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Demonstrating the Efficacy of Learning Ecology in an Outdoor Science Education Program on 5th Grade Science Oklahoma Core Curriculum Test Scores

A Thesis

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By Jocelyn Perez

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Approved for the Department of Biology

May 2, 2014

By ______________________________
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Dedication

This work is dedicated, with love, to my family. To my husband for always being on my side and loving and supporting me throughout all of the ups and downs; to my mom and dad for their love and for believing in me throughout my whole life; to my brother for cheering me on from both near and far; and to my grandparents for their love and encouragement.

Table of Contents

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Abstract

Science education is in need of reform in order to better meet the learning needs of the students. The goal of this research was to determine if the implementation of an outdoor education program has a significant impact on the learning of ecological material in fifth grade students as measured by a state administered exam. After controlling for several demographic factors, schools that participated in a local outdoor education program were included in the experimental group (n=5 schools) and those who did not attend were members of the control group (n=5 schools). Through analysis of scores on the portion of the exam specific to ecology as well as overall science scores, it was determined that there is no significant difference between groups. Thus, outdoor education does not appear to have a significant impact on student learning. However, there were numerous limitations of this study and further research is required.

Background

Educational Standards and Assessment

It has been documented that students are not learning according to the standards for learning. The 2009 National Assessment of Education Progress (NAEP) has shown in *The Nation's Report Card for Science* that 34% of 4th graders scored at or above the proficient level on their science assessment. That value for 8th graders dropped to 30%, and for 12th grade students the number decreased again to 21% of students at or above the proficient level (National Center for Education Statistics, 2011). There is clearly a need to implement new strategies to reach students and increase their understanding of core science concepts.

The reasons students are not learning are threefold. First, the National Research Council's (NRC) report *Learning Science in Informal Environments: People, Places, and Pursuits* states that the problem with federal education policy is that it "creates incentives for mathematics and literacy instruction which appears to be reducing instructional time in science and other subject matters, especially in the early grades" (NRC, 2009, p. 13). Second, research summarized in *Taking Science to School* (NRC, 2007) shows that many of the major assumptions on how students learn are mistaken. For decades it was thought that children were not developmentally able to handle the more complex scientific theories. It is suggested that students' understanding of concepts is held-back only by their conceptual knowledge, not their reasoning abilities (NRC, 2007). Thus there may be a disconnect between how teachers are able to teach scientific material and how students are actually able to learn. Third, it is suggested that for maximum learning to occur, students must be actively engaged and interested in the topic being discussed. The NRC (2007, p. 186) found that "motivation and attitudes toward science play a critical role in science learning, fostering students' use of effective learning strategies that result in deeper understanding of science." Many classrooms do not foster the motivation side of learning, merely focusing on content memorization.

According to *Taking Science to School*, for a child to be considered proficient in the sciences they must possess both knowledge and reasoning skills. They must "know, use, and interpret scientific explanations of the natural world; generate and evaluate scientific evidence and explanations; understand the nature and development of scientific knowledge; and participate productively in scientific practices and discourse" (NRC, 2007, p. 221). To become proficient, new specific standards were needed.

The Next Generation Science Standards (NGSS) are a set of K-12 learning standards established with the goals of better preparing students for college and the workforce. There are too few young adults seeking positions in science, technology, engineering and mathematics (STEM) fields. The NGSS also demonstrate how science is practiced in real situations due to the integration of both content and application instead of keeping these ideas as separate entities. These new standards have been developed in a two-step process that was led by 26 states. First came the development of the NRC guide *A Framework for K-12 Science Education: Practices, Cross-cutting Concepts, and Core Ideas* (see Table 1 for details). The second step was the development of the standards based on the *Frameworks*. The National Research Council, National Science Teacher's Association (NSTA), the American Association for the Advancement of Science (AAAS), and Achieve, Inc. were the lead partners in the development of the NGSS (Achieve, Inc., 2013). As of November 2013, eight states (including California, Maryland, Vermont, Rhode Island, Kansas, Kentucky, Delaware, and Washington) have adopted the NGSS (Achieve, Inc., 2013, & Issaquah Press, 2013).

The NGSS are unique because they consist of three dimensions integrated into one performance expectation. Performance expectations are intended to describe what a student should be capable of doing at the end of instruction in each grade level (Achieve, Inc., 2013). Performance expectations are created to be in close association with the Common Core State Standards (CCSS), as designated with the seven Crosscutting Concepts (see Table 1).

Prior to the creation and adoption of the NGSS, states followed (and some still choose to follow) their own set of standards for each grade level and educational topic. Oklahoma established a set of statewide standards for learning titled the Oklahoma Priority Academic Student Skills (PASS). They were originally developed for each curriculum area (except technology) for use in the 2003 to 2004 school year. The new Oklahoma Academic Science Standards are closely aligned to the NGSS, but still exclude the topics of climate change and evolution.

The depth of knowledge set forth by the PASS is assessed by statewide Oklahoma Core Curriculum Tests (OCCT) for elementary and middle school students, and by End of Instruction (EOI) tests for high school students that are administered at the end of the course. According to the Oklahoma State Department of Education (OSDE), the OCCT is a criterion-referenced testing program to compare student performance on specific standards (OSDE, 2011). These assessments are considered statistically valid testing instruments.

The 5th grade Science OCCT assesses student knowledge in the content areas of physical science, life science, and earth/space science. The life science portion of the 5th grade OCCT comprises 27% of the 2008 exam and 29% of the 2009 through 2012 exams (OCCT Technical Reports, 2009-2012). Thus, nearly one-third of the scientific knowledge tested in Oklahoma is associated with ecology or environmental information, specifically with the relationships amongst organisms and between organisms and their environment. The standard and objectives designated for this subset of the exam are described in Table 2. Due of the large percentage of the test being related to the topic of ecology, outdoor education is one possible method to increase students' overall science content knowledge.

What is Outdoor Education?

Outdoor education is a part of the larger category of informal learning. Outdoor education is a subset of a larger theme of learning known as informal, or place-based education. Informal education comprises a wide range of topics and locations. The focus of the subject matter might include the core subjects of math, science, language arts and social studies. Furthermore, curricula such as art, music, and physical education can implement informal education programs. The locations might vary from schoolyard greenhouses to zoo or museum programs or outdoor camps established for education. Parkin (1998) expands this view, stating the objectives for outdoor education may include a wide range of topics, including academic, social, physical, or a combination of these. Academic subject matter might include scientific principles such as ecological phenomena, literary concepts such as poetry about nature, and mathematical concepts like determining the angle of sunrays. Physical and social learning objectives might include sports related tasks, such as hiking and fishing, and activities like teambuilding events and games. Science itself is described as a collection of knowledge about the natural world and the process of establishing that knowledge (NRC, 2007) and thus it goes to reason that science education must involve our natural (informal) surroundings. Research by The Committee for Learning Science in Informal Environments states that "structured, non-school science programs can feed or stimulate the science-specific interests of adults and children, may positively influence academic achievement for students, and may expand participants' sense of future science career options" (NRC, 2009, p. 3). The National Science Board and the Academic Competitiveness Council conducted evaluations of Science Technology Engineering and Mathematics (STEM) programs to determine their effectiveness. The researchers cited "Informal Education and Outreach" as one of the three essential aspects of education, thus indicating that it is important for "U.S. economic competitiveness, particularly the future ability of the nation's education institutions to produce citizens literate in STEM" (U.S. Department of Education, 2007, p. 5). The process of learning in an informal environment, specifically through outdoor education, allows students to have a meaningful experience with a plethora of topics throughout the grade levels.

The specific details of what outdoor education entails are varied, although there is agreement on five key factors: it is an experiential method of learning, it occurs (at least partially) in the outdoors, it is interdisciplinary, it involves community interaction, and it involves relationships. First, outdoor education is an experiential method of learning. This non-traditional approach to science education goes hand-in-hand with the idea put forth by the NRC that "students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves" (NRC, 2012, p. 30). These experiences must involve all of the senses (Priest, 1986) and provide a meaningful context for the material being taught (Woodhouse and Knapp, 2000). By varying the source of information, the students are able to identify how the new information fits with their current schema of knowledge. This idea of building on prior knowledge directly ties back to the construction of the performance expectations of the NGSS (Achieve, Inc., 2013).

Second, outdoor education must occur at least partially outside. The outdoor environment becomes the source of knowledge (Boss, 1999) and can occur in natural or man-made regions (Wiener, 1967). The location may be as basic as a schoolyard or as advanced as a educational site developed for the sole purpose of outdoor education. By illuminating the idea that there are things to be learned all around us, it is a logical conclusion that the student will develop a greater appreciation for life itself.

An additional aspect of outdoor education is that it is inherently interdisciplinary and spans across the grade levels. This again relates to the NGSS standards, as they are interdisciplinary and weave throughout the grade levels as well. Interdisciplinary activities allow for application of knowledge (Erdogan, 2011), and showing the connection between various disciplines allows for a deeper understanding (Ivanitskaya et al., 2002). In addition to being interdisciplinary, outdoor education is appropriate throughout the grade levels (Wiener, 1967). This directly ties outdoor education to the scope and sequence of the Oklahoma PASS. What the standards set forth for the lower grade levels feeds into what is expected of the upper levels, and, at the elementary level, span across the various disciplines of science. By utilizing the interdisciplinary and multi-grade level approach to learning, outdoor education seeks to foster a deeper understanding of the curriculum material.

Fourth, the community plays a key role in outdoor education. Woodhouse and Knapp (2000) echo the ideas of interdisciplinary material and experiential learning and expand on these by adding that outdoor education must involve the community in educating students. Community involvement is thought to help foster interest in the subject matter for the student. A requirement specifically of the teacher's curriculum for outdoor education is it must be aligned with the local curriculum (Brookes, 2002). Community leaders such as school board members and government officials determine which standards of learning are implemented in the school district. By aligning the outdoor education curriculum with these standards, it ensures that the material taught outside of the classroom is beneficial to student success within the course. By focusing on what is important to the local community, outdoor education not only increases student interest levels but also helps to meet local educational goals.

Lastly, outdoor education places a large emphasis on relationships. Priest (1986) states that the relationships of outdoor education encompass four types: interpersonal (between others), intrapersonal (within oneself), ecosystemic (interdependence within an ecosystem), and ekistic (the relationship of people with their surroundings). The relationships within an ecosystem are one of the major topics assessed in life science courses. This ecosystemic relationship can be directly observed in any outdoor science education program. The ideal outdoor education program will include all four patterns of relationships, thus leading to the realization of experiential learning (Priest, 1986).

Thus, the goal of outdoor education is to provide programs that reach students on the three learning domains through an experiential method of education that emphasizes relationships in an interdisciplinary fashion in alignment with the curriculum. This goal coincides directly with the *Frameworks* (NRC, 2012), NGSS (Achieve, Inc., 2013), U.S. competency in STEM and the future economy of the United States (U.S. Department of Education, 2007).

What Outdoor Education is Not

In addition to a discussion on what outdoor education encompasses, it is also important to note what it is not. First, outdoor education is not intended to be the sole location of learning. Teachers must become facilitators of learning through instructing the students using informal education and then reinforcing those same themes back in the classroom setting (Brookes, 2002). By educating students in natural settings as well as in the classroom, students are better able to see the connections between what they are learning and their own lives. Second, although the terms “outdoor education” and “environmental education” are often used interchangeably, this is a misconception. Outdoor education is a form of place-based instruction, meaning the learning is taking place in the location appropriate to the topic, whereas environmental education can occur either indoors or outdoors (Woodhouse and Knapp, 2000). Adkins and Simmons further distinguish the two by explaining that environmental education has a goal of creating citizens who are knowledgeable and take action in environmental issues, whereas outdoor education is intended to teach specific objectives on a variety of topics using the outdoor arena (Adkins & Simmons, 2002). Finally, outdoor education is not to be implemented for all topics. Certain specific ideas, such as molecular structures or how to use a piece of electrical equipment, will clearly not lend themselves well to an outdoor setting. Only objectives dealing with items found natively outside should be taught in an outdoor education program. It is important to recognize these distinguishing characteristics in a discussion of what comprises outdoor education.

Prior Research

Prior studies completed on outdoor education indicate a positive correlation between participation in an outdoor education experience and attitudes toward the environment and science itself (Dettmann-Easler & Pease, 1999; Malinowski & Fortner, 2010). Other studies have demonstrated a connection between improving ones attitude towards the environment and an increased knowledge of ecological phenomena (Carrier Martin, 2003; Bradley, Waliczek, and Zajicek, 1999; Francovicova & Prokop, 2011). Research has also demonstrated a connection between participation in an outdoor education experience and how effective educators view themselves to be (Carrier, 2009; Holden et al., 2011).

What the Research is Lacking

Participation in outdoor education programs regarding ecological phenomena has a positive effect on knowledge and attitudes toward the environment. Yet despite the plethora of studies on attitudes and the connections with learning, the research is deficient in two key areas. The first area is research that focuses purely on knowledge gains. Although it is an important part of the educational process to engage students' interest in the material, students are not assessed on their feelings toward a topic. It is therefore essential that research be conducted to determine if there is a measurable academic advantage to implementing outdoor educational learning programs. The second area that needs to be addressed is the lack of reliable testing instruments used by researchers in previous studies. One common thread in the research up to this point is the use of non-standardized evaluation tools. Researchers often create their own assessment to be used for pre and post-evaluation. This casts a shadow of doubt to the reliability and validity of the argument for outdoor education programs (Crompton and Sellar, 1981). In a time of standardized assessment, it is necessary to determine if the research finding that outdoor education increases student content knowledge regarding ecological phenomena also applies to state administered exams as opposed to teacher or researcher developed assessments. It is the goal of this researcher to eliminate these two areas of deficiency.

Goal of this Research

The goal of this project is to investigate if learning science in informal environments, such as outdoor ecology-based programs, will increase learning over traditional instructional methods as measured by a standardized state exam. The research will compare how well 5th grade students score on their OCCT exam when they participated in an ecology-based outdoor science education program versus those who did not. The null hypothesis states there is no significant difference (alpha level = 0.05) in learning between students who are taught ecology in an outdoor education setting and those strictly learning in a classroom setting as measured by a state administered exam. The alternative hypothesis is that research will show that there is a significant difference (alpha level = 0.05) in knowledge between those learning ecology in an outdoor education setting and those strictly learning in a classroom setting as measured by a state administered exam. The independent variable is whether the students participated in an outdoor-based ecology program or were strictly taught ecology in an indoor, classroom setting. The dependent variables are the overall OCCT test scores as well as scores specific to the life science objective on organisms and environments.

Materials and Methods

Materials Required and Data Availability

This experiment required a minimum of materials. Employees of the Oklahoma State Department of Education (OSDE) previously compiled the OCCT test scores and the breakdown by objective. All data were obtained electronically via CD created by the OSDE. The name of the outdoor education site is not given per Institutional Review Board (IRB) requirement. Furthermore, school names, teacher names, and student names are not reported in this study according to IRB requirements. The statistical analysis computer program SAS (Statistical Analysis System), version 9.1 was used in the research. This program is available on the computers in the lab of the Mathematics and Statistics building on the University of Central Oklahoma campus. Finally, an 8 GB flash drive was used to securely store the electronic data throughout the course of the study along with the CD provided by the state department. The data analyzed range from the 2007-2008 school year through the 2011-2012 school year. No earlier data are available because before the 2007-2008 school year there was not a state-testing program established for the 5th grade. The data from the 2007-2008 test are not reliable, as schools were not required to report any information on the test scores. According to an official at the Office of Accountability and Assessment of the Oklahoma State Department of Education (Matt Morgan, Personal Communication, 2013), as the years progress, data becomes more complete.

Selection of Schools for Data Analysis

There are several locations throughout the state of Oklahoma that provide outdoor-educational opportunities to students. One such location is in the vicinity of Oklahoma City and has been educating students for over a decade. This Oklahoma City-based outdoor education location was contacted to determine which schools have attended the outdoor education site, what grade level attended, and during which years. These schools served as a pool of data for the selection of schools for the experimental group. This pool of schools consisted of 19 Oklahoma and Texas schools. Texas schools were excluded from this study because the state exams those students take at the end of the year are not the same as those in Oklahoma. Private schools were eliminated due to not participating in the OCCT. Additional schools were eliminated when they attended the camp for less than four years. One final school was eliminated due to boundary-line changes during the course of the last 10 years, which placed the same students at different schools over the course of the data collection for this study. This created an experimental group of five Oklahoma public schools that have participated in outdoor education for a minimum of four consecutive years.

The control group of teachers and schools consisted of those who taught ecology in a classroom setting without attending the outdoor education site. The following criteria were used to determine the data pool for the control group. The criteria is based on matched classes and student information:

1. Schools must be of the same type, i.e. public schools in Oklahoma.
2. Students are in the 5th grade for the first time.
3. Students studied must include both males and females.

4. The students taking the test are considered by the state of Oklahoma to be Full Academic Year (FAY).
5. Students participate in the regular version of the OCCT, thus English-Language Learners (ELL) and Special Education students are not included in this study.

The experimental group of schools contained three within the same district, one in the Oklahoma City metro area, and one in rural southern Oklahoma. As these schools are a diverse sampling, control group schools were additionally selected to be similar to the experimental schools. Three control group schools were selected within the same district as the three experimental schools. One control school is in the Oklahoma City metro, and one is a rural school south of the metro.

Further comparisons between the control group schools and experimental group schools were made to ensure that the schools were as similar as possible. The district report cards provided to the public by the Oklahoma State Department of Education were accessed for each school to determine average number of days missed per student, percentage of students eligible for free or reduced lunch, and percentage of Caucasian students. These data were analyzed statistically to determine that there was no significant difference between the groups.

Data Analysis

Data in this study included mean OCCT scores, the percent correct on the ecology objective, and school demographics (factors that might impact the OCCT score): the average number of days missed per student, the percent of Caucasian students, and the percent of students eligible for the state's free or reduced lunch program. These variables were further categorized by school, group (experimental – A through E, control – F through J), test year (2009 through 2012), and four proficiency levels based on the OCCT scores (unsatisfactory = 1 through advanced = 4).

The data were summarized by school, group (experimental and control), test year within group, and test year within school using summary statistics: sample size, mean, standard deviation, and range (minimum to maximum) were all determined. Small sample sizes for the 2009 test year demonstrated that schools did not have to report their findings on the OCCT, as confirmed by the State Department of Education Office of Accountability and Assessment. Line graphs were used to display, by group, yearly trends for the means of OCCT scores and the percent correct on the ecology objective. A bar graph was used to display a comparison of percentages within each group for each year at each proficiency level.

For each quantitative variable (mean OCCT score, average number of days missed, percentage of students eligible for free or reduced lunch, percentage of Caucasian students, and mean score on ecology objective), a two-factor analysis of variance was used to determine significant differences between the means for group and among years. If the interaction between group and year means was significant, t-tests were used to determine significant differences between the group means at each year and a one-factor analysis of variance for yearly means within each group. For significant differences among years, a Tukey's multiple comparison test was used to determine which years were significantly different ($p < 0.05$).

For the qualitative variable (percentage of students at each performance level), a Mantel-Haenszel Chi-square test was used to determine significant differences among groups with regard to the percent of students within the four ordered performance levels based on the OCCT scores.

P-values less than 0.05 were considered significant in all analyses.

Results

Summary statistics for school demographics are shown in Tables 3, 4, and 5. Results of the statistical analyses of the differences between means for the groups and years are shown in Tables 6, 7, and 8.

The average number of days missed per student ranged from 6.36 (2009) to 7.24 (2011) in the experimental group and 7.22 (2012) to 8.12 (2010) in the control group. Although higher averages occurred each year in the control group, there was no significant difference between the means with regard to group ($p = 0.0606$). Within both groups there were significant differences between years (experimental, $p = 0.0224$; control, $p = 0.0145$) and in both groups the two higher means occurred in 2010 and 2011.

The mean of the percentage of Caucasian students in experimental schools ranged from 68.8% (2011) to 70.8% (2009) and 66.6% (2011) to 68.8% (2012) in the control schools. Higher mean percentages occurred each year in the experimental group; however, there were no significant differences between the means with regard to group or year.

The mean of the percentage of students eligible for free or reduced-price lunch ranged from 34.6% (2009) to 42% (2012) in the experimental group and 40.6% (2009) to 48.6% (2011) in the control group. The yearly means for the control group were at least 4% higher than in the experimental group but there was no significant difference between the groups. For both groups, there were significant differences between yearly means (experimental, $p = 0.0053$; control, $p = 0.0067$).

Statistical analyses of the differences between raw OCCT score means for the groups and years are shown in Table 9. Means are graphically displayed in Figure 1. The means for OCCT scores ranged from 33.57 (2009) to 35.21 (2011) in the experimental group and 33.08 (2009) to 34.92 (2012) in the control group. Higher averages in the experimental group, as compared to the control group, occurred in all four years. There were significant differences between the means with regard to group in 2010 and 2011. Within both groups, there were significant differences between years (experimental, $p = 0.0011$; control, $p = 0.0006$) with the largest difference in means occurring between 2009 and 2010 in the experimental group and between 2011 and 2012 in the control group.

Results of the statistical analyses of the differences between means for the groups and years with regard to percent correct on the ecology objective are shown in Table 10. Means are graphically displayed in Figure 2. The means for percentage correct on the ecology objective ranged from 71.8 (2010) to 78.01 (2012) in the experimental group and 67.94 (2011) to 77.73 (2012) in the control group. The differences between means for the groups was significant in 2010 and 2011 (experimental, $p = 0.0234$; control, $p = 0.0001$) with higher means in the experimental group. Within both groups there were significant differences between years (experimental, $p < 0.0001$; control, $p < 0.0001$) with a similar U-shaped pattern in means during the four years.

Summary statistics for the percent of students who scored at each of the four performance levels based on OCCT scores and results of the statistical analyses of the differences between groups at each year with regard to the percentages are shown in Table 11. The percentages are graphically displayed in Figure 3.

The higher percentages occurred in performance levels 3 and 4 in both the experimental and control groups. Significant differences between the groups occurred in 2010 ($p = 0.0013$) and 2011 ($p = 0.0018$). In 2010, approximately 52% of the experimental group scored at level 4 whereas approximately 55% of the control group scored at level 3. Similarly, in 2011 a higher percentage of students in the experimental schools scored at level 4 (49%) and a higher percentage of students in the control schools scored at level 3 (50%). In 2009 and 2012, level 3 had higher percentages in both the experimental and control groups.

Conclusions

Through analysis of the data, the following three conclusions have been reached.

Conclusion #1 – The analyses of all three demographic categories (tables 6, 7, 8) reveal that although there were instances of significant difference within the groups from year to year, there was no significant difference between the control and experimental schools in any of the test years. This lends support to the validity of this study because the possibility of socioeconomic status, race, and absenteeism affecting the results has been removed. This is an essential piece of this research because without eliminating these factors, there can be no true conclusions drawn from this study.

Conclusion #2 – The results of the analysis of mean on raw OCCT scores (table 9 and figure 1) as well as the analysis of percentage correct on the ecology objective (table 10 and figure 2) indicate participation in an outdoor education program does not appear to result in increased ecological knowledge, despite discovering instances of significant difference. The data demonstrate a significant difference between the control group and experimental group means in both overall 5th grade science OCCT score and on the portion of the test specific to ecology in the 2010 and 2011 test years with the experimental group scoring higher in both years. This significant difference suggest the null hypothesis should be refuted and lends support to the alternative hypothesis that participation in an outdoor ecology-based educational program increases student learning over those in a traditional education setting.

The data show that both experimental and control groups showed a trend of improvement overall between 2009 and 2012. However, no significant difference was found between groups on the overall 2009 and 2012 OCCT test. The lack of a significant difference between groups in

2009 might be because of what the test actually assesses. Current PASS are not based on how students actually learn, and thus it is a reasonable assumption that a test which is aligned to the PASS is also not accounting for how students learn. Therefore the OCCT might not actually be a true measure of the effectiveness of outdoor education programs (which do account for how students best learn science). The lack of significant difference in 2012 might be due to a revision of science PASS in 2011, which teachers were instructed to adhere to beginning during the 2011-2012 school year, or some additional factor not accounted for by this research.

Although the data analyses of this research have shown some areas of statistical significant difference, it is important to discuss the practical differences. Upon closer examination of the actual OCCT scores, in 2010 the experimental mean was 34.99 and the control mean was 33.49. Although these are statistically different, there numerically is only 1.5 points difference; which on a 45-question test amounts to a mere 3% difference. Additionally for 2011, the mean OCCT score was 35.21 for the experimental group and 33.38 for the control group. This is numerically a difference of 1.83 points, which is 4% difference.

There was also no significant difference between the ecology portion of the test in 2009 or in 2012, but a significant difference in the years 2010 and 2011. These split results cast reasonable doubt on the hypothesis that participation in the outdoor education programs leads to higher amounts of learning of ecological material. There appears to be a factor playing a role in how well students are learning science, however it is unlikely that said factor is only the location at which the education is occurring.

Since the data for both overall OCCT score and score on the ecology portion of the exam shows such inconsistency with results, any significant differences between groups must be negated due to the conflicting data on overall OCCT scores. It is the conclusion of this researcher that there is not sufficient evidence that participation in the outdoor education program improves knowledge on ecological phenomenon. The null hypothesis must therefore be accepted.

These findings are inconsistent with the studies previously conducted by Bradley, Waliczek, and Zajicek (1999), Cronin-Jones (2000), and Francovicova and Prokop (2011), all of whom found significant differences between groups. The findings further conflict with the results of the fifth grade group researched by Carrier Martin (2003), which also showed a significant difference.

However, the data show consistency with the fourth grade group of the Carrier Martin study (2003). Within this grade, there was no significant difference and Carrier Martin discussed that the teachers of the two grades analyzed showed differing levels of enthusiasm for the outdoor topics. This causes this researcher to conjecture that the teachers' attitudes may have also played a key role in this study. If this is the case, it is further reasonable to speculate that it has actually been teacher attitude that has created the significant differences, or lack there of, in the data for this study as well as other prior research.

The results of data analysis appear to further support Crompton and Sellar's findings (1981) that many assessment instruments used by past researchers were potentially unreliable. These other formats were non-standardized and self-created, whereas the OCCT is a standardized, criterion-referenced exam. It is possible that the use of a standardized test has resulted in findings alternate to prior studies.

Conclusion #3 – The analysis of the percentage of students scoring at each performance level on the OCCT (table 11 and figure 3) supports the data findings of both mean raw score and ecology objective analyses. The Mantel-Haenszel Chi-Square test was used to compare what percentage of students scored at each proficiency level on the overall science OCCT. Analysis of the data determined consistent results with the analysis of mean OCCT score and the score on the ecology portion of the OCCT with significant differences between the groups for 2010 and 2011, but not 2009 or 2012. The breakdown of each performance level is not at even increments, as shown in Table 12. Thus, the data are skewed towards more students receiving a level 3 than those receiving a level 2 or level 4. Despite these uneven distributions of scores, it is still shown that the test years of 2010 and 2011 show significant differences for all three analyses (overall mean OCCT scores, percentage correct on the ecology objective, and percentage of students at each proficiency level).

The results of these analyses are not surprising given the current Oklahoma PASS standards. They are vastly different from the NGSS. The PASS are not cross-curricular, they are not connected throughout the grade levels, and they do not account for how students learn. However, newly revised PASS are being adopted in 2014 which will be closely related to the NGSS. This may cause future analyses to show vastly different results than those found in this study.

Limitations of This Study

The limitations of this study exist in four essential areas. First, the number of years this study encompasses is very small, only four consecutive years. This limitation was unavoidable due to the lack of data available from the Oklahoma State Department of Education. It was not mandated that schools report OCCT scores prior to the 2008-2009 school year. Thus, there is no valid data that could be compared from 2008 or before.

The second major limitation is the broad range of factors that affect student success. This research has accounted for three such factors (socioeconomic status, attendance, and race). However, there is a multitude of other possible factors. The education level of parents and other family members as well as aspirations for the future may affect student performance. Additionally, teacher background/attitude, school materials, and classroom environment may have implications on the test scores.

A third category of limitation in this research is consistency of educational materials. The classroom teachers in the study locations might or might not have used the same instructional materials while in the classroom. Furthermore, those in the experimental group might or might not have participated in the exact same lessons at the outdoor education location. The control group may have also taken trips outside of the school to other locations such as zoos or science museums. Controlling for these factors was outside the scope of this research, but is recommended for future research.

Fourth, there is a question as to how much follow-up was done with the students of the experimental group upon returning to their school setting. It is unknown if classes who participated in outdoor education were also instructed in their classroom setting upon returning to the school site. As suggested by Brookes (2002) as well as Hammerman and Hammerman (1973), the follow-up of the teacher back in the classroom setting is of utmost importance to successfully accomplishing the goals of outdoor education programs and school curricula objectives.

Suggestions for Future Research

Future research is required on this topic to determine if there is truly no significant difference between those who learn ecology in an outdoor education program and those who learn strictly in a classroom setting. A pre-test of student knowledge is required. Additional statistical analyses of variables such as teacher degree type, highest degree held by parents, and teacher attitudes toward science would eliminate possible compounding factors. Furthermore, the years of data collection must be expanded. There must be data showing that the control group schools did not participate in any form of outdoor education, and the same outdoor education program must be also be adhered to by all those in the experimental group. There must be control over amount of time learning about ecology within and between groups.

In a future large-scale study, it would be interesting to see a comparison of scores on end of year tests in other states. Do students in Texas, for example, have the same significant difference between groups? Furthermore, the same type of study may be applied to specifically those states that have adopted the NGSS.

The additions of each of the stated analyses and controls will produce a study with results that will hopefully pinpoint what is actually the root of the differences found in this study – whether it be outdoor education, teacher attitude, or another unforeseen cause.

Overall, educational research has its obstacles to overcome due to the extensive number of variables that impact learning. A student’s home-life, prior learning experiences, and aspirations for the future all can affect how well a student will perform in school and cannot necessarily be controlled for in an experiment due to the vast amount of possibilities. It must be a priority for everyone in this nation to maximize the positive influence teachers can have to inspire and educate. Participation in outdoor education programs which specifically target certain content and skill areas is one such way that both teachers and community members can help effectively instruct students. Through this study, it has been demonstrated that students learning in an outdoor ecology based program had a significant difference in knowledge as measured by their OCCT scores in 2010 and 2011. Further analysis of testing data is suggested on this topic in order to help influence school leaders and policy makers to adopt such programs as part of their regular curriculum.

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Data Tables and Figures

Table 1: The Three Dimensions of the Frameworks

Dimension	Details
Scientific and Engineering Practices	1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information
Crosscutting Concepts	1. Patterns 2. Cause and effect: Mechanism and explanation 3. Scale, proportion, and quantity 4. Systems and system models 5. Energy and matter: Flows, cycles, and conservation 6. Structure and function 7. Stability and change
Disciplinary Core Ideas	*Physical Sciences* PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and their applications in technologies for information transfer *Life Sciences* LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, and dynamics LS3: Heredity: Inheritance and variation of traits LS4: Biological evolution: Unity and diversity *Earth and Space Sciences* ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity *Engineering, Technology, and Applications of Science* ETS1: Engineering design ETS2: Links among engineering, technology, science, and society

(*NRC, 2012, p. 3*)

Table 2: 5th Grade Life Science Standard and Objectives

Standard 2	**Objectives**
Organisms and Environments – Organisms within an ecosystem are dependent on one another and the environment. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:	1. Organisms in an ecosystem depend on each other for food, shelter, and reproduction. a. Ecosystems include food chains and food webs. b. Relationships exist between consumers, producers, and decomposers within an ecosystem. c. Predator and prey relationships affect populations in an ecosystem
	2. Changes in environmental conditions due to human interactions or natural phenomena can affect the survival of individual organisms and/or entire species. a. Earth's resources can be natural (non-renewable) or man-made (renewable). b. The practices of recycling, reusing, and reducing help to conserve Earth's limited resources.

(OSDE, 2012)

Table 3: Summary Statistics for Average Number of Days Missed Per Student Per Test Year

For each subgroup per year, data listed (top to bottom) is: sample size (n), mean number of days missed per student, standard deviation, and range.

Subgroup	Test Year				Total
	2009	2010	2011	2012	
Experimental Group	5 6.36 0.60 5.80 – 7.20	5 7.18 0.16 6.90 – 7.30	5 7.24 1.01 6.20 – 8.90	5 6.38 1.06 5.50 – 8.20	**20** **6.79** **0.85** **5.5 – 8.90**
Control Group	5 7.24 0.67 6.40 – 8.00	5 8.12 0.41 7.60 – 8.70	5 7.82 0.72 6.90 – 8.70	5 7.22 0.64 6.40 – 8.00	**20** **7.60** **0.69** **6.40 – 8.70**

Table 4: Summary Statistics for Percentage of Caucasian Students Per Test Year
For each subgroup per year, data listed (top to bottom) is: sample size (n), mean percentage of Caucasian students at site, standard deviation, and range.

Subgroup	Test Year				Total
	2009	2010	2011	2012	
Experimental Group	5 70.80 5.72 63 – 76	5 69.80 5.31 64 – 74	5 68.80 4.21 63 – 73	5 69.40 3.05 65 – 73	**20** **69.70** **4.37** **63 – 76**
Control Group	5 67.60 3.05 64 – 71	5 67.00 4.42 61 – 73	5 66.60 6.27 57 – 74	5 68.80 3.90 65 – 74	**20** **67.50** **4.27** **57 – 74**

Table 5: Summary Statistics for Percentage of Students Eligible for Free or Reduced Lunch Prices

For each subgroup per year, data listed (top to bottom) is: sample size (n), mean number of students eligible for free or reduced lunch, standard deviation, and range.

Subgroup	Test Year				Total
	2009	2010	2011	2012	
Experimental Group	5 34.60 15.69 19 – 57	5 38.00 17.93 19 – 63	5 41.20 15.99 23 – 64	5 42.00 20.14 20 – 72	**20** **38.95** **16.36** **19 – 72**
Control Group	5 40.60 15.45 20 – 61	5 42.80 17.43 26 – 69	5 48.60 16.33 26 – 70	5 46.80 14.72 26 – 66	**20** **44.70** **15.05** **20 – 70**

Table 6: Analysis of Average Number of Days Missed

Subgroup	Test Year				*Analysis of Variance*	*Tukey's Multiple Comparisons*
	2009	2010	2011	2012		
Experimental	6.36	7.18	7.24	6.38	p = 0.0224	*
Control	7.24	8.12	7.82	7.22	p = 0.0145	10 – 9, 12

There was no significant difference between means for groups (p = 0.0606).
** sample size too small*

Table 7: Analysis of Percentage of Caucasian Students

Subgroup	Test Year			
	2009	2010	2011	2012
Experimental	70.80	69.80	68.80	69.40
Control	67.60	67.00	66.60	68.80

There was no significant difference between means for subgroups (p = 0.4372).
There was no significant difference between means for years (p = 0.3540).
There was no significant interaction between subgroups and years (p = 0.5353).

Table 8: Analysis of Percentage of Students Eligible for Free/Reduced Lunch

Subgroup	**Test Year**				***Analysis of Variance***	***Tukey's Multiple Comparisons***
	2009	**2010**	**2011**	**2012**		
Experimental	34.60	38.00	41.20	42.00	p = 0.0053	9 – 11, 12; 10 - 11
Control	40.60	42.80	48.60	46.80	p = 0.0067	9 – 11, 12

There was no significant difference between means for groups (p = 0.5986).

Table 9: Analysis of Mean 5th Grade Science Raw OCCT Scores

Subgroup	**Test Year**				***Analysis of Variance***	***Tukey's Multiple Comparisons***
	2009	**2010**	**2011**	**2012**		
Experimental Mean	33.57	34.99	35.21	35.18	p = 0.0011	9 – 10, 11, 12
Control Mean	33.08	33.49	33.38	34.92	p = 0.0006	12 – 9, 10, 11
t-test	p = 0.3259	p = 0.0015	p = 0.0002	p = 0.5905		

Table 10: Analysis of Ecology Objective Percent Correct

Subgroup	**Test Year**				***Analysis of Variance***	***Tukey's Multiple Comparisons***
	2009	**2010**	**2011**	**2012**		
Experimental	74.11	71.80	73.50	78.01	p<0.0001	12 – 9, 10, 11
Control	74.19	68.67	67.94	77.73	p<0.0001	12 – 9, 10, 11; 9 – 10, 11
t-test	p = 0.9522	p = 0.0234	p = 0.0001	p = 0.8242		

Table 11: Analysis of Percents of Performance Level of 5th Grade Science OCCT Scores
For each test year, data listed (top to bottom) is sample size (n) and percent of students who scored at indicated performance level.

Year	Group	Proficiency Level				Mantel-Haenszel Chi-Square
		1	2	3	4	
2009	Experimental	2 0.50%	23 5.75%	218 54.50%	157 39.25%	p = 0.2264
	Control	6 1.46%	27 6.55%	228 55.34%	151 36.65%	
2010	Experimental	1 0.25%	16 3.98%	176 43.78%	209 51.99%	p = 0.0013
	Control	4 0.93%	18 4.18%	236 54.76%	173 40.14	
2011	Experimental	2 0.49%	17 4.15%	192 46.83%	199 48.54%	p = 0.0018
	Control	9 2.11%	31 7.28%	212 49.77%	174 40.85%	
2012	Experimental	7 1.70%	22 5.34%	194 47.09%	189 45.87%	p = 0.4892
	Control	2 0.48%	28 6.67%	215 51.19%	175 41.67%	

Table 12: Performance Levels on the OCCT

Performance Level	Raw Score for Test Years 2009 – 2011	Raw Score for Test Year 2012
1	0 – 14	0 – 15
2	15 – 21	16 – 22
3	22 – 36	23 – 37
4	37 – 45	38 – 45

Figure 1: Mean 5th Grade Science OCCT Scores

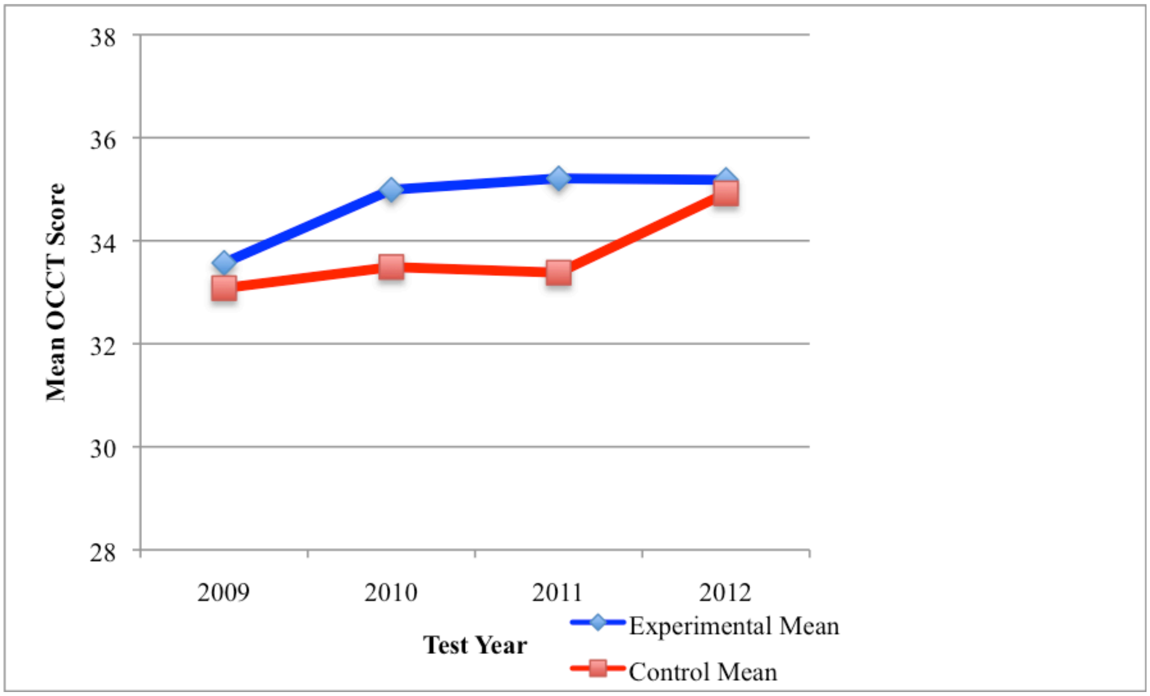


Figure 2: Mean Percentage Correct on Ecology Objective

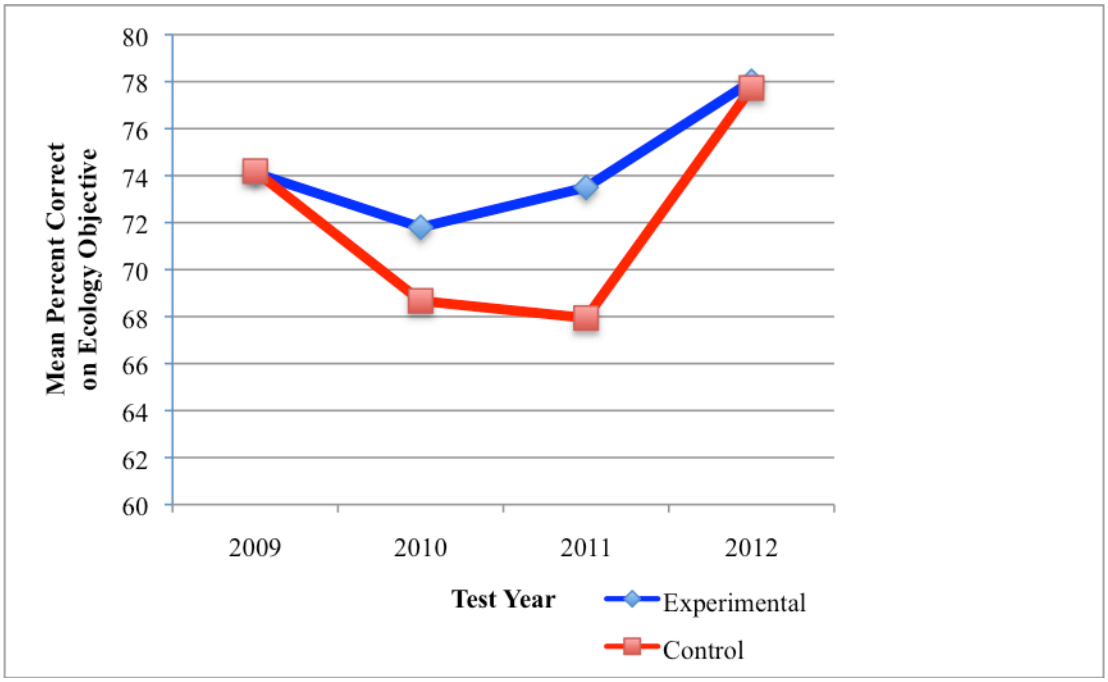
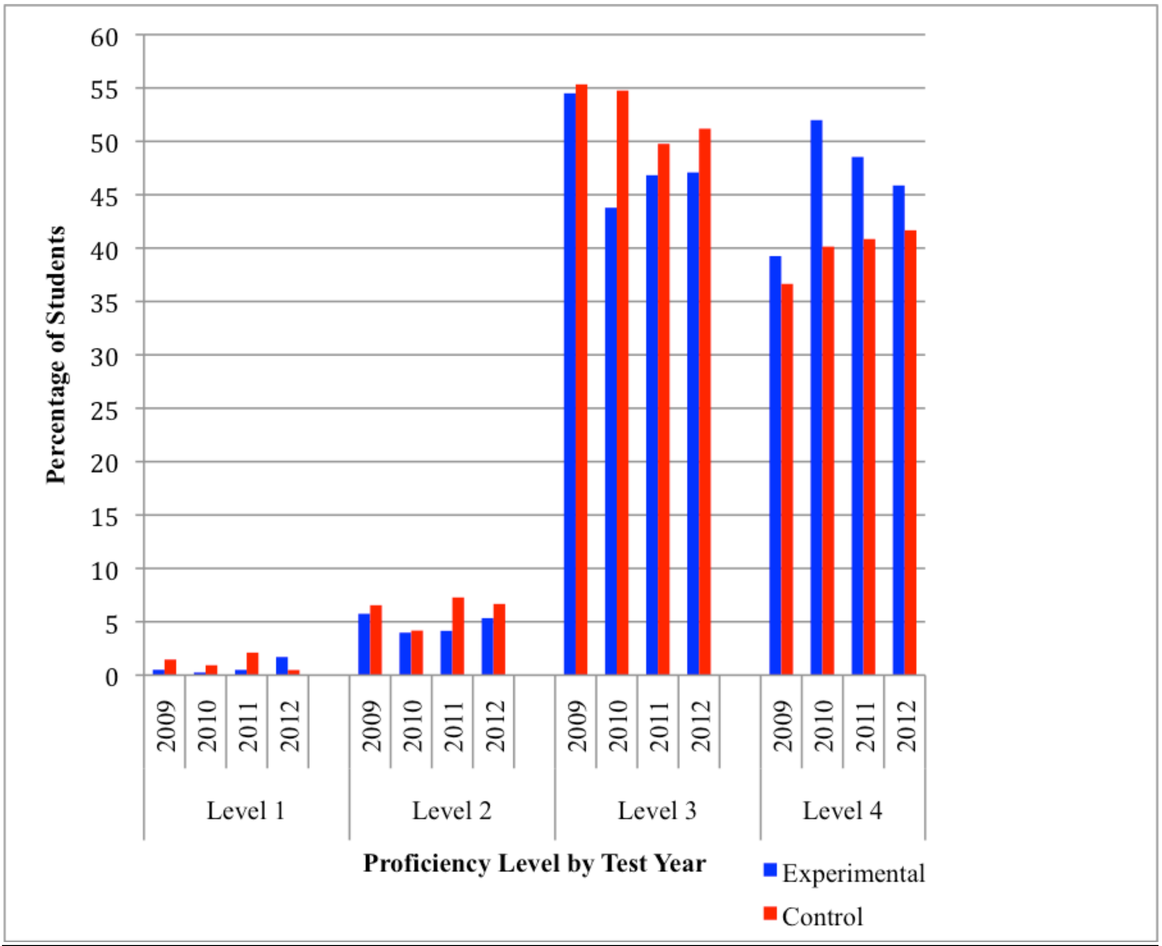


Figure 3: Percentage of Students at Each Performance Level and Test Year



Appendix A: Helpful Acronyms

1. ACC – Academic Competitiveness Council
2. ACE – Achieving Classroom Excellence
3. CCSS – Common Core State Standards
4. ELL – English Language Learners
5. EOI – End of Instruction
6. FAY – Full Academic Year
7. IRB – Institutional Review Board
8. NAEP – National Assessment of Education Progress
9. NCLB – No Child Left Behind Act
10. NGSS – Next Generation Science Standards
11. NRC – National Research Council
12. NSES – National Science Education Standards
13. NSTA – National Science Teachers Association
14. OCCT – Oklahoma Core Curriculum Test
15. OSDE – Oklahoma State Department of Education
16. PASS – Priority Academic Student Skills
17. SAS – Statistical Analysis System
18. STEM – Science Technology Engineering and Mathematics

Appendix B: Expanded Background

Development of National Standards of Education

History of Science Education Standards

Improving education has been a goal of many policy makers, educators, and parents since education in schools began. However, it was not until the 1980s that national education standards gained support by state governments. There were several key events that led to the development of the national standards. In 1981, the Secretary of Education Terrel H. Bell established the National Commission on Excellence in Education. This commission published the detailed report entitled *A Nation at Risk* in 1983 (National Commission on Excellence in Education, 1983). This report outlined the problems facing the country due to a "mediocre" education system and called for major reforms to be made in areas such as curriculum (National Commission on Excellence in Education, 1983). President George H.W. Bush created the National Education Goals Panel in 1990. Following this establishment, the standards for mathematics education became the first national education standards.

Science education standards came several years later. The National Science Teachers Association (NSTA) called upon the National Research Council (NRC) to create a set of national science education standards in the spring of 1991. After 18 months of research and writing, followed by approximately an additional year of revision, the first national science standards were released in December of 1994 in the document "National Science Education Standards".

According to the NRC, the National Science Education Standards (NSES) are used as "criteria to judge quality: the quality of what students know and are able to do the quality of the science programs that provide the opportunity for students to learn science; the quality of science teaching; the quality of the system that supports science teachers and programs; and the quality of assessment practices and policies" (NRC, 1996). It is intended that these national standards be used by state and local boards of education to determine if the students are making satisfactory achievements in learning.

The use of standards as instruments to test educational performance became law in January of 2002. President George W. Bush established the No Child Left Behind Act (NCLB), which requires "education reforms grounded in scientific research and evaluated for effectiveness through yearly assessments of student performance" (U.S. Department of Education, 2007). NCLB asserts that states must follow established standards of learning and assess the progress of students on meeting these standards through testing programs.

Evidence Students Aren't Learning According to the Standards

Following the creation of the NSES and the implementation of NCLB, further evaluation was required to determine the status of science education. Research was also required to determine what might be done to improve it. The Academic Competitiveness Council (ACC) was established by the Deficit Reduction Act of 2005 to do the following:

1. Identify all federal programs with a mathematics or science education focus
2. Identify the effectiveness of those programs
3. Determine areas of overlap or duplication among those programs
4. Identify target populations served by such programs
5. Recommend process to efficiently integrate and coordinate those programs.

Due to this charge, the ACC, chaired by the secretary of education, conducted a study that was published in a 2007 report to Congress. The report noted that there is a growing worry about the United States being able to produce future mathematicians, engineers, scientists and other technologists. This is expected to have economic consequences for the U.S. and may cause a loss of competitive edge (U.S. Department of Education, 2007).

The 2009 National Assessment of Education Progress (NAEP) has shown in *The Nation's Report Card for Science* that 34% of 4th graders scored at or above the proficient level on their science assessment. That value for 8th graders dropped to 30%, and for 12th grade students the number decreased again to 21% of students at or above the proficient level (National Center for Education Statistics, 2011). There is clearly a need to implement new strategies to reach students and increase their understanding of core science concepts.

Why Students Aren't Learning

A possible reason for the decline in student achievement in the science fields is suggested in the NRC's *Learning Science in Informal Environments: People, Places, and Pursuits* (NRC, 2009a). This report states that the problem with federal education policy is that it "creates incentives for mathematics and literacy instruction which appears to be reducing instructional time in science and other subject matters, especially in the early grades" (NRC, 2009a, p. 13). According to a national survey of teachers by Horizon Research, the average number of minutes per day spent in elementary school science classes was only 19 minutes for grades K-3 and 24 minutes for grades 4-6 in 2012 (Banilowe et al., 2013, p. 54). With lessening classroom time available for science education, it is increasingly important that we, as educators, teach with maximum impact.

Research summarized in *Taking Science to School* (NRC, 2007) shows that many of the major assumptions on how students learn are mistaken. For decades it was thought that children were not developmentally able to handle the more complex scientific theories. The NRC has found that "children entering school already have substantial knowledge of the natural world" (NRC, 2007, p. 2) and that "children can reason in ways that provide helpful starting points for developing scientific reasoning" (NRC, 2007, p. 53). It is suggested that students' understanding of concepts is held-back only by their conceptual knowledge, not their reasoning abilities (NRC, 2007). Thus there might be a disconnect between how teachers are able to teach scientific material and how students are actually able to learn.

It is also suggested that for maximum learning to occur, students must be actively engaged and interested in the topic being discussed. The NRC (2007, p. 186) found that "motivation and attitudes toward science play a critical role in science learning, fostering students' use of effective learning strategies that result in deeper understanding of science." Many classrooms do not foster the motivation side of learning, merely focusing on content memorization. In this respect, education as a whole needs to find ways of actively engaging the students' interest, as well as to foster a deeper knowledge of content. In order to achieve the necessary impact on student learning we need to consider research on how students learn and specifically on how they learn science.

The *Frameworks*: A Possible Solution to Improving Science Education

The NRC report entitled *Learning Science in Informal Environments: People, Places, and Pursuits* (NRC, 2009a) along with other reports such as *Science for All Americans* (Rutherford & Ahlgren, 1990) and *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), suggest that guidelines for science education are necessary in order to fulfill this search for deeper knowledge (NRC, 2012). The proposed new guidelines are called "Frameworks" to guide the development of science standards, as well as suggest connections to other disciplines. This NRC guide, *A Framework for K-12 Science Education: Practices, Cross-cutting Concepts, and Core Ideas,* indicates that science education does not currently meet the desired outcomes "because it is not organized systematically across multiple years of school, emphasizes discrete facts with a focus on breadth over depth, and does not provide students with engaging opportunities to experience how science is actually done" (NRC, 2012, p. 1).

The *Framework* was developed with two goals. First, there was a need to update the previous standards. More than a decade has passed since the release of the National Science Education Standards (1994), and the research on learning and teaching has changed during that time-span. Second, to produce standards aligned with the Common Core State Standards (CCSS). The adoption of the CCSS "prompted interest in comparable documents for science" (NRC, 2012, p. 8).

The foundation of the *Framework* is deeply rooted in educational research. Studies on how students learn science (NRC, 2007), what role laboratory activities have in high school settings (NRC, 2005a), and the importance of learning in nontraditional settings (NRC, 2009a) laid the foundation for the *Framework*. Research on science learning assessment was also evaluated from *Systems for State Science Assessment* (NRC, 2005b). The work *Engineering in K-12 Education* (NRC, 2009b) provided information about what skills and knowledge are necessary for building a foundation for engineering. The Framework committee also took into consideration the earlier NSES and the American Association for the Advancement of Science's work, *Benchmarks for Science Literacy,* when developing the new guidelines (NRC, 2012).

The *Frameworks* are "intended as a guide to standards developers as well as for curriculum designers, assessment developers, state and district science administrators, professionals responsible for science teacher education, and science educators working in informal settings" (NRC, 2012, p. 8). The development of the *Frameworks* is also in light of the fact that there is a "growing national consensus around the need for greater coherence—that is, a sense of unity—in K-12 science education. Too often, standards are long lists of detailed and disconnected facts" (NRC, 2012, p. 10). This emphasizes the idea that the science curriculum of the United States is "a mile wide and an inch deep" (NRC, 2012, p. 10). The *Framework* is unique from other standards initiatives because they consist of three dimensions: science and engineering practices, disciplinary core ideas, and crosscutting concepts. The dimensions show a much more connected and dynamic approach to the teaching and learning of science than previous efforts. These three dimensions are detailed in Appendix C, Table 1.

According to *Taking Science to School*, for a child to be considered proficient in the sciences they must possess both knowledge and reasoning skills. They must "know, use, and interpret scientific explanations of the natural world; generate and evaluate scientific evidence and explanations; understand the nature and development of scientific knowledge; and participate productively in scientific practices and discourse" (NRC, 2007, p. 221). To become proficient, new specific standards were needed.

The Next Generation Science Standards (NGSS) are a set of K-12 learning standards established with the goals of better preparing students for college and the workforce. There are too few young adults seeking positions in science, technology, engineering and mathematics

(STEM) fields. The NGSS also demonstrate how science is practiced in real situations due to the integration of both content and application instead of keeping these ideas as separate entities. These new standards have been developed in a two-step process that was led by 26 states. First came the development of the *Frameworks* (Appendix C, Table 1). The second step was the development of the standards based on the *Frameworks*. The National Research Council, National Science Teacher's Association (NSTA), the American Association for the Advancement of Science (AAAS), and Achieve, Inc. were the lead partners in the development of the NGSS (Achieve, Inc., 2013). Draft versions of the NGSS were open to public comment in the spring and in the fall of 2012. The finalized standards became open for adoption by states starting fall of 2013. As of November 2013, eight states (including California, Maryland, Vermont, Rhode Island, Kansas, Kentucky, Delaware, and Washington) have adopted the NGSS (Achieve, Inc., 2013, & Issaquah Press, 2013).

The NGSS are also unique because they consist of three dimensions integrated into one performance expectation. Performance expectations are intended to describe what a student should be capable of doing at the end of instruction in each grade level (Achieve, Inc., 2013). These three dimensions of the performance expectation are the three dimensions of the *Frameworks*: science and engineering practices, disciplinary core ideas, and crosscutting concepts. There are eight science and engineering practices, which describe skills and actions of the students (Appendix C, Table 1). These are to be implemented in each grade. The Disciplinary Core Ideas are grouped into Life Science, Earth and Space Science, Physical Science, and Engineering. Each has specific content information that students will be instructed with growing sophistication through the years in school. Performance expectations are created to be in close association with the Common Core State Standards (CCSS), as designated with the seven Crosscutting Concepts (Appendix C, Table 1).

There are connections among the performance expectations and they are also linked to each other and throughout the grade levels. The connections between science topics within the same grade level include, for example, life science and physical science. The performance expectations are that are linked to each other across grade levels helps to reinforce topics and build on the level of knowledge. The topic "Ecosystems: Interactions, Energy, and Dynamics" is assessed in elementary school, middle school, and high school at varying degrees of difficulty (Achieve, Inc., 2013).

According to the NSTA (2003), environmental literacy is an "essential component of a comprehensive science education program". The new Next Generation Science Standards will continue to place high value on ecological concepts. Issues like "generating sufficient energy, preventing and treating diseases, maintaining supplies of clean water and food, and solving the problems of global environmental change" (NRC, 2012, p. 9) will be shown to have necessary ties to the science fields and engineering.

Oklahoma State Standards of Education

Prior to the creation and adoption of the NGSS, states followed (and some still choose to follow) their own set of standards for each grade level and educational topic. Oklahoma established a set of statewide standards for learning titled the Oklahoma Priority Academic Student Skills (PASS). They were originally developed for each curriculum area (except technology) for use in the 2003 to 2004 school year. The new Oklahoma Academic Science

Standards are closely aligned to the NGSS, but still exclude the topics of climate change and evolution.

The depth of knowledge set forth by the PASS is assessed by statewide Oklahoma Core Curriculum Tests (OCCT) for elementary and middle school students, and by End of Instruction (EOI) tests for high school students that are administered at the end of the course. According to the Oklahoma State Department of Education (OSDE), the OCCT is a criterion-referenced testing program to compare student performance on specific standards (OSDE, 2012b). These assessments are considered statistically valid testing instruments. Oklahoma students entering into their freshman year of high school during the 2008 to 2009 school year must pass EOI tests in the subject areas of English II and Algebra I. They must also pass two tests out of the subjects of Biology, English III, Algebra II, Geometry, and U.S. History in order to graduate high school. These requirements are designated by the Achieving Classroom Excellence (ACE) legislation (OSDE, 2012a). Since there is an emphasis on students passing their EOI tests, it stands to reason that students need to build a strong foundation of success on the OCCTs in order to prepare them for these future exams.

The 5th grade Science OCCT assesses student knowledge in the content areas of physical science, life science, and earth/space science. Student performance on the test is ranked in the categories of Advanced, Proficient, Limited Knowledge, and Unsatisfactory. On the 2009 fifth grade Science OCCT, 83.88% of students scored satisfactory or above with the adjusted scores. It was 86.82% of students in 2010, 88.7% in 2011 and 88.3% in 2012 (OCCT Technical Reports, 2009-2012).

The life science portion of the OCCT comprises 27% of the 2008 exam and 29% of the 2009 through 2012 exams. Thus, nearly one-third of the scientific knowledge tested in Oklahoma is associated with ecology or environmental information, specifically with the relationships amongst organisms and between organisms and their environment. The standard and objectives designated for this subset of the exam are described in Table 2 of Appendix C. Due of the large percentage of the test being related to the topic of ecology, outdoor education is one possible method to use to increase students' overall science content knowledge.

Outdoor Education

What is Outdoor Education?

Outdoor education is a part of the larger category of informal learning. Outdoor education is a subset of a larger theme of learning known as informal, or place-based education. Informal education comprises a wide range of topics and locations. The focus of the subject matter might include the core subjects of math, science, language arts and social studies. Furthermore, curricula such as art, music, and physical education can implement informal education programs. The locations might vary from schoolyard greenhouses to zoo or museum programs or outdoor camps established for education. Parkin (1998) expands this view, stating the objectives for outdoor education might include a wide range of topics, including academic, social, physical, or a combination of these. Academic subject matter might include scientific principles such as ecological phenomena, literary concepts such as poetry about nature, and mathematical concepts like determining the angle of sunrays. Physical and social learning objectives might include sports related tasks, such as hiking and fishing, and activities like teambuilding events and games. Science itself is described as a collection of knowledge about the natural world and the process of establishing that knowledge (NRC, 2007) and thus it goes to reason that science education must involve our natural (informal) surroundings. Research by The Committee for Learning Science in Informal Environments states that "structured, non-school science programs can feed or stimulate the science-specific interests of adults and children, may positively influence academic achievement for students, and may expand participants' sense of future science career options" (NRC, 2009a, p. 3). The National Science Board and the Academic Competitiveness Council conducted evaluations of Science Technology Engineering and Mathematics (STEM) programs to determine their effectiveness. The researchers cited "Informal Education and Outreach" as one of the three essential aspects of education, thus indicating that it is important for "U.S. economic competitiveness, particularly the future ability of the nation's education institutions to produce citizens literate in STEM" (U.S. Department of Education, 2007, p. 5). The process of learning in an informal environment, specifically through outdoor education, allows students to have a meaningful experience with a plethora of topics throughout the grade levels.

The specific details of what outdoor education entails are varied, although there is agreement on five key factors: it is an experiential method of learning, it occurs (at least partially) in the outdoors, it is interdisciplinary, it involves community interaction, and it involves relationships. Outdoor education is an experiential method of learning. This non-traditional approach to science education goes hand-in-hand with the idea put forth by the NRC that "students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves" (NRC, 2012, p. 30). The report *Taking Science to School* (NRC, 2007) arrived at this same conclusion about the necessity of participating in scientific practices. According to Priest, "experiential learning requires the full use of the six senses (sight, sound, taste, touch, smell, and intuition) and involves the three domains (cognitive, affective, and motoric) of learning" (Priest, 1986, p. 14). Thus by including all of the senses and the three learning domains, students will be able to develop a deeper understanding of the nature of scientific knowledge. Woodhouse and Knapp expand on this idea, stating that the "main purpose of 'outdoor education' is to provide meaningful contextual experiences—in both natural and constructed environments—that complement and expand classroom instruction, which tends to be dominated by print and electronic media" (Woodhouse and Knapp, 2000, p. 1). By varying the source of information, the students are able to identify how the new information fits with their current schema of knowledge. This idea of building on prior knowledge directly ties back to the construction of the performance expectations of the NGSS (Achieve, Inc., 2013). These contextual experiences allow for a deeper understanding and appreciation of the learning material. Learning by doing, or experiential learning, is an educational tool with high value for educators.

Outdoor education involves "using outdoor materials, themes, processes, and field observations" (Smith, 1970, p. 8) and might be done in areas "ranging from wilderness preserves to man-influenced areas" (Wiener, 1967, p. 696). Outdoor education also "uses the student's whole environment as a source of knowledge" (Boss, 1999, p. 2). This allows "the community, rather than the classroom" to be "the context of learning" (Boss, 1999, p. 2). The outdoor environment might be as basic as a schoolyard or as advanced as a educational site developed for the sole purpose of outdoor education. This broader scope of the source of knowledge opens the student's mind to the possibilities of the world around them. By illuminating the idea that there are things to be learned all around us, it is a logical conclusion that the student will develop a greater appreciation for life itself.

An additional aspect of outdoor education is that it is inherently interdisciplinary and spans across the grade levels. This again relates to the NGSS standards, as they are interdisciplinary and weave throughout the grade levels as well. Erdogan states the "students who are involved in these activities have more opportunity to observe the relationship among various disciplines. The student can also observe how theoretical knowledge can (be) implemented into the practice" (Erdogan, 2011, p. 2236), and showing the connection between various disciplines allows for a deeper understanding and a more "complex, internalized organization of knowledge" (Ivanitskaya et al., 2002, p. 99). Furthermore, using the interdisciplinary methodology helps students to "emphasize higher-order thinking (e.g., analyzing, applying, generalizing) and seek meaningful connections between and among disciplines" (Ivanitskaya et. al., 2002 p. 97). In addition to being interdisciplinary, outdoor education is appropriate throughout the grade levels (Wiener, 1967). This directly ties outdoor education to the scope and sequence of the Oklahoma PASS. What the standards set forth for the lower grade levels feeds into what is expected of the upper levels, and, at the elementary level, span across the various disciplines of science. By utilizing the interdisciplinary and multi-grade level approach to learning, outdoor education seeks to foster a deeper understanding of the curriculum material.

The community plays a key role in outdoor education. Woodhouse and Knapp (2000) echo the ideas of interdisciplinary material and experiential learning and expand on these by adding that outdoor education must involve the community in educating students. Community involvement is thought to help foster interest in the subject matter for the student. A requirement specifically of the teacher's curriculum for outdoor education is it must "shape and interpret experiences in response to particular circumstances, and (be) in accordance with a deep understanding of local curriculum imperatives" (Brookes, 2002). Community leaders such as school board members and government officials determine which standards of learning are implemented in the school district. By aligning the outdoor education curriculum with these standards, it ensures that the material taught outside of the classroom is beneficial to student success within the course. By focusing on what is important to the local community, outdoor education not only increases student interest levels but also helps to meet local educational goals.

Outdoor education places a large emphasis on relationships. Priest (1986) states that the relationships of outdoor education encompass four types: interpersonal (between others), intrapersonal (within oneself), ecosystemic (interdependence within an ecosystem), and ekistic (the relationship of people with their surroundings). The relationships within an ecosystem are one of the major topics assessed in life science courses. This ecosystemic relationship can be directly observed in any outdoor science education program. The ideal outdoor education program will include all four patterns of relationships, thus leading to the realization of experiential learning (Priest, 1986).

Thus, the goal of outdoor education is to provide programs that reach students on the three learning domains through an experiential method of education that emphasizes relationships in an interdisciplinary fashion in alignment with the curriculum. This goal coincides directly with the Frameworks (NRC, 2012), NGSS (Achieve, Inc., 2013), U.S. competency in STEM and the future economy of the United States (U.S. Department of Education, 2007).

Research shows a link between outdoor education and environmental attitudes. The Merriam-Webster Dictionary (Merriam-Webster's online dictionary, n.d.) defines attitude as "a feeling or way of thinking that affects a person's behavior". Thus, it is a reasonable assumption that a student's attitude toward a topic is highly influential in how he or she will apply him/herself toward the learning of said topic. Prior studies completed on outdoor education indicate a positive correlation between participation in an outdoor education experience and attitudes toward the environment and science itself. Dettmann-Easler and Pease (1999) conducted a study to determine how participation in a residential, outdoor environmental education program affected 5^{th} and 6^{th} grade students' attitude toward wildlife. The student participants attended one of six different sites and were interviewed on their attitudes before and after attending the programs. Dettmann-Easler and Pease (1999) found a significant improvement in attitude toward wildlife among the students as compared to those who did not attend the outdoor program. A study conducted by Malinowski and Fortner (2010) was conducted to determine if participation in a brief (one and a half day) place-based program increased sixth graders' attitudes toward science. Their findings were that attitudes toward science were positively affected, with significant results in the categories of general science feelings and the value of science. If outdoor education programs are able to increase feelings toward science in general and towards the environment, place-based education must be an important addition to the science curricula.

There are connections between environmental attitudes and increased knowledge of ecology. There have also been many studies showing a connection between improving ones attitude towards the environment and an increased knowledge of ecological phenomena.

In a study completed by Cronin-Jones (2000), third and fourth grade students participated in a 10-day unit on ecology. It was determined that students learning environmental science in an outdoor schoolyard showed significantly increased levels of environmental attitude compared to prior to completing the program. The students also exhibited a significant increase in environmental knowledge on post-test scores. There was therefore a positive relationship between increased attitude toward the environment and learning gains.

Carrier Martin (2003) conducted a study to "examine the effects of participation in regular outdoor schoolyard environmental education activities on environmental knowledge, attitudes, behaviors, and comfort levels of forth and fifth grade students". It was determined that there was no significant difference between the fourth graders attitudes or knowledge. In comparison to the control fifth grade group, the fifth grade experimental group showed a significant difference in both comfort level and environmental knowledge. Martin points out, however, that the teachers of the control and experimental group demonstrated a notable "difference in the levels of enthusiasm for environmental issues" (Carrier Martin, 2003, p. 58), thus suggesting that this is the reason for no significant difference within the fourth grade groups or possibly for the increase in the 5th grade scores. This study also indicated a significant difference between male and female scores with females scoring higher.

An additional study conducted by Bradley, Waliczek, and Zajicek (1999) demonstrated that there was a correlation between attitude and knowledge on environmental curriculum material. Students participating in a 10-day environmental science program in Texas experienced a 22% gain in environmental knowledge. The results showed a significant difference ($p<0.01$) between scores overall as well as specifically on 12 of the 18 questions. There was also a significant difference in pre and post-test attitudinal scores.

A study conducted on Slovakian fifth graders (Francovicova & Prokop, 2011) supports this conclusion. The goal of their research was to determine if outdoor environmental education had an influence on knowledge and attitudes, specifically towards plants. The experimental group who participated in learning ecological material in a meadow showed a significant difference in scores on both a post-test and a retention test. These data support the hypotheses that knowledge and attitudes can be positively influenced by participation in an outdoor education program (Francovicova and Prokop, 2011).

Each of these studies provide support that participation in outdoor education improves knowledge levels and attitudes toward the environment.

Studies show important benefits for educators participating in outdoor education. Research has demonstrated a connection between participation in an outdoor education experience and how effective educators view themselves to be. This may be of particular importance in preparing pre-service teachers. In a study completed by Carrier (2009), it was determined that by participating in an outdoor education program, the future teachers developed a greater sense of self-efficacy or confidence in their teaching abilities (Carrier, 2009). Thus by using the actual setting in which science is occurring, beginning teachers feel they are better able to impart the subject matter. This is especially important in elementary science education as the background of "elementary pre-service teachers are not traditionally focused on science" (Carrier, 2009). Outdoor education programs have also been shown to improve self-efficacy for current educators after their participation in a professional development program showing implementing outdoor educational activities (Holden et al., 2011). According to Holden et. al (2011), "teachers' self-efficacy and outcome expectancy have been consistently associated with student achievement." This provides further strength to the study by Martin, showing that how effective teachers view themselves to be has a powerful impact on learning. By increasing how effective the teacher views him/herself to be, the student's knowledge gains are also increased. Outdoor educational programs are helpful for both pre-service and current teachers by improving their self-efficacy, and thus resulting in greater student achievement.

What Outdoor Education is Not

In addition to a discussion on what outdoor education encompasses, it is also important to note what it is not. First, outdoor education is not intended to be the sole location of learning. Teachers must become facilitators of learning through instructing the students using informal education and then reinforcing those same themes back in the classroom setting. This "offers the possibility of transcending some limitations of schooling without abandoning some necessary foundations of curriculum" (Brookes, 2002, p. 421). In Hammerman and Hammerman's Teaching in the Outdoors (1973), they state the following:

> *"Another of the more tangible results that classroom teachers observe is an increased interest in what-is-in-the-book. After having captured an insect, or having found a rock specimen, or finally, after much searching, having located a single constellation in the night sky, a pupil is often motivated to turn eagerly and voluntarily to his textbooks in an effort to learn more about his discoveries."*

By educating students in natural settings as well as in the classroom, students are better able to see the connections between what they are learning and their own lives. Second, although the terms "outdoor education" and "environmental education" are often used interchangeably, this is a misconception. Outdoor education is a form of place-based instruction, meaning the learning is taking place in the location appropriate to the topic, whereas environmental education can occur either indoors or outdoors (Woodhouse and Knapp, 2000). Adkins and Simmons (2002) further distinguish the two by explaining that environmental education has a goal of creating citizens who are knowledgeable and take action in environmental issues, whereas outdoor education is intended to teach specific objectives on a variety of topics using the outdoor arena. Finally, outdoor education is not to be implemented for all topics. Certain specific ideas, such as molecular structures or how to use a piece of electrical equipment, will clearly not lend themselves well to an outdoor setting. Only objectives dealing with items found natively outside should be taught in an outdoor education program. It is important to recognize these distinguishing characteristics in a discussion of what comprises outdoor education.

Appendix C: Background and Summary Data Tables

Table 1: The Three Dimensions of the Frameworks

Dimension	**Details**
Scientific and Engineering Practices	1. Asking questions (for science) and defining problems (for engineering) 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Using mathematics and computational thinking 6. Constructing explanations (for science) and designing solutions (for engineering) 7. Engaging in argument from evidence 8. Obtaining, evaluating, and communicating information
Crosscutting Concepts	1. Patterns 2. Cause and effect: Mechanism and explanation 3. Scale, proportion, and quantity 4. Systems and system models 5. Energy and matter: Flows, cycles, and conservation 6. Structure and function 7. Stability and change
Disciplinary Core Ideas	*Physical Sciences* PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and their applications in technologies for information transfer *Life Sciences* LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, and dynamics LS3: Heredity: Inheritance and variation of traits LS4: Biological evolution: Unity and diversity *Earth and Space Sciences* ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity *Engineering, Technology, and Applications of Science* ETS1: Engineering design ETS2: Links among engineering, technology, science, and society

(*NRC, 2012, p. 3*)

Table 2: 5th Grade Life Science Standard and Objectives

Standard 2	Objectives
***Organisms and Environments* –** Organisms within an ecosystem are dependent on one another and the environment. The student will engage in investigations that integrate the process standards and lead to the discovery of the following objectives:	3. Organisms in an ecosystem depend on each other for food, shelter, and reproduction. a. Ecosystems include food chains and food webs. b. Relationships exist between consumers, producers, and decomposers within an ecosystem. c. Predator and prey relationships affect populations in an ecosystem
	4. Changes in environmental conditions due to human interactions or natural phenomena can affect the survival of individual organisms and/or entire species. a. Earth's resources can be natural (non-renewable) or man-made (renewable). b. The practices of recycling, reusing, and reducing help to conserve Earth's limited resources.

(OSDE, 2012b)

Table 3: Summary Statistics for Average Number of Days Missed Per Student Per Test Year

For each subgroup per year, data listed (top to bottom) is: sample size (n), mean number of days missed per student, standard deviation, and range.

<table>
<tr><th rowspan="2">Subgroup</th><th colspan="4">Test Year</th><th rowspan="2">Total</th></tr>
<tr><th>2009</th><th>2010</th><th>2011</th><th>2012</th></tr>
<tr><td>Experimental Group</td><td>5
6.36
0.60
5.80 – 7.20</td><td>5
7.18
0.16
6.90 – 7.30</td><td>5
7.24
1.01
6.20 – 8.90</td><td>5
6.38
1.06
5.50 – 8.20</td><td>20
6.79
0.85
5.5 – 8.90</td></tr>
<tr><td>Control Group</td><td>5
7.24
0.67
6.40 – 8.00</td><td>5
8.12
0.41
7.60 – 8.70</td><td>5
7.82
0.72
6.90 – 8.70</td><td>5
7.22
0.64
6.40 – 8.00</td><td>20
7.60
0.69
6.40 – 8.70</td></tr>
</table>

Table 4: Summary Statistics for Percentage of Caucasian Students Per Test Year
For each subgroup per year, data listed (top to bottom) is: sample size (n), mean percentage of Caucasian students at site, standard deviation, and range.

Subgroup	Test Year				Total
	2009	2010	2011	2012	
Experimental Group	5 70.80 5.72 63 – 76	5 69.80 5.31 64 – 74	5 68.80 4.21 63 – 73	5 69.40 3.05 65 – 73	**20** **69.70** **4.37** **63 – 76**
Control Group	5 67.60 3.05 64 – 71	5 67.00 4.42 61 – 73	5 66.60 6.27 57 – 74	5 68.80 3.90 65 – 74	**20** **67.50** **4.27** **57 – 74**

Table 5: Summary Statistics for Percentage of Students Eligible for Free or Reduced Lunch Prices

For each subgroup per year, data listed (top to bottom) is: sample size (n), mean number of students eligible for free or reduced lunch, standard deviation, and range.

Subgroup	Test Year				Total
	2009	2010	2011	2012	
Experimental Group	5 34.60 15.69 19 – 57	5 38.00 17.93 19 – 63	5 41.20 15.99 23 – 64	5 42.00 20.14 20 – 72	**20** **38.95** **16.36** **19 – 72**
Control Group	5 40.60 15.45 20 – 61	5 42.80 17.43 26 – 69	5 48.60 16.33 26 – 70	5 46.80 14.72 26 – 66	**20** **44.70** **15.05** **20 – 70**

Table 6: Analysis of Average Number of Days Missed

Subgroup	Test Year				*Analysis of Variance*	*Tukey's Multiple Comparisons*
	2009	2010	2011	2012		
Experimental	6.36	7.18	7.24	6.38	p = 0.0224	*
Control	7.24	8.12	7.82	7.22	p = 0.0145	10 – 9, 12

There was no significant difference between means for groups (p = 0.0606).
** sample size too small*

Table 7: Analysis of Percentage of Caucasian Students

Subgroup	Test Year			
	2009	2010	2011	2012
Experimental	70.80	69.80	68.80	69.40
Control	67.60	67.00	66.60	68.80

There was no significant difference between means for subgroups (p = 0.4372).
There was no significant difference between means for years (p = 0.3540).
There was no significant interaction between subgroups and years (p = 0.5353).

Table 8: Analysis of Percentage of Students Eligible for Free/Reduced Lunch

Subgroup	Test Year				*Analysis of Variance*	*Tukey's Multiple Comparisons*
	2009	2010	2011	2012		
Experimental	34.60	38.00	41.20	42.00	p = 0.0053	9 – 11, 12; 10 - 11
Control	40.60	42.80	48.60	46.80	p = 0.0067	9 – 11, 12

There was no significant difference between means for groups (p = 0.5986).

Table 9: Analysis of Mean 5th Grade Science Raw OCCT Scores

Subgroup	**Test Year**				***Analysis of Variance***	***Tukey's Multiple Comparisons***
	2009	**2010**	**2011**	**2012**		
Experimental Mean	33.57	34.99	35.21	35.18	p = 0.0011	9 – 10, 11, 12
Control Mean	33.08	33.49	33.38	34.92	p = 0.0006	12 – 9, 10, 11
t-test	p = 0.3259	p = 0.0015	p = 0.0002	p = 0.5905		

Table 10: Analysis of Ecology Objective Percent Correct

Subgroup	Test Year				*Analysis of Variance*	*Tukey's Multiple Comparisons*
	2009	2010	2011	2012		
Experimental	74.11	71.80	73.50	78.01	p<0.0001	12 – 9, 10, 11
Control	74.19	68.67	67.94	77.73	p<0.0001	12 – 9, 10, 11; 9 – 10, 11
t-test	p = 0.9522	p = 0.0234	p = 0.0001	p = 0.8242		

Table 11: Analysis of Percents of Performance Level of 5th Grade Science OCCT Scores
For each test year, data listed (top to bottom) is sample size (n) and percent of students who scored at indicated performance level.

Year	Group	Proficiency Level 1	Proficiency Level 2	Proficiency Level 3	Proficiency Level 4	Mantel-Haenszel Chi-Square
2009	Experimental	2 0.50%	23 5.75%	218 54.50%	157 39.25%	p = 0.2264
	Control	6 1.46%	27 6.55%	228 55.34%	151 36.65%	
2010	Experimental	1 0.25%	16 3.98%	176 43.78%	209 51.99%	p = 0.0013
	Control	4 0.93%	18 4.18%	236 54.76%	173 40.14	
2011	Experimental	2 0.49%	17 4.15%	192 46.83%	199 48.54%	p = 0.0018
	Control	9 2.11%	31 7.28%	212 49.77%	174 40.85%	
2012	Experimental	7 1.70%	22 5.34%	194 47.09%	189 45.87%	p = 0.4892
	Control	2 0.48%	28 6.67%	215 51.19%	175 41.67%	

Table 12: Performance Levels on the OCCT

Performance Level	Raw Score for Test Years 2009 – 2011	Raw Score for Test Year 2012
1	0 – 14	0 – 15
2	15 – 21	16 – 22
3	22 – 36	23 – 37
4	37 – 45	38 – 45

Table 13: Summary Statistics for OCCT Score by School Site by Test Year

For each school site per year, data listed (top to bottom) is: sample size (n), mean OCCT score, standard deviation, and range.

School Site	Test Year				Total
	2009	**2010**	**2011**	**2012**	
A	62 31.66 6.15 18 – 43	67 34.48 6.83 11 – 44	63 37.35 5.04 20 – 44	77 34.91 7.60 15 – 45	**269** **34.62** **6.79** **11 – 45**
B	91 35.73 5.96 17 – 45	81 39.14 3.75 26 – 45	76 37.34 4.70 27 – 45	94 38.81 4.37 19 – 45	**342** **37.74** **4.96** **17 – 45**
C	72 36.56 6.06 16 – 45	75 35.12 6.05 17 – 44	75 35.69 6.68 14 – 45	59 34.93 6.97 14 – 44	**281** **35.60** **6.42** **14 – 45**
D	94 32.65 7.67 14 – 44	99 34.62 7.32 15 – 45	112 35.29 6.84 12 – 45	98 34.24 6.49 16 – 45	**403** **34.25** **7.12** **12 – 45**
E	81 31.00 6.47 13 – 43	80 31.58 7.16 15 – 43	84 31.13 6.77 15 – 43	84 32.62 7.39 12 – 44	**329** **31.59** **6.96** **12 – 44**
Experimental Group Summary	**400** **33.57** **6.87** **13 – 45**	**402** **34.99** **6.80** **11 – 45**	**410** **35.21** **6.55** **12 – 45**	**412** **35.18** **6.89** **12 – 45**	**1624** **34.74** **6.81** **11 – 45**
F	98 35.02 6.40 18 – 44	89 34.79 5.35 14 – 43	97 35.13 6.44 13 – 44	79 35.44 5.93 17 – 45	**363** **35.09** **6.05** **13 – 45**
G	73 33.12 6.82 14 – 45	70 32.93 7.11 14 – 43	82 32.76 6.85 14 – 44	70 34.24 6.88 16 – 43	**295** **33.24** **6.90** **14 – 45**
H	39 35.23 5.80 21 – 44	64 34.59 6.23 23 – 45	47 37.23 4.22 25 – 44	41 33.98 7.45 18 – 42	**191** **35.24** **6.09** **18 – 45**
I	105 33.18 7.76 11 – 45	105 35.84 5.52 16 – 45	93 33.41 7.64 13 – 45	138 36.01 6.55 14 – 44	**441** **34.75** **6.98** **11 – 45**
J	97 30.12 6.85 14 – 44	103 29.67 7.53 13 – 43	107 30.56 8.0741581 9 – 43	92 33.79 6.8637254 10 – 44	**399** **30.97** **7.52** **9 – 44**
Control Group Summary	**412** **33.08** **7.11** **11 – 45**	**431** **33.49** **6.77** **13 – 45**	**426** **33.38** **7.32** **9 – 45**	**420** **34.92** **6.69** **10 – 45**	**1689** **33.72** **7.01** **9 – 45**

Table 14: Summary Statistics for Percent Correct on Ecology Objective
For each school site per year, data listed (top to bottom) is: sample size (n), mean percent correct on objective, standard deviation, and range.

School Site	Test Year				Total
	2009	2010	2011	2012	
A	56 72.04 17.22 25 – 100	67 70.15 18.27 17 – 100	58 80.50 15.97 42 – 100	69 78.75 17.05 25 – 100	**250 75.35 17.63 17 – 100**
B	88 76.72 17.79 17 – 100	81 79.69 14.67 33 – 100	73 77.18 16.69 42 – 100	94 84.96 13.27 33 – 100	**336 79.84 15.93 17 – 100**
C	69 81.62 15.91 33 – 100	69 76.52 16.67 33 – 100	71 74.87 19.08 17 – 100	56 77.89 16.55 25 – 100	**265 77.18 17.23 17 – 100**
D	92 72.59 19.76 33 – 100	89 70.03 22.00 17 – 100	98 74.03 20.18 17 – 100	95 72.45 18.83 17 – 100	**374 72.32 20.16 17 – 100**
E	78 67.82 18.73 17 – 100	79 64.73 20.71 8 – 100	84 63.68 20.39 17 – 100	78 75.81 18.04 17 – 100	**319 67.92 20.00 8 – 100**
Experimental Group Summary	**383 74.11 18.56 17 – 100**	**385 71.80 19.37 8 – 100**	**384 73.50 19.53 17 – 100**	**392 78.01 17.33 17 – 100**	**1544 74.37 18.84 8 – 100**
F	88 79.49 51.49 25 – 100	83 71.13 15.47 25 – 100	85 74.05 16.23 17 – 100	73 79.18 15.53 33 – 100	**329 75.91 16.01 17 – 100**
G	68 76.44 15.30 33 – 100	65 71.02 21.06 25 – 100	80 64.64 21.48 17 – 100	59 77.95 15.06 33 – 100	**272 72.00 19.35 17 – 100**
H	37 78.16 17.02 33 – 100	59 72.31 18.72 25 – 100	47 76.79 15.48 42 – 100	41 72.51 21.66 8 – 100	**184 74.67 18.37 8 – 100**
I	99 73.13 18.42 17 – 100	102 73.51 16.17 17 – 100	90 67.31 20.84 17 – 100	138 79.33 7.65 25 – 100	**429 74.00 18.66 17 – 100**
J	90 66.84 18.91 17 – 100	103 58.34 24.34 17 – 100	102 61.93 24.25 8 – 100	89 76.31 18.00 8 – 100	**384 65.45 21.88 8 – 100**
Control Group Summary	**382 74.19 17.78 17 – 100**	**412 68.67 19.50 17 – 100**	**404 67.94 21.08 8 – 100**	**400 77.73 17.51 8 – 100**	**1598 72.07 19.45 8 – 100**

Appendix D: Possible Outline of Future Research

It is the recommendation of this researcher that further study be conducted on this topic to account for these limitations. My specific recommendations for a future study include the following criteria:

1. Due to the adoption of new PASS in 2014, a minimum of two academic years must be waited before beginning new data collection. This will allow for an adjustment period for teachers to alter their curriculum if needed to match the new standards.
2. Using the same selection of schools for the control and experimental groups, conduct a pre-test using a released version of a prior OCCT examination that uses the new PASS. Pre-tests are essential to account for actual increases in knowledge versus prior knowledge.
3. The years of data collection for analysis must be expanded to a period of seven years or more. More years of testing data are needed to determine if the significant difference between the control and experimental groups' OCCT scores on the 2010 and 2011 tests can be attributed only to participation in an outdoor ecology based program or some other factor.
4. Analysis of additional demographic factors must be completed. Comparisons of highest educational level of the parents and type of degree held by the teacher are needed. An additional point of interest would be to discover if there are differences between how boys and girls compare in their scores.

5. Attitudinal surveys must be completed by teachers of each group. As shown in prior studies (Carrier Martin, 2003; Holden et al, 2011), teacher attitude may have a significant impact on how the students perform and thus must be measured and analyzed.
6. The experimental groups must all participate in the same version of the outdoor education program. Although the regional outdoor education programs offer a variety of courses to participate in, this must be controlled in order to yield the most accurate results. Furthermore, program length must be consistent for all experimental group schools.
7. It must be verified that the control group schools do not participate in any form of outdoor education or place-based instruction. If it is found that they do, this school must be eliminated from the study results.
8. Amount of time spent in the classroom reviewing or expanding on the material learned in the outdoor program must also be analyzed to locate any significant differences within the experimental group.

The additions of each of the stated analyses and controls will produce a study with results that will hopefully pinpoint what is actually the root of the differences found in this study – whether it be outdoor education, teacher attitude, or another unforeseen cause.

In a future large-scale study, it would be interesting to see a comparison of scores on end of year tests in other states. Do students in Texas, for example, have the same significant difference between groups? Furthermore, the same type of study may be applied to specifically those states that have adopted the NGSS.

Overall, educational research has its obstacles to overcome due to the extensive number of variables that impact learning. A student's home-life, prior learning experiences, and aspirations for the future all can affect how well a student will perform in school and cannot necessarily be controlled for in an experiment due to the vast amount of possibilities. It must be a priority for everyone in this nation to maximize the positive influence teachers can have to inspire and educate. Participation in outdoor education programs which specifically target certain content and skill areas is one such way that both teachers and community members can help effectively instruct students. Through this study, it has been demonstrated that students learning in an outdoor ecology based program had a significant difference in knowledge as measured by their OCCT scores in 2010 and 2011. Further analysis of testing data is suggested on this topic in order to help influence school leaders and policy makers to adopt such programs as part of their regular curriculum.

Appendix E: Full List of References

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