiar with the process. “Many teachers in public schools have little knowledge of what inquiry is…” (Johnson, 2006, p. 2) and teacher preparation and professional development programs do not provide teachers with the tools necessary to implement inquiry effectively (Berns & Swanson, 2000). A 2006study by Johnson indicated several barriers to teacher success in implementing inquiry-based teaching. Among those barriers were not having been prepared to teach science as inquiry and personal beliefs about science and science teaching (p. 4, 7). It is these barriers that, again, provide a basis for this study, where the participants were pre-service teachers.

Experiential Education and Student Achievement

Since the publication of *A Nation of Risk* (1983) and the inception of No Child Left Behind (2001), teachers and administrators across the country have scrambled to raise test scores in order to realize student achievement and provide supporting evidence to stakeholders that achievement is on the rise. More and more effort is placed on emphasizing standardized testing in reading, writing, and mathematics as supporting evidence for moving closer to the goal. Traditionally, classrooms have been teacher centered and focused on the dissemination of facts. The push toward constructivism, as evidenced by the writings of Bruner and Vygotsky (Kearsley 2009) illustrate that education is amidst a shift in philosophy. With this shift, there becomes a need for a shift in methodology. One is not present without the other. Experiential practices are consistent with the goals of constructivism, but do these methodologies improve student achievement?

Place-based education and student achievement: An example.

Service learning, a place-based effort, differs from other forms of experiential education only in that the person performing the service is not usually the one, or only one, to benefit from the completed task. A 2006 study from Scales, Roehlkepartain, Neal, Kielsmeier, and Benson suggests experiential methods of instruction are related to academic achievement and the achievement gap. Scales et.al, conducted a national survey of principals and middle and high school students, as well as middle and high school students in Colorado Springs, to determine how principals perceive the academic impact of service-learning, what the relationship is between service and achievement, and the effects of long-term exposure to service learning. The impact of student learning varied according to the amount of time a student participated in a service learning project. This study did not put the students through a service learning project, but rather surveyed the amount of time students gauged themselves to have spent in service learning projects.

Students were divided into four groups according to socioeconomic status: high socioeconomic status (HSES) with service learning, HSES without service learning, low socioeconomic status (LSES) with service learning, and LSES without the service learning component. Results indicated that principals of urban and schools where most students were non-white tended to base the outcome of service learning on student attendance, engagement, and achievement of participants. Students within the HSES, who participated in service learning, had the highest mean score of all four groups in achievement related assets. However, LSES who participated in service learning had a higher mean score than did HSES without a service learning component.

With regard to student attendance, students who participated in a service learning component were more likely to attend school on a regular basis and show a positive commitment to learning for the long term. Scales et.al, do admit that service learning is only one component having a major impact on academic achievement and also, this survey was based on perception, not actual attendance rates. However, the results of this study are positive and worth consideration.

General experiential education and student achievement: An example

Rather than focus on the vehicle for delivering the experiential method of learning, as in the service learning from the previous section, Hitz and Scanlon (2001) researched the academic achievement of students participating in a course directed by various experiential education methods versus those students taking a non-experiential, more teacher-centered course. The study was conducted over a three month period of time where 10th grade students were instructed by project based experiential learning method use in the Agricultural and Environmental Education programs in an at-risk area of Pennsylvania. The project was based on surface area, volume and coordinate geometry where some students were taught through the project based method and others through more traditional methods of classroom teaching. Hitz and Scanlon were working with students from a low socioeconomic background with average academic ability. Upon analysis of the posttest and pretest, students in the traditional, teacher-centered classroom scored higher on unit tests right after taking the test, however, more importantly is that the students in the experiential group showed a prolonged understanding of the subject matter, as was shown in the three week follow-up test to determine retention. Hitz and Scanlon continued that not only is retention greater, but so is a more positive attitude toward learning.

According to the Center for Collaborative Learning, or the CCL, (2009), the Boston, Massachusetts Pilot Schools Experiential Education Demonstration (PSEED), a three-year demonstration project serving seven schools from kindergarten to 12th grade, to better implement experiential learning in the classroom resulted in students using higher-order thinking where teachers asked probing questions as opposed to showing and telling (CCL, 2009). Students had more opportunities to participate in the learning rather than watching and ultimate responsibility of learning was in the hands of the students. One elementary school developed a unit on farming where students visited farms, prepared and tasted foods, wrote about their experiences and produced books on the unit. The prolonged use of experiential methods caused a change in student attitude and behavior and increased student engagement, as shown through interviews, observations, and documentation (CCL, 2009).

Outdoor learning, environmental education and student achievement: An example.

Perhaps one of the most significant pieces of research today is that of Lieberman and Hoody's (1998) *Closing the Achievement Gap*: *Using the Environment as an Integrated Text for Learning (EIC)* data compiled from the State Education and Environmental Roundtable. EIC recognizes the use of the natural living environment, as well as best practices in teaching to aid students in science developing a construct for learning. It is an opportunity to connect learning to the students' surroundings, but is not limited to the classroom environment. In fact, EIC can reach beyond the community to the surrounding ecosystems. Common features of EIC include a student centered environment with a cross categorical curriculum, collaboration and cooperation between students and teachers, and many problem solving scenarios based on a locale for which the students already relate. EIC has been known to increase the enthusiasm of student learning, as well as, develop character education values such as pride and ownership, which eventually decrease discipline issues, as measured by interview data, observation, and site surveys and summarized in a comparative analysis of disciplinary actions, attendance, and attitude.

Data collected from the 40 schools across the United States, 15 elementary, 13 middle, and 12 high schools, used in the study had varying objectives. Fourteen of the schools measured EIC against classrooms with traditional structure. Results indicated an increase in testing, grade point averages, and attitude, while decreasing the number of student absences. One hundred percent of Learning Survey data reported that EIC approaches helped students learning science better than teaching with traditional methods. More specifically, students who engaged in EIC for science demonstrated an increase in content knowledge, process skills, and principles. Students were better able to apply science to other situations having a deeper understanding of real-life application.

I could only surmise as to why more schools are not using the environment as an integrated context for learning. In larger urban areas, it would make sense that there would be some concern regarding student safety in using the out of doors, especially in areas where students might have to walk a short distance. Although the immediate school grounds might have an outdoor classroom, there may be a certain amount of risk related to being outside of the school in high crime areas. In addition, this type of instruction requires new preparation every year, depending on the group and background of the students.

Some schools may have outdoor classrooms. However, there is a certain amount of upkeep required of these classrooms. Resources for planting, tools, tables or benches, and paint supplies all come with an expense that many schools do not have the extra funds to support. It may become necessary to find funding through business-based grants, like Home Depot and the Department of Natural Resources, in order to sustain this valuable tool of learning.

Similar to Lieberman and Hoody (1998) is Glenn's (2000) research funded and supported by the National Environmental Education & Training Foundation (NEETF) and The North American Association for Environmental Education (NAAEP). Glenn completed case studies on seven different school buildings across the nation. In a first grade Pasadena, Texas classroom, 19 children consistently scored higher on standardized tests than their peers, in the same building. Research attributes this to instructional method. The teacher guides instruction by what the students encounter in their daily lives. The knowledge learned comes from real experiences.

Tompkinsville Elementary in Tompkinsville, Kentucky has experienced an increase of 25 percentage points in science standardized tests, over a four-year period, after implementing outdoor education classroom and teacher professional development. The school supports the notion that environmental curriculum based on the area in which they live has a positive impact on academic achievement. Thus, school administrators should consider monies used toward environmental education as an investment not only in students' futures but also in their academic achievement (Glenn, 2000).

Experiential education methods go a long way toward differentiation in and out of the classroom. All of the methods illustrated in this chapter can only help to broaden the scope of teachers' instructional strategies and skills.

This literature review addressed the foundation of experiential education, experiential education methods, teacher perception of science instruction, and methods of experiential education in regard to student achievement. Certainly, the studies discussed in this chapter have given light to substantial need for the research conducted in this study.

Chapter 3 addresses the methodology for which this study was managed. The following three research questions guide the hypotheses and variables found throughout the chapter:

1. What are the perceptions of elementary teachers in regard to science instruction?

2. If given the experiential tools to guide instruction, will teachers change their perceptions of science instruction?

3. Can pre-service elementary education teachers be influenced to use experiential instructional tools as a result of personal experience?

At the conclusion of Chapter 3, the reader will have a better understanding of the instrument used in data collection, as well as the workshop design.

Chapter 3: Methodology

This mixed methods study is based on an experiential workshop presentation, the administering of a pre and post test survey, and follow-up survey, where applicable. In order to determine the teacher's perception about science and science instruction, it was necessary to administer the Science Teachers Efficacy Belief Instrument (STEBI-A, B). The workshop was the variable used to attempt a positive change in teacher attitude towards science education. The STEBI was administered a second time, at the closing of the workshop, to find out whether or not a change occurred in the teacher's perception. This method was chosen as the most direct route to identifying whether or not a change occurred as a direct result of going through the professional development workshop.

Research Question

This study addresses the question, Can experiential education strategies improve elementary science teachers' perceptions of and practices in science teaching? The research collected is an attempt to better understand the relationship between teacher and practice.

Hypothesis

$H_0 1$: There will be no difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_1 1$: There will be a difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_0 2$: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

$H_1 2$: There will be a difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

The following questions defined the study:

1. What are the perceptions of elementary teachers in regard to science instruction?

2. If given the experiential tools to guide instruction, will teachers change their perceptions of science instruction?

3. Can pre-service elementary education teachers be influenced to use experiential instructional tools as a result of personal experience?

For determining answers to these questions, data was gathered and analyzed using a t-test for dependent means and a z-test for proportions.

Purpose

The purpose of this study is not only to determine whether or not experiential education strategies can change teacher perception of science and science instruction within the elementary school, but also to conclude whether or not it would be prudent to conduct further research on the topic. As an avid enthusiast for various methods in experiential education, I hope to broaden the spectrum of users. Much current experiential research is limited to the *Journal for Experiential Education, Journal for Environmental Education*, and *Journal of Science Teacher Education*. It is the intention to continue the research and make it available to other teacher education periodicals and journals and to further science education reform.

Workshop Design

The workshop design for this study was Project WET, a nationwide integrated environmental curriculum for grades K-12. "Project WET focuses on water resources as they relate to human needs and the natural world and is a source of interdisciplinary instructional activities…" (Project WET, 1995, ¶3).

Project WET began in 1984 by the North Dakota State Water Commission and was adopted by Montana University in 1989 and has spread throughout the United States over the last 20 years. Missouri adopted the program in 1995 where it was sponsored by the Department of Natural Resources and today has several local communities that support the funding of the program, now housed at Missouri State University.

The curriculum and activity guide for Project WET is written in a teacher friendly manner and provides 92 lessons connecting science process skills and Bloom's Taxonomy with an integrated approach for teaching science, mathematics, language arts, and social studies. Project WET is a not for profit agency so the curriculum is available only to those who have participated in the workshop. I became involved with Project WET, Wild and Learning Tree after being contacted by a professor who wanted to provide the training for pre-service teachers in a class for which I was an adjunct. After participating in the training along with my students, I was so excited that I decided to seek becoming a trained facilitator in the fall of 2008 and am now able to provide training for the three projects.

The workshop was held at Lindenwood University over a one-day period to equal seven hours time on task both in and out of doors. In the morning and early afternoon, approximately 38 participants rotated through a series of six centers. Students were broken into groups of three and spent 45 minutes with each of four facilitators and the instructor of the course. All facilitators were trained in Project WET, as well as the course instructor. A sample of lessons used were Macro-invertebrate Mayhem, Poison Pump, Is there Water on Zork?, and The Incredible Journey (Project WET, 1995) The lessons chosen were based on which provided the most rounded illustration of the varying concepts and skills that could be learned from each lesson. For example, in Macro-invertebrate Mayhem, the skill set for the lesson plan is gathering information, organizing (categorizing), and interpreting (drawing conclusions). The format of the lesson identifies the objectives, materials, connections, background, procedure, activities, assessment, extensions, and resources available. In Macro-invertebrate Mayhem, students play a game of tag to simulate the effects of environmental stressors on macro-invertebrate populations. Students wear a name tag and picture identifying them as one of the following: caddisfly larva, mayfly nymph, stonefly nymph, dragonfly nymph, damselfly nymph, midge larva, rat-tailed maggot.

The facilitator informs the participants that scientists often sample macro-invertebrate populations to monitor stream quality. Some macro-invertebrates are intolerant to certain stressors. In the game, the macro-invertebrate participants will try to cross a playing field (the stream) without getting tagged by environmental stressors. However, the macro-invertebrates have various movements that may hinder their progress across the field. If the macro-invertebrate is tagged while crossing the field, that person must go to the side-line and flip their card, which will show a picture of a more tolerant species. The round ends when all of the macro-invertebrates have been tagged or reached the end of the playing field. After each round, the facilitator records the number of each species on chart paper. What participants will eventually find is that the numbers of macro-invertebrates fluctuate dependent upon the stressors. Thus, during certain conditions some populations thrive while others decline. The objective of the game is to illustrate how water quality affects differing species and to explain how population diversity can help us to determine the health of an ecosystem. This game fulfills several objectives: simulation of real world events, physical activity, and teaching of science concepts. The lesson plan and format are provided in Appendix C.

The curriculum and activity guide is divided into sections based on the needs of the teacher. For convenience, the writers of Project WET developed cross-referencing grids to aid the teacher in finding appropriate activities quickly. The eight grids are divided by topic, subject area, time, grade level, teaching method, assessment strategies, skills (Bloom's Taxonomy), and the Environmental Education framework. There is also a section regarding measurement, resources, a glossary and an alphabetical listing of the lesson titles, along with the lesson plans.

Prior to the beginning of the workshop students were given 20 minutes to complete the STEBI- B pre-survey questionnaire. This is a paper-pencil survey. Upon completion of the Project WET lessons, participants were given ‘a float through the guide’ in which instructors handed out the curriculum and activity guide and walked the participants through special sections of interest, such as the history of Project WET and the skills grids available for quickly choosing an appropriate lesson plan.

Participants were then split into small groups of two or three and given the opportunity to role play teaching one of the activities in the guide. Verbal reflection was given between groups’ role play. Many students had ideas about how they could use the lessons within varying units of study, for example, using the Poison Pump lesson plan (a plan to pinpoint where the spread of cholera is coming from within a small town) in a study of 1800’s Europe or 19th century St. Louis , where major cholera outbreaks killed thousands of people. This could be an interdisciplinary study of science and history. One group suggested using the lesson in relation to today’s H1N1 influenza scare while another suggested a unit in waste management. At the end of the workshop, participants were given time to take the STEBI-B post survey before leaving.

Sample Selection

The study participants were obtained through contacting an adjunct instructor, from a local university program, who taught an elementary science methods course for pre-service teachers. The opinions of the participants about science and science instruction were not revealed to the primary investigator. No limitations were placed on number of years teaching, educational background, age, or gender. Attending the workshop was voluntary for the class.

Sample Demographic Information

Table 2

Sample Demographics

Gender	
Male	2
Female	35
Age	
20-29	32
30-39	6
40 +	0
Participation	95%
Major Area of Study	
Early Childhood	1
Elementary	30
Special Education	4
Other	3
Ethnicity	
White-not Hispanic	35
African American	2
Other	1

The workshop was comprised of two males and 35 females which is most typical split between genders for early childhood and elementary education majors. Students enrolled in the course, Elementary/Middle School Science Methods, were in their senior year of study. Thirty-two individuals were between the ages of 20 and 21, while five individuals were above the age of 30. Ninety-five percent of students enrolled in the course, participated in the workshop.

This workshop was open to all students regardless of race or ethnicity. However, data reflects 34 White, two African American, and one Pacific Islander student present, which is fairly typical of the teaching profession.

Independent Variables

Workshop Design. Project WET is a nationwide integrated environmental curriculum for grades K-12 (Project WET, 1984, 1995). The Project WET framework reflects national science goals and objectives, as well as, the grade level expectations written by the Missouri Department of Elementary and Secondary Education.

Participants. The Project WET workshop was limited to pre-service teachers and their teacher spouses.

Dependent Variables

STEBI-B. The Science Teacher Efficacy Belief Instrument-A and B, likert scale scores, were used to determine teachers' perceptions of science and science teaching.

Data Instruments

During the period of the study, pre-service and in-service teachers engaged in an experiential education workshop, where a paper copy of the Science Teacher Efficacy Belief Instrument-STEBI- B (Enochs & Riggs, 1990) was administered as a pre survey, to test for a significant difference between good and poor teacher perception of science instruction. Following the workshop, a second paper copy of the STEBI- B was administered to the same group of participants. However, the mortality loss of the survey was one student who needed to leave early due to employment issues. To achieve the results of the likert-style survey, a z test for the difference of proportions and a t test for the difference in means for individual questions were used for analysis. A copy of the STEBI- B is located in Appendix D.

The purpose of this study was to determine whether or not experiential education strategies in the elementary classroom can alter teachers' perceptions of science instruction. In the end, I am looking for a significant difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop, as well as a significant difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop

This chapter has been a compilation of the methodology used to conduct the study. Chapter 4 will address the methodology in more detail as the data will be analyzed to determine whether or not the null hypotheses are to be accepted or rejected.

Chapter 4: Results

This chapter includes a discussion of the data examined during the study. The demographics of the sample, as well as the original research question provide the foundation for data collection and conclusions were made based on the statistical analysis.

The purpose of this study was to identify the perceptions that elementary teachers have concerning science instruction and to determine whether or not the use of experiential instruction changes those perceptions. For the question, can experiential education strategies improve elementary science teachers' perceptions of and practices in science teaching, the following research questions defined the study:

1. What are the perceptions of elementary teachers in regard to science instruction?
2. If given the experiential tools to guide instruction, will teachers change their perceptions of science instruction?
3. Can pre-service elementary education teachers be influenced to use experiential instructional tools as a result of personal experience?

Analysis of Demographic Data

The population of this study included 38 pre-service teachers. Refer to Table 1, in Chapter 3, for a compilation of the data taken from the demographics portion of the survey.

The participants in this workshop were predominantly white, 20 to 29 year old students, whose major area of study was, in fact, Elementary Education. However, also participating were students whose major area of study was either Early Childhood Education or Special Education with an age range from 20 to 40 years. Each respondent completed the STEBI-A or B both prior to and after participating in the workshop. It should be noted that the majority of students were female, white, not Hispanic, which is typical of this major area of study for the chosen study site.

Research Question 1: What are the perceptions of elementary pre-service and in-service teachers in regard to science instruction?

Thirty-eight pre-service teachers answered all 23 questions on the STEBI-B survey. Each question is directly related to teacher perceptions, so an analysis of each individual question was required to understand the whole of teacher perceptions. The survey was a likert-type scale. Each student was asked to answer to what degree they believed the statement to be true, according to the scale which was recorded as SA=strongly agree, A=agree, UN-uncertain, D=disagree, SD= strongly disagree. The following tables are a record of the data represented.

Table 3

Pre-service teacher attitudes toward teaching science

			Pre	Post
2.	I will continually find better ways to teach science.			
		Strongly Agree	22	24
		Agree	14	18
		Undecided	1	1
		Disagree	0	0
		Strongly Disagree	0	0
3.	Even if I try very hard, I will not teach science as well as I will most subjects.			
		Strongly Agree	0	0
		Agree	5	4
		Undecided	7	6
		Disagree	21	20
		Strongly Disagree	5	7

Table 4

Pre-service teacher perception of effectiveness in teaching science

		Pre	Post
5.	I know the steps necessary to teach science concepts effectively.		
	Strongly Agree	0	7
	Agree	13	26
	Undecided	20	4
	Disagree	5	0
	Strongly Disagree	0	0
6.	I will not be very effective in monitoring science experiments.		
	Strongly Agree	0	0
	Agree	3	2
	Undecided	6	3
	Disagree	21	22
	Strongly Disagree	8	10
8.	I will generally teach science ineffectively.		
	Strongly Agree	1	0
	Agree	0	1
	Undecided	4	2
	Disagree	20	20
	Strongly Disagree	13	14
12.	I understand science concepts well enough to be effective in teaching science.		
	Strongly Agree	2	9
	Agree	23	24
	Undecided	10	4
	Disagree	3	0
	Strongly Disagree	0	0

Table 5

Pre-service teacher perception of conceptual understanding in science

		Pre	Post
17.	I will find it difficult to explain to students why science experiments work.		
	Strongly Agree	0	0
	Agree	4	2
	Undecided	7	8
	Disagree	25	19
	Strongly Disagree	2	8
18.	I will typically be able to answer students' science questions.		
	Strongly Agree	3	9
	Agree	21	21
	Undecided	11	7
	Disagree	3	0
	Strongly Disagree	0	0
19.	I wonder if I will have the necessary skills to teach science.		
	Strongly Agree	4	1
	Agree	12	9
	Undecided	6	8
	Disagree	16	16
	Strongly Disagree	0	2
20.	When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the students understand it better.		
	Strongly Agree	0	1
	Agree	2	0
	Undecided	8	4
	Disagree	26	20
	Strongly Disagree	2	10

Table 6

Pre-service teacher perception of student and teacher motivation in science

		Pre	Post
21.	Given a choice, I will not invite the principal to evaluate my science teaching.		
	Strongly Agree	4	0
	Agree	4	4
	Undecided	8	5
	Disagree	26	17
	Strongly Disagree	2	11
22.	When teaching science, I will usually welcome student questions.		
	Strongly Agree	17	20
	Agree	19	16
	Undecided	2	1
	Disagree	0	0
	Strongly Disagree	0	0
23.	I do not know what to do to turn students on to science.		
	Strongly Agree	0	0
	Agree	4	1
	Undecided	13	2
	Disagree	2 0	22
	Strongly Disagree	1	12

A *z* test for the difference between means was administered to determine if there was a difference in the average response on the likert-type scale when comparing the pre and post surveys. Then a *z* test for the difference between proportions was used to find a significant difference, if any, in the way participants answered the questions before and after the workshop.

Hypotheses for the *z* test for proportions were as follows:

$H_0 1$: There will be no difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_1 1$: There will be a difference in the number of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participation in the workshop.

$H_0 2$: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

$H_1 2$: There will be a difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

Hypotheses for the *z*-test difference between means were as follows:

$H_0 1$: There will be no difference in the average likert scale response in the combined strongly agree/agree categories when comparing responses before participation in the workshop to responses after participation in the workshop.

$H_1 1$: There will be a difference in the average likert scale response in the combined strongly agree/agree categories when comparing responses before participation in the workshop to responses after participation in the workshop.

$H_0 2$: There will be no difference in the average likert scale response in the combined strongly disagree/disagree categories when comparing responses before participation in the workshop to responses after participation in the workshop.

$H_1$2: There will be a difference in the average likert scale response in the combined strongly disagree/disagree categories when comparing responses before participation in the workshop to responses after participation in the workshop.

At a confidence level of .05, a *z*-test for the difference between two means yielded a *t*-test value of 0.685 (see table 7), no significant difference was found between the averages for the strongly agree/agree and strongly disagree/ disagree categories on the pre and post survey responses. However, to be thorough, a question-by-question analysis was also completed, on selected questions, to check for any significant difference between the number of respondents to agree and disagree categories for the questions.

Table 7

z test: Two Sample for Means between SA/A

	Variable 1	Variable 2
Mean	6.807692	7.653846
Known Variance		
Hypothesized Mean	0	
z	-0.35955	-0.16641
P(Z<=z) two tail	0.719186	
z Critical two tail	1.959964	

Table 8

z test: Two Sample for Means between SD/D

	Variable 1	Variable 2
Mean	8.423077	8.846154
Known Variance	95.37	72.69
Hypothesized Mean	0	
z	-0.16641	
P(Z<=z) two tail	0.867836	
z Critical two tail	1.959964	

Research Question 2: If given the experiential tools to guide instruction, will teachers change their perceptions of science instruction?

On the survey tool, questions 1, 4, 7, 9, 10, 11, and 13-16 are questions focusing on the achievement of the student. The remaining questions are more closely related to the general perceptions, attitudes, and beliefs a pre-service or in-service teacher might have at any given time. For the purpose of this study, questions 2, 3, 5, 6, 8, 12, and 17-23 have been analyzed individually with a z test for the difference in proportions to determine whether or not there was change in perceptions of science instruction after the administration of the workshop.

At a confidence level of .05 hypotheses for the z-test for the difference in proportions were as follows:

$H_0$1: There will be no difference in the proportion of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participating in the workshop.

$H_1$1: There will be a difference in the proportion of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participating in the workshop.

$H_0$2: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

$H_1$2: There will be a difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

Statement number 2: I will continually find better ways to teach science.

Pre survey data indicates that 97% of participants responded to statement number 2 that they will indeed try to find better ways to teach science. This is reflected in the z-test values of 1.00 for the strongly agree/agree group and a score of 0, for the strongly disagree/disagree group, and indicated no significant difference in the outcome of the pre and post survey question.

Statement number 3: Even if I try very hard, I will not teach science as well as I will most subjects.

Of those same respondents in statement number 2, answers to number 3 indicated only 62% disagreed that they would not teach science as effectively as other subjects, leaving 38% as either undecided or in agreement that they may not be as effective as other areas of study. Although 38% is over one third of the population, statement number 3 also indicated that there is no significant difference in the outcome of the pre and post survey questions, with *z* scores at -0.34 for strongly agree/agree and -0.17 strongly disagree/disagree respectively.

Statement number 5: I know the steps necessary to teach science concepts effectively.

Knowing science process skills and the steps in the scientific method are a standard for science teachers on any grade level. Unfortunately in this sample, only 36%

of participants felt ready to teach science concepts effectively prior to the workshop. After completing the activities in the experiential workshop there was an increase of 53% of the respondents who perceived themselves as knowing science concepts and process skills well enough to teach effectively. This is the largest increase in the question-response survey. Using -1.96 and 1.96 critical values and a *z* test to check for a difference in proportions, the *z*-test value of 3.57 for the strongly agree/agree responses and -2.27 for the strongly disagree/disagree responses exceed the critical value on the two-tailed test, which allowed the researcher to reject the null hypothesis and note that there was a significant difference making this topic worthy of further study.

Statement number 6: I will not be very effective in monitoring science experiments.

More than 80% of the respondents disagreed that they would be ineffective in teaching science, as well as the reverse where more than 80% agree that they understand science concepts well enough to be effective in teaching science. Although these percentages support one another, they do not support the findings in statement number 5, where in the pre-survey, 64% of respondents did not feel they would teach science concepts effectively. Twenty-three percent of respondents indicated that they were unsure as to whether or not they could monitor science experiments effectively. *Z* scores show -0.4 for strongly agree/agree and 0.17 for strongly disagree/disagree and do not allow the researcher to reject the null hypothesis.

Statement number 8: I will generally teach science ineffectively.

The total of pre-service teachers who did not believe that they would be ineffective at teaching science, in general did not change from the pre and post survey responses. Approximately 90% either strongly disagreed or disagreed to the statement. *Z* scores of zero support the no change evidence.

Statement number 12: I understand science concepts well enough to be effective in teaching science.

Z-test values of 1.40 for strongly agree/agree and -1.7 for strongly disagree/disagree on statement number 12 showed no significant difference in proportions. Although, one would think these scores would coincide with those in statement number five, where more than 50% of the population believed they did not know the steps to teaching science concepts effectively, the collective responses do not allow the researcher to reject the null hypothesis noting a significant difference to make this topic worthy of further study.

Statement 17: I will find it difficult to explain to students why science experiments work.

In regard to aiding students in understanding science concepts by explaining to them how things work, on average, 70% or more of respondents felt they would not be at a loss as to how to help the students understand it better. Upon evaluating z scores for statement number 17, -0.83 for strongly agree/ agree and -1.03 for strongly disagree/disagree responses do not allow the researcher to reject the null hypothesis noting a significant difference in the topic.

Statement 18: I will typically be able to answer students' science questions.

Almost 40% of respondents felt they would, typically, not be able to answer some science questions. Upon evaluating *z* values for questions 18, the values of 1.03 and -1.75 indicate that responses for question number 18 did not fall inside of the critical value range and do not allow the researcher to reject the null hypothesis to note a significant difference in the topic.

Statement 19: I wonder if I will have necessary skills to teach science.

On average, prior to the workshop, 42% of the participants were curious as to whether or not they would have the necessary skills to teach science. This percentage decreased by almost half on the post-survey questionnaire. Still, *z* scores indicate there is no significant difference in proportion, leaving no choice but to not reject the null hypothesis that:

$H_0$1: There will be no difference in the proportion of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participating in the workshop.

$H_0$2: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

Statement 20: Given a choice, I will not invite the principal to evaluate my science teaching.

Z scores for statement 20 are -1.30 and 0, for strongly agree/agree and strongly disagree/disagree respectively, so the researcher did not reject the null hypothesis. The difference in pre and post survey responses to statement number 20 is an increase of two within the strongly disagree/disagree categories combined. A shift from 68% to 78% of the respondents indicated that they would indeed be willing to invite the principal into the classroom to evaluate their science teaching.

Statement 21: When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.

Seventy-three percent of the respondents to both the pre and post the survey statements believed they could help students to better understand science concepts. This response is in agreement with statement number 8 and 12, but do not support pre survey responses to statement number 5, where respondents claimed to not know science concepts well enough to teach science effectively. However, z scores of -1.206 and -1.54 for strongly agree/agree and strongly disagree/disagree still indicate there to be no significant difference in responses to statement 21.

Statement 22: When teaching science, I will usually welcome student questions.

There was no change in the pre and post survey responses for statement number 22, concerning student questioning. This is supported by a z score of zero which indicates no significant difference in survey responses.

Statement 23: I do not know what to do to turn students on to science.

Interestingly enough, only five participants felt they might not know what to do in order to turn students on to science. When associated with statement 19, one might say, participants may not have the skills to teach, but they do know how to motivate the students to learn science. Z scores for question 23 are -1.37 and 0.34 for strongly agree/agree and strongly disagree/disagree respectively and do not allow the researcher to reject the null hypothesis and not a significant difference in proportions when comparing pre survey responses to post survey responses.

The final research question asked the following:

Research Question 3. Can pre-service elementary education teachers be influenced to use experiential instructional tools as a result of personal experience?

Yes, they absolutely can be influenced to use experiential instructional tools as a result of personal experience. This is evident from the survey results collected using Survey Monkey as a vehicle for collection. Nine follow-up questions were issued to the participants in the spring semester of the academic year. Although the results of the STEBI-B seemed to be indicative of little change between the pre and post survey responses, the nine follow-up questions support a trend of change (See appendix F for a list of follow-up questions). The results of the nine follow-up questions, distributed using a web-based survey company, are illustrated in the following pie charts.

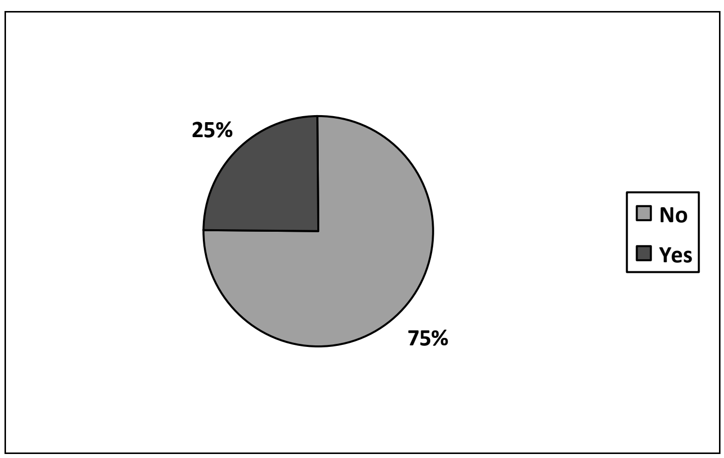

Figure 4. Number of respondents who are student teaching in winter 2010.

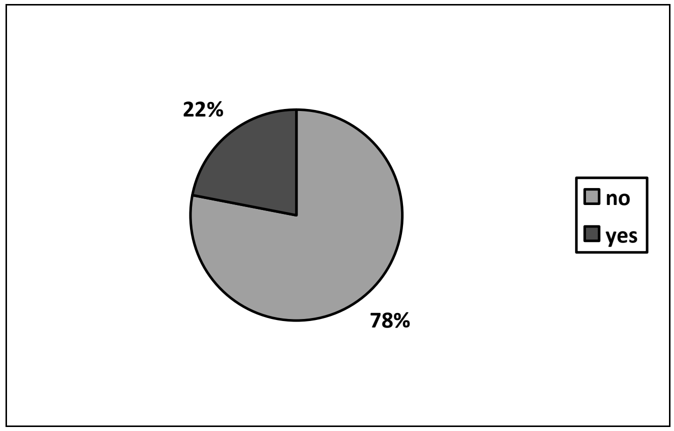

Figure 5. Number of respondents who have implemented a Project WET lesson.

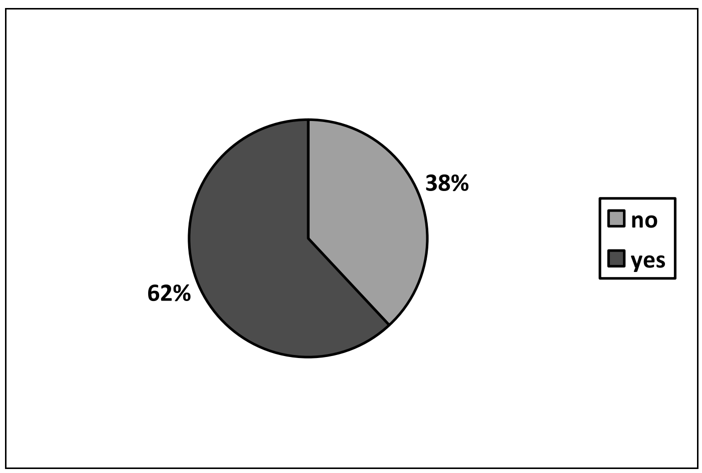

Figure 6. Familiarity to science concepts prior to instruction.

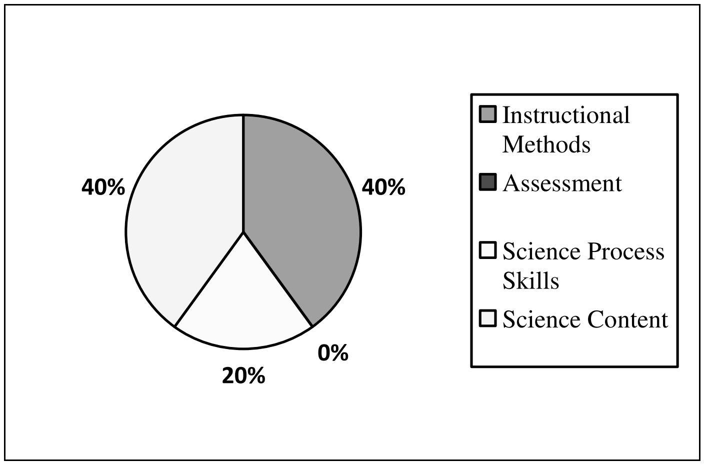

Figure 7. Science concepts learned.

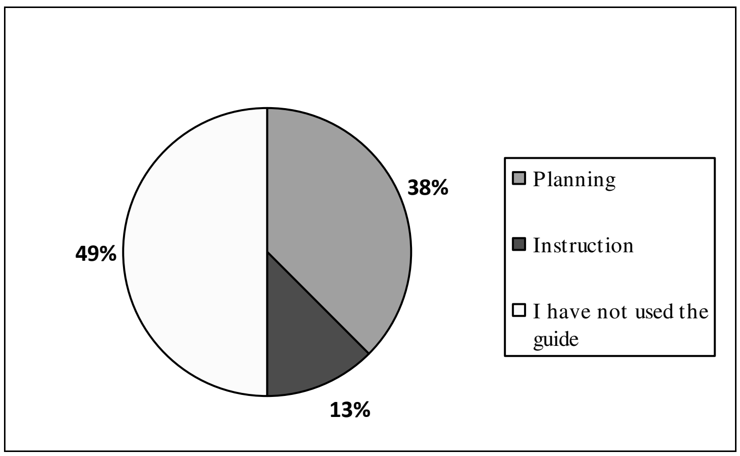

Figure 8. Utilization of Project WET guide.

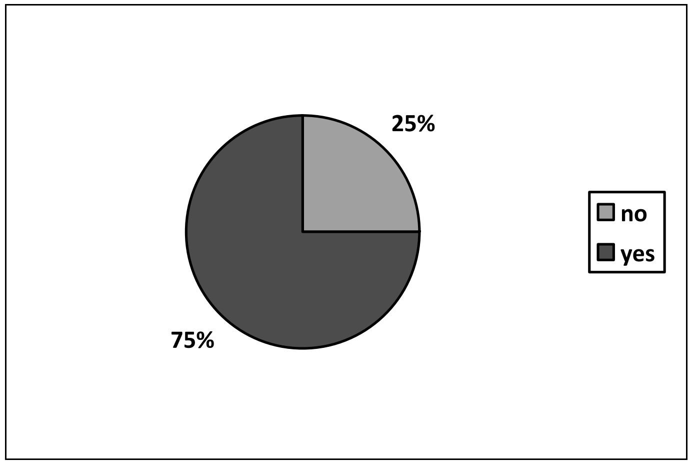

Figure 9. Science teaching comfort level.

The last two questions of the follow-up survey were open-ended questions in order to try and gain some idea as to how memorable the lessons were for the students. Question number eight asked, “What do you remember most about the workshop?” One respondent said, “I remember doing the experiment to find out which liquid was water and building a boat that would make it through a storm”.

Another student commented on that same activity. “I loved the activity we did outside when we were told to make a boat that was sturdy enough to hold the egg during a storm. The kids will enjoy being outside and it gives them a chance to be creative. I loved it!” Others commented on the ways to gain student attention, varying teaching strategies, and the fact that science can be fun.

The final question for follow-up asked how the students would use the workshop to guide their instruction. One student said they would try to be a more hands-on teacher, while another commented that the activities would keep the students’ interests. Perhaps the most provocative statement was “I will use this because it reached to different age levels and in special education some students may not understand in the same way as others and this book gives different ways to do things." This statement drives home the fact that experiential learning really does provide many of the tools necessary to teach to a diverse population.

In conclusion, 12 of the 13 statements regarding teacher efficacy in teaching science did not show a significant difference in the proportions of responses for comparison of the pre and post survey, as indicated by the *z* values and overall allowing the researcher to conclude that there is not enough evidence to reject the null hypothesis that:

$H_0$1: There will be no difference in the proportion of respondents answering strongly agree/agree before participation in the workshop when compared to respondents answering strongly agree/agree after participating in the workshop.

$H_0$2: There will be no difference in the number of respondents answering strongly disagree/disagree before participation in the workshop when compared to respondents answering strongly disagree/disagree after participation in the workshop.

However, the nine follow-up questions give hope to the fact that after taking an experiential workshop and having had time to think about, plan and use an activity guide, respondents have a better understanding of and comfort level in science instruction.

Chapter 5: Recommendations and Implications

Based on the data gathered from this study, 12 of the selected 13 survey statements rejected the null hypotheses. Therefore overall, this researcher can conclude that we can reject the null hypothesis that experiential education does not change elementary teachers' perceptions of and practices in science teaching. A discussion of variables, inferences, and recommendations for further study of experiential education has bloomed from the data gathered.

Variables

Workshop design. After careful consideration, it would seem that the workshop design was flawed from the outset. In general, the workshop was limited by time, but Project WET is a longitudinal curriculum. Given the ideal opportunity, I would have chosen to have the workshop over a period of about three days. Although lessons from the curriculum can stand alone, it is more purposeful to use them in a unit of study. Units of study are typically several days, if not weeks, in coming to completion. The workshop would have been more effective if given over more than one-day, perhaps even a week. Although, general consensus by students and facilitators seemed to be that the workshop was a very positive experience. By the end of the day, students were viewing teaching science as something that does not have to be uncomfortable. Many students agreed that they enjoyed the hands-on activities and that the lessons within the activity guide were easy to follow with little preparation, especially for those activities that only needed preparation one time and then could be used over and over again. An example would be the blocks showing the various stages of water used in "The Incredible Journey." Once they have been prepared, they could be re-used many times.

A longitudinal study is also the best avenue for reflection. Metaphorically speaking, reflection allows individuals to turn the light of experience back on their mind. Careful consideration of any given situation allows an individual to go back over the what, when, where, and why of an opportunity. Reflection bridges experience and learning. A professor of mine once said that the cycle of reflection is a "triangular so what" model (See Figure 10).

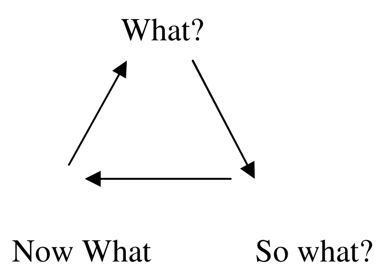

Figure 10. The "what, so what, now what" reflection cycle.

When one identifies "what", it is important to be able to lay claim to the significance of 'what', meaning 'so what'. What makes the task worth doing? What is central to the study? Then, when the task is done, one makes a reflection connection by evaluating what comes next, the "now what" of the triangle. Now that I know what I know, what can, or will, I do with this new knowledge? If there is no growth from an experience, there has been no learning. In the Project WET workshop, time was a constraint on reflection. Participants were able to reflect verbally throughout the day by sharing thoughts and ideas. However, participants were not given time for quiet personal reflection on the day's events. That lessened the level of reflection taking place.

Participants. Reflection was also affected by the participants. Originally, the workshop was scheduled to include both pre-service and in-service teachers. If given the opportunity to do this again, I would definitely go to greater lengths to insure that I had a representative sample of each. As it were, I did not know until the day of the workshop whether or not there would be any in-service teachers in attendance. The pre-service teachers were taking the course by which Project WET was offered. I knew there would be a reliable sampling from this group. The plan was to do follow-up visits with the in-service teachers by asking them to participate in journal reflections, as well as scheduling a time for the investigator to visit their classrooms at which point they would then retake the STEBI-A. Unfortunately, there were no in-service teachers in attendance of the workshop.

Data Instrument. In regard to the data instrument, the STEBI-A and B, I do not believe I would use the exact same statements were I to do this again. Although I see the significance of all 23 statements, I did not evaluate 10 of the statements and could probably have thrown those statements out from the onset. My reasoning was that those 10 statements were not necessarily based upon teacher perception of science or science teaching, but rather students and their achievement. I did find that the 13 statements relating to teacher efficacy were appropriate given the information I was looking to find. However, in the future, I see the necessity, also, of having a few open-ended questions that allow the participants some reflection prior to and after the workshop. I would include questions that were more informative of what participants knew about experiential education, its uses, and their perceptions of the method. For example, asking the question, “What is your definition of experiential learning?” would have given me some insight into whether or not participant thinking matched the study’s definition of experiential education. If someone knew nothing about experiential learning, he or she could have had a much more profound experience with the workshop than someone who already knew the acumen of using experiential education in the classroom.

Inferences and Recommendations

I would like to make some inferences regarding the data instrument questions used for the evaluation. Review the questions and consider Table 9. I have divided 13 of the STEBI-A, and B statements into two separate groups. Common themes between each statements were attitude, behavior, and perception of science teaching and the knowledge of science concepts. Although they are most certainly precursors to efficacy, attitude, perception, and behavior are difficult to measure. It is unlikely that any pre-service teacher, worthy of teaching, would admit that he or she would not continually look for better ways to teach science and one would expect that if they tried harder, they would produce better results. I expected the strongly agree/agree answers to these first two statements, from Table 2, to be fairly high. What did surprise me was that 10 and 12 of the 38 participants in the pre and post survey, respectively, admitted that they either did not know or were in agreement that they would not teach science as well as other subjects.

Table 9

Attitude, Behavior, and Perception of Science Teaching	*Knowledge of Science Teaching*
I will continually find better ways to teach science.	I know the steps necessary to teach science concepts effectively.
When teaching science, I will usually welcome students' questions.	I understand science concepts well enough to be effective in teaching.
Even if I try very hard, I will not teach students science as well as I will most subjects.	I will typically be able to answer science questions.
I will generally teach science ineffectively.	I will find it difficult to explain to students why science experiments work.
I will not be very effective in monitoring science experiments.	
I wonder if I will have necessary skills to teach science. .	
Given a choice, I will not invite the principal to evaluate my science teaching.	
When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the students understand it better.	
I do not know what to do to turn students on to science.	

What needs to be known now is why the participants felt they would not teach as well in science as in other subjects. Likely, it is the comfort level they have for teaching science. One question necessary to surveying teacher efficacy for science instruction would be to know the amount of time the participant has had preparing for teaching science content. This was not a part of the STEBI-B, but I believe it is equally important.

The level of comfort for teaching science also has a direct bearing on statement number 21. If respondents were given a choice, four strongly agreed that the likelihood of inviting the principal in to view science lesson, would be nil. After the workshop, there were no respondents who strongly agreed there would be no invitation for the principal to visit the science classroom. Again, this reinforces that if given the opportunity to participate, practice in, or teach experiential education methods there is a positive outcome.

In that same respect, there was a positive outcome in the responses to statement number 23. Prior to the workshop only one person strongly disagreed that they didn’t know what to do to turn students on to science. After the workshop, 12 students strongly disagreed. Again, this has to do with the level of comfort one has to the subject. If given enough opportunity to interact with science through hands-on investigations that are real to life, then it would seem that one’s level of comfort for doing science would increase. That does not necessarily mean they will come to love science, but it does open the window for less of an aversion to science.

The responses to statement number five (Table 4) also had some interesting results. The statement was, “I know the steps necessary to teach science concepts effectively”. Prior to the workshop, 20 participants answered this question as undecided. After the workshop, only four participants answered the same way. Prior to the workshop, 13 respondents agreed that they knew the steps and after the workshop, 26 agreed that they knew the steps necessary to teach science concepts effectively. At the end of the workshop, no respondent answered in disagreement that they knew the steps necessary to teach science concepts effectively. This tells me that the workshop helped to define the scientific method for many students and also helped to affirm for those students who believed they already understood.

Certainly the knowledge of science concepts is an outcome of science teacher preparation. Students who have not taken a course in Geology would find it difficult to instruct students on the various formations of rocks and minerals. It is difficult to teach what is not known or what has not been experienced. Chapter 1 pointed out the number of science credits needed to fulfill an elementary teaching certificate, above the general studies level, to be three credits in the state of Missouri. Those three credits are bound to the methods course for teaching elementary science. A certificated elementary school teacher can then test for a middle school science certificate. If he or she passes the national exam at the required passing score for the state, this teacher becomes certificated and can advance to science in the middle grades with no further science education. It is no surprise, then, that high school teachers find science concept skills lacking for incoming freshmen. High schools science teachers have a minimum of 18 hours in science credit, at least lending potential to good science teaching at the high school level, but what of elementary and middle school teachers who have had the minimum three credit hours? One cannot gain an understanding of any subject without spending some time studying that subject.

It is clear that teacher preparation is a key to successful and effective instruction. In the case of this study, I noticed that some respondents were taking the methods class out of order. Ordinarily, methods courses are taken just before the student teaching semester. Of those students who answered the follow-up survey questions, only 25%

were student teaching in the semester following the workshop which took place during the science method course. It is likely that the number of positive responses to the workshop would increase had more students been in the student teaching semester and availing themselves to the Project WET activity guide. I believe this to be true because of the positive trend in the follow-up survey. It also makes sense to me that if the workshop would have been longer and had been more depth than breadth, it would have likely made a deeper impression on participants, especially with a follow-up component. An idea for further research would be one where the follow-up component actually required the researcher to visit the respondents in the student teaching classroom, and perhaps even watch the student teaching one of the Project WET lessons.

While teacher preparation is a key component to success in the classroom, professional development of continuing teachers is crucial to maintaining effectiveness. Since experiential education easily lends itself to workshops focused on science education, as well as other core subjects, and is written to be grade level appropriate, it could be especially useful to differentiate instruction. One pre-service teacher noted that "…some students may not understand in the same way as others…" and she intended to use the workshop information to help her differentiate instruction for special education students. It would be most effective to engage in experiential professional development that is ongoing.

Pre-service teachers do have the benefit of having, for lack of a better term, professional development in the form of class work daily. They are continually taking in new developments and this continues on into the first year. Many colleges and universities have mentoring programs for first year teachers, but after the first year, new teachers are on their own. Unfortunately, professional development is often a one-time seminar or workshop. If only a handful of pre-service teachers indicated they had experienced the workshop and used its components a few weeks or even months later, as indicated in the nine follow-up survey questions, I imagine that ongoing professional development of the same kind would cause teachers to continually use the method until it became second nature to them. Even though the z-scores from the STEBI-A did not indicate a significant difference in outcomes, there was a difference, albeit small. I am inclined to believe that extended time within the workshop and follow-up visits to student teachers in the classroom would lead to substantial gains in the use of experiential education and in student achievement.

Thus far in my inferences and recommendations, I have indicated a need for change in the following areas:

1. Using survey questions to find out respondents' definition of experiential education.
2. Identifying how much time respondents have spent in preparation of science.
3. A need for more specific science coursework for elementary and middle school pres-service teachers.
4. More workshop time to explore experiential education methods.
5. Follow-up visits with respondents.
6. Ongoing professional development.

One final recommendation would be to offer experiential education professional development to in-service teachers. There is likely a profound difference in the attitudes, behaviors, and perceptions of new teachers as opposed to those that have been teaching for several years. It would be interesting to know how many longtime classroom teachers already use some form of experiential education, as well as, those who do not and whether or not they are opposed to the idea. Do teachers view professional development on new topics as another one-time wonder?

Final Reflection

If I had the workshop to implement again, I would change several things. I have always believed that when a person is immersed into subject matter that they get a better understanding of the subject matter. For example, if I know nothing about pioneering history and take a week long workshop that requires me to dress as a pioneer, use pioneering tools to build fire, cook meals, and farm ground, then I will probably gain a better understanding of what it meant to be a pioneer because I have done it. Experiential education is much the same. It requires a person to enter a role that they would otherwise not normally do to experience life in that role. Many methods require risk taking and challenge. Providing lessons from Project WET was a very basic form of experiential learning because the lessons do require one to take a role. However, the lessons can also stand alone. They do not have to be presented as a unit of study. It has been my experience that interdisciplinary thematic units of study offer a good jumping off point for the schooling of experiential education. They can also be lengthy. It takes time and practice to learn new things. Thus, if I had to do this again, I think I would build a workshop around a theme. I would offer it as a week-long camp and design my evaluation to reflect what participants know and do not know, learned and did not learn about experiential education. My follow-up would be in the form of classroom visits to see teachers in action and to identify change in their teaching. I would also want to collect reflective journals, both during the camp experience and on follow-up visits. Reflection urges growth in teaching. Through reflection one experiences change. This study is all about inciting instructional change through experiential education, more specifically change in science instruction. If change occurred in the attitudes, behaviors, and perceptions of those who teach science, or any other subject, I believe it to have been well worth the time.

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Appendix A. DESE Elementary Teaching Certification Requirements

MISSOURI DEPARTMENT OF ELEMENTARY AND SECONDARY EDUCATION
CERTIFICATION REQUIREMENTS FOR
ELEMENTARY (GRADES 16)

Revised ***January 2008***

I. GENERAL REQUIREMENTS:
A. A baccalaureate degree from a college or university having a teacher education program approved by the Missouri Department of Elementary and Secondary Education or from a college or university having a teacher education program approved by the state education agency in states other than Missouri;
B. Must have recommendation of designated official for teacher education in the college or university;
C. Must have a grade point average of 2.5 on a 4.0 scale overall and in the major area of study;
D. Must complete the content knowledge or specialty area test designated by the State Board of Education with a score equal to or greater than the Missouri qualifying score;
E. Completion of professional requirements, as determined by the recommending college or university, which may exceed these minimum requirements; and
F. Individuals who completed their teacher education program outside of the United States shall provide documentation of completion of course work in the following:
1. English Composition, two (2) courses, each a minimum of two (2) semester hours;
2. U.S. History, three (3) semester hours; and
3. U.S. Government, three (3) semester hours.

II. PROFESSIONAL REQUIREMENTS: A minimum of sixty (60) semester hours of professional preparation. Competency must be demonstrated in each topic listed to the satisfaction of the teacher preparation institution.
A. Foundations for Teaching (Minimum requirement of ten (10) semester hours):
1. Foundations of Education;
2. School Organization and Management;
3. Personalized Teaching Strategies;
4. Self Awareness and Human Relations;
5. *Child Growth and Development;
6. Psychology of Learning;
7. *Psychology and/or Education of the Exceptional Child (including the Gifted); and
8. Behavior Management Techniques (Interpersonal Relationships);
B. Teaching Methods (Minimum requirement of fifteen (15) semester hours):
1. Reading (three (3) courses required, minimum total of eight (8) semester hours);
2. As a minimum, the teaching method competencies shall include:
a. Children's Literature;

b. Language Arts;
c. Math;
d. Science;
e. Social Science to include Geography and Economics;
f. Art;
g. Music;
h. Physical Education; and
i. Microcomputer Applications in Education; and
C. Clinical Experiences (Minimum requirement of ten (10) semester hours):
A minimum of two (2) semester hours of field experiences prior to student teaching and a minimum of eight (8) semester hours of student teaching in elementary grades are required. Teachers meeting certification requirements for Early Childhood or Middle School teaching certificates will be exempt from this clinical experience requirement. A fully certificated secondary teacher with two (2) or more years of secondary teaching experience may satisfy this requirement through the completion of a two (2) or more semester hour practicum at the elementary level; and *Revised* ***January 2008***
D. Elementary School Courses:
1. Courses appropriate for Elementary grades:
a. Mathematics (two (2) courses, minimum total of five (5) semester hours)
b. Economics;
c. Geography;
d. Health; and
e. Art or Music; and
2. Area of Concentration:
The student must have a total of at least twenty one (21) semester hours in an area of concentration.
***Denotes minimum of two (2) semester hours required.**

Appendix B. The principle of experiential education practices are:

1. Experiential learning occurs when carefully chosen experiences are supported by reflection, critical analysis and synthesis.

2. Experiences are structured to require the learner[2] to take initiative, make decisions and be accountable for results.

3. Throughout the experiential learning process, the learner is actively engaged in posing questions, investigating, experimenting, being curious, solving problems, assuming responsibility, being creative, and constructing meaning.

4. Learners are engaged intellectually, emotionally, socially, soulfully and/or physically. This involvement produces a perception that the learning task is authentic.

5. The results of the learning are personal and form the basis for future experience and learning.

6. Relationships are developed and nurtured: learner to self, learner to others and learner to the world at large.

7. The educator[3] and learner may experience success, failure, adventure, risk-taking and uncertainty, because the outcomes of experience cannot totally be predicted.

8. Opportunities are nurtured for learners and educators to explore and examine their own values.

9. The educator's primary roles include setting suitable experiences, posing problems, setting boundaries, supporting learners, insuring physical and emotional safety, and facilitating the learning process.

10. The educator recognizes and encourages spontaneous opportunities for learning.

11. Educators strive to be aware of their biases, judgments and pre-conceptions, and how these influence the learner.

12. The design of the learning experience includes the possibility to learn from natural consequences, mistakes and successes.

Appendix C. Project WET lesson format template

Grade Level:	Summary:
Subject Areas:	Objectives:
Duration:	Materials:
Setting:	Making Connections:
Skills:	Background:
Charting the Course (related activities):	Procedure:
Vocabulary:	Activity:

Wrap Up and Action:

Assessment:

Extensions:

Resources:

Notes (for comments):

Appendix D. STEBI-B

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE

A = AGREE

UN = UNCERTAIN

D = DISAGREE

SD = STRONGLY DISAGREE

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA	A	UN	D	SD
2. I will continually find better ways to teach science.	SA	A	UN	D	SD
3. Even if I try very hard, I will not teach science as well as I will most subjects.	SA	A	UN	D	SD
4. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA	A	UN	D	SD
5. I know the steps necessary to teach science concepts effectively.	SA	A	UN	D	SD
6. I will not be very effective in monitoring science experiments.	SA	A	UN	D	SD
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	SA	A	UN	D	SD
8. I will generally teach science ineffectively.	SA	A	UN	D	SD

9.	The inadequacy of a student's science background can be overcome by good teaching.	SA	A	UN	D	SD
10.	The low achievement of some students cannot generally be blamed on their teachers.	SA	A	UN	D	SD
11.	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA	A	UN	D	SD
12.	I understand science concepts well enough to be effective in teaching science.	SA	A	UN	D	SD
13.	Increased effort in science teaching produces little change in some students' science achievement.	SA	A	UN	D	SD
14.	The teacher is generally responsible for the achievement of students in science.	SA	A	UN	D	SD
15.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA	A	UN	D	SD
16.	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA	A	UN	D	SD
17.	I will find it difficult to explain to students why science experiments work.	SA	A	UN	D	SD
18.	I will typically be able to answer students' science questions.	SA	A	UN	D	SD
19.	I wonder if I will have necessary skills to teach science.	SA	A	UN	D	SD
20.	Given a choice, I will not invite the principal to evaluate my science teaching.	SA	A	UN	D	SD

21.	When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	SA	A	UN	D	SD
22.	When teaching science, I will usually welcome student questions.	SA	A	UN	D	SD
23.	I do not know what to do to turn students on to science.	SA	A	UN	D	SD

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EDUCATION

Ed.D., Educational Leadership, Lindenwood University, St. Charles, MO 2010
DISSERTATION: *Can experiential education strategies improve elementary science teachers' perceptions of and practices in science teaching?*

M.Ed., Curriculum and Instruction, UM-St. Louis, St. Louis, MO 2000

M.A.T., Science Education, Webster University, St. Louis, MO 2000

B.S., Education, Missouri State University, Springfield, MO 1992

ACADEMIC /TEACHING EXPERIENCE

Education Specialist, St. Louis Community College, St. Louis, MO 2007-present
Outreach education between college and local school districts, curriculum writer, Mobile Technology Lab Instructor: Biotechnology, Clinical Laboratory, Chemical Technology, and Horticulture

Teacher, Hazelwood School District, Hazelwood, MO 2006-2007
Taught 6th grade science, mathematics, communication arts, and social studies

Coordinator for Professional Experiences, UM-St. Louis, St. Louis, MO 2004-2006 Taught Introduction to Classroom Teaching and Elementary Science Methods courses and coordinated field experiences for pre-service teachers

Adjunct Instructor, Harris Stowe State University, St. Louis, MO 2004
Taught Secondary English Methods to pre-service teachers

Teacher, St. Louis Public School District, St. Louis, MO 1999-2003
Taught 6th grade science courses

Teacher, Clinton School District, Clinton, MO 1998
Taught Title I communication arts and mathematics to 6th , 7th and 8th grade students

Teacher, Roscoe C-6 School District, Roscoe, MO 1997-1998
Taught communication arts, science, mathematics, and social studies to 7th and 8th grade students

ACADEMIC /Professional Organizations

National Science Teachers Association
Association of Science Teacher Educators
Science Teachers of Missouri
Missouri Biotechnology Association
St. Louis Agribusiness Club