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Regis University
College for Professional Studies Graduate Programs
Final Project/Thesis

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THE IMPLEMENTATION OF OUTDOOR EDUCATION

by

Charles L. Yancey

A Research Project Presented in Partial Fulfillment
Of the Requirements for the Degree
Masters of Education

REGIS UNIVERSITY

May, 2007

ABSTRACT

The Implementation of Outdoor Education

This project addressed the problem of student engagement by giving teachers a set of laboratory lesson plans that can be performed outdoors. These lessons let the instructor move his/her classroom outside to do experiment in the environment that they occur. The labs were designed to be completed in any type of environmental setting in which a school might be located and with limited instructor preparation time. The last chapter of this paper includes a section containing feedback from experts pertaining to the validity of this project.

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Chapter 1

INTRODUCTION

The use of outdoor experiments in a science curriculum is not frequently used, today, in the traditional school system but it is necessary in order to develop a complete science student. Currently, the majority of material that is presented in science classrooms is in the form of a lecture and a meaningless laboratory for reinforcement. Balfakih (2003) explained that most material is presented by the educator in a lecture style and, rarely, is it supplemented with any other teaching methods. However, this style of teaching is slowly being phased out, in part due to the work of Gardner (1983). When a student experiences real hands-on science in the field, an important connection is made to the student's daily life.

Statement of the Problem

Too often, science teachers become complacent in the daily lecture and typical science experiments, and they never venture outdoors to do actual science in the field. This hands-on approach to science is overlooked due to the perceived complexity of preparation or lack of knowledge about the types of experiments that can be done. These types of hands-on experiments in an outdoor setting can seem overwhelming and impractical, especially in an urban environment, but it is the educators' responsibility to develop and provide experiences that can produce an impact on the student. Educators must be willing to take students into the field in order to produce life long science learners and ensure that an enduring understanding of the topic occurs.

Purpose of the Project

The purpose of this project will be to develop a curricular group of lessons that can be used to help educators produce life long science learners. This will be accomplished through the use of outdoor laboratory that can be performed in any setting whether it is urban or rural and require little preparation. The experiments will be designed for secondary students and can be completed within a typical 60 minute class period. It is this author's goal to help educators to develop memorable science experiences that are consistent with the Standards established by the Colorado Department of Education (CDE; 2006).

Chapter Summary

It is this researcher's position that science experiments must be moved out of doors. When class is held in the natural world, students will be able to make the real life connection to the work in which they are involved. In Chapter 2, the Review of Literature, this researcher presents the background information to support the position that scientific experiments should be moved outside. In addition, the researcher will demonstrate that students can learn through a variety of styles, and the use of outdoor education can be effective with many of these styles. In Chapter 3, Method, the methods for the implementation of this project will be detailed.

Chapter 2

REVIEW OF LITERATURE

The purpose of this project will be to develop an outdoor science unit plan for educators to use either as a whole or in segments throughout the school year.

Slingsby (2006) stated that outdoor education “takes place in an unfamiliar environment away from home and school which inspires curiosity before it even starts” (p. 51). This notion that students will already be interested in the topic is encouragement enough to implement such a unit plan. Bogner (1999) found that the use of outdoor education can bring all science disciplines together and help create a total understanding. Because most scientific concepts are taught in a lecture format, students never have the opportunity to see science in action. However, this type of field work is needed in order to show how science is done by professionals.

Scientific Misconceptions

Crockett (2004) asserted that all students have scientific misconceptions that educators must address. The most common misconceptions include: (a) “Large or heavy objects always sink,” (b) “the moon’s phases are caused by the shadow of the earth falling on the moon,” (c) “magnets attract all metals,” (d) “the earth is the center of the solar system,” (e) “batteries have electricity inside them,” and (f) “you can see and hear a distant event simultaneously” (p. 34). Crockett explained that all of these misconceptions could be corrected through the use of experiments and explanation of the concepts. An open forum for question and answer sessions must be utilized,

along with educator guided experiments in order to develop more complete scientific students.

Students' Impressions of Science

Hart (1997) found that 50% of all students, no matter what grade, ranked science as either their favorite or nearly their favorite subject. Hart explained that this is due to the subject matter and the students' ability to explore interesting topics. Hart wrote:

Science's popularity has much to do with its ability to stimulate young people's curiosity and maintain their interest through *doing* and not merely being passive listeners (it clearly is not a "boring" subject, from kids' point of view; history, math and English vie that for distinction). (p. 5)

Nearly one-half of all science students are taught by the traditional method of lecture and only periodically experience hands on experiments. The other half do experience hands on instruction, and Hart quoted one student who said,

In my other classes, we sit down the whole time; we don't get up and move around and stuff. So in science, we move all over the classroom and sometimes, a lot of times, we're not even in the classroom. So I think that's why it's fun. (p. 7)

Also, Hart found that 59% of students gave their teacher a perfect score if he/she was a hands on style of teacher, and only 44% gave their teacher high marks if he/she was a traditional style teacher. Hart explained that these high marks might be inflated due to enthusiastic teachers.

The Traditional Classroom

Balfakih (2003) explained that the most common teaching practices for science are: (a) question and answer sessions, (b) lecture, and (c) textbook work. Also, in science classrooms, today, students still spend the majority of their time

listening to lecture with intermittent hands on activities. Similarly, Wittig (1992) stated that science education has become a “static encyclopedia presented via monologues” (p. 1), and the experiments are based on following directions to reach some predictable outcome. Wittig maintained that no true science takes place in such classrooms, only cookie cutter experiments and long winded lecture. Grossman (2005) reported that, in his own classroom, he presented the material and expected the students to be able to apply the material on the test. However, many of the students did not have the appropriate knowledge base to do this and eventually failed.

Wingfield (2005) explained that the traditional classroom is a passive learning environment with little or no opportunity for students’ involvement in their own education. They asserted that lecture is important in order to give students the scaffolding needed to accomplish more technical science queries later. However, they cited Allen and Young (1997) who noted that students learn more effectively when they experience concepts in an active situation.

Experiments in the Traditional Classroom

According to Wittig (1992), classroom experiments have become static and are merely a hands on lecture. That is, the experiments are no longer experiments but, instead, are exercises with predictable outcomes. Wittig stated: “labs become places for simple observation or for reproducing data from the textbook” (p. 6). Also, Wittig observed that experiments are no more than self-demonstrations that supplement the lecture. Similarly, Sutman, Schmuckler, Hilosky, Priestley, and Priestley (1996) explained that laboratory activities are additions to the lecture rather than the driving force behind the course, and the majority of questions are posed

because of students' concern about procedures for completion of the experiment.

Sutman et al. cited Tobin and Gallagher (1987) who asserted that these types of experiments do not promote high level thinking, and students spend a majority of the time off task. Also, Wyatt (2005) explained that these types of experiments do not resemble true experimentation in any way.

"Good" Experiments

Wyatt (2005) asserted that good experiments are ones that force students to build an original laboratory set up where the outcome is not known. With the use of these types of experiments, not only can the students understand the assigned course work but they will help with future science concepts. Sutman et al. (1996) called for a reduced number of *procedural* experiments in order to foster higher order thinking.

Cooperative learning. As reported by Chang and Mao (1999), students should be placed in a cooperative learning environment with their peers. In cooperative learning, students are placed in small groups when they participate in laboratory activities. The use of these small groups provide students with the opportunity to be individuals within a group setting; thus, they have more independence and can develop higher self-esteem. Also, the use of cooperative learning in a laboratory allows students to interact with each other to determine the best approach to solve a problem. Balfakih (2003) cited Donmoyer (1996) and Secules, Cottom, Bray, and Miller (1997) and stated that: "The integration of cooperative learning within active learning activities leads to the development of critical and independent thinking skills, deeper understanding of concepts, and longer-lasting learning" (p. 606).

Implementation problems. Wyatt (2005) explained that the teacher must rehearse the *right answer*, and stated that, “With original research there is no ‘right’ answer to find; there is only data to be collected” (p. 84). This is a problem that educators must overcome in order to produce so called, good experiments. However, student centered experiments are difficult to implement in the traditional hour long class (Wittig, 1992). The educator must be creative in order to develop experiments that fit within the traditional time frame.

Educational Strategies

Multiple Intelligences Theory

Gardner (1983) explained that intelligence can be broken up into eight different modes: (a) linguistic, (b) logical-mathematical, (c) spatial, (d) bodily-kinesthetic, (e) musical, (f) interpersonal, (g) intrapersonal, and (h) naturalist. Gardner asserted that the majority of educators focus on the linguistic and logical-mathematical intelligences and praise those students who excel with the use of these types of intelligences. However, sometimes, students who do not fall into linguistic or logical-mathematical intelligence are labeled as learning disabled. Eisner (2004) stated: “the concept of multiple intelligences represents an effort to reframe our conception of intelligence, a concept that historically has been both redefined and singularized” (p. 33).

Gardner (1983) maintained that educators should include as many of the intelligences as possibly in their lesson planning. This will help to insure that all students are being reached and information is transferred correctly and completely. Field trips, role play, inner reflection, and cooperative learning are underutilized,

even those activities that can have the most impact on students. Many of these experiences are never used, partly because of: (a) limited budgets, (b) standardized testing requirements, and (c) lack of educator knowledge (Eisner, 2004).

Problems With Multiple Intelligences Theory

Gardner (1997) reported that MI is difficult to understand and even more demanding for educators to implement in the classroom. He stated: “MI may be appealing, but it is not for the faint-hearted, nor for those in search of a quick fix” (p. 20). Eisner (2004) affirmed this position in the statement:

What all of this adds up to is that increasingly our schools are operating within a policy culture that has been technicized. Such a culture leaves little space for professional innovation. All too often the teacher becomes a handmaiden to the tests whose scores provide the basis on which teacher, school, and students will be judged. (p. 34)

Thus, Eisner inferred that the use of MI in the classroom is not feasible in the current educational environment. Gardner asserted that a radical change must be made to the educational system in order for MI to become an integral part of the landscape, but many practices can be implemented quickly and effectively.

Multiple Intelligence in Action

Armstrong (1994) maintained that the use of MI is used, in varying degrees, in elementary schools at present, but it is no longer present when students reach secondary schools. Armstrong stated: “Children do not leave their multiple intelligences behind once they reach puberty. If anything, the intelligences become even more intense” (p. 27). Armstrong asserted that the bodily-kinesthetic and intrapersonal intelligences are the most important during adolescence and are

underutilized in instruction. He suggested that students should participate in numerous activities.

They should be role-playing literature. They should be interviewing, surveying, building, dramatizing, rapping, cooperating, computing, problem solving, sketching, and learning in a thousand other ways. Why? Because these are the activities that go on in the real world. (p. 28)

Armstrong argued that, if the experiences students have in school cannot be related to the real world, then no actual learning has occurred. Therefore, this is why MI is so important to utilize in the current school curriculum. Armstrong explained that an educator does not have to teach the same concept in eight different ways, but should try to teach the subject in a different and exciting way.

Inquiry Based Learning

The focus of inquiry based learning is on a hands on approach to learning (Exine, 2004). Furthermore, students learn best by doing, not by listening or being showed. Humans are naturally curious, and through the encouragement of this curious nature in the classroom, students are better able to understand complex subjects. Haefner (2004) stated: “experiences engaging in science inquiry enable students to both learn important science concepts and become familiar with ways of formulating questions” (p. 1654). Also, Haefner explained that these types of questions help students to gain a more complete understanding of scientific subjects.

Importance of Inquiry

According to Haefner (2004), questioning is one of, if not, the most important aspect of science. If students are not allowed to question topics, then a deeper understanding is not attained. Exline (2004) explained that, as students advance in the traditional educational system, the tendency to ask questions is lost. Students

become fact oriented and lose the motivation to explore ideas. Many students memorize the dates of events but do not truly understand the reasoning behind the event. This memorization of material is further supported by the use of multiple choice tests given by educators.

Exline (2004) stated that: “Inquiry implies a ‘need or want to know’ premise” (p. 2). This notion of wanting to know the reasoning behind concepts is crucial in order to achieve a deeper knowledge of the material. By fostering this questioning of the natural world, Exline explained that educators can better prepare students for college and the world outside of school.

Implementing Inquiry in the Classroom

Educators must be schooled in inquiry based assessment before they can successfully implement it in their classroom. According to Haefner (2004), most educators lack sufficient content knowledge to successfully implement such a strategy due to the lack of their own educational experience. If the educator does not fully understand the material, how then can he or she diversify the way in which it is taught? Haefner suggested that educators should participate in a subject specific, inquiry based course before they implement it in their own classroom.

Inquiry involves a student centered approach to education, whereby the teacher is merely a facilitator (Exline, 2004). Problems are assigned to the students, and the means by which they are solved is flexible. The work produced will vary, and it is the educator’s job to facilitate the correct outcomes.

Benefits of Inquiry in Science

The use of inquiry helps students to understand the material, and it gives them a good command of the use of the scientific method (Balfakih, 2003). These are the two main goals that educators should strive for, and inquiry is one tool that can be used to attain these goals. Exline (2004) explained that educators, who are exposed to inquiry based learning, are better able to make connections to other topics in science. Photosynthesis is better understood in the context of the sun, plants, and the role of carbon dioxide rather than the stand alone process. Use of this kind of cross content knowledge will result in a more complete learner and foster the natural curiosity of the individual.

Experiential Learning

According to Smith (2005), Kolb's (1975, as cited in Smith) theory of experiential learning is based on a cycle of learning. This cycle consists of four elements: (a) concrete experience, (b) observation and reflection, (c) forming abstract concepts, and, (d) testing new situations. This cycle can be entered at any element, but the completion of the cycle is fundamental in order to produce a long lasting mental impact. Once the cycle is completed, the task of learning is not finished because the goal of experiential learning is more like a spiral. Smith stated that "if learning has taken place the process could be seen as a spiral. The action is taking place in a different set of circumstances and the learner is now able to anticipate the possible effects of the action" (p. 4). Smith asserted that, through the use of experiential learning, students are better able to make connections and see the relevance to other subjects.

According to Balfkih (2003), students make assumptions about subjects, based on their own experiences with that subject. He emphasized that it is important to make these experiences as positive and accurate as possible. This can be done through the use of hands on, student centered experiments and experiences. Smith (2005) made the connection that, once this experience has taken place, it is the educator's duty to promote the completion of the cycle of learning. Also, McGlenn (1999) explained that students are not just static objects, instead, they interact with their environment and use past experiences and knowledge to make learning connections.

Experiential Learning Findings

In McDavitt's (1994) study, it was found that, on average, students did 25.4% better when they were exposed to experiential learning techniques than those who were exposed to traditional learning techniques. He found that the experiential group did 45% better on the high order thinking components than the traditional group, and the range of incorrect answers was 58.4% smaller. In regard to lower order thought questions, students in the experiential group did 11.3% better than those students in the traditional group who had an incorrect answer range of 25%. McDavitt found that students did better on both high order and lower order questions when they were exposed to experiential teaching techniques. He believes these dramatic results are due, in part, to the natural learning process of all humans. McDavitt asserted that experiential learning is related to MI, in that, it exposes students to a variety of different learning styles.

Some of the limitations that McDavitt (1994) identified in his study were time and limited student involvement. Also, he addressed the limitations of the tool used and the charisma of the educator. McDavitt went on to state: “Assessing High Order Thought through the form of a partially standardized test is limiting and somewhat contradictory to the philosophy of Higher Order Thought” (p. 62).

Outdoor Education

Participation in outdoor education can notably increase students’ knowledge and enduring understanding of the scientific world around them while, at the same time, it develops awareness of the environmental problems around them (Bogner, 1999). Also, outdoor education can be used to bring all of the sciences together to help students make connections between them (Troy & Schwaab, 1982, as cited in Bogner). In addition, Bogner cited Leeming, Dwyer, Porter, and Cobern (1993), who found that generally the data are inconclusive, with concern to the effectiveness of outdoor education, due to limited testing or measurement methods. Bogner maintained that the real problem, in most cases, is with the instructor’s inability to make the connections between science and everyday life.

According to Slingsby (2006), outdoor education should be a vital part of the science classroom. He stated:

The purpose of teaching science to children at school is to introduce them to thinking like scientist, to using scientific knowledge and understanding to help them live their lives and to coping with new knowledge as it comes to light throughout the rest of their lives. To do so without ever leaving the classroom or laboratory, without going back through the wardrobe into the real world, is to miss a vital ingredient. (p. 51)

When classes are conducted outdoors, students are provided with the type of experiences that can increase their curiosity and desire to study science. According to

Finn, Maxwell, and Calver (2002), outdoor education is the missing ingredient in the promotion of an inquiry based science curriculum. Also, the use of outdoor education can be the means by which all science subjects are linked together. In addition, Gardner and Boix-Mansilla (1994) asserted that the use of an outdoor education program can span all subject matters in a single lesson. Mathematics, English, social issues, history, and of course science can be addressed in a single outdoor lesson plan on bacteria.

The Effectiveness of Outdoor Education

The Bogner Study

The use of hands-on learning in outdoor settings can increase a student's empathy for environmental and conservational issues (Bogner, 1999). Since the majority of learning occurs in the classroom, many students become removed from outdoors and become indifferent to environmental issues. Students would be benefited if educators held class outside and, thus, they could establish long lasting connections to the environment and increase students' awareness.

Bogner (1999) conducted his study in order to prove empirically that students stored information better and longer when hands on approaches were used. Also, Bogner wanted to measure the effect of outdoor program participation on students' awareness of environmental issues.

Method. To assess the effectiveness of the project, Bogner (1999) used a pretest/posttest. The pretest was administered to the participants in the form of a questionnaire, and the data were collected in a computer readable worksheet. The questionnaire was used to obtain students' perceptions on environmental issues and

beliefs. A unit plan on the migration behaviors of the swift was then implemented. Then, Bogner had the students take a posttest that contained questions on environmental issue feelings and content knowledge about the swift. The time between the pretest and posttest was approximately 5 weeks. The posttest questions included 6 questions about the program, 10 multiple choice questions concerning content knowledge, and 19 questions about environmental beliefs.

Results of the Bogner Study. Bogner (1999) concluded that students, who were given the opportunity to participate in this type of program again, would do so. The only finding that was statistically significant ($p < .01$) was whether students would participate in a biology workshop held after school. The responses to all other program questions were not significant.

In regard to environmental awareness, Bogner (1999) found that responses to all but 2 of the 19 questions were not significant. Students were more apt to be environmentally friendly by a very significant margin ($p < .01$), and they enjoyed nature by a significant margin ($p < .01$). Bogner asserted that this showed that some environmental awareness was developed in the students.

The findings from the Bogner (1999) study supported those of Troy and Schwaab (1982, as cited in Bogner); participation in outdoor education helps to bring all the sciences together for students, and it encourages active learners. Also, Bogner's findings supported those of Hendee (1972, as cited in Bogner), in that, participation in field trips can increase students' positive outlook on nature and encourage awareness.

Long Term Stream Monitoring

Overholt and MacKenzie (2005) looked at the effectiveness of a long term stream monitoring unit in a general science classroom. They maintained that the institution of such a program allows students to get out of the classroom and experience science as scientists do. Through the analysis of individual streams, students could address imbalances in the stream system and pose solutions.

Methods. Much like Bogner (1999), a questionnaire was used by Overholt and Mackenzie (2005), but in this case, both the instructor and students were surveyed. The study included both a pretest and a posttest to assess the effects of the intervention.

Results. Overholt and Mackenzie (2005) reported that 91% of the teachers reported that students were apt to ask questions about science topics. Also, 91% of the teachers allowed the students to share the information gained from the stream monitoring with the community. Of the students, 70% agreed that the community benefited from the information gained, also 70% agreed that stream monitoring helped them understand the information presented in class. Of the teachers, 64% reported that the stream monitoring helped to promote a sense of wonder among the students, which helped to further science inquiry.

Overholt and Mackenzie (2005) went on to state that:

Students are immersed in inquiry activities where the answer is unknown. They are asked to find explanations for problems in their community. They learn about how science works by designing their own experiments and collecting data using techniques and skills practiced by scientists. (p. 55)

Overholt and Mackenzie explained that this type of project helps students to integrate new information which fosters further curiosity.

Chapter Summary

As demonstrated in this review of literature, there are many means by which students learn science, and it is in the instructor's best interest to move the classroom outdoors. According to Slingsby (2006), "It [outdoor education] takes place in an unfamiliar environment away from home and school which inspires curiosity before it even starts" (p. 51). Slingsby explained that, in an age of declining proficiency in science, students need to be immersed in the environment where science can be observed first hand. Much like the old myth of Newton and the falling apple, science must be viewed in context in order to promote interest. According to Meichtry (2005), students do better on standardized tests and in all aspects of the educational system if exposed to a cooperative inquiry lesson plan that exposes students to a majority of multiple intelligences in an outdoor setting.

It is this researcher's opinion that the goal of science education should be to move the classroom outside in order to promote curiosity and help students understand science as a whole, not subject specific. When the classroom is moved outside, students will be exposed to a variety of leaning styles, and it is this researcher's hope that it will promote scientific curiosity. In Chapter 3, this researcher will detail the method used in order to reach this goal.

Chapter 3

METHOD

The purpose of this project was to develop a group of plans for teachers to use as a tool to teach science in outdoors. The plans consist of several outdoor laboratory experiments that can be completed in the typical 60 minute class period. The experiments utilized the nature that, typically, is found around a school. Trees, grass, and many other biological environments can be found around schools, and these laboratories will provide teachers with the means necessary to utilize these environments.

Target Audience

This project was designed for application with students in secondary schools, but should be easily configured to suit the needs of some simple science topics for the elementary grades. Educators in need of new ways to reach students, who are not typically interested in science, should adopt some of the plans in order to gain buy in from those students. Also, participation in these plans should engage those students who are scientifically inclined, and it could be used as a spring board for further investigation.

Goals and Procedures

The goal of this project was to develop a group of plans that educators can use to promote science engagement with their students by moving the classroom outdoors. The plans will be convenient for educators to implement and will require little to no

preparation time. It should be applicable for all schools despite their location and environment.

Peer Assessment

Assessment of these plans was obtained from four colleagues through informal feedback, recommendations, and suggestions for further research. Each colleague was given a copy of the plans and asked to evaluate them. They then provided the author with suggestions for continued revision.

Chapter Summary

There is a need to move classroom science away from lectures and worksheets toward hands on inquiry based learning. Students are naturally inquisitive about the world around them and the processes that occur. These plans addressed some of the questions raised by students and gave educators a tool to address this natural curiosity. This researcher used the knowledge gained from extensive research on outdoor education in order to produce plans that educators can implement simply. In Chapter 4, the plans are provided for educators. These lessons should be simple to understand and easily adapted for differing school environments. In Chapter 5, contributions and limitations of the outdoor plans are addressed.

Chapter 4

RESULTS

The purpose of this project was to develop a group of plans for teachers to use as a tool to teach science in outdoors. Educators, throughout the educational system, are always searching for ways to engage students in the subject matter. The goal of these plans is to show educators that science does not have to be confined to the classroom but instead, should take place in the environment from which it occurs. These experiments should typically take a single class period to complete and require no specific environmental conditions. It was the authors hope to provide a compilation plans that could be used throughout a semester in variety of science topics. Educators would pick and choose experiments that coincided with the topic that they were currently covering.

The plans are based on the template provided by Regis University. This template allows educators to organize material in an easy to follow manner. The following pages contain the lesson plans in no particular order along with a chapter summary.

Daily Experiment Plan 1: Distance Determined by Speed Lab

Duration	50 minutes
Learner Outcomes / Benchmarks	Students will understand the speed equation and how they can use different aspects of the equation to find different outcomes
Transition	<p>First 10 minutes: Instructor will cover the speed equation ($\text{Speed} = \text{Distance} / \text{Time}$)</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 2: Physical Science: Students know and understand common properties, forms, and changes in matter and energy. (Focus: Physics and Chemistry)</p> <ul style="list-style-type: none"> - 2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged. - describing and predicting chemical changes (for example, combustion, simple chemical reactions), and physical interactions of matter (for example, velocity, force, work, power), using word or symbolic equations <p>Math Standard:</p> <p>STANDARD 2: Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.</p> <ul style="list-style-type: none"> - Represent, describe, and analyze patterns and relationships using tables, graphs, verbal rules, and standard algebraic notations. <p>STANDARD 3: Students use data collection and analysis, statistics, and probability in problem solving situations and</p>

	<p>communicate the reasoning used in solving these problems</p> <p>Read and construct displays of data using appropriate techniques (for example, line graphs, circle graphs, scatter plots, box plots, stem-and leaf-plots) and appropriate technology.</p>	
Daily Materials Needed	Pencil, pen, notebook, stop watch, meter stick,	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students what speed is. Is speed constant or does it change? Where have they seen a measure of speed?	
Pre-Assessment	See anticipatory set	
	Differentiated Learning Needs	
Teaching the Lesson	<p>35 – 45 minutes: Students are going to find their speed over a certain distance at a constant pace. This pace should remain constant as they walk around the school to find the unknown distance. Since $\text{Speed} = \text{Distance} / \text{Time}$, if they know their speed (the previous found pace) and the time it takes to walk around the school they should be able to find the distance around the school.</p> <p>The instructor should pace out the distance around the school before hand. This will help when the class breaks down the data. Once the students have found their time around the school and have figured the distance the class should come back together to find a class average. In most cases this average will be very close to the distance found by the instructor.</p> <p>If the weather does not permit going outside this experiment can be done inside the school around a hallway or something equivalent.</p>	
	Differentiated Learning Needs	Students might have a difficult time understanding what a pace is and how to determine their speed in the initial parts of this lab. The instructor should give them a firm distance, such as 3 meters, to find their speed over.

Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Give the students the correct distance around the school and ask them to explain why they found a different distance.	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Distance Determined by Speed

I. Purpose:

To determine the distance around the hall by using your speed and time it takes you to walk the hall.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Meter Stick

Stop watch

B. Protocol:

1. Determine your speed by walking a certain distance at a constant pace. Record your time to the nearest second and determine your meters per second
2. Walk at a constant pace around the school recording your time.
3. Using your speed equation, determine the distance around the school.

IV. Data/Results:

A. Calculations: $\text{Speed} = \frac{\text{Distance}}{\text{time}}$

B. Tables:

	Distance (meters)	Time (seconds)	Speed (m/sec)
Certain Distance			
Around the Hall			
Around the Hall 2			

C. Qualitative and Quantitative Questions

1. How does the average speed relate to the distance covered and the time taken for travel?
2. Given your average speed for a certain distance, how could you determine the distance around the school?
3. What is the distance around the school?
4. How far can a dragster go in 30 seconds if the average speed of the dragster is .7 mile per second?

V. Analysis:

1. Explain what happened in the experiment.

2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. Explain how speed is determined.
2. Explain why everyone did not get the same value for the distance around the hall.
3. Explain how you can determine your average speed on a trip if you go 360 mile is six hours.

Daily Experiment Plan 2: How Clean is the Water Around Your School?

Duration	50 minutes – This lesson should be completed after a rain.
Learner Outcomes / Benchmarks	Students will understand how pollution around the school can affect the water they find.
Transition	<p>First 10 minutes: The instructor will explain the difference between ground water and surface water and which type the school has rights to. What type of water does the neighborhood around the school use?</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 2: Physical Science: Students know and understand common properties, forms, and changes in matter and energy. (Focus: Physics and Chemistry)</p> <ul style="list-style-type: none"> - 2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged. - describing and predicting chemical changes (for example, combustion, simple chemical reactions), and physical interactions of matter (for example, velocity, force, work, power), using word or symbolic equations. <p>Math Standard:</p> <p>STANDARD 2: Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.</p> <ul style="list-style-type: none"> - Represent, describe, and analyze patterns and relationships using tables, graphs, verbal rules, and standard algebraic notations.

Daily Materials Needed	Pencil, pen, notebook, water test kit (this test kit can be purchased from your schools lab equipment supplier), water samples collected from around the school.	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students where they believe their drinking water comes from. You might be able to surprise them. Then ask them if they believe the water to be relatively clean before it goes to the processing plant or is it typically dirty. How clean do they think the water around the school is?	
Pre-Assessment	See anticipatory set	
	Differentiated Learning Needs	
Teaching the Lesson	35 – 45 minutes: Students will go outside to determine the cleanliness of the water around the school. Point out specific places that they should be able to find water and how specifically they should collect the water. Background information regarding how to use the water test kit should be covered in detail.	
	Differentiated Learning Needs	Instructor should spend the majority of the time with students needing help. The test can be confusing and could use some further explanation.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Talk about some of the pollutants found in the water and some possible sources for these pollutants.	

Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

How Clean Is the Water Around Your School?

I. Purpose:

To determine the cleanliness of the water around your school after a rain.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Water samples from around your school

Water test kit (kit should include test tubes, eye droppers, test strips)

B. Protocol:

1. Collect several water samples from different areas around your school after a rain has occurred.
2. Create a data table in which to record the results of your test. Your data table could look like the one below.
3. Complete each test as directed by your water test kit instructions.
4. Record the results of your tests

IV. Data/Results:

A. Calculations:

B. Table: Create a table using your data collected from the test results.

	Sample 1	Sample 2	Sample 3	Sample 4
DO				
pH				
Nitrates				
Phosphates				
Fecal coliform				

C. Qualitative and Quantitative Questions

1. Describe what each of your test means.
2. Describe the overall quality of your water samples.
3. Would you drink your water sample? Why?
4. Would you swim in the place where you collected your water sample? Why?
5. How is the body of water you tested used right now? You may need to do some research to answer this question.

6. Do you think the current use is the best use of the water? Why or why not?
7. How much do you trust the results of your work? Explain your response.

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. If the water around your school is contaminated where do you think the contamination is coming from? How could you stop this contamination from occurring?

Daily Experiment Plan 3: Identifying Solid Materials in Air

Duration	50 minutes
Learner Outcomes / Benchmarks	Students will understand that the air we breath is full of solids and can be concentrated in different areas around the school.
Transition	<p>First 10 minutes: Instructor will lecture on air quality, specifically the presence of solids in the air. The instructor might give some specific places around to the school to collect samples.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.2: Students know and understand the general characteristics of the atmosphere and fundamental processes of weather. <p>Math Standard:</p> <p>STANDARD 2: Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.</p> <ul style="list-style-type: none"> - Represent, describe, and analyze patterns and relationships using tables, graphs, verbal rules, and standard algebraic notations. <p>STANDARD 3: Students use data collection and analysis, statistics, and probability in problem solving situations and communicate the reasoning used in solving these problems</p>

	<ul style="list-style-type: none"> - Read and construct displays of data using appropriate techniques (for example, line graphs, circle graphs, scatter plots, box plots, stem-and leaf-plots) and appropriate technology.
Daily Materials Needed	Pencil, pen, notebook, glass microscope slides, petroleum jelly, balance, wax crayon, hand lens, microscope
	Differentiated Learning Needs Same materials as above
Anticipatory Set	5 minutes: Ask students what pollutants might be in the air and where would be the best place to find the most pollutants.
Pre-Assessment	See anticipatory set
	Differentiated Learning Needs
Teaching the Lesson	35 – 45 minutes: Students will go outside to place their slides with petroleum jelly on them to capture solids in the atmosphere. The instructor should keep a close watch on the students so they do not go into dangerous areas. Some good places to find solids in the atmosphere around schools would be: maintenance areas, areas where the climate control system dumps air, in the parking lot, by a busy intersection or street, and the front door of the school.
	Differentiated Learning Needs Students should be helped with the math section of the lab as well as selecting locations to place the slides.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.
	Differentiated Learning Needs Students should be given extra help and more one-on-one attention
Post-	The lab write up will be the post assessment

Assessment	Differentiated Learning Needs	Same as above
Closure	Ask the students what kinds of pollutants were found? Why were these pollutants found in this particular place? Guide discussion to find the answer.	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Identifying Solid Materials in Air

I. Purpose:

To separate and analyze some solid materials that pollute the air and to determine the rate at which these pollutants are deposited around your school.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

glass microscope slides	Petroleum jelly	Balance
microscope	hand lens	wax crayon

B. Protocol:

1. Choose sites inside and outside your classroom where you think there may be various amounts of solids falling from the air. Choose six places where the materials will be varied both in the total amount and the types of materials. As you pick each location, estimate the type and amount of material that you think might be deposited. Check these estimates against your observations. Cover seven glass slides with petroleum jelly. The seventh slide will be your control. It will be left in a safe area in the classroom. Write the location of the slide on the bottom of the slide with a wax pencil.
2. After preparing the slides, measure the mass of each on the balance. The estimate of the amount of solids falling to earth depends on the precision of your measurement of the mass. Be as accurate as possible. Record each of the masses. Be careful not to touch the petroleum jelly.
3. Place each slide in the site written on the bottom of the slide. The slides will be left for seven days. Each day, visit the location of each slide and record any day-to-day differences. Estimate the amount of materials that you think are accumulating. Do any sites seem to be accumulating more solids than others?
4. At the end of the seven days, retrieve the slides, again being careful not to disturb the surface. Again measure the mass of the slides and record the measurement for each location. Weigh the control as well to see if it changed.

- Using the microscope or hand lens, view the slides, starting with the control. Since the control was placed in a relatively dust-free area, it should show very little material deposited on it. Try to determine the various types of solids.

IV. Data/Results:

A. Calculations:

$$\frac{\text{Number of kilograms on six slides}}{\text{Area of six slides}} = \frac{\text{number of kilograms on 1 kilometer}^2}{10,000,000,000}$$

B. Table: Fill in the chart below.

Collection Point and Location	Initial Mass	Final Mass	Difference
Control			
Site 1:			
Site 2:			
Site 3:			
Site 4:			
Site 5:			
Site 6:			

C. Qualitative and Quantitative Questions

- What types of day-to-day changes did you notice?
- What types of particles can you observe on the slides using a hand lens or microscope?
- Determine the number of kilograms of solids falling on each square kilometer of land around your school per week in the following way. Determine the total amount of material accumulated on your six slides in kilograms. Determine the area of one slide in square centimeters and multiply your answer by six. Use the equation given in the Calculations section of your lab. A square kilometer contains 10,000,000,000 square centimeters.

V. Analysis:

- Explain what happened in the experiment.
- Tell why you got the results you did.
- What experimental errors were there and what effect did each have?
- What impact does it have on the world-uses or problems?

5. What questions does this experiment generate for future research?

VI. Conclusion:

1. Did the areas where you thought the solids would accumulate in the greater quantity do so? Explain the cause of the great accumulation.

Daily Experiment Plan 4: Measuring the Size of the Sun

Duration	50 minutes
Learner Outcomes / Benchmarks	Students will understand how to measure things that are very far away using mathematical principles
Transition	<p>First 10 minutes: Instructor will lecture on how we can use the ratio of the distance to an object to figure out the size of the object.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.4: Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored. <p>Math Standard:</p> <p>STANDARD 2: Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.</p> <ul style="list-style-type: none"> - Represent, describe, and analyze patterns and relationships using tables, graphs, verbal rules, and standard algebraic notations. <p>STANDARD 3: Students use data collection and analysis, statistics, and probability in problem solving situations and communicate the reasoning used in solving these problems</p>

	<ul style="list-style-type: none"> - Read and construct displays of data using appropriate techniques (for example, line graphs, circle graphs, scatter plots, box plots, stem-and leaf-plots) and appropriate technology. 	
Daily Materials Needed	Pencil, pen, notebook, meter stick, lens holder, screen holder, convex lenses, cardboard screen, ring stand, Burette clamp, test-tube clamp (these materials should be available through your schools lab equipment suppliers)	
	<table border="1"> <tr> <td>Differentiated Learning Needs</td> <td>Same materials as above</td> </tr> </table>	Differentiated Learning Needs
Differentiated Learning Needs	Same materials as above	
Anticipatory Set	5 minutes: Ask students to think about how ancient cultures might figure out the size of the sun. What is <i>scale</i> and how can we use it to determine the actual size of an object.	
Pre-Assessment	See anticipatory set	
	<table border="1"> <tr> <td>Differentiated Learning Needs</td> <td></td> </tr> </table>	Differentiated Learning Needs
Differentiated Learning Needs		
Teaching the Lesson	35 – 45 minutes: It is important to build a model of the lab set up. Make sure you have this done before the start of class for it can take some time to figure out. It is also important for the instructor to explain what a ratio is and how we use them. Have the students build their set up in the classroom before going outside to do the experiment. Make sure that students understand that looking directly at the sun through the lens could cause blindness. The set-ups might take some tinkering with to work so, it is important for the instructor to have a useable set-up as a back up.	
	<table border="1"> <tr> <td>Differentiated Learning Needs</td> <td>Students should be helped with the math section of the lab as well as building the set-up.</td> </tr> </table>	Differentiated Learning Needs
Differentiated Learning Needs	Students should be helped with the math section of the lab as well as building the set-up.	
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.	

	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Ask the students what the size of the sun is. Take the average of all of the sizes and this number should be pretty close to the actual size of the sun. Make sure to inform the students what the actual size is.	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Measuring the Size of the Sun

I. Purpose:

To determine the size of the sun.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Meter stick	lens holder	screen holder
convex lenses	cardboard screen	ring stand
Burette clamp	test-tube clamp	

B. Protocol:

1. Place the test-tube clamp on the ring stand and clamp the meter stick into the test-tube clamp. Place the lens holder at one end with the lens in place. At the opposite end of the meter stick set up the screen and screen holder.
2. Bring the setup outside and aim it at the sun. **It is important not to look at the sun directly.**
3. Once the setup is aligned with the sun's rays, move the screen toward the lens until a sharp clear, disk-shaped image of the sun is visible on the screen. Determine the distance from the lens to the screen. Carefully draw a pencil line on the edge of the image. Your answers to the following questions will depend on how carefully this is done.
4. Move the lens 5 to 10 cm toward the screen and shift the screen slightly to the left. Then move screen away from the lens until the image is again sharp and clear. Again record the distance and draw a circle around the image. Repeat this procedure a third time.
5. Measure the size of each of the images you drew on the screen.

IV. Data/Results:

A. **Calculations:** $\frac{\text{actual distance to the sun}}{\text{Lens-to-image distance}} = \frac{\text{actual diameter of the sun}}{\text{diameter of the image}}$

B. **Drawing:** Your sketches of the sun should be stapled and turned in with your lab write up.

C. Qualitative and Quantitative Questions

1. What is the average distance to the image?
2. What is the average size of the image?
3. The distance to the sun has been determined to be 150,000,000 km. Using this value, calculate the diameter of the sun. Remember the ratio of the distance is equal to the ratio of the diameters. Use the equation in the Calculations section.
4. How would you determine the distance to a planet if you knew its diameter?

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. What would be the limitations on using this method to calculate the size of other heavenly bodies?

Daily Experiment Plan 5: Observations of a Sample of Earth Material

Duration	50 minutes	
Learner Outcomes / Benchmarks	Students will be able to make accurate observations of materials.	
Transition	<p>First 10 minutes: Instructor will lecture on how to make accurate observations and how to use their 5 senses to help.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>	
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.1: Students know and understand the composition of Earth, its history, and the natural processes that shape it. 	
Daily Materials Needed	Pencil, pen, notebook, spoon, 20 to 30 grams of dry soil from around the school, hand lens, microscope, graph paper, toothpick, watch glass, eyedropper, and safety goggles.	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students what they think might be found in the soil around the school. How would they prove that?	
Pre-Assessment	See anticipatory set	
	Differentiated Learning Needs	

Teaching the Lesson	35 – 45 minutes: It is important for the instructor to be very stringent on their expectations of the drawings. Since this experiment would typically occur at the beginning, of course students need to become accustomed to the high expectations of the instructor. Do not accept a “B” or “C” for a drawing but only accept an A piece of work. It might be useful to plant some materials in the areas that students would take sample from. Maybe place some iron fillings, salt, or any other material that is easy to identify by its physical characteristics. The instructor might want to have some samples of “A” drawings available for students to observe.	
	Differentiated Learning Needs	Students drawing should be graded less stringently and certain aspects or characteristics should be pointed out by the instructor.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Ask the students what materials they found in the soil around the school. How did those materials get there? What physical characteristics of the material did they use to prove their claim?	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Observations of a Sample of Earth Material

I. Purpose:

The purpose of this lab is to make observations of a sample of soil.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Plastic spoon or scoop	toothpick	watch glass
50-mL beaker	Eyedropper	20-30 grams of soil
safety goggles	hand lens	graph paper

B. Protocol:

1. Put on your safety goggles.
2. Obtain a sample of some soil taken from the area around your school building. The soil sample should be dry. Spread approximately half of the sample on the graph paper so you can observe the lines on the paper through the sample.
3. Place the rest of the sample in the palm of your hand and rub it to determine how it feels. Let it slip between your fingers onto the graph paper.
4. Place approximately half the sample in the watch glass and add water, one drop at a time. Watch how the sample changes. Can you notice any odor?
5. Look at the sample using the hand lens and try to observe the different constituents in the sample.
6. Keep the sample at your table and answer the questions in section C of your Data/Results.

IV. Data/Results:

A. Calculations:

B. Drawing: Draw a sketch of the sample as it appears when magnified.

C. Qualitative and Quantitative Questions

1. What did you notice about the general appearance of the soil sample when you first obtained it?
2. What did the sample feel like? Was it soft or gritty? Were there some particular particles that were noticeable to the touch?
3. Using the graph paper as a background, estimate the range in size of the particles that make up the soil.
4. By observing the sample, determine information about the location from which it was taken or its origin.

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. What can you conclude about the material found?

Daily Experiment Plan 6: The Refracting Telescope

Duration	50 minutes
Learner Outcomes / Benchmarks	Students will understand the workings of a refracting telescope and how light travels through it.
Transition	<p>First 10 minutes: Instructor will lecture on how light travels and how light can be refracted. It might be helpful to show light being refracted through water. Most students will have noticed this while swimming or looking through a bowl filled with water.</p> <p>5 minutes: Instructor will explain the lab to the students before starting construction of the telescope.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.4: Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored. <p>STANDARD 3: Students use data collection and analysis, statistics, and probability in problem solving situations and communicate the reasoning used in solving these problems</p> <ul style="list-style-type: none"> - Read and construct displays of data using appropriate techniques (for example, line graphs, circle graphs, scatter plots, box plots, stem-and leaf-plots) and appropriate technology.
Daily Materials Needed	Pencil, pen, notebook, meter stick, lens holder, screen holder, convex lenses, cardboard screen, ring stand, Burette clamp (your schools lab equipment supplier should be able to provide the equipment)

	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students how the majority of astronomy is done. Explain that the majority of astronomy is done through telescopes and the data gathered from these telescopes are the foundation of the science.	
Pre-Assessment	See anticipatory set	
	Differentiated Learning Needs	
Teaching the Lesson	35 – 45 minutes: It is important to build a model of the lab set up. Make sure you have this done before the start of class for it can take some time to figure out. Have the students build their telescope in the classroom before going outside to view near by objects. The instructor should check the telescope before the venture outside. The construction of the telescope and the knowledge gained about light refraction is the key to this experiment. Looking at a near by object and observing the difference when the telescope is turned around can all be done at school. If the instructor wishes he or she can check the equipment out to the students to take home and observe the moon. It is important that the instructor keeps track of checked out equipment because of the expense. The students should look at a relatively easy object to find in the night sky such as the moon.	
	Differentiated Learning Needs	Students should be helped with the construction and the light refraction concept.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students that way the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above

Closure	Ask the students how their telescope worked. If the instructor has the means, the students should be shown the images they were looking at with a professional telescope.	
Independent Practice	The lab write up will be the independent practice and the optional night viewing with the telescope.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

The Refracting Telescope

I. Purpose:

To learn the component of a simple refracting telescope by constructing one.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Meter stick	lens holder	screen holder
two convex lenses	cardboard screen with translucent center	
ring stand	Burette clamp	

B. Protocol:

1. To find the focal length of each of the lenses, place on lens in the lens holder and set it on the meter stick. Set the screen on its holder near the opposite end of the meter stick. Place the meter stick perpendicular to the classroom windows. Move the screen toward the lens until an object at least 100 meters away from the lens is focused to form a sharp image on the screen. Measure the distance from the lens to the screen and make a note of the length.
2. Repeat step 1 for the second lens.
3. To set up a refracting telescope, place the lens with the longer focal length near one end of the meter stick and focus an image of the window on the screen. Mount the second lens on the opposite side of the screen from the first lens, and slide it along the meter stick until you can see a clear image of the window on the screen. Measure the distance from the screen to the second lens.
4. Now reverse the position of the two lenses. Note what happens to the image.

IV. Data/Results:

A. Calculations:

B. Drawing: Draw a sketch of the same image with the two different lens set ups.

C. Qualitative and Quantitative Questions

1. What is the focal length of each of the two lenses that you were given?
2. How does the measured distance in step 2 compare to the focal length of the lenses?
3. What changes does the eyepiece make in the appearance of the image?
4. What happens to the image when the lenses are reversed and the shorter focal-length lens is closer to the object being viewed? Is this a better arrangement?
5. When the eyepiece of a telescope is removed and a camera is put in its place, where should the film be located?
6. What should the relative focal length of the objective and eyepiece lenses be in a refracting telescope?
7. What is the function of the eyepiece lens?

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. Build a telescope on your own at home. Your teacher should check out lenses and equipment to you. What features can you see on the moon? What would make a better telescope?

Daily Experiment Plan 7: Stair Power Lab

Duration	50 minutes
Learner Outcomes / Benchmarks	Students will understand how the power equation can be used to determine their power running up stairs.
Transition	<p>First 10 minutes: Instructor will cover the power equation (Power = Work x Time). Prior to this lab students need to have a firm grasp of the Work equation (Work = Force x Distance) and the Force equation (Force = Mass x 9.8 m/s²) because they are integral parts of this lab. Students need to understand the dynamic relationship between the power and work equation in order to be successful in this lab.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 2: Physical Science: Students know and understand common properties, forms, and changes in matter and energy. (Focus: Physics and Chemistry)</p> <ul style="list-style-type: none"> - 2.3 Students understand that interactions can produce changes in a system, although the total quantities of matter and energy remain unchanged. - describing and predicting chemical changes (for example, combustion, simple chemical reactions), and physical interactions of matter (for example, velocity, force, work, power), using word or symbolic equations <p>Math Standard:</p> <p>STANDARD 2: Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.</p> <ul style="list-style-type: none"> - Represent, describe, and analyze patterns and

	<p>relationships using tables, graphs, verbal rules, and standard algebraic notations.</p> <p>STANDARD 3: Students use data collection and analysis, statistics, and probability in problem solving situations and communicate the reasoning used in solving these problems</p> <p>Read and construct displays of data using appropriate techniques (for example, line graphs, circle graphs, scatter plots, box plots, stem-and leaf-plots) and appropriate technology.</p>	
Daily Materials Needed	Pencil, pen, notebook, stop watch, meter stick,	
	<table border="1"> <tr> <td>Differentiated Learning Needs</td> <td>Same materials as above</td> </tr> </table>	Differentiated Learning Needs
Differentiated Learning Needs	Same materials as above	
Anticipatory Set	5 minutes: Ask students what power means. Do they display more power when they are running or walking and why.	
Pre-Assessment	See anticipatory set	
	<table border="1"> <tr> <td>Differentiated Learning Needs</td> <td></td> </tr> </table>	Differentiated Learning Needs
Differentiated Learning Needs		
Teaching the Lesson	<p>35 – 45 minutes: The first step for the student is weigh themselves. This might be uncomfortable for some students and if they do feel uncomfortable it is ok for the student to ballpark their weight.</p> <p>Students will then go outside to a set of stairs that are usually found around a school. If no stairs can be found outside, some interior stairs will work fine if the students can be somewhat quiet. Students need to understand that the distance they are going to be measuring is the distance they travel vertically up the stairs. They need not measure the whole staircase but can measure the height of one stair and then multiply that height by the total number of stairs. The instructor should measure the staircase on his/her own; that way the true distance up the stairs is known. The students might come up with some crazy numbers because they forgot to convert their measurements from centimeters to meters.</p> <p>The power equation will not work unless the students first find the amount of work it needed to ascend the stairs. Make this clear to them or they will struggle.</p>	

	Differentiated Learning Needs	Students should be helped with the math portion of this lab. The equations within equations can be difficult to grasp and some explaining will be needed.
Guided Practice / Instructional Strategies		The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students to insure the lab is done correctly.
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment		The lab write up will be the post assessment
	Differentiated Learning Needs	Same as above
Closure		Give the students the power taken by you to run the stairs and ask why your results differed from theirs. In most case the weight of the instructor is great and thus takes more power to run the stairs.
Independent Practice		The lab write up will be the independent practice.
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Stair Power Lab

I. Purpose:

The purpose of this lab is to investigate the power that can be produced by running up a set of stairs

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

Meter Stick

Stop watch

Stairs

B. Protocol:

1. Weigh yourself in pounds and convert to Newton's. Remember that your weight = mass x 9.8 m/s^2 (acceleration due to gravity), so just change pounds to Newton's. 100 lbs. = 100 N
2. Run as fast as you can up a set of stairs while your partner times you in seconds.
3. Walk up the set of stairs while your partner times you.
4. Lastly, proceed up the stairs at a medium pace.
5. Measure the height of one stair and then count the number of stairs in the whole staircase to determine the total height of the stairs.
6. Students must first figure out their work in order to find their power.
7. Using your power equation, determine how much power you produce at each speed.

IV. Data/Results:

A. Calculations: Work = Force x Distance and Power = Work x Time

B. Tables:

	Running	Medium	Walking
Height in Meters			
Force (N)			
Time (s)			
Power (Watts)			

C. Qualitative and Quantitative Questions

1. How does the power change when you ascend up the stairs at different speeds?
2. Find someone with a similar time as you. Was your power the same? Explain?

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. Explain how power is determined.
2. Explain why everyone did not get the same power.

Daily Experiment Plan 8: Temperatures in a Microclimate

Duration	50 minutes	
Learner Outcomes / Benchmarks	Students will be able to make accurate temperature readings in a microclimate.	
Transition	<p>First 10 minutes: Instructor will lecture on how to take an accurate temperature reading using a thermometer.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>	
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.2: Students know and understand the general characteristics of the atmosphere and fundamental processes of weather. 	
Daily Materials Needed	Pencil, pen, notebook, meter stick, 100 meters of string, stakes, hammer, thermometer, and masking tape	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students if they believe temperature can vary within a meter. If they do believe that this can happen have them explain.	
Pre-Assessment	See anticipatory set	
	Differentiated Learning Needs	

Teaching the Lesson	35 – 45 minutes: This lab can be very time consuming if the grid pattern is not explained by the instructor well. It might be beneficial for the instructor to set up the grid before the class. The instructor should stress the importance of making an accurate temperature reading. The instructor should do some spot checks to make sure they are reading it correctly. Once back in the classroom compare the readings and discuss some possible reasons for the differing temperatures.	
	Differentiated Learning Needs	Students having difficulties reading a thermometer should be given attention and help.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students so that the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Ask the students to describe a scenario where the temperatures would be all the same and a scenario where there would be drastic changes in temperature.	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Temperatures in a Microclimate

I. Purpose:

To observe the variation in temperature in a small area as with changes in elevation.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

meter stick	100 meters of string	stakes
masking tape	hammer	thermometer

B. Protocol:

1. Establish a grid pattern of 6 meters. Mark your starting point and each meter for six meters. Label each of these points 1 through 6. Do the same at right angles to your first line. Starting with the same point numbered 1, mark the new line A through F. This gives you a means to identify each point. Set the grid in a position where there is a boundary between warm and cool places. Examples are next to the school building. Shaded and sunlit area, and along the edge of a parking lot.
2. Using the strings and stakes, or masking tape if the surface allows, mark all of the intersection points. A member of the class will stand at each of the points and record the temperature.
3. Once you are at your position on the grid, face north and hold your thermometer by the top at eye level. The thermometer should be in your shadow. Do not handle the bulb of the thermometer. Wait approximately three minutes to allow the thermometer to reach the air temperature. When your teacher gives a signal, record the temperature at eye level.
4. Place the thermometer on the ground between your feet with the bulb pointing north. The thermometer would again be in your shadow. Again wait for three minutes. When your teacher gives a signal, record the temperature of the thermometer.
5. Once you return to the classroom, each person in turn, starting with point A1, can read off the two temperatures he or she recorded until everyone has all the values.

IV. Data/Results:

A. Calculations:

B. Table: Fill in the two grids with the temperatures recorded by your class. Not all the spots will be filled in unless there are 36 students.

Eye Level

	1	2	3	4	5	6
A						
B						
C						
D						
E						
F						

Ground Level

	1	2	3	4	5	6
A						
B						
C						
D						
E						
F						

C. Qualitative and Quantitative Questions

1. Suppose the lines on your grid were only 5 to 10 centimeters apart. How would you expect the temperatures to vary?
2. Why should the thermometers be shielded from direct sunlight?
3. How would the wind vary the readings of the thermometers?
4. Why are there differences between the readings at ground level and at eye level?
5. What conditions could affect the temperature variation in the area you just measured?

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?

4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. How might microclimate affect different areas of a city? Should certain business be built in different areas of a city?

Daily Experiment Plan 9: Weathering Around Us

Duration	50 minutes	
Learner Outcomes / Benchmarks	Students will be able to understand that weathering is occurring around us all the time and in some instances can be a rather quick process.	
Transition	<p>First 10 minutes: Instructor will lecture on weathering and remind the students of the different types of weathering. The instructor should also inform the students on how to use a micrometer correctly.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>	
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.1: Students know and understand the composition of Earth, its history, and the natural processes that shape it. 	
Daily Materials Needed	Pencil, pen, notebook, metric ruler, micrometer, sandpaper, new piece of glass, old piece of glass, rock hammer, hand lens, and safety goggles.	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students what they think might weather more quickly. The instructor can come up with his or her own examples. (I might use limestone and granite)	
Pre-	See anticipatory set	

Assessment	Differentiated Learning Needs	
Teaching the Lesson	35 – 45 minutes: It is important for the instructor to explain the safety concerns with using a rock hammer and the delicacy needed to use a micrometer. If the students are not mature enough, I would recommend skipping this lab or skipping portions of this lab. Once outside the instructor should direct the students to what is ok to hammer on and what is not ok. Also the instructor should strategically place the piece of glass so that the students will be able to locate them. Also if a statue or monument is not close to the school, the school building itself will serve the purpose.	
	Differentiated Learning Needs	Students might need help in reading the micrometer correctly and handling of the glass. The instructor should be mindful of the needs of the students and appropriate action taken to help them.
Guided Practice / Instructional Strategies	The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students, to insure the lab is done correctly.	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Ask the students what they found. Ask them to explain the different amounts of weathering on different materials. Then explain to them acid rain and things that can affect the weathering timeline.	
Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

Weathering Around Us

I. Purpose:

To observe that weathering is a slow process that occurs all around us.

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

metric Ruler	micrometer	sandpaper
new piece of glass	old piece of glass	rock hammer
safety goggles	hand lens	

B. Protocol:

1. Visit the exterior of the school. Look for things that show that weathering has occurred. Make a list of things that are observed.
2. Collect a rock which has been exposed to the weather or chip a piece of rock from a nearby outcrop and bring the sample back to the classroom.
3. Find a piece of exposed metal such as steel or copper. Measure its thickness with the micrometer. Then use the sandpaper and remove the rust or oxidation surface and remeasure the thickness.
4. Visit a nearby statue or monument. Look for spots on the statue or monument where there is a difference in the appearance of the surface due to weathering. Measure the difference in the depth of the letters to determine how much rock was weathered.
5. Use the micrometer to measure the thickness of a piece of old glass found around the school. Compare the thickness to that of the new piece of glass.

IV. Data/Results:

A. Calculations:

- #### B. Drawing:
- Draw a sketch of the piece of old glass when examined through the hand lens.

C. Qualitative and Quantitative Questions

1. What things did you notice in the area around the school building that were evidence of weathering?
2. Metal surfaces oxidize and become thicker by the addition of oxygen atoms. How much thicker did the metal's surface become?
3. Very old window glass is uneven and measurements of each side may show some variation. As a piece of glass sits in the sash, the glass slowly flows downward due to gravity. If you are lucky enough to have found a piece of glass that shows a small increase in thickness on one side. Compare the variation in thickness of the old glass with the new.
4. Look at the piece of rock that you brought into the classroom. If you have not broken the rock using the rock hammer, do so now. Can you determine how deeply weathered the rock is? Use your ruler and measure the depth of the weathered surface and record that measurement.

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. Estimate the ages of all of the materials gathered and give an explanation for that estimate.
2. Did you find that different materials weather at different rates? What were those estimated rates?

Daily Experiment Plan 10: When is Local Noon?

Duration	50 minutes	
Learner Outcomes / Benchmarks	Students will be able to determine that local solar noon might be different from local clock noon and why.	
Transition	<p>First 10 minutes: Instructor will lecture on what noon really is and how we can determine it. It also might be useful to explain how ancient cultures determined noon.</p> <p>5 minutes: Instructor will explain the lab to the students before continuing outside.</p> <p>If the instructor wants the students to copy down the lab in a notebook, more time will be needed.</p>	
Standards	<p>Science Standards Addressed</p> <p>STANDARD 1: Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.</p> <p>STANDARD 4: Earth and Space Science: Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space. (Focus: Geology, Meteorology, Astronomy, Oceanography)</p> <ul style="list-style-type: none"> - 4.4: Students know the structure of the solar system, composition and interactions of objects in the universe, and how space is explored 	
Daily Materials Needed	Pencil, pen, notebook, bubble level, nail 5 cm, magnetic compass, piece of plywood 30 cm by 45 cm, clock, protractor, tape, and a hole puncher	
	Differentiated Learning Needs	Same materials as above
Anticipatory Set	5 minutes: Ask students how ancient cultures determined when noon was. What is a sun dial?	
Pre-	See anticipatory set	

Assessment	Differentiated Learning Needs	
Teaching the Lesson	<p>35 – 45 minutes: The construction of the sun dial can be dangerous and time consuming. The instructor might want to consider building the sun dials before class in order to prevent accidents and save time.</p> <p>The main difficulty with this lab will be the drawings at the end and the time needed to complete this lab. It might be useful to have different classes complete different aspects of this lab and then combine their results later.</p> <p>The instructor should complete this lab prior to class in order to have an exemplar of the drawing. Have the students read the lab carefully and complete each sentence in the protocol one at a time. Let them struggle a little with the wording of the lab and the protocol. If they are not getting it, do an example on the board, step by step as they complete their own work following your lead.</p> <p>Some students will not get this lab altogether and the maturity level and comprehension level of the students should be taken into consideration when doing this lab.</p>	
	Differentiated Learning Needs	Go through the protocol step by step with the students and give them tips on where to place the compass. It might be helpful to have one of your accelerated students pair with a special needs student.
Guided Practice / Instructional Strategies	<p>The process of doing the lab will be the guided practice. Instructors should be present while the students are doing the lab and should give feedback to the students. Instructors should help the students to insure the lab is done correctly.</p>	
	Differentiated Learning Needs	Students should be given extra help and more one-on-one attention
Post-Assessment	The lab write up will be the post assessment	
	Differentiated Learning Needs	Same as above
Closure	Ask the students if they found a difference in time between local solar noon and local time noon. If so why did they find a difference?	

Independent Practice	The lab write up will be the independent practice.	
	Differentiated Learning Needs	Students will receive extra time to complete the assignment
Summarize, Evaluate & Reflect		

When is Local Noon?

I. Purpose:

To measure the angle of the sun, how solar time differs from clock time, and the direction of true north

A. Problem

B. Background

II. Hypothesis:

III. Procedure:

A. Materials:

bubble level	piece of plywood 30 cm by 45 cm	
5cm nail	clock or watch	
plain paper	protractor	
magnetic compass	tape	paper punch

B. Protocol:

1. Tape two corners of a long edge of a sheet of plain paper to the board. Punch a hole as close to the center of the edge of the paper as possible. Set the nail on the board so it comes up through the hole you punched in the paper. Tape the head of the nail to the board so it does not move. Then tape the other corners of the paper.
2. Set the experiment up outside between 10 a.m. and 2 p.m. The board needs to be level. Check both the long and short directions of the board when leveling. Do not move the board at any time. Use the magnetic compass to align the board to north and mark north on the paper.
3. Starting at a 10:30 a.m., mark the position of the tip of the nail. Write the exact time next to the mark. Continue this procedure in ten minute intervals until 2:00 p.m.
4. Bring the board into the classroom when all the points are plotted. Do not disassemble the board. Set the straightedge with one end on the first point and let it touch but not rest on the nail. Measure the angle that was produced by the nail with the protractor and write it down next to the time. Do the same for the rest of the points.
5. Lift the tape from the bottom two corners and remove the nail. Retape the paper to the board. Connect the shadow point with a smooth line. Not a straight line.

6. Find where the shortest shadow line is located. You can estimate its position by measuring the distance from the center of the punched hole to the line. There is a geometric means to locate the shortest line.
7. Use a drafting compass set the point in the center of the punched hole. Open the compass so it reaches close to both ends. Move the compass point to one of the intersections, and make a quarter circle opposite the punched hole. Do the same from the other intersection. The two quarter circles should cross. Connect the center of the punched hole to the intersection of the quarter circles. This line should lie on the shortest shadow line.
8. Estimate the time when this shortest shadow occurred from the times you wrote on the sheet. Estimate what the angle of the sun was at the time as well.

IV. Data/Results:

A. Calculations:

B. Drawing: Your sketches of the sun path should be stapled and turned in with your lab write up.

C. Qualitative and Quantitative Questions

1. What was the date of the experiment? Was daylight saving time in effect?
2. What was the angle of the sun when you started and ended the experiment? What was the greatest angle?
3. What is the shape of your nail line if you observe it from the nail's position?
4. The shortest shadow line points toward the north. Extend your shortest shadow line and the line showing the direction of magnetic north. What is the angle between the two north-pointing ends of the lines?

V. Analysis:

1. Explain what happened in the experiment.
2. Tell why you got the results you did.
3. What experimental errors were there and what effect did each have?
4. What impact does it have on the world-uses or problems?
5. What questions does this experiment generate for future research?

VI. Conclusion:

1. What was the time difference between your estimate of the time at the shortest shadow and noon? Why were the times different?

Chapter Summary

The purpose of this chapter was to present 10 labs that can be complete outside. The project combined skills both used in math and science. The labs require a certain maturity level in students and strict supervision by the instructor. The goal of this project was to present instructors with an outdoor option for teaching science that should increase buy in from the students. The following chapter, Chapter 5, will provide a discussion about the limitations of the labs, objectives achieved, evaluations of the labs and recommendations for future growth within the project. The information will be reviewed by experts in the field of education and shared in the last chapter.

Chapter 5

DISCUSSION

Assessment and Strengths of the Research Project

Chapter 5 will discuss success of this project and feedback from experts concerning the strengths and weaknesses of the project. All teachers met with the author of this project and discussed strengths of the project, weaknesses of the project and improvements for the project.

Contributions of the Project

Based on feedback, this project successfully addressed the issue of becoming complacent as an educator and improving students understanding of the scientific world around them. The experts agreed that moving the classroom outdoors can illustrate science topics in the natural environment in which they occur. This leads students to a deeper understanding of the topic while also creating lasting knowledge.

All teachers who participated in this study agreed that the labs were appropriate for high school aged students but some of the labs are too advanced for middle school aged students. One teacher, who is a middle school teacher, stated that the labs would be a great way to get student buy in. A second expert felt that this project would be a great addition to the labs that he already does and it would be a great way to show natural process in action. In addition, feedback also indicated that the lesson plans were in-depth and gave great sense of what to look for when completing the lab. Another respondent

said that adding an outdoor lab would increase an instructor's effectiveness in explaining a topic. Also, this teacher felt that they would be implemented easily and could be used across the sciences.

Limitations of the Research Project

The three teachers stated that the project was good but could use some improvements. Suggestions included that some of the labs were confusing and would be difficult to complete in a 50 minute class period. Labs would be difficult for lower level students to complete and the questions asked in the post lab write could use some polishing along with the lab protocols.

One of the major limitations of this research project is the outdoor environment of the school in which the teacher is instructing. Some labs would not be suitable in the urban environment due to lack of natural materials. Also, many of the labs require students to move around the school freely to explore the environment but this could be a problem in a city around busy streets. Another limitation would be the lab equipment; if the instructor does not have a well stocked equipment room then it might be difficult to complete the labs. A well funded science department would be necessary to purchase many of the items required for some of the labs. Lastly, the time required to complete the labs is insufficient. Students would require a second period in order to complete the majority of the labs.

Recommendations for Additional Research

Educators might benefit from research that focuses on outdoor education and procedures to effectively implement an outdoor plan. Educators should not just go outside for outside's sake but should be conscience about the educational objective they

would like to complete. Educators would also benefit from a more in depth study of Gardner's Multiply Intelligence Theory as well as experiential and inquiry based learning. It is recommended that the instructor should complete a course in outdoor education. These objectives should be focused towards the Colorado Student Assessment Program.

Research Project Summary

In many instances educators will come across a lackadaisical student who is unmotivated and uninterested in science. Consequently, educators need to look to alternative ways to reach their students. By taking students outdoors to do science experiments, educators should expect to see an increase in buy-in from the students. This buy-in will also lead to increased comprehension of science topics. It will also increase the educator's ability to relate science to the "real world" which is always on the tongues of students.

It was the author's goal to produce a set of laboratory lesson plans for teachers to use as needed. The variety of laboratory lesson plans lends itself to use in many different science disciplines and should be used to complement an already strong unit plan.

REFERENCE LIST

- Armstrong, T. (1994). Multiple intelligences: Seven ways to approach curriculum. *Educational Leadership*, 53(3), 26-28. Retrieved June 14, 2006, from ERIC database.
- Armstrong, T. (1999). Multiple intelligences. Retrieved June 16, 2006, from http://www.ThomasArmstrong.com/multiple_intelligences.htm
- Balfakih, N. (2003). The effectiveness of student team-achievement division (STAD) for teaching high school chemistry in the United Arab Emirates. *International Journal of Science Education*, 25(5), 605-624. Retrieved June 14, 2006, from ERIC database.
- Bogner, F. (1999). Empirical evaluation of an educational conservation programme introduced in Swiss secondary school. *International Journal of Science Education*, 21(11), 1169-1185. Retrieved May 20, 2006, from Academic Search Premier database.
- Chang, C., & Mao, S. (1999). The effects on students' cognitive achievement when using the cooperative learning method in earth science classrooms. *School Science and Mathematics*, 99(7), 374-379. Retrieved June 14, 2006, from ERIC database.
- Colorado Department of Education. (2006). Retrieved June 16, 2006, from <http://www.cde.state.co.us/>
- Crockett, C. (2004). What do kids know- and misunderstand- about science?. *Educational Leadership*, 61(5), 34-37. Retrieved June 14, 2006, from ERIC database.
- Eisner, E. (2004). Multiple Intelligences: Its tensions and possibilities. *Teachers College Record*, 106(1), 31-39. Retrieved June 14, 2006, from ERIC database.
- Exline, J. (2004). What is inquiry-based learning? Retrieved June 21, 2006, from <http://www.thirteen.org/edonline/concept2class/inquiry/index.html>
- Finn, H., Maxwell, M., & Calver, M. (2002). Why does experimentation matter in teaching ecology? *Journal of Biological Education*, 36(4), 158-162. Retrieved June 14, 2006, from ERIC database.

- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic.
- Gardner, H. (1994). Intelligences in theory and practice: A response to Elliot W. Eisner, Robert J. Sternberg, and Henry M. Levin. *Teachers College Record*, 95(4), 576-583. Retrieved June 14, 2006, from ERIC database.
- Gardner, H., & Boix-Mansilla, V. (1994). Teaching for understanding-within and across the disciplines. *Educational Leadership*, 51(5), 14-18. Retrieved June 14, 2006, from ERIC database.
- Gardner, H. (1997). Multiple intelligences as a partner in school improvement. *Educational Leadership*, 55(1), 20-21. Retrieved June 14, 2006, from ERIC database.
- Grossman, R. (2005). Discovering hidden transformation: Making science and other courses more learnable. *College teaching*, 53(1), 33-40. Retrieved June 14, 2006, from ERIC database.
- Haefner, L. A., (2004). Learning by doing? Prospective elementary teachers' developing understanding of science inquiry and science teaching and learning. *International Journal of Science Education*, 26(13), 1653-1674. Retrieved June 14, 2006, from ERIC database.
- Hart, P. U.S. Student Report Card on Science Education. (1997). *The Bayer Facts of Science Education III*. Pittsburgh, PA: (ERIC Document Reproduction Service No. ED 461 478)
- McDavitt, D. University of Virginia (1994). *Teaching for understanding: Attaining higher order learning and increased achievement through experiential instruction*. Curry School of Education, VA: (ERIC Document Reproduction Service No. ED 374 093)
- McGlenn, J. Elon College Conference on Teaching and Learning (1999). *Paper presented at Challenge and Response: Rethinking Key Issues in College Learning*. McGlenn, J. (ERIC Document Reproduction Service No. ED 458 668)
- Meichtry, Y. (2005). Teaching the web of life. *Science Activities: Classroom Projects and Curriculum Ideas*, 42(3), 3-9. Retrieved June 14, 2006, from ERIC database.
- Overholt, E., & Mackenzie, H. (2005). Long-term stream monitoring programs in U.S. secondary schools. *Journal of Environmental Education*, 36(3), 51-56. Retrieved June 14, 2006, from ERIC database.

- Slingsby, B. (2006). The future of school science lies outdoors. *Journal of Biological Education*, 40(2), 51-52. Retrieved June 12, 2006, from Academic Search Premier database.
- Smith, M. (2005). *David A. Kolb on experiential learning*: David A. Kolb's model of experiential learning can be found in many discussions of the theory and practice of adult education, informal education and lifelong learning. We set out the model, and examine its possibilities and problems. Retrieved June 21, 2006, from <http://www.infed.org/biblio/b-explrn.htm>
- Sutman, F., Schmuckler, J., Hilosky, A., Priestley, H., & Priestley, W. Center for Laboratory Studies. (1996). *Seeking more effective outcomes from science laboratory experiences (grades 7-14)*. Six Companion Studies: (ERIC Document Reproduction Service No. ED 393 703)
- Wingfield, S. (2005). Active versus passive course designs: The impact on student outcomes. *Journal of Education for Business*, 81(2), 119-123. Retrieved June 16, 2006, from ERIC database.
- Wittig, K. (1992). *Keywords for science education: Alive and active*. (ERIC Document Reproduction Service No. ED 354 148)
- Wyatt, S. (2005). Extending inquiry-based learning to include original experimentation. *Journal of General Education*, 54(2), 83-89. Retrieved June 16, 2006, from ERIC database.