Fourth Grade Supplemental Science Programs and Corresponding Student Achievement in Crawford Central School District

By
Mary Eddins
Department of Environmental Science
Allegheny College
Meadville, Pennsylvania

April, 2014

Fourth Grade Supplemental Science Programs and Corresponding Student Achievement in Crawford Central School District

By
Mary Eddins
Department of Environmental Science
Allegheny College
Meadville, Pennsylvania

April, 2014

Submitted in fulfillment of the senior thesis requirements of the
Department of Environmental Science at Allegheny College
and approved by the senior thesis committee.

	4/29/14		04/29/14
Dr. Thomas Eatmon	Date	*Dr. Caryl Waggett*	Date

Pledge

Acknowledgements

My senior project was inspired by my passion for education, which would not have been realized without the guidance of Dr. TJ Eatmon. I would also like to thank Dr. Eric Pallant for supporting me throughout my time at Allegheny and Dr. Caryll Waggett, my second reader, for feedback during this project's development. Thank you all.

I would like to thank the wonderful people that encouraged me throughout this process: my comp group, roommates, parents, and sisters. You have provided a great deal of support and I am extremely grateful.

Name: Mary Eddins Date: Spring, 2014
Major: Environmental Science
Thesis Committee: Dr. Thomas Eatmon, Dr. Caryl Waggett

Title: Fourth Grade Supplemental Science Programs and Corresponding Student Achievement in Crawford Central School District

---

This study examines recent supplemental science programs integrated into fourth grade curriculum in Crawford Central School District and corresponding student achievement on the science portion of the Pennsylvania System of School Assessment (PSSA). The district has previously supported using an outdoor learning center and science symposium to prepare students for the state examination, and the following report provides a thorough analysis of the strategies used by each program and the reported Science PSSA scores during the time of programming. Program descriptions were gained through in-person interviews and provided information on the curriculum, management, and outcomes of the French Creek Outdoor Learning Center and Science Symposium. A comparison was made between the two programs using a developed set of criteria for successful approaches to science education. PSSA score reports were retrieved from the Department of Education and further explored through a chi-square data analysis. The comparison of programs displayed which areas current science education initiatives could expand on, and others to maintain. This portion of the analysis led to recommendations for future programming as the Crawford Central School District administration moves forward with the science symposium. The chi-square analysis did not link the change in supplemental science programming to significant changes in student achievement; however, this study was limited to great extent due to time-related factors. Because the study analyses only past programming, valuable information gained from on-site observations or unique assessment for programming was impossible to include. Overall, this study provides a clear report of past programming used for fourth grade science in Crawford Central School District and Science PSSA scores from 2008-2013.

Table of Contents

Introduction……..6
Review of Literature……7
Standards-based Curriculum and State Assessments……...7
Science Education Initiatives…….10
Best Strategies and Practices…….16
Data Collection……..17
Results……...19
French Creek Outdoor Learning Center Interview Responses……..19
Science Symposium Interview Responses…….23
Science PSSA Score Reports…….26
Discussion…..…….30
Conclusion and Recommendations……37
References…….....42
Appendix……46

Introduction

The widespread shift to standards-based curriculum is presenting challenges for the United States public education system. Standards, created by each state through guidelines set by the federal government, are ambitious learning goals for students to master. Unfortunately, given teacher preparation, time restrictions of the academic year, and dearth of materials, many of these standards are difficult for schools to meet (National Research Council [NRC], 2011). Because of these common restrictions, standards often require complex trade-offs for overall curriculum. The federal government has placed the national emphasis for student achievement on mathematics and language arts performance, and this narrow focus has marginalized science instruction for many elementary schools across the nation (The Lawrence Hall of Science [LHS], 2011). Reports of concern are acknowledging students of the United States are falling behind competing nations in Science, Technology, Engineering, and Math (STEM) studies (NRC, 2011). This global perspective is causing federal, state, and local stakeholders to reevaluate areas of concern for student achievement and incorporate science into the highest priorities of education. Elementary schools across the nation are using different methods and supplemental programs to improve science instruction despite the current climate of limitations.

For Crawford Central School District in Meadville, Pennsylvania, science education initiatives have been incorporated into the curriculum to improve student achievement in elementary science. Until 2011, the fourth grade curriculum at Crawford Central School District included a two-day field trip to the French Creek Outdoor Learning Center (FCOLC). The FCOLC used Earthkeeper's curriculum, developed by Steve Van Matre in 1990. Instruction at the FCOLC, which was typically given by the center's head director, primarily consisted of outdoor learning and hands-on experience to provide natural science education. The program focused on the main ecological concepts of energy flow, cycling, interrelationships, and change. Fourth graders visited the FCOLC prior to taking the science portion of the Pennsylvania System of School Assessment (PSSA), an annual state-mandated exam for all students in Pennsylvania. Unfortunately, because of budget cuts, the outdoor learning center is no longer in use.

Crawford Central School District sought to continue providing additional science programming to fourth graders through a "science symposium" at Allegheny College. The piloted symposium was held on March 19th and 20th of spring 2013. The two-day program aimed to better prepare students for the scientific material covered on the PSSA, which was

administered shortly after the program during the week of April 22nd. Five different instructors led activities on the topics of stream ecosystems, wildlife, recycling, agriculture, and rock cycle. The selected topics were based on available volunteer instructors and Science PSSA subject matter for fourth grade. East End and Cochranton Elementary schools participated in the program, with each school spending one-day on the college campus. For 2014, the school district administration hoped to include all five schools, but due to available resources extended the program to only three. The district intends to carry on with the program in future years.

This study examines recent supplemental science programs integrated into fourth grade curriculum in Crawford Central School District and the corresponding student achievement on the Science PSSA. The district has previously supported using the FCOLC and Science Symposium in preparing students for the state examination, and the following report provides a thorough analysis of the strategies used by each and the Science PSSA scores during the times of programming. Both programs are compared on the grounds of effective science teaching strategies, incorporated Pennsylvania state standards, and resulting PSSA scores. The report includes each program's curriculum, instructional methods, program management, and outcomes for review. The planning committee, school district administration, educators, and the general public should be provided a clear analysis of fourth grade supplemental science initiatives over the last decade to better inform program evaluation and future decision-making.

Review of Literature

Standards-based Curriculum and State Assessments

All states, including the Pennsylvania Department of Education (PDE), have set expectations for public school students through academic standards. An academic standard, as defined by the PDE, is a "statement of what students are expected to know and be able to do at specific grade levels" (PDE, 2013b, p. 1). Standards-based education has become the norm for school districts in the United States, particularly after the passing of No Child Left Behind (NCLB) legislation. No Child Left Behind requires states to identify their own standards, support classroom instruction aimed at the self-designed standards, ensure qualified teachers are in every classroom, and create assessment tools to measure student progress towards reaching the standards (Marx & Harris, 2006).

The American Association for the Advancement of Science (AAAS) and the National-Research Council (NRC) have greatly influenced the development of national science standards by outlining recommendations for what all students should know and be able to do in science (Marx & Harris, 2006). The standards ultimately set goals for science education in which all students participate in inquiry-based learning to understand naturally occurring events and phenomena (Collins, 1997). Grounded in the philosophy of John Dewey, who believed education begins with curiosity, inquiry-based learning is a student-centered, active learning approach (Savery, 2006). Inquiry-based learning heavily relies upon hands-on activities for students to focus on questioning, critical thinking, and problem solving (Savery, 2006). Activities following this model allow students to investigate, discover, and experience new content (Savery, 2006). The NSE-standards do not establish a national science curriculum, but instead describe a vision for elementary science content, instruction, and assessment (Collins, 1997). Although strictly following the NCES standards is voluntary, many states have used these national standards as guidelines for crafting their own state standards (Marx & Harris, 2006).

The implementation of standards-based curriculum has presented unique challenges for both teachers and students of science education (Geier et. al, 2007). Typically, elementary science programs from kindergarten to sixth grade are limited in terms of teaching training and materials (Stamp & O'Brien, 2005). Elementary teachers typically have weaker science backgrounds and less preparation courses than science teachers in grades 7-12 (Stamp & O'Brien, 2005). On average, elementary schools also have significantly less science equipment, supplies, and budget than middle and high schools (Stamp & O'Brien, 2005). In addition to lacking adequately prepared instructors and materials, schools are under great pressure to meet federal and state achievement targets primarily weighted on English Language Arts and Mathematics in elementary schools. Many teachers acknowledge this national focus is inhibiting the amount of time and resources available for science instruction (LHS, 2011).

High-stakes assessments have created a barrier to science education reform, as more attention is given to subjects directly affecting a school's Adequate Yearly Progress or AYP. The AYP was set by the No Child Left Behind Act and is used to determine overall school performance (Johnson, Zhang, & Kahle, 2012). Overall school performance has great influence over the funding provided to schools and programs, as well as reorganization and staff replacements (Geier et. al, 2007). The main subjects determining the AYP are reading and

mathematics. Thus, science instruction has thus been minimized, especially for elementary and middle school students, and less support has been provided to improve science-teaching strategies for teachers (Johnson, Zhang, & Kahle, 2012). The shift of concentration towards multiple-choice assessments has served as a catalyst for narrow curriculum (National Research Council, 2011). Teachers across the country are encouraged to use the basic method of recall tactics for science instruction, as the majority of state assessments focus on the recall of content knowledge (Rivet & Krajcik, 2008). It is not a surprise, then, that many teachers fear extended time for inquiry-based learning will hinder state assessment practice and thus lower student achievement (Johnson, Zhang, & Kahle, 2012). Because no national framework for developing science assessments exists, schools are often caught between supporting the science inquiry modeled by NCES standards and strictly preparing students to perform well on high-stake, norm-referenced exams (Marx & Harris, 2006).

While Pennsylvania began implementing standards-based education in the mid-1990's, science and technology academic standards, as well as environment and ecology, were not adopted until 2002-2006 (PDE, 2013b). Educators across the nation are under pressure to improve test scores, and Pennsylvania is no exception (Ferguson, Angell, & Tudor, 2001). To determine student achievement in these academic standards, the PDE developed the Pennsylvania System of School Assessment (PSSA). This assessment was first crafted in 1998 to measure student achievement in reading and math. In 2008, the PSSA began administering a science test to grades 4, 8, and 11. The purpose of the PSSA is to provide school administration, educators, parents, and students with an overall understanding of school performance. Scores are intended to be considered in the development of future curriculum and should be used to improve instruction by focusing on student needs. In addition to the PDE standards, the PSSA meets requirements set by the national government policy, No Child Left Behind (NCLB). The legislation requires all states to develop assessments in grades 3-8 and at least one assessment in grades 9-12 (PDE, 2013c).

The Science PSSA requires students to "connect and create meaning for factual information" (PDE, 2013c, p. 49). Students must have knowledge of specific factual information and be able to integrate scientific facts into larger concepts (PDE, 2013c). The science portion includes the following categories: earth and space science, natural science, biological science, and physical science. These categories are drawn from the state's academic standards (PDE,

2013c). The fourth grade science assessment includes both multiple choice and open-ended questions. All students receive extra time if needed to complete the exam and scores fall into advanced, proficient, basic, or below basic levels. The state suggests districts aim for students scoring within the advanced or proficient categories for all subjects, but the science portion is not included in the determination of AYP.

Science Education Initiatives

Elementary science is a local, state, and national issue for public education (Stamp & O'Brien, 2005). Nationally developed standards are calling for an emphasis on a "hands-on" approach to learning, but elementary schools across the nation are struggling to make science a priority subject with the present emphasis on math and language arts achievement (Stamp & O'Brien, 2005). No Child Left Behind legislation holds districts accountable for assessing students in grades 3-8 in mathematics and language arts, and scores for these subjects determine if a school has made Adequate Yearly Progress (AYP) (Marx & Harris, 2006). The legislation also requires states to measure student progress in science at least once each year within grades 3-5, but does not include science in the AYP report (Marx & Harris, 2006). The pressure from NCLB legislation has caused teachers and school administrators to focus instruction and student outcomes in the academic areas that are used to hold schools accountable for AYP, and thus has resulted in diminishing time for science instruction (Marx & Harris, 2006). Consequently, elementary science is often sparse and inconsistent; the subject often varies from teacher to teacher, grade level to grade level, and district to district (Stamps & O'Brien, 2005).

Because test preparation is a high priority for schools across the nation, concerns that science instruction will significantly narrow for short-term success on tests have surfaced. Test preparation has often eliminated and will likely continue to impede the ambitious components of inquiry-based science instruction in marginal or failing schools that must show immediate improvement on statewide tests (Marx & Harris, 2006). Despite this current climate, districts across the nation are improving science education in elementary schools. The majority of initiatives fall into the following categories: professional development, collaboration with higher education, informal programming, and environmental education.

Schools across the nation are ensuring science is incorporated into daily curriculum by providing professional development trainings on the subject to general education teachers. Many

school districts and institutions have decided to enhance professional development of teachers around science instruction after recognizing both the quality and quantity of elementary science lessons are essential in improving student achievement (Stamp & O'Brien, 2005). Research has shown science is a weak area for many elementary teachers, as studies report many teachers believe they have low self-efficacy for the subject and are unfamiliar with the national science standards (Marx & Harris, 2006). Specifically, many teachers do not feel prepared to implement activities key to high-quality instruction such as inquiry-based learning and investigation (LHS, 2011). If lacking preparation and confidence in science instruction, elementary teachers will likely avoid presenting the subject in daily curriculum (Harlow, 2012). There is currently no infrastructure to deliver the amount of professional development necessary to reach the nationwide goals set by NCES (Marx & Harris, 2006). To improve the current lack of preparation, teacher education and certification programs must include science instruction and content coursework especially for the elementary level (Marx & Harris, 2006). Teachers must be able to use curriculum materials effectively in order for high quality instruction to occur. While some schools are beginning to incorporate science into professional development, fewer than 21% of districts in the country provide this service to elementary teachers on a regular basis (LHS, 2011). In addition to incorporating science into professional development trainings, some districts are adding science resource teachers to their faculty to provide science instruction by rotating through classes and training other general education teachers (LHS, 2011). Through content knowledge, instructional strategies, and material use, many districts and teacher certification programs are beginning to place a greater emphasis on science.

Public school districts within the United States are also collaborating with higher education institutions to improve science education at the elementary level. For example, Binghampton University in New York has collaborated with a local school district to develop "5E" (engage, explore, explain, elaborate, evaluate) teaching cycles that match the state and district curriculum guidelines (Stamp & O'Brien, 2005). This program design is a "hands-on, minds-on" inquiry-based method that is effective at any grade level for science instruction. Teams of "teaching fellows", graduate students of science at the university, and the elementary education teachers worked together to implement the units. The initiative was successful because teachers, as experts in student learning, and university students, as experts in scientific content, shared ideas to collaboratively create the lesson plans. After designing units, the graduate

students were present in the elementary classrooms to record, analyze, and reevaluate the lesson plan.

A long-term partnership between Hazelwood School District, an underserved school district in Missouri, and Washington University also illustrates collaboration efforts between public schools and higher education institutions to improve science education (McCarthy, 2013). Washington University faculty and staff provides professional education to general elementary teachers on science content, activities, and materials. Participating teachers receive 15 hours of instruction as well as science materials and kits to use in their classrooms. This program, which has sustained over the last 6 years, revolves around using evidence-based practices, fostering collaborative learning, and building a strong teacher leadership team. The university starts by surveying teachers, observing classrooms, and using test data to identify curriculum components related to weak areas receiving lower scores on high-stake assessments and in need of improvement.

The partnership between the University of Michigan and Detroit Public Schools serves as an additional example of collaboration (Geier et. al, 2007). The university created an 8-10 week inquiry-based model curriculum for the public school system's use. Graduate students designed the program and sent lesson plans to elementary teachers in the Detroit Public School System for revisions. To supplement the model curriculum, the university facilitated professional development opportunities for elementary school teachers. Professional development services offered to elementary teachers included weeklong summer institutes, Saturday workshops, teacher discussion groups, online resource access, and limited classroom support from graduate students. As seen through the previous examples, collaboration with higher education can enhance science in public school systems through knowledgeable faculty and staff, dedicated students, and resources to receive additional funding.

Informal programming is another direction public schools are taking to strengthen elementary curriculum. Although difficult to define, informal science programs differ from formal education primarily in the supports, goals, and agency of the learner (Harlow, 2012). Students have more agency in choosing what they learn and how they engage in a less structured setting, and the material is typically not centered on a high-stakes assessment (Harlow, 2012). Learning outcomes from informal programming are not restricted by state standards, but are instead focused on student's experience and enjoyment (Harlow, 2012). Informal science

programming supports open-ended questions and personally relevant experience that enables greater understanding for student participants (Kisiel, 2012). In contrast, formal education is planned, structured, and has specific objectives for students to meet (Bozdogan & Yalcin, 2009). Informal science programs typically refer to places like science centers, museums, nature centers, zoos, and aquariums, but can also refer to science nights, science fairs, or outdoor investigations around the school building (Ramey-Gassert, 1997). The National Science Education Standards previously recommended that school science programs should reach out beyond the classroom to include community resources (Kisiel, 2012). Science learning taking place in a new environment can resonate with student learners,and strengthen overall science curriculum (Ramey-Gassert, 1997).

Many schools take 1-day trips to museums, as museums have a great potential to spark curiosity, motivate, and engage the student audience (Ramey-Gassert, 1997). Science centers typically have well-informed volunteers and activity facilitators to guide students through investigations and inquiry-based learning (Ramey-Gassert, 1997). Previous research has found visits to science centers increase elementary students' interest in science and can improve student achievement (Bozdogan & Yalcin, 2009). Many schools stress the importance of informal learning experiences for all subjects, especially science, because enjoyment is considered essential for learning.

Family science nights, as another example of informal science programming, can increase participation and quality of educational experiences for elementary students. These programs give agency to the learner, by having an option to attend, and provide opportunities for families to learn scientific concepts with one another (Harlow, 2012). These events are usually held in the elementary buildings after school hours in an auditorium, gymnasium, or cafeteria (McDonald, 1997). The school-based program can allow students to float from stations that capture their interest, follow a schedule of activities/experiments, or give one large presentation to all participants (Harlow, 2012). The programs typically work with one or two grade levels, and are held one night a week for multiple weeks. A session lasts, on average, 90 minutes and includes both instruction and hands-on activities or experiments for participants to try (McDonald, 1997). Science educators from a university, community members, parents, or older students serve as facilitators and volunteers for the activities (Sullivan & Hatton, 2011). Informal programs, such as family science nights, can introduce the social aspect of learning by bringing

together a diverse mix of individuals with varying levels of expertise and prior knowledge (McDonald, 1997). Existing research has found connections between family involvement and elementary students' success in academics, providing more reason for schools to host such events (Lunden, 2005). Informal programming, as described, has a range of possibilities and can likely be incorporated into schools' existing curriculums.

Lastly, multiple elementary schools are implementing environmental education programs to improve student comprehension in not only science but many subjects. Such initiatives are justifiable, as early data shows an integrated, well-designed approach can in fact improve standardized tests scores across all disciplines (Ferguson, Angell, & Tudor, 2001). Reasons for environmental education's success include increasing motivation to learn, improving behavior in the classroom, relating school curriculum to the real world, and developing critical thinking skills (Council on Environmental Education, 2004). Environmental education takes attention away from teacher-centered learning and allows the environment to become the focal point for instruction. Research suggests environmental education provides hands-on activities that allow students to integrate theory and practice (Erdogan, 2011). Students participating in outdoor learning are able to observe the cause and effect relationships occurring in a given natural environment (Erdogan, 2011). Teachers and students work side-by-side to understand real world problems addressing wetlands, rivers, forests, or agriculture (Ferguson, Angell, & Tudor, 2001). Using real-world problems as a learning tool broadens environmental education to include social studies, health, art, and literature as well. Thus, nature-related activities are inherently interdisciplinary (Erdogan, 2011). Within environmental education, students are challenged to make connections between disciplines and relate new material to prior knowledge, which creates a comprehensive learning experience (Ferguson, Angell, & Tudor, 2001). The multi-dimensional discipline makes learning more relevant and capable of increasing student understanding (Ferguson, Angell,& Tudor, 2001). When learning is applicable, students are more likely to be interested in academics and motivated to achieve in school (Washington State Report, 2007).

Existing research and literature note that additional studies are required to prove using the environment as an instructional tool achieves measureable results for student learning (Ferguson, Angell, & Tudor, 2001). While further research is needed, studies have found a relationship between environmental education and student achievement on state assessments. A groundbreaking study entitled "Improving test scores through environment education: is it

possible?" compared 77 pairs of demographically equivalent schools (Bartosh et. al, 2006). Half of the schools integrated environmental education into their curriculum and the other half had little or no environmental education present (Bartosh et. al, 2006). The study compared Washington Assessment of Student Learning (WASL) scores from the two sets of schools over a five-year period (Bartosh et. al, 2006). The study found schools that incorporated environmental education consistently scored higher on the state assessment than schools that implemented traditional curriculum (Bartosh et. al, 2006). While the schools with environmental education integrated well-developed curriculum throughout the year, the study still suggests environmental education can contribute to student success on state assessments. The National Wildlife Federation (NWF) has also cited examples showcasing environmental education's success. Tompkinsville Elementary in Kentucky increased achievement in statewide tests after integrating environmental issues into the curriculum and five Florida model schools in the environmental education program steadily improved scores on the FCAT assessment (NWF, 2009). A Washington State Environmental Education Report, issued in 2007, summarized 15 studies and linked certain environmental education programs with positive impacts on student self-esteem, level of engagement, motivation, and civic engagement, as well as science performance and achievement. Self-esteem is extremely important for student achievement on state assessments as it reflects student confidence in their ability to think and make appropriate choices and decisions (Washington State Report, 2007).

Undeniably, the influence of short-term environmental intervention on student achievement must be further examined. Existing research suggests that besides cognitive learning effects, short-term environmental education is ineffective in intervening with participant environmental attitude and behavior (Sellman & Bogner, 2012). While short-term programs have yet to show corresponding connectedness with nature, programs of longer-duration have shown positive effects (Sellman & Bogner, 2012). With that said, 1-day environmental education program are typically a better match for school curriculum as residential programs often produce problems for school schedules. Densely packed curricula throughout the academic year often restrict out-of-school experiences to no more than 1 day (Sellman & Bogner, 2012). A gap in research exists for examining short-term environmental education intervention effects on overall student achievement on state assessments, as well as offering alternatives to longer duration residential programs.

Best Strategies and Practices

While the initiatives previously discussed are extremely diverse, recent findings of effective science instruction strategies and practices can guide the majority elementary science programming. The National Science Education Standards (NSES) has called for a shift in science instruction, aiming to move away from teacher-center practices towards the use of more effective instruction such as inquiry-based learning and exploration driven by student interest (Johnson, Zhang, & Kahle, 2012). Existing research points out effective science program characteristics and teaching strategies, which can be easily adopted throughout the school year and are associated with increased student achievement on state assessments (Johnson, Zhang, & Kahle, 2012). Washington State's Environmental Education Report (2007) suggests existing research on environmental education has shown that effective programs are tied to either teaching practices with elements of active experiential learning or program characteristics that promote community involvement, an integrated curriculum, an evaluation component, and well-trained staff. Additional program characteristics noted by the Washington State report included effective communication and documentation, involvement of community partners, professional development for teachers devoted to environmental education, authentic assessment, and long-term programming used throughout the year (2007).

Existing research supports that overall authentic and enthusiastic teaching can enhance long-term retention of scientific material and improve performance on state mandated assessments (Johnson, Zhang & Kahle, 2012). Research has shown students taught by enthusiastic, engaging science teachers that incorporated inquiry-based learning outperformed students who had less effective teachers (Johnson, Zhang & Kahle, 2012). Effective teaching strategies for science include: enhanced context strategies, inquiry-based learning, questioning strategies, and collaborative learning (Schroeder et. al, 2007). Contextualized content relates new material to student's prior knowledge and experiences (Rivet & Krajcik, 2008). Inquiry-based learning allows students to answer questions through investigation (Johnson, Zhang, & Kahle, 2012). Effective questioning strategies engage students in cognitive, inquisitive questions that ask students to draw from many disciplines and integrate other subjects (Rivet & Krajcik, 2008). Lastly, collaborative learning enables students to use newly learned knowledge to complete meaningful projects (Rivet & Krajcik, 2008). Such science teaching strategies are not limited to outdoor residential experiences, but can instead be used in a classroom, throughout the year to

increase student achievement. Such strategies have been the focuses of recent reform in many other countries as an emphasis on science, technology, engineering and mathematics (STEM) has emerged (Johnson, Zhang, & Kahle, 2012).

Data Collection

While multiple means of supplementary science instruction are used across the nation, two specific programs have recently been incorporated into the fourth grade curriculum in Crawford Central School District. This study examines the French Creek Outdoor Learning Center (FCOLC), in operation from 1998-2011, and the 2013 piloted Science Symposium with corresponding student achievement on the Science PSSA. The programs are reviewed in regards to the evidence-based practices and theories encouraged by existing research.

Supplemental science instruction previously used to prepare fourth grade students for the Science PSSA was examined through in-person interviews and student score reports on the state assessment. Interviews were conducted with previous directors, active community partners, and planning committee members for the FCOLC and 2013 Science Symposium. The Director of the FCOLC provided the majority of information regarding the background, program design, instruction, and limitations of the science initiatives up until 2011. The Director of McKeever Environmental Learning Center, in Sandy Lake, PA, provided the information regarding the specific Earthkeeper's curriculum used at the FCOLC. Lastly, the planning committee of the 2013 Science Symposium provided all information regarding the new program. The interview questions, guided by the criteria of program management, curriculum, and outcomes, provided insight into the different approaches to science education recently used by Crawford Central School District (Figure 1). Program management was discussed to review the characteristics of the facility used, design and organization of the programs. Collins' (1997) definition of curriculum as "the structure, organization, balance, and presentation of science content" was adopted for this study and considered in the examination of how the program's curriculum was developed, what content/Pennsylvania State Standards were incorporated into the program, the expertise of instructors, and materials used. Outcomes were reviewed through curriculum and student-learning goals set by the particular program.

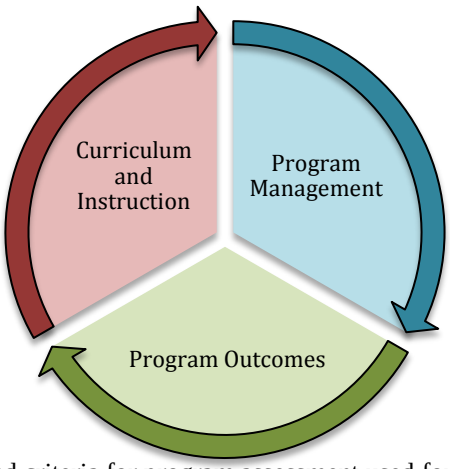


Figure 1. The guiding principles and criteria for program assessment used for the French Creek Outdoor Learning Center and Piloted Science Symposium.

Score reports from 2008-2013 for Crawford Central School District fourth graders were used to assess student achievement during periods of varying supplemental science programming. Score reports could only be traced back to 2008 because the Science PSSA was introduced in that year. Student and school level achievement test data, such as the PSSA Score Reports, are the most widely available and used measures for accountability purposes in the United States (NRC, 2011). High-stake achievement test scores are used in this study because the reports are attainable through the Department of Education, test content and format has remained consistent throughout the given time period, and test results are commonly used and accepted in education research and policy.

The PSSA Score Reports were collected for each individual school from 2008-2013. The categories for scores used are Performance Level Descriptors (PLDs), which include Advanced Science, Proficient, Basic, and Below Basic. The PLDs are the narrative description of the skills and knowledge demonstrated by students and the cut scores are the numeric definitions of these levels. Over the six-year span being analyzed, the PSSA Science assessment content and scoring has remained the same. Raw scores of up to 68 points are not presented to the school district, but rather a scaled score using the Rasch Model places student scores in one of four categories (Table 1). The Rasch Model is a psychometric model for analyzing categorical data and considers the trade-off between the respondent's (student's) abilities, attitudes, and personality traits with the difficulty of the item. Thus, each question is weighted on an individual basis and may contribute to the total score differently than other questions.

Table 1. Scoring categories and corresponding cut scores for the 4th Grade Science PSSA

Scoring Category	**Advanced Science**	**Proficient**	**Basic**	**Below Basic**
Cut Score	1483-2254	1275-1482	1150-1274	1050-1149

Results

FCOLC Interview Responses

Before the FCOLC opened, select schools from Crawford Central School District traveled to McKeever Environmental Learning Center in Sandy Lake, Pennsylvania to gain supplemental science programming. Students attending the McKeever field trip participated in Earth education activities from Steve Van Matre's Earthkeeper's curriculum. Because students and teachers who took part in these field trips provided positive feedback to administration, Crawford Central School District hoped to send fourth graders from all schools to McKeever. Unfortunately, this program was never made available to the entire fourth grade due to inadequate funding. Although the district's students could not attend McKeever, all fourth grade teachers from Crawford Central School District participated in trainings/workshops at the Sandy Lake facility. The goal was for the fourth grade teachers to incorporate the Earthkeeper's philosophy into their daily classroom activities. Training for general education teachers was no longer provided at McKeever after the FCOLC opened. The FCOLC began programming in July 1998 after the administration approved the idea for the center and appointed Judy Acker as director. After the proposal passed, Judy took the on the role of director and tried facilitating environmental education with the help of volunteers. Judy recalled the challenges involved with relying on volunteers that eventually led to part-time positions at the center:

> Unfortunately, the volunteers became unreliable. Without paid positions, instructors would often call off with little notice or not show up for programming. Eventually, funding was later approved to hire part-time teachers to assist in the activities. The FCOLC mainly employed retired teachers, all of which were trained at McKeever with the Earthkeeper's curriculum (Appendix A).

While the Earthkeeper's program does not require certified teachers facilitate activities, the director and hired instructors at FCOLC did have backgrounds as former elementary education

teachers. The director of the program was a 1st grade teacher for 11 years before transitioning into the role at FCOLC. In addition, the director continuously attended teacher workshops at McKeever Environmental Learning Center.

The FCOLC, which also used the Earthkeeper's curriculum model, was incorporated into fourth grade programming for Crawford Central School District. The facility allowed students to venture onto 170 acres of fields, riparian areas, forests, and forest edge to engage in hands-on science activities. Instruction at the center was entirely outside, however, there was a pavilion to use for breaks, meals, and shelter from unanticipated, extreme weather conditions. A fully equipped bathroom facility and multiple outhouses near activity locations were onsite as well. The facility was adequately prepared for the Earthkeeper program.

The Earthkeeper's program at FCOLC was constructed as two consecutive school days, with students participating in four activities each day. Students came immediately on buses from their individual elementary school in the morning and programming commenced at the center as soon as the possible. Judy expressed the time constraints:

> The Earthkeeper's program was designed to be an overnight experience, so by the time the students got onsite and settled, the time for activities was significantly shortened. But, the program made the best use of the given school day (Appendix A).

The program director and instructors divided the fourth graders into smaller groups for the duration of the program. The first day of programming was referred to as the "Knowledge Day", where the main Earthkeeper's concepts were introduced to the fourth graders. The second day of programming was referred to as "Experience Day", which allowed students to more fully investigate and discover the meanings of the main concepts through hands-on activities.

The Earthkeeper's program is very comprehensive in design as each activity builds on previous concepts and experiences to result in an entirely cumulative learning process. Student interest is initially gained before the field trip even begins. The program starts in the students' regular classroom when the teacher receives and reads a message from the "training center" (the term referring the FCOLC for the Earthkeeper's program) to the class. The mysterious message grabs the students' attention as questions arise as to what the Earthkeeper program entails. Once

at training, the experience commences in the official Earthkeeper's lab. The formal atmosphere of a ceremony in the lab and responsibility the student agrees to take on at training creates a unique experience for the student.

Lecturing is not an employed teaching method at Earthkeeper training. Instead of only listening to the instructor to gain knowledge, students engage in hands-on activities to independently discover the meaning of concepts. The Earthkeeper's curriculum used instructional strategies that called for student participation. Judy Acker, the director of the FCOLC shared:

> The heavy use of inquiry-based learning forced students to use and become in tuned with their senses, as well as think about how the environment they saw functioned (Appendix A).

The chosen activities utilized the learner's five senses to ultimately form a relationship with the environment. Fran Bires, the director of McKeever Environment Learning Center, commented on the props used in the Earthkeeper's program:

> The reason there are so many props is because ecological concepts are so abstract. For example, you can't see energy. The props really help the kids, in a creative way, retain the information (Appendix A).

Costumes and constructed scenery enhanced the experience for visual learners. Many activities were scripted for the instructors and allowed the fourth grade students to act out different aspects of each ecological concept. While props were used for most of the activities, the students themselves did not receive many materials. Students were given a pouch at the beginning of the program that held a pencil and journal to keep track of the main concepts and use for self reflection. The journals served as a formative assessment strategy for as Fran describes:

> Kids first read a concept, but in order to really learn about it they go out and do a hands-on activity, which typically takes an hour and fifteen minutes. This activity serves as an example for the specific ecological concept and provides a unique

> opportunity for students to engage with the material. The training manuals (journals) require students to provide their own example afterwards before going on to the next activity. This serves as an assessment for each concept (Appendix A).

Throughout the program, students earn keys. If participants understood all concepts, the students earned their keys. As a reward for completing each step of the Earthkeeper's process, two keys were earned at the training center, and two were earned back home or in their regular classroom after the program. Fran explained the significance of the keys:

> The keys students earn, as they become Earthkeeper's, set this program apart from other outdoor or environmental education programs. The take home piece ensures environmental stewardship, as students cannot leave what they learned behind. Their experience is then integrated into their lives back home. Notes are sent home to the child's guardian/parent to ensure habits are adopted (Appendix A).

In 2008, when the Science PSSA began assessing all fourth graders in the state, FCOLC expanded its curriculum to include the Wondership program. This addition was created to link material covered at the FCOLC with Pennsylvania's Core Curriculum. The FCOLC director made visits to the fourth grade classrooms following the Earthkeeper's program to review the concrete concepts in a structured setting. A PowerPoint presentation was given to reintroduce scientific vocabulary and the main ecological concepts included throughout the Earth education activities. The Wondership program served as a post lesson and further means of formative assessment for the Earthkeeper's experience.

It is important to note that the Earthkeeper's program is not equivalent to outdoor education or environmental education. While the different educational philosophies overlap, outdoor education more frequently refers to survival skills, such as using a compass and starting a fire, and outdoor excursions like camping. Environmental education is typically more specific by focusing on a set environment and the organisms involved. Earth education, on the other hand, focuses on the big pictures of ecology. Fran reflected on these distinctions:

> Outdoor education works on skills like canoeing. Environmental education is close to what the Earthkeeper's program represents, but this is truly an Earth education. It is completely holistic. The experience is not and should not be classified as a field trip. The experience looks at the whole picture, not just a local environment and can thus be applied anywhere (Appendix A).

The main goal of the Earthkeeper's program is for students to leave the training center with a better understanding of the main ecological concepts of ecological change, interrelationships, cycles, and energy flow. Because these ecological concepts align with Pennsylvania State Standards, the state's core curriculum is manifested in this goal. Additional activities occur outside of the four main concepts and also align with state standards. For example, during lunch the recycling process and compost system are often described as students separate their trash after finishing the meal. Because the program was not designed around state standards, many of the self-reflection aspects such as the "magic spot", a time for students to sit in silence with nature, remain. The Earthkeeper's model focuses on allowing students time outdoors to gain insight into the natural world around them. The program is designed to encourage students to take responsibility for the surrounding environment. Before the closing ceremony, students draft an action plan for environmental stewardship and a goal for the program is for students to share what they learned with others at home.

Time was often observed as a restriction at the FCOLC. Shortening the program to even less time than the typical school day did limit the content covered and amount of time students were given for self-reflection. In addition, student behavior often depended on whether or not their classroom teacher was present during the Earthkeeper's field trip. Some teachers sent substitutes for the duration of the program and students often acted out when their permanent teacher was not there. If classroom teachers were not fully engaged in the program, their lack of participation interfered with the experience; for example cell phones being used by teachers often caused a distraction for the students.

Science Symposium Interview Responses

The FCOLC was removed from the Crawford Central School District curriculum in 2011 due to budget cuts and lack of funding. A planning committee came together to devise alternative

programming. The committee included Crawford Central School District 4th Grade Teachers, the Director of Elementary Curriculum, Technology, and Title Program, the District Literacy Integration Coach, and Allegheny College Faculty and Staff. This planning eventually led to the idea of hosting a "science symposium" for fourth graders at Allegheny College in the spring, before the Science PSSA was administered. The first program occurred in March of 2013. On two consecutive school days, fourth graders from East End and Cochranton Elementary Schools were brought onto the college campus for a daylong science event.

The Science Symposium planning committee created a database of environmental science and general science community resources in the Meadville, PA area to potentially lead activities for the symposium. This database was used to reach out to community members to secure instructors. The potential instructors were provided a list of topics covered on the fourth grade Science PSSA. The potential instructors were then asked to select a topic they felt most comfortable creating a lesson for and submit a summary of what that lesson would entail. The list of topics included weather, earth and space, energy, physical science- matter, renewable and nonrenewable resources, ecosystems, forces and friction, water cycle, agriculture, ecology, humans and the environment, recycling, and data. After this process, five community members were selected to facilitate activities for the two-day pilot program. Community members included Allegheny College Faculty, Environmental Educators, and professionals in the general field of science. Allegheny College student volunteers and faculty from the college's Office of Community Service assisted the instructors during their lessons.

The Science Symposium's activities were selected based on the topics assessed by the fourth grade Science PSSA and the instructors available to volunteer on the selected dates. For programming, fourth graders were brought onto Allegheny College immediately from school. The science activities were designed as stations and placed throughout the college in different buildings. Facilitators divided students into five groups upon arrival. The small sized student groups, between 10-13 fourth graders at each station, were ideal for the nature of the lessons. The use of indoor buildings was not equivalent to outdoor education, however, the sustainable aspects of certain buildings was described to the students and activities were not interrupted by weather conditions. Allegheny College students were assigned to each group of fourth graders to transition from one station to another. Each activity lasted 45 minutes, with three activities completed in the morning and two activities after lunch.

The program was designed to gain students interest with interactive, hands-on science activities. The lessons presented during the pilot program included bird migration, aquatic macro-organisms, recycling, the rock cycle, and electricity. All activities were interactive and allowed the students to explore through experimentation, modeling, acting, or design. The main goal of the piloted Science Symposium was to provide fourth grade students an opportunity to engage in learning by doing before the Science PSSA was administered in April. Erin O'Day Frye a member of the planning committee described the program goals:

> The program sought to provide students a chance to explore the fundamentals of science in a different atmosphere. While most instruction was indoors for the Science Symposium, the college campus provided a unique opportunity for fourth graders to gain exposure to higher education and experience what a college campus is like (Appendix A).

A summative assessment was not given to students at the end of the symposium, but some activities did have students complete a worksheet, which was used as formative assessment for their general education teachers. The Science Symposium was built around the Pennsylvania State Standards for fourth grade science and made preparation for the PSSA a priority by covering topics assessed by the state.

The main restrictions of the science symposium dealt with communication between teachers, presenters, and volunteers. Because the instructors were chosen close to the date of the symposium and from various community partners, the instructors were unaware of what prior knowledge the students had on their topics before the symposium. The general education teachers, likewise, were unaware of what specific content would be presented at the symposium and were unable to fully prepare the students for the field trip. College student volunteers did not communicate with the presenters beforehand and were unaware of the lessons and content as well. During the committee meeting, members noted small challenges:

> The transitions between activities were often too short or too long. Students sometimes traveled to an activity close by, and at other times needed to walk a far distance to reach the next building (Appendix A).

Overall, feedback from teachers and students was positive. Ann Noonen, another member of the planning committee, shared:

> Teachers were impressed with the hospitality provided by the college and volunteers. The teachers also thought the symposium followed a well-structured schedule. The number of volunteers made the day run smoothly (Appendix A).

Science PSSA Score Reports

Final reports administered by the Pennsylvania Department of Education present the percentage of student scores from an individual school falling into each of the four categories; however, the chi-square categorical data analysis performed in this study must be used on real numbers, not percentages. For this analysis, the percentage of students scoring in each category per year was converted into the real number of students by using the given total number of students taking the exam at the individual school. Percentages are included on all graphical representations of student achievement to easily compare schools (Figures 2-6). Because percentages alone can be misleading and obscure differences in large sample sizes, real numbers were used to ensure the total number of students at each school was expressed (Appendix B). The graphical representations are intended to display data trends in student achievement from 2008-2013. The data in this report can consider if student achievement significantly changed during this time period.

Through observations of the score reports, a drastic drop in the number of fourth graders attending East End/Second District Elementary School(s) occurred after 2011. The real number graph shows a high number of students from 2008-2011, the time frame in which both schools were operating and attending the French Creek Outdoor Learning Center. Beginning in 2012, the two schools have condensed to only Second District. In 2010 and 2011, the schools have a high percentage of students scoring in the below basic performance level (Figure 2). The percentage and number of students scoring in all categories varies a great deal for these schools. Cochranton Elementary School score reports have stayed relatively consistent from 2008-2011 (Figure 3). West End Elementary School had a dip in the number of fourth grade students in 2009, but had the highest percentage of students scoring in Advanced Science that year (Figure 4). Similarly,

Neason Hill had the least number of fourth graders in 2008, but also had the highest percentage of students scoring in Advanced Science that year (Figure 5). Neason Hill had significantly more students from 2010-2012. First District Elementary school experience fluctuations in the number of students throughout the six-year span (Figure 6). The highest percentage of students scoring Advanced Science occurred in 2009, the year with the least amount of total students. A greater number of students have been enrolled in fourth grade at First District for 2012 and 2013. During these two years, a higher percentage of students scored in the below basic proficiency level. All elementary schools in Crawford Central School District, with the exception of Cochranton Elementary Schools, experienced noticeable fluctuations in fourth grade student enrollment and scoring.

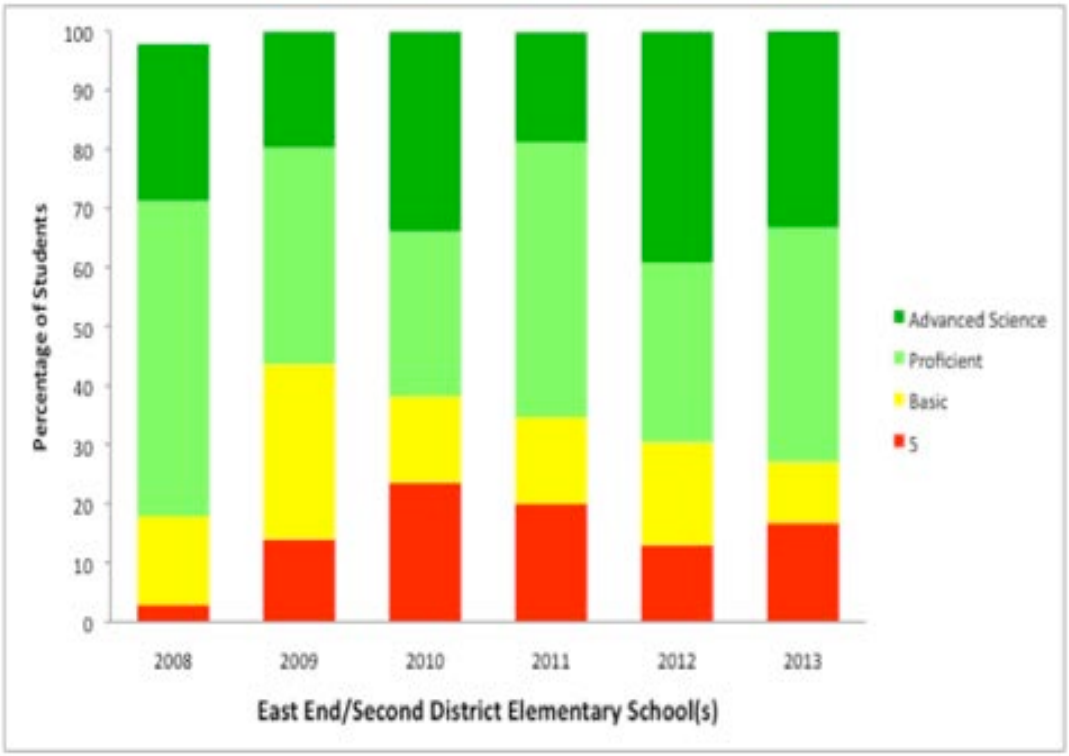


Figure 2. The percentage of total students scoring in each category on the Science PSSA from 2008-2013 at East End/Second District Elementary School(s).

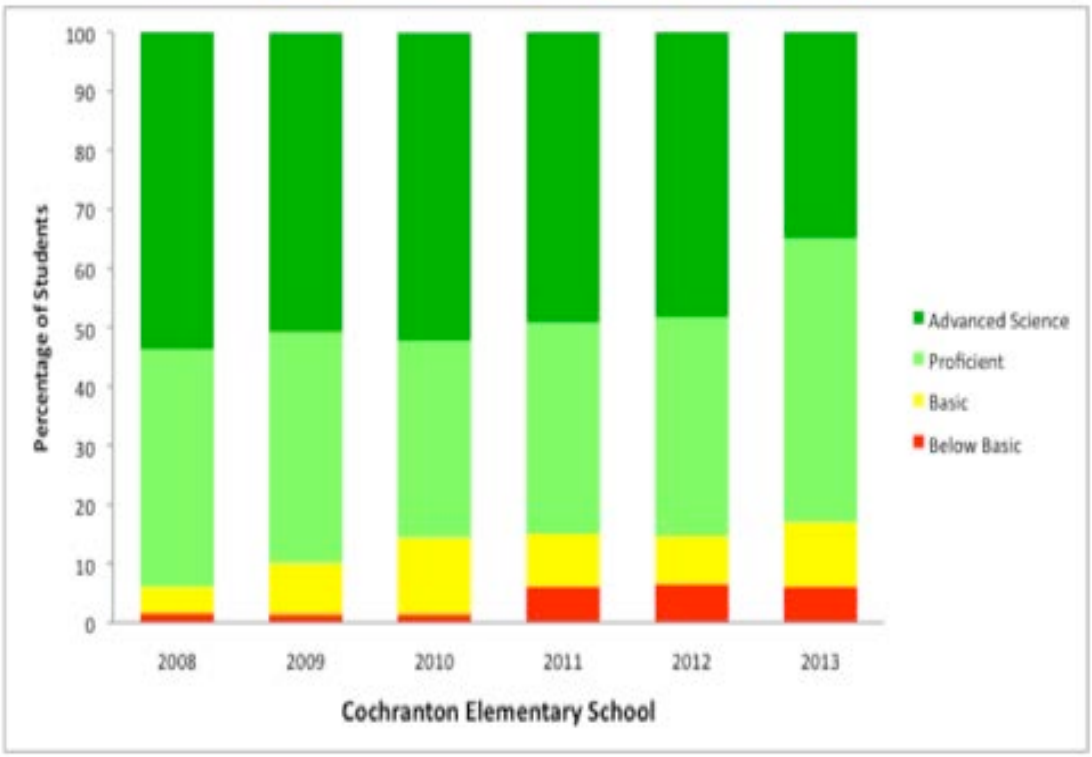


Figure 3. The percentage of total students scoring in each category on the Science PSSA from 2008-2013 at Cochranton Elementary School.

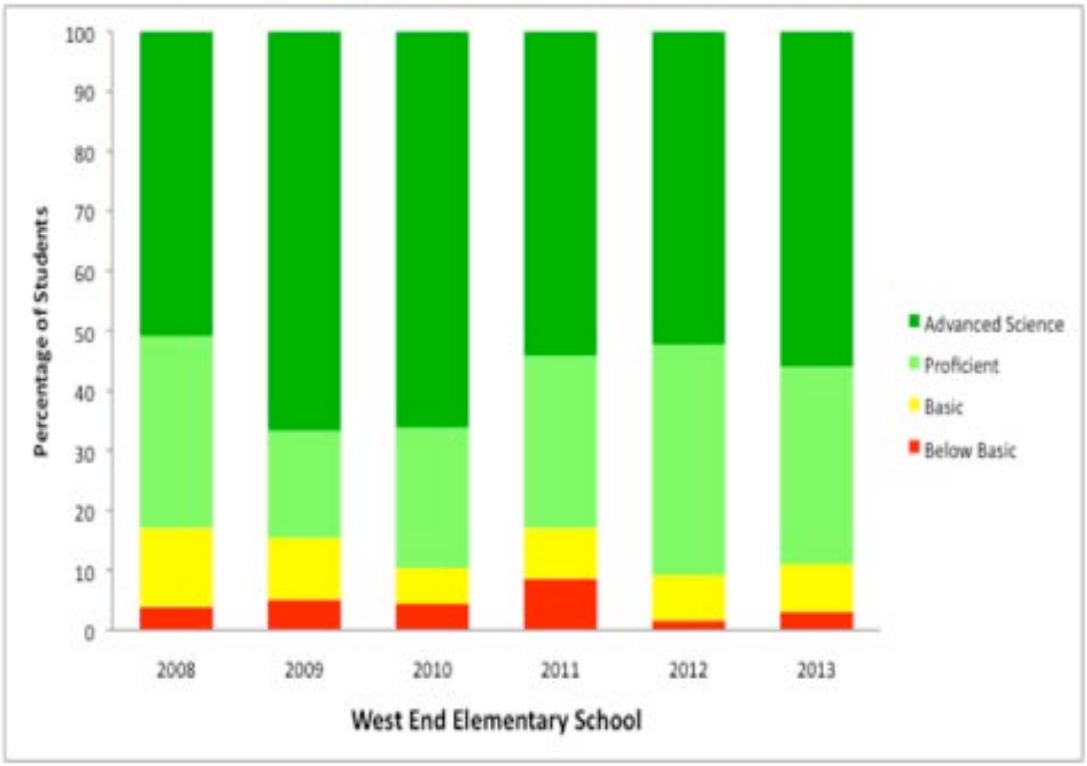


Figure 4. The percentage of total students scoring in each category on the Science PSSA from 2008-2013 at West End Elementary School.

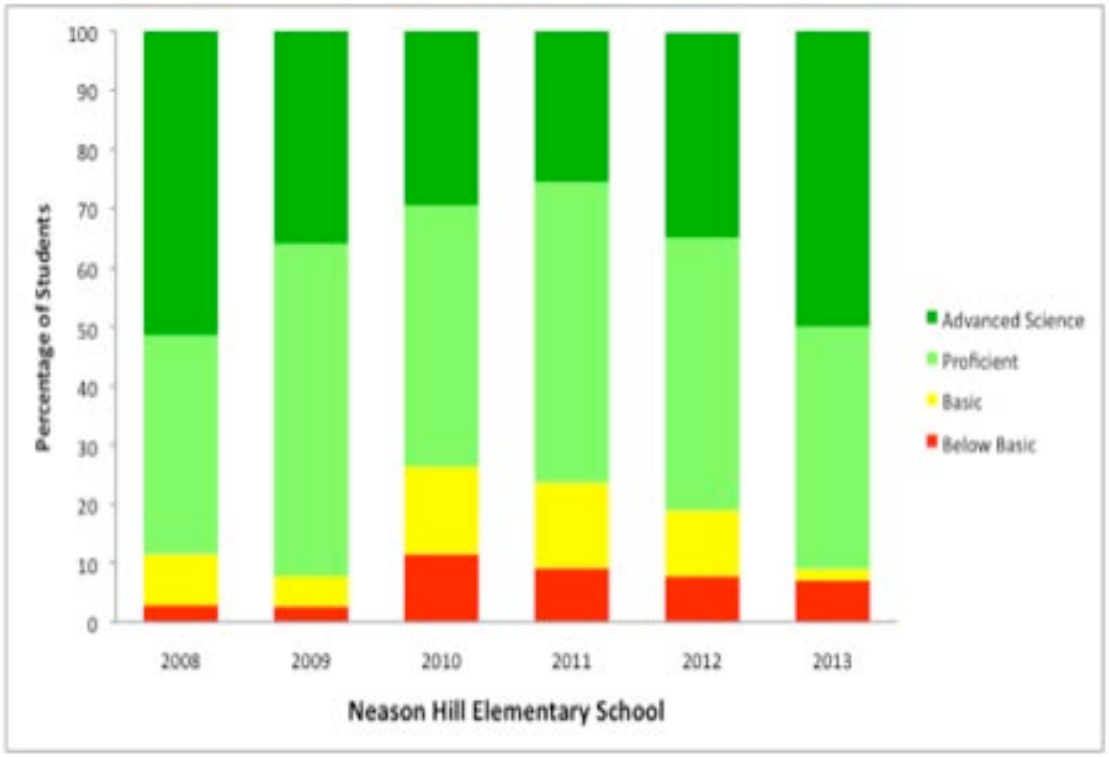


Figure 5. The percentage of total students scoring in each category on the Science PSSA from 2008-2013 at Neason Hill Elementary School.

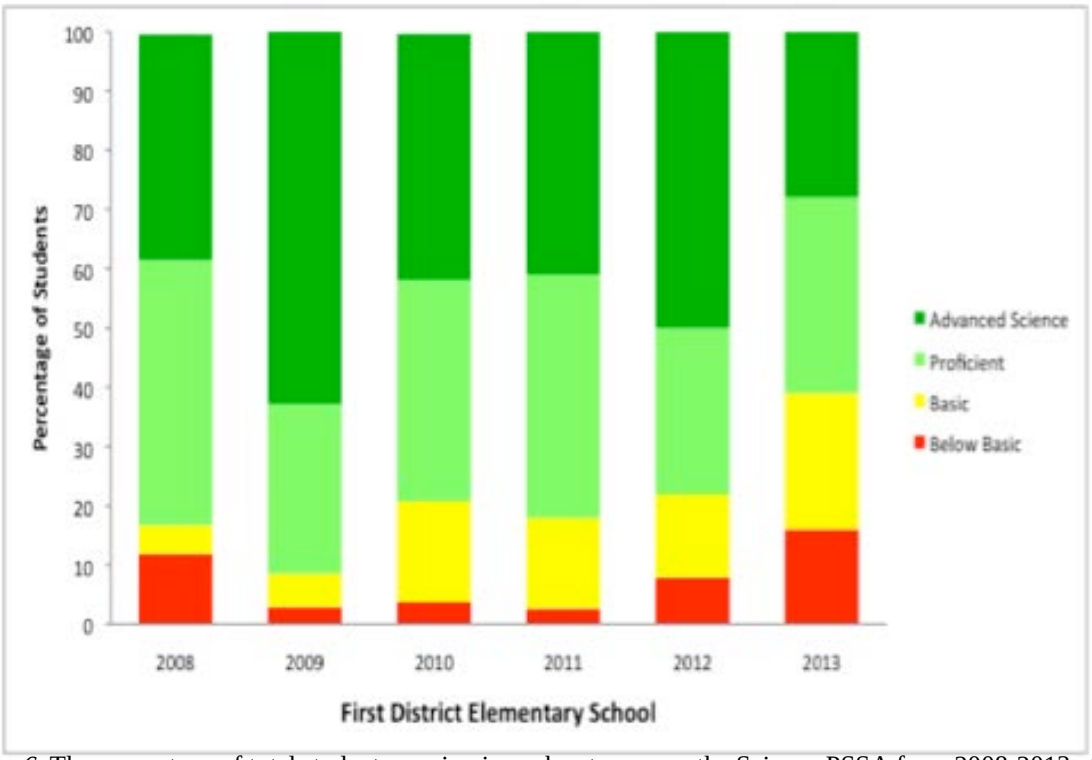


Figure 6. The percentage of total students scoring in each category on the Science PSSA from 2008-2013 at First District Elementary School.

Discussion

The effective approaches to supplemental science instruction previously described in the review of literature are used to further explore the FCOLC and the 2013 piloted Science Symposium. The criteria used to compare the FCOLC and Science Symposium includes standards-based curriculums, collaboration with higher education, professional development, informal programming, environmental education, and overall integration of best strategies and practices (Figure 7). Aspects of the FCOLC and the Science Symposium that reflected the approaches to supplemental instruction encouraged by existing research are listed for review (Table 2). The comparison highlights the effective methods used by both programs, overall strengths of each, and areas were further development could occur.

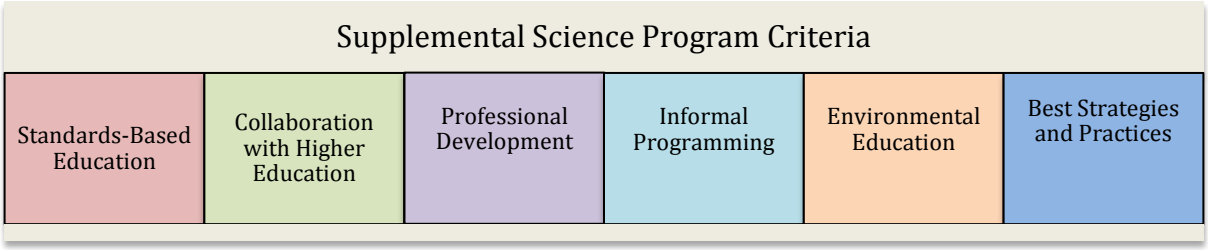


Figure 7. The guiding principles and criteria for program assessment used on the French Creek Outdoor Learning Center and Piloted Science Symposium

By comparing previous science initiatives with the developed supplemental science program curriculum, the main differences between the French Creek Outdoor Learning Center (FCOLC) and Science Symposium are found in the informality of programs, collaboration with higher education, and environmental education components. Fortunately, while research is minimal on the effectiveness of standards-based teaching, some studies acknowledge gains in student achievement with standards-based instruction (Geier et. al, 2007). In regards to Pennsylvania State Standards, both programs addressed similar 4th Grade Science Assessment Anchors (Appendix C). The distinction, however, is that the Science Symposium built the lessons and activities around the standards, while the FCOLC's alignment with standards was unplanned. The FCOLC did further emphasize standards after the Science PSSA was released with the added Wondership program, but this was a separate feature and did not take place during the 2-days of Earthkeeper's training.

Table 2. Successful program approaches based on existing research incorporated into the FCOLC and Science Symposium supplemental programs previously used in Crawford Central School District.

Program Approach	***FCOLC***	***Science Symposium***
Standards-based Curriculum	7/12 PDE Science Grade 4 Assessment Anchors (Appendix C) were integrated into the curriculum. The Wondership program, added in 2008, reiterated the standards addressed at the center to the students back in their general education classroom.	7/12 PDE Science Grade 4 Assessment Anchors (Appendix C) were integrated into the curriculum. The state standards for 4th grade science were used to design the program activities and guide instruction.
Collaboration with Higher Education	There was no collaboration with higher education institutions.	The program worked with Allegheny College for the facility used, instructors, and general volunteers.
Professional Development	General education teachers did not receive specific training through the FCOLC. Teachers had the opportunity to observe and assist in the activities for fourth graders and received information about the FCOLC program before taking their students.	The general education teachers could assist and observe during the symposium activities, but did not receive specific training from the instructors. Teachers also did not receive specific information on the content of the science symposium before the day of programming.
Informal Programming	The program took place outside the regular school building in an outdoor center, for a total of two days. The Earthkeeper's curriculum was not structured around state standards and frequently used open-ended questions to direct each activity. No formal assessments were given.	The program took place at Allegheny College, which allowed students to engage in material outside their usual setting. The program lasted one day and was designed around state standards. No formal assessments were given to students during the program. Community resources were utilized for the program to run.
Environmental Education	The environment was the focal point of the FCOLC and guided instruction on four main ecological concepts. All activities were performed outside, on a 170-acre property with riparian, forest, and forest edge areas.	The environment was addressed in the majority of activities, but was not present in all. The activities were performed indoors. Some activites took place inside LEED certified, energy efficient buildings with indoor vegetation and aquaponics systems.
Best Strategies and Practices	The FCOLC used inquiry based activities and active experiential learning. Activities built upon students' prior knowledge and were required to investigate to find the answer to an open-ended question. Staff was well trained in the Earthkeeper curriculum.	Inquiry based learning was used and students participated in hands-on activities. Staff was well trained in their subject area, but no specific training for the program was given.

While standards can provide key guidelines for instruction, the success of the FCOLC in addressing the standards without designing the program around them may suggest such a practice is not necessary. When examining the informality of each program, the contrast between reliance on and flexibility with standards holds great importance. Both the FCOLC and Science brought students outside their typical classroom setting for either one or two days. However, the FCOLC curriculum revolved around open-ended questions and was not based on the high-stakes assessment. The Earthkeeper's key ecological concepts, without intention, did align with fourth grade science standards. The Science Symposium, on the other hand, had detailed objectives that strictly addressed state standards. To a large extent, the FCOLC portrayed an informal program, as this approach focuses on student's experience and enjoyment rather than state standards (Harlow, 2012). Contrastingly, the Science Symposium encompassed the community aspect of informal programming that is suggested by the National Science Education Standards (Kisiel, 2012). The FCOLC operated independently with a director and employed instructors, but the Science Symposium did reach out to community partners for the facility, instructors, and general volunteers. More specifically, the Science Symposium worked in partnership with Allegheny College, as the campus was used to not only host the event but the majority of instructors was pulled from the college faculty. As previously discussed, collaboration with higher education can further enhance science initiatives through the expertise of the institution's staff and resources (Stamp & O'Brien, 2008; McCarthy, 2013; Geir et. al, 2007). Because the open-ended nature of programming is key for student enjoyment and overall retention, and using community resources aides connecting academic content with real-world problems, the two informal programming pieces could be integrated into one program to further exhibit informal learning and gain the associated benefits.

Evident in the comparison, environmental education is a key aspect of the FCOLC, but was not the focal point of the science symposium. The content presented in the Earthkeeper's curriculum strictly relates to one of four ecological concepts and follows a philosophy that students must form a relationship with the natural world in order to adopt environmentally friendly practices after the program ends. The FCOLC created the atmosphere, as described by Erdogan (2011), for students to observe cause and effect relationships in a natural environment. While the Science Symposium incorporated environmental science topics such as bird migration and stream ecology, the overall program was not concerned with students building a relationship

with nature. Instead, the Science Symposium sought to address topics likely to appear on the Science PSSA. The comparison clearly displays FCOLC as a short-term environmental education intervention and the Science Symposium as general science education program. Environmental education has been shown to improve student achievement on state assessments by having positive impacts on self-esteem, level of engagement, motivation, and critical thinking skills (Washington State Report, 2007). It is important to note, however, that a gap in research exists in assessing the effectiveness of short-term environmental education on student achievement. The majority of existing research finds correlation between long-term environmental education initiatives and student success (Bartosh et. al, 2006, Sellman & Bogner, 2012). While the FCOLC provided a unique, environmental education experience for students, this study cannot determine the overall effectiveness of the Earthkeeper's approach on student achievement. Environmental education can have other effects on students, such as improving classroom behavior and connectedness with nature (Washington State Report, 2007). If the school district and teachers seek such improvements, future programming could include more environmentally focused activities taking place outside, in a particular ecosystem or on the elementary school/college campus.

Although neither program focused on professional development for general education teachers, both the FCOLC and the Science Symposium utilized the researched practices of inquiry-based learning and hands-on activities. Again, the majority of existing research connects long-term integration of hands-on activities to improve science achievement (Stohr-Hunt, 1996). However, the programs did encompass instructional methods that have directly correlated past studies with improved test scores. Instructors from the FCOLC were well trained in the specific Earthkeeper's curriculum used in the program, and the instructors volunteering for the Science Symposium were well educated in their area of expertise (i.e. recycling, geology, and stream ecosystems.) due to their professional interests. High quality instruction and prepared staff have been noted by research as crucial to the success of a program (Washington State Report, 2007). Unfortunately, the degree in which this study can analyze the staff and instructors for each program is limited to great extent. On-site observations for teaching methods and instruction were not possible because past programming is examined. Aspects noted by Rivet and Krajcik (2008) as effective science teaching methods such as teacher enthusiasm, enhanced context strategies, question strategies, and collaborative learning were difficult to assess through in-

person interviews alone. Thus, barriers to obtaining information on best strategies and practices used at the FCOLC and Science Symposium have narrowed this portion of the analysis. High quality instruction should undoubtedly continue being used during programs, but professional development is extremely important for students to receive outstanding science education throughout the year. Because both programs lacked resources for the general elementary teachers, this could be an area to expand for future endeavors.

To gauge whether significant variation occurred in student achievement, a chi-square data analysis was performed on 2008-2013 fourth grade Science PSSA scores for Crawford Central School District. The chi-square test was chosen due to the limiting conditions of the scoring, specifically not having accessible raw score reports, and format of the Science PSSA. The chi-square test examines the number of observations falling into different categories. For the purpose of this analysis, observations refer to the number of students scoring in a specific performance level. The chi-square test compares the observed frequencies, or number of students scoring in each category, with the expected frequencies, or the expected number of students scoring in the category if the null hypothesis is true. The null hypothesis refers to the general default position that there is no relationship between the two measured phenomena, or that the potential treatments, which in this study refers to the change in science programming, has no effect. If the resulting chi-square data can lead to rejecting or disproving the null hypothesis, then the belief may stand that a relationship exists between observations. The calculation for the chi-square is found below.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

χ^2 = the test statistic $\sum$ = the sum of

O = Observed frequencies E = Expected frequencies

The calculated chi-square value is compared to a set critical value to verify the significance. The critical value for a data set is determined by degree of freedom (df). The df is calculated by multiplying the number of rows minus 1 by the number of columns minus one for the given data table (Appendix C). If the chi-square value is less than the critical value determined by the degree of freedom, the null hypothesis cannot be rejected or disproved. If the chi-square value is greater than the critical value, a relationship can in fact be observed.

A probability value (p-value) is also calculated (Appendix C). The p-value represents the probability of obtaining a test statistic at least as extreme as the one actually observed, assuming that the null hypothesis is true. The null hypothesis will be rejected if the p-value is less than the critical value of .05. The chi-square calculations and corresponding p-values will prove if a significant change in student achievement on the Science PSSA occurred during the shift in science programming for Crawford Central School District.

This study performed multiple chi-square tests on the Science PSSA Score Reports to examine fluctuations in student achievement. Separate chi-squares were determined for individual schools, as each school within Crawford Central School District has had unique changes and circumstances that could be overlooked if the district was only analyzed as a whole. An exception was needed for East End and Second District Elementary Schools. From 2008-2011, East End Elementary School and Second District Elementary School were separate entities and had individual score reports. However, the two elementary schools merged in 2012. Due to these structural changes, the score reports from both schools from 2008-2011 were combined to create a consistent data set. The two schools appear as one, East End/Second District for the entire report.

The analysis found chi-squares for each school from 2008-2010 to determine if significant change occurred during the years the FCOLC was in use, and 2011-2013 to determine if significant change occurred after the FCOLC was cut from the curriculum, specifically during the two years of transition and one year with two schools participating in the piloted science symposium. In addition, the 2008-2010 scores and 2011-2013 scores for each school were collapsed to produce a single chi-square value to determine if a significant change in scores occurred pre and post FCOLC. Lastly, an all-encompassing chi-square for Crawford Central School District was determined by collapsing the 2008-2010 scores with the 2011-2013 scores to assess if eliminating the FCOLC resulted in a significant change in fourth grade student achievement on the PSSA Science (Table 3). Given the resulting chi-square values and degrees of freedom (4 and 3), the probability values were calculated to prove if any significant change occurred (Appendix D). The only significant p-value less than .05 was found in the chi-square calculation for East End/Second District Elementary Schools from 2008-2010 (Table 3).

Table 3. Chi-square results and P-values for Crawford Central School District and each individual elementary school for the years the French Creek Outdoor Learning Center was in operation and after the program was cut from fourth grade curriculum.

Years	School	Chi Square	P Value
2008-2010	Cochranton	4.055	0.399
2011-2013	Cochranton	3.419	0.755
2008-2010	First District	11.699	0.069
2011-2013	First District	11.728	0.068
2008-2010	West End	5.113	0.529
2011-2013	West End	4.849	0.563
2008-2010	Neason Hill	10.598	0.102
2011-2013	Neason Hill	8.753	0.188
2008-2010	East End/Second District	20.490	0.002
2011-2013	East End/Second District	8.291	0.218
2008-2010/2011-2013	Cochranton	7.394	0.061
2008-2010/2011-2013	First District	5.814	0.121
2008-2010/2011-2013	West End	3.181	0.365
2008-2010/2011-2013	Neason Hill	0.207	0.976
2008-2010/2011-2013	East End/Second District	2.376	0.498
2008-2010/2011-2013	CCSD	4.055	0.399

In regards to student achievement on the Science PSSA during from 2008-2013, the only significant p-value less than .05 was found in the chi-square calculation for East End/Second District Elementary Schools from 2008-2010. By only using the chi-square test, it is difficult to determine the exact cause of the chi-square of significant value for East End/Second District. During this time, the FCOLC was in operation and provided consistent programming to all five schools, including East End and Second District Elementary Schools. However, the significant change in scores could result from merging the two schools scores together for the entire time span. Because East End and Second District schools merged in 2012, their separate Science PSSA score results were combined for the chi-square data analysis, as a data set for a chi-square analysis must stay constant. The significant differences in scores could be linked to the structural change from the joining of the two elementary schools, or reflect outside factors influencing test scores in either or both elementary schools. The remaining elementary schools showed no significant fluctuation in Science PSSA score reports from 2008-2013. Thus, the elimination of the FCOLC and Earthkeeper's curriculum cannot be linked, as the null hypothesis has not been disproven, to a sizeable change in fourth grade student achievement on the Science PSSA.

The chi-square test, as previously stated, only determines if the change in scores was significant. A more thorough review of curriculum beyond the supplemental science programs must be performed to determine the direct causes of score fluctuation. This report cannot prove

causation between supplemental science programming and student achievement because of the wide range of external factors not included in the analysis. For example, science curriculum may vary depending on the specific teacher within one elementary school. Because teachers have multiple subjects to address in an academic year, some teachers may focus more on one subject than another, depending on their own interests, previous training, academic background, and comfort level (Sandall, 2003). As major differences in teacher quality can exist within one school, students may receive a stronger or weaker science education purely based on which teacher they are assigned (Rockoff, 2004). Additional factors such as student interest in science, curriculum and material changes throughout the academic year, reliance on textbooks, extracurricular activities students participate in, family and community influences, and socioeconomic level of students are just some examples that could cause fluctuations in student achievement (Geier et. al, 2007; Stamp & O'Brien, 2005; Sandall, 2003). Because of these limitations, this report can only provide a thorough analysis of recent supplemental science programs used in Crawford Central School District and the Science PSSA scores during that time period to educate future science initiatives.

Conclusion and Recommendations

This study serves as a baseline report on previous fourth grade science programming used in Crawford Central School District and corresponding student achievement on the Science PSSA. The incorporation of supplemental science programs, as exemplified by the planning committee of the Science Symposium, is often geared toward standardized test preparation. This report cannot completely evaluate the effectiveness of the FCOLC or Science Symposium in improving student achievement on the Science PSSA, but can serve as one portion for analysis. Test scores, despite being the most common form of evidence for effective practices, do not present the entire picture of student success (Rockoff, 2004; Stohr-Hunt, 1996). However, standardized test scores and overall educational standards can be used as one factor to gauge student achievement and comprehension of material. Standards can help guide curriculum and determine which areas of a subject need more instructional time than others. Other variables aside from supplemental science instruction could potentially be linked to the fluctuations in fourth grade Science PSSA scores in the future, and these variables may prove standardized tests hold more credibility in directing science curriculum. These variables include, but are not limited

to teacher background and training in science, teacher enthusiasm, professional development in science, materials used for students and teachers, learning environment for students and teachers, socioeconomic status of students, student interest in science, extracurricular activities students participate in, and family and community influences. Additional research is needed to determine how standardized test scores relate to these variables for Crawford Central School District.

For future analysis of student achievement in Crawford Central School District, measures unable to be included in this study should be used to evaluate improvement. Although standardized test scores are considered key indicators of student achievement in education research and policies, raw data is difficult obtain, may not be fitting for certain types of analysis, and is not always helpful when comparing student achievement beyond state lines (Geier et. al, 2007; Rockoff, 2004). These issues have caused many researchers to develop unique forms of assessment for specific science programming, to use in addition to standardized test results, to more fully student achievement (Geier et. al, 2007). These assessments could focus not only on PSSA science content retention, but also student enjoyment of the experience, student motivation, and behavior as well. Although some measures are difficult to quantify, educators could benefit from understanding what the students enjoyed learning about and how the reacted to learning in a new environment. Creating an additional form of assessment was not possible for the historical analysis performed in this study, but is recommended for future analysis of current science programming in Crawford Central School District. Standardized tests scores should remain in future analysis and evaluations, as this measure is regarded as a valuable tool in assessing the effectiveness of science programming, but authentic assessments must be incorporated as well (Stohr-Hunt, 1996). Standardized tests can be used, to an extent, in comparison between schools or districts, but additional factors must be further explored to understand the causes for score variation.

More information, such as available funding, grants, and teacher feedback is needed to determine which recommendations are possible and desired by Crawford Central School District and community partners. Allegheny College students or Meadville community members could further explore the other influences previously mentioned including teacher background and training in science, teacher enthusiasm, materials used, learning environment, socioeconomic status of students, student interest in science, extracurricular activities students participate in, and family and community influences that may be contributing to PSSA score fluctuations. Future

studies building upon this report should analyze one or more of these variables to determine if and what the effect may be on student achievement on the Science PSSA. Moving forward from this report, the results found in the chi-square analysis show scores have remained relatively constant from 2008-2013, and the developed supplemental science program criteria can be used to determine which aspects can be included or improved for future initiatives. Given the results of the supplemental science program analysis, the following options should be considered to improve and expand elementary science initiatives:

1) Professional Development

Expanding professional development trainings for elementary education teachers should utilize the surrounding network of community partners working in or related to the field of science. Allegheny College faculty and staff frequently present lectures on a wide range of science topics throughout the academic year, and may be willing to deliver presentations during evening or Saturday times to enable elementary teachers to participate. Attending lecture presentations could further develop elementary teachers' content knowledge and consequently increase confidence in teaching science. As previously discussed, the University of Michigan graduate students and professors provided weeklong summer programs and Saturday workshops, led teacher discussion groups, and put together online resources for elementary teachers in the surrounding Detroit area (Geier et. al, 2007). Washington University faculty and graduate students similarly worked to provide a 15-hour certificate program for elementary school teachers in science instruction (McCarthy, 2013). Allegheny College faculty and staff may be able to provide similar services to Crawford Central School District teachers. In addition to the college, community partners already being utilized for the Science Symposium may be able to provide professional development programming as well. The database put together by members of the Science Symposium planning committee can be used to locate such resources. Such initiatives would improve professional development programs offered to elementary teachers in the field of science. Professional development is an area both the FCOLC and Science Symposium did not address, but could undeniably be incorporated with the available community resources.

2) Collaboration with Allegheny College for Program Design and Implementation

In addition to faculty and staff, Allegheny College students could assist in further enhancing science initiatives. Students with majors in the sciences or with a minor in education may be interested in working closely with college faculty and the Crawford Central School District on curriculum design. General courses, such as Environmental Education, junior seminars, potential internship credit, and senior projects could provide Allegheny students with opportunities to collaborate with elementary teachers and develop activities or units on scientific topics. It is extremely important, as noted by Kisiel (2012) to take the teacher's background, daily objectives, challenges, and attitudes, into account when designing effective lesson plans. As displayed by Binghampton University in New York, college faculty and students can form "teaching fellows" to design lessons and units (Stamp & O'Brien, 2005). Groups of students assigned to a specific classroom or elementary school can observe classes, meet with teachers, design programs based on the classroom and teacher's needs, present ideas to the teachers, and refine before handing over for teachers' use (Stamp & O'Briend, 2005). Under this model, the college students would observe the newly designed lessons in the classroom to further refine the content and instructional techniques prescribed.

Yearly curriculum, test prep, and test taking require a significant amount of instructional time in the daily classroom (Marx & Harris, 2006). If teachers do not have enough time in the school year to try new lessons, college faculty and staff may be able to offer supplemental programs in the evenings, like the family science nights discussed by McDonald (1997). Universities in Southern California worked with the surrounding school district to put on monthly family science nights. This idea could be adopted for Crawford Central School District by using either college campus or elementary school buildings for supplemental programming. Allegheny College students would still need to gain information from the teachers on what science topics to focus on, but could provide this program without interfering with elementary teacher's daily schedule. Fourth grade families would be invited, preferably each month, to a science night with different stations focusing on one or more science topics. Effective teaching strategies, like inquiry-based learning, could be used at events, and if offered on a monthly basis the instruction would be provided throughout the entire year, rather than just one event before the Science PSSA is administered. As previously discussed, the majority of research proves long-term interventions with hands-on activities, inquiry-based learning, and environmental education

are effective in improving student achievement on state assessments (Sellman & Bogner, 2012; Bartosh et. al, 2006; Stohr-Hunt, 1996). Elementary teachers could also be invited to such events to serve as a professional development program to gain experience with different instructional methods and science topics.

3) Improve accessibility of existing lessons and teaching methods

Because teacher quality for science instruction, academic background, and comfort can vary greatly within a school and district, resources should be shared between educators and community partners. Teacher discussion groups are key for skill sharing, but online resources could be useful as well. In addition to lesson plans and resources developed by fellow teachers, Allegheny College and other community partners could contribute as well. Existing senior projects at the college have created science themed lessons and units for elementary students, but the research is not always accessible to the public through the existing senior project database. Students embarking on independent studies or senior projects can work towards creating an online archive to display previously designed lessons, and can continue adding to the resources as well. Such resources would provide teachers additional ways to expand science education and integrate the researched best strategies and practices, like inquiry-based learning, into the classroom.

As previously noted, all recommendations must be further explored through available funding, grants, and teacher feedback. Interviews with current fourth grade elementary students and willing community members/Allegheny College staff is of outmost importance in moving forward and further developing supplemental programming to determine the most current needs for science education and the existing/possible resources to use. These recommendations serve as options for the administration, educators, Allegheny College, and community partners to consider when moving forward with supplemental science programming for fourth grade in Crawford Central School District.

References

Bartosh, O., Tudor, M., Ferguson, L., & Taylor, C. (2006) Improving test scores through environmental education: Is it possible? *Applied Environmental Education & Communication*, 5 (3), 161-169.

Bennett, D.B. (1984). Evaluating environmental education in schools: A practical guide for teachers. *Unesco-UNEP International Environmental Education Program*, 1-105. Retrieved from http://unesdoc.unesco.org/images/0006/000661/066120eo.pdf

Bozdogan, A.E. & Yalcin, N. (2009). Determining the influence of a science exhibition center training program on elementary pupils' interest and achievement in science. *Eurasia Journal of Mathematics, Science & technology Education, 5*(1), 27-34.

Collins, A. (1997). National science education standards: Looking backward and forward. *The Elementary School Journal*, 97 (4), 299-313.

Council on Environmental Education (2004). Report card on the status of environmental education in Washington State. Retrieved from http://www.peecworks.org/PEEC/PEEC_Research/01798A36-001D0211.0/

Environmental Protection Agency. (2012). Environmental education grants. Retrieved from: http://www.epa.gov/education/grants/index.html

Erdogan, M. (2011). The effects of ecology-based summer nature education program on primary school students' environmental knowledge, environmental affect and responsible environmental behavior. *Environmental Sciences: Theory & Practice, 11*(4), 2233-2237.

Geier, R., Blumenfeld, P.C., Marx, R.W., Krajcik, J.S., Fishman, B., Soloway, E. & Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching, 45*(8), 922-939.

Harlow, D.B. (2012). The excitement and wonder of teacher science: What pre-service teachers learn from facilitating family science nights. *Journal of Science Teacher Education, 23,* 199-220.

Johnson, C.C., Zhang, D., Kahle, J.B. (2012). Effective science instruction: impact on high-stakes assessment performance. *Research in Middle Level Education 35* (9), 1-14.

Kisiel, J. (2013). "Introducing future teachers to science beyond the classroom." *Journal of Science Teacher Education*, 24, 67-91.

Larson, L.R., Green, G.T., & Castleberry, S.B. (2010). Construction and validation of an instrument to measure environmental orientations in a diverse group of children. *Environmental Behavior, 43*(1), 73-89.

The Lawrence Hall of Science. (2012). High hopes- few opportunities: The status of elementary science education in California. *The Center For the Future of Teaching and Learning*, 1-20.

Lunden, C. (2005). So, host family science night? *Science and Children, 42*(8), 30-35.

Marx, R.W. & Harris, C.J. (2006). No child left behind and science education Opportunities, challenges, and risks. *The Elementary School Journal, 106*(5), 467-478.

McCarthy, L.G. (2013). Closing the gap: How one school district went about fixing standardized science test scores. *Washington University in St. Louis*.

McDonald, R.B. (1997). Using participation in public school family science night programs as a component in the preparation of pre-service elementary teachers. *Science Teacher Education*, 577-585.

McKeever Environmental Learning Center. (2012). *School programs.* Retrieved from http://www.mckeever.org/school-educational-programs.html

The National Research Council. (2011). Successful K-12 STEM education indentifying effective approaches in science, technology, engineering, and mathematics. *The National Academies Press*, 1-24.

National Wildlife Federation. (2009, September 9). *Using the outdoors to enhance classroom performance: A school readiness guide for teachers and parents.* Retrieved from https://www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2009/Time-Out.aspx

Pennsylvania Department of Education. (2007a). *Science grade 4 assessment anchors and eligible content*. Retrieved from http://static.pdesas.org/content/documents/Grade_4_Science_Assessment_Anchors.pdf

Pennsylvania Department of Education. (2013b). *Fact sheet: PA standards and the common core.* Retrieved from http://www.pacommoncorestandards.com/files/2713/6544/9314/FACT_SHEET_for_PA_Academic_Standards_and_the_Common_Core__.pdf

Pennsylvania Department of Education. (2013c). *PSSA assessment handbook.* Retrieved from www.portal.state.pa.us/…/pssa_assessment_handbook_2012-2013_pdf

Ramey-Gassert, L. (1997). Learning science beyond the classroom. *The Elementary School Journal, 97*(4), 433-450.

Rivet, A.E. & Krajcik, J.S. (2008). Contextualizing instruction: leveraging students' prior knowledge and experiences to foster understanding of middle school science. *Journal of Research in Science Teaching, 45,* 79-100.

Rockoff, J.E. (2004) The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Association,* 247-252.

Sandall, B.R. (2003). Elementary science: Where are we now? *Journal of Elementary Science Education, 15*(2), 13-30.

Savery, J.R. (2006). Overview of problem-based learning: Definitions and distinctions." *Interdisciplinary Journal of Problem-based Learning, 1*(10), 9-20.

Schroeder, C.M., Scott, T.P., Tolson, H., Huang, T.Y., & Lee, Y.H. (2007). A meta-analysis of national research: effects of teaching strategies on student achievement in science in the USA. *Journal of Research in Science Teaching, 44,* 1436-1460.

Sellmann, D. & Bogner, F.X. (2013). Effects of a 1-day environmental education intervention on environmental attitudes and connectedness with nature. *Eur J Psychol Educ 28,* 1077-1086.

Stamp, N. & O'Brien, T. (2005). GK-12 partnership: A model to advance change in science education. *BioScience, 55(1),* 70-77.

Stohr-Hunt, P.M. (1996). An analysis of hands-on experience and science achievement. *Journal of Research In Science Teaching, 33*(10), 101-109.

Sullivan, J & Hatton, M. (2011). Math and science night: A twist on the traditional event to engage families in exploring and learning through inquiry. *Science and Children,* 58-63.

Van Matre, S. (1990). *Earth education: A new beginning*. Greenville, West Virginia: The Institute for Earth Education.

Washington State Department of Education. (2007). *Environmental education report: empirical evidence, exemplary models, and recommendations on the impact of environmental education on k-12 students.* Retrieved from http://www.k12.wa.us/environmentsustainability/pubdocs/eereport.pdf

Appendix A.

French Creek Outdoor Learning Center and Science Symposium Interview Questions
(Judy Acker and 2013 Science Symposium Planning Committee)

1.) What were the expectations for the 4th graders attending the French Creek Outdoor Learning Center [FCOLC]? Did the expectations change during the duration of the program?

2.) How was the program evaluated or assessed? Specifically, were students given a pre/posttest? After evaluation, were alterations made?

3.) Who determined the curriculum used during the program? Who was in charge of changing the program curriculum?

4.) Which of the Pennsylvania State were incorporated into the program?

5.) What skills did students develop with this program?

6.) What was the layout of the program? How long was the program? Where did the lessons take place (i.e. indoor or outdoor, lab room, etc.)?

7.) Did the facility meet the needs of the program?

8.) What community resources were utilized?

9.) Did the program make efficient use of time?

10.) What experience did you have with environmental education prior to the directing this program?

11.) What materials were used? How was the material presented?

12.) What kind of teaching strategies were used?

13.) What were the most successful aspects of the program? Were there any aspects of the program you think could have used improvement?

*14.) What differences did you see between the FCOLC and the piloted science symposium last spring?

*15.) How was student behavior during instruction during the 2013 symposium?

*Indicates questions asked only for the science symposium interviews and committee meetings.

Earthkeeper's Curriculum Interview Questions
(Fran Bires, McKeever Environmental Learning Center)

1.) What are the characteristics of the Earth Keepers program?

2.) What are the learning objectives for students in the Earth Keepers program?

3.) What teaching strategies are used in this program?

4.) What materials and type of learning environment/facility are needed?

5.) Are instructors required to have expertise in environmental education?

6.) Are state standards incorporated into the curriculum?

7.) What skills can students learn through this program?

Appendix B.

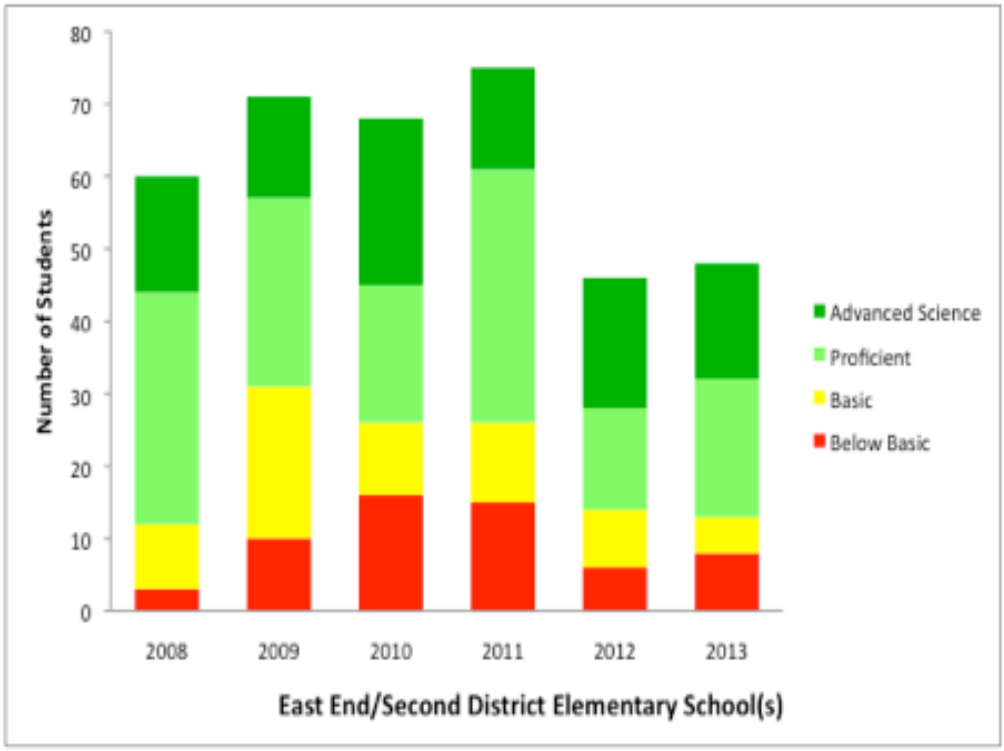


Figure 8. The number of students scoring in each of the four PSSA Science Performance Levels from 2008-2013 at East End/Second District Elementary School(s).

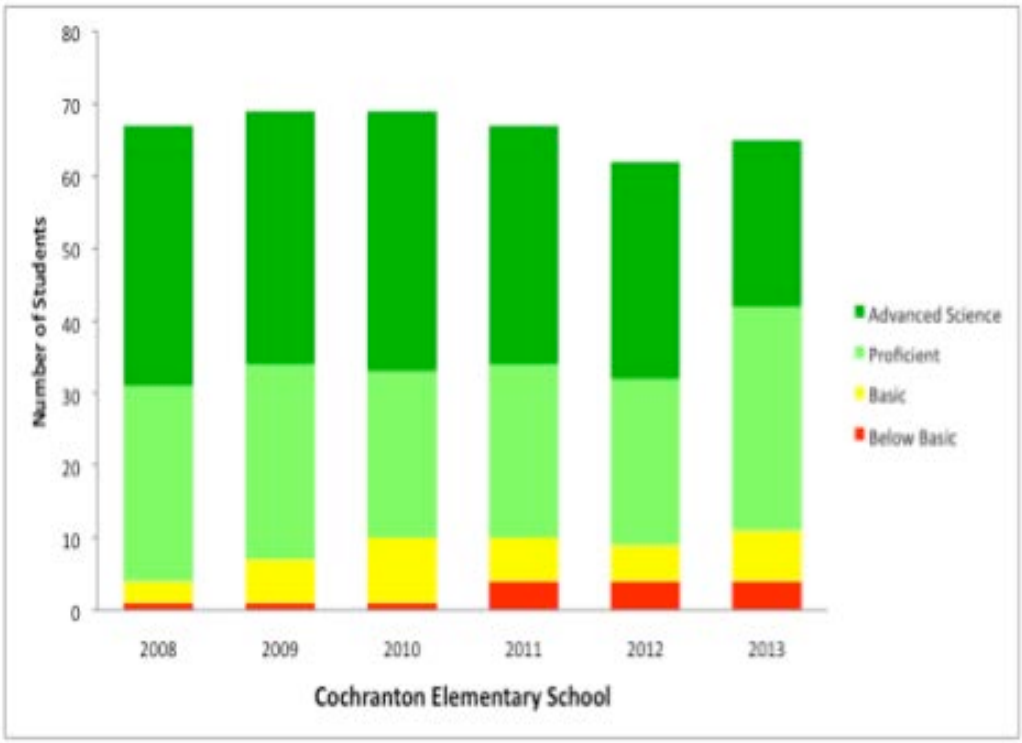


Figure 9. The number of students scoring in each of the four PSSA Science Performance Levels from 2008-2013 at Cochranton Elementary School.

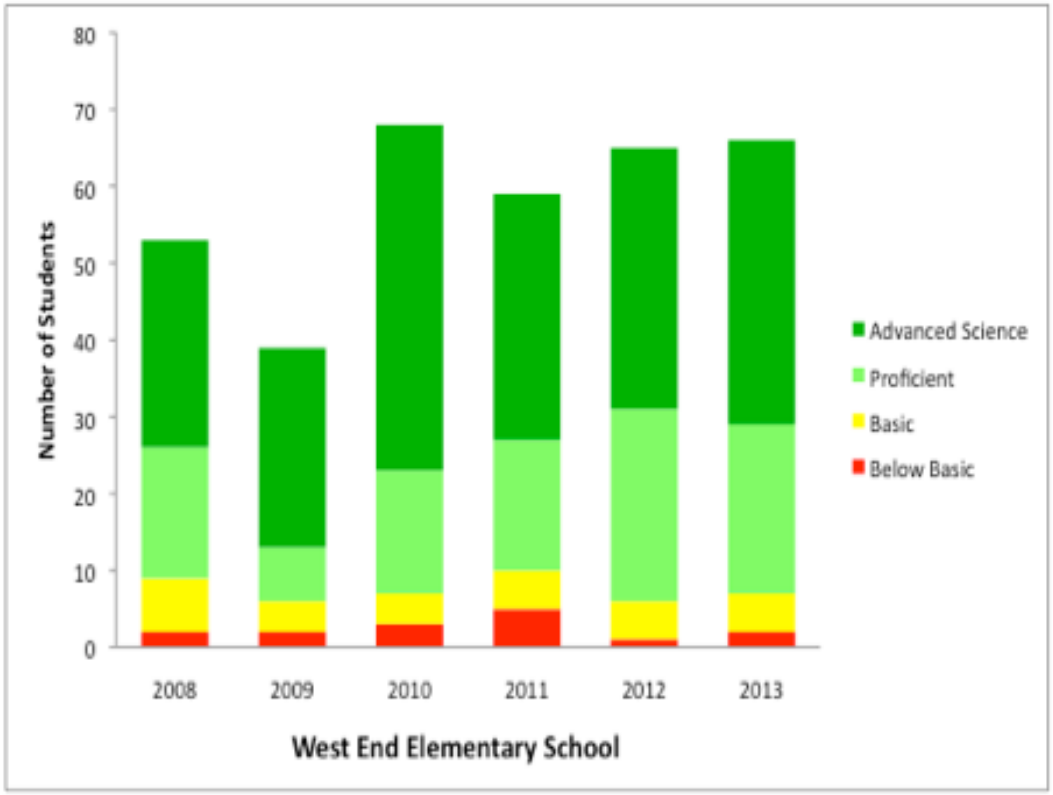


Figure 10. The number of students scoring in each of the four PSSA Science Performance Levels from 2008-2013 at West End Elementary School.

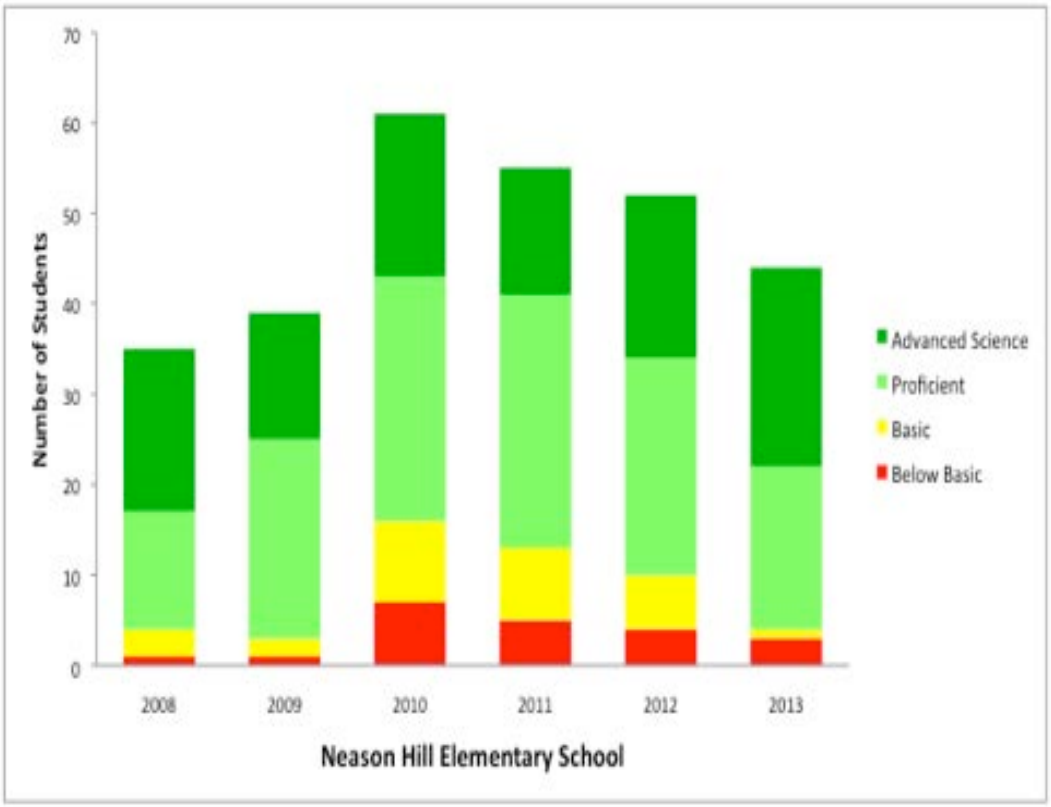


Figure 11. The number of students scoring in each of the four PSSA Science Performance Levels from 2008-2013 at Neason Hill Elementary School.

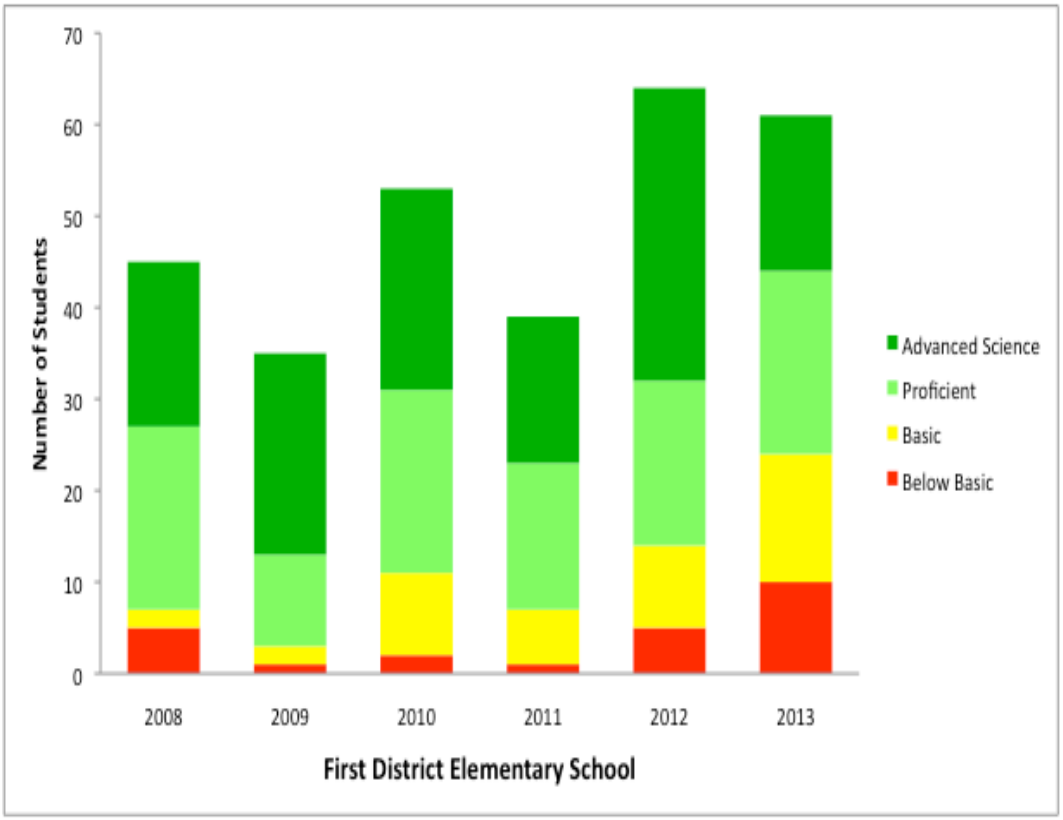


Figure 12. The number of students scoring in each of the four PSSA Science Performance Levels from 2008-2013 at First District Elementary School.

Appendix C.

To determine the standards incorporated into the FCOLC and piloted Science Symposium, the Pennsylvania Department of Education [PDE] Science Grade 4 Assessment Anchors and Eligible Content Criteria were used as a basis for comparison (PDE, 2007a). The Assessment Anchors are a tool used to design the PSSA and connect the state assessment to classroom practice. The Assessment Anchors essentially condense the extensive list of standards for each grade and specific subject to clarify and focus instruction. The same science standards categories are included in the Assessment Anchors, but the anchors tighten the focus of what is assessed. The PDE believes aligning instruction to the Assessment Anchors prepares students for the PSSA and ensures a rigorous and demanding curriculum. The Assessment Anchors are organized by the same reporting categories used on the Science PSSA- Natural Sciences, Biological Sciences, Physical Sciences, and Earth and Space Science. The Science Assessment Anchors cover 17 major categories from both the Science and Technology and Environment and Ecology state standards.The Assessment Anchors for 4th Grade Science are used to summarize the content taught at the FCOLC and Pilot Science Symposium (Table 2). The Assessment Anchors, or overarching standards, addressed in each program have been determined and compared for review. For each lesson or activity included in the FCOLC or Science Symposium curriculum, the corresponding Assessment Anchors were determined based on the content and objectives covered.

Table 4. Lessons and activities addressing the Science Grade 4 Assessment Anchors.

4th Grade Science Assessment Anchor	French Creek Outdoor Learning Center Lesson	2013 Science Symposium Lesson
S4.A.1 Reasoning and Analysis	Munchline, Great Speck, Connections	Bird Migration
S4.A.2 Processes, Procedures, and Tools of Scientific Investigations		
S4.A.3 Systems, Models, and Patterns	Great Speck, Connections	Rock Cycle
S4.B.1 Structure and Function of Organisms	Great Speck	Aquatic Macros
S4.B.2 Continuity of Life	Times Capsules	
S4.B.3 Ecological Behavior and Systems	Time Capsules	Recycling
S4.C.1 Structure, Properties, and Interactive of Matter and Energy		Electricity
S4.C.2 Forms, Sources, Conversion, and Transfer of Energy	Munchline	Electricity
S4.C.3 Principles of Motion and Force		
S4.D.1 Earth Features and Processes that Change Earth and Its Resources	Time Capsules	Recylcing
S4.D.2 Weather, Climate, and Atmospheric Processes		
S4.D.3 Composition and Structure of the Universe		

Appendix D.

Table 5. The values and tables used for chi-square and p-value calculations.

ID	YR	N	AS	P	B	BB
Cochranton	2008	67	36	27	3	1
Cochranton	2009	69	35	27	6	1
Cochranton	2010	69	36	23	9	1
Cochranton	2011	67	33	24	6	4
Cochranton	2012	62	30	23	5	4
Cochranton	2013	65	23	31	7	4
First District	2008	45	18	20	2	5
First District	2009	35	22	10	2	1
First District	2010	53	22	20	9	2
First District	2011	39	16	16	6	1
First District	2012	64	32	18	9	5
First District	2013	61	17	20	14	10
West End	2008	53	27	17	7	2
West End	2009	39	26	7	4	2
West End	2010	68	45	16	4	3
West End	2011	59	32	17	5	5
West End	2012	65	34	25	5	1
West End	2013	66	37	22	5	2
Neason Hill	2008	35	18	13	3	1
Neason Hill	2009	39	14	22	2	1
Neason Hill	2010	61	18	27	9	7
Neason Hill	2011	55	14	28	8	5
Neason Hill	2012	52	18	24	6	4
Neason Hill	2013	44	22	18	1	3
East End/Second District	2008	60	16	32	9	3
East End/Second District	2009	71	14	26	21	10
East End/Second District	2010	68	23	19	10	16
East End/Second District	2011	75	14	35	11	15
East End/Second District	2012	46	18	14	8	6
East End/Second District	2013	48	16	19	5	8