Utilization of Outdoor Education in the Environmental Science Classroom

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Will urban sprawl spread so far that most people lose all touch with nature? Will the day come when the only bird a typical American child ever sees is a canary in a pet shop window? When the only wild animal he knows is a rat – glimpsed on a night drive through some city slum? When the only tree he touches is the cleverly fabricated plastic evergreen that shades his gifts on Christmas morning?

-Frank N. Ikard, North American Wildlife and Natural Resources Conference, Houston, March 1968

“Not the place but the path, not the goal but the way” – Jonathan Kozol
Abstract

This qualitative action research study documented the observed and reported experiences of a high school environmental science teacher and sixteen of his honors students when traditional classroom practices were replaced with outdoor educational techniques. The study centered around a series of outdoor projects that required students to abandon their pre-conceived notions of the outside world, and explore the connections between themselves and a local aquatic ecosystem. The study suggests that when outdoor educational techniques are utilized, the students will increase their connections to the outdoors, learn how to work together, and gain a better understanding of their place the world.
Acknowledgments

Completing this study would not have happened without the support of several important individuals. To the students who participated in the study, thank you for walking the quarter mile out to the pond everyday and enduring the great outdoors with such enthusiasm. Without your participation and input we would never have gotten anywhere. I cannot tell you how grateful I am that all of you were so willing to participate in this study. Never stop getting dirty.

To my wife, Denise, thank you for holding down the fort while I sat in front of the television writing for days and for tolerating the never ending repeats of *Survivorman* that played in the background while I worked.

Thanks to my colleagues, for their ideas and for acting as a sounding board as I developed the activities for this study. Thanks, Nick, for always finding another resource from your home library and for all the needed items that just “fell into your possession.” Thanks, Tom, for not complaining when I pilfered your stocks of poster board, markers, pencils, scissors, and any other items that I needed.

Thanks to Dr. Zales for keeping the momentum going and for fixing my never ending supply of misplaced commas. You taught me what is means
to be a teacher-researcher and this study would not have happened without your guidance, patience, and support.
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Figure 1: The study area. This student photo was shot from the outdoor classroom.
Researcher Stance

I teach Environmental Science in a classroom that has no windows. If you look around my room, you will see fish tanks, reptile cages, deer mounts, skulls, and even a full shoulder mount of a caribou with Christmas lights wrapped around its antlers. I have tried to bring the outdoors into my classroom, but despite all this, my students cannot see a tree or feel the breeze on a nice spring day. Not unless I take them out of my classroom.

My childhood was rather unconventional. Staying inside was not an option for me. I grew up surrounded by woods. My parents would not allow me to stay inside and play video games. We played outside, all day, almost every day. On warm sunny days we swam in the pond behind my parent’s house, fished, and rode our bikes. On rainy days, the activities were not that much different. We learned conservation and why our woodlands are important on frequent hunting trips with my father and grandfather. While I understand that not every child has the opportunities that I had, I find it very troubling to drive past parks and see nobody there. Most of my students cannot name a local, state, or national park when they start my class in September. I see fewer and fewer fathers hunting with their children during deer season, and fewer kids playing at the park or in their yards on nice days.
The practice of utilizing outdoor education as the principal means of instruction is one that needs to be strongly considered if students are going to gain a better appreciation of the environment. It is no wonder that most students today lack the motivation and curiosity that I had as a child. Why are these children turned off? Weeks states, “I generally find that the student received and believed a message that he can’t do or understand science the way his schools have told him he must. The kids who have been ‘turned off’ often have just as much need and desire to know how their bodies work or how crystals grow as the engaged student, but something has gone awry in how these kids explore and find out about science” (2001, p. 9).

There is a mental disconnect that needs to be fixed. Why have we taken the outdoors out of our science classrooms? Some authors fear that this situation goes much farther. In his book, “The Last Child in the Woods,” Louv (2006) discusses how the disconnect from nature goes beyond the classroom and into the community where the games and activities we enjoyed as children are now socially unacceptable. He identifies communities designed to have vast amounts of open space for kids to play and explore only to reveal that most of the open space is off limits for one reason or another (Louv, 2006). The community he discusses went from a place where kids could play outside, building forts in the woods and
constructing bicycle ramps in the streets, to a place where forts are fire hazards and ramps are a liability. Parents put up basketball hoops in their driveways only to be informed that they were in violation of their Homeowner’s Association policies. The kids, surrounded by vast tracks of outdoors, have to stay inside (Louv, 2006).

Most students who take environmental science will be able to explain the place of a wolverine (Gulo gulo luscus) in its environment, however most would not be able to describe how it looks, sounds, or acts. Students will be able to tell me that the wolverine is an apex predator, and what an apex predator does, however they most likely would not be able to point to the wolverine on a poster containing other apex predators. My hope is that by taking my students out of the classroom and allowing them to study and look for the animals that live around them, they will develop a better understanding of the roles those animals play. I believe that unless we show our children that the outside world is valuable and important, we stand no chance of preserving what little wild areas we have left.

My goal is to incorporate a connection to the natural world while teaching students the issues facing our environment and the importance of dealing with these issues. My school provides the perfect opportunity to accomplish this goal. The campus is home to a 34-acre wild habitat known as
the Environmental Tract. The Tract contains a two-acre pond, two to three acres of wetland habitat, a bird blind, outdoor classroom, and walking path. I hope that by exposing my students to a natural setting and allowing them to explore and investigate the environment, I will be able to foster a deeper connection and a better understanding of the world outside. The question I am going to investigate is: What are the observed and reported experiences of teacher and students when traditional classroom practices are replaced with outdoor educational techniques in an Honors Environmental Science classroom?
Figure 2: Student photo of Chickweed.
Literature Review

Introduction

Why are elementary school children so enthusiastic about school and high school children so unmotivated? Somewhere during the process of formal education we are losing that motivation, and sense of excitement. Today's classroom, while giving the appearance of being organized, lacks any resemblance to the natural world. Could our need for organization and control, even if that control is artificial, be the root cause of the lack of motivation and interest seen in today's high school classroom? Friere states: “Students, as they are increasingly posed with problems relating to themselves in the world and with the world, will feel increasingly challenged and obliged to respond to that challenge (1970, p. 81). Could the solution to today's unmotivated students be to simply take them outside?

Place Based Education

Smith, Carlson, Masters, and Donaldson (2007) define outdoor education as learning “in” and “for” the outdoors. “It is a means of curriculum extension and enrichment through outdoor experiences” (p. 20). Today most educators focus only on the “for” the outdoors, and we seem have forgotten about the importance of the “in” portion. Very rarely do teachers take students outside of the regular classroom to explore the world they live in,
even when the opportunities are available (Smith, Carlson, Masters, & Donaldson, 2007). This exclusion of the “in” portions of environmental education is not only detrimental to the development of our students, but limits environmental educators to activities that merely cover content instead of allowing students to develop a connection with the environment. Broda identifies several examples of using the outdoors to enhance curriculum. Some of those include:

- Use data they have gathered outdoors to construct graphs, tables, and charts.
- Find patterns occurring in nature and incorporate them into their own creative works.
- Use indirect measurement techniques to find the height of buildings and trees.
- Explore the concept of texture in art by experiencing texture in nature. (2002, p. 35)

Why do students today lack the motivation and curiosity? Why are these children turned off? Weeks states, “I generally find that the student has received and believed a message that he can’t do or understand science the way his schools have told him he must. The kids who have been ‘turned off’ often have just as much need and desire to know how their bodies work or
how crystals grow as the engaged student, but something has gone awry in how these kids explore and find out about science” (2001, p. 9).

Despite all the possibilities for outside instruction, most teachers rarely take advantage of it. Foran (2005) notes, “To go outside with a group of school children is usually not a common instructional occurrence in public education. The inside act of teaching dominates curricular instruction” (p. 148). Why? Research conducted by Crawford (2007) concerning teacher perceptions on inquiry found that many teachers avoid outdoor education methods. He notes statements, such as “My students are only concerned with grades,” “My students are too lazy,” “and those techniques do not work with my students” (p. 635).

Place-based education is not a new concept. Foran (2005) notes that researchers Knapp, Woodhouse, and Lewicki have identified the practice as an underlying method for 100 years. However the practice is only recently being discussed in the literature. Davidson (2001) found that implementing place-based education showed that students improve their self-concept and lived experience as a result of being placed in an outdoor setting. Francovicova and Prokop (2011) conducted research examining whether outdoor education practices had an influence on students attitudes and knowledge. They found that students’ attitudes improved greatly after
implementation of the outdoor program and that the changes in attitude were long lasting. They also concluded that the outdoor program made biology more attractive to the students.

The positive impacts of outdoor based education have also by discussed by Ajiboye and Olatundun (2010). They conducted an action research project examining the effects of using outdoor techniques on improving understanding of environmental concepts. The study consisted of 408 fifth grade students from Nigeria. They determined that students retained a better knowledge of material using outdoor educational activities with discussion. This approach proved more effective at improving pupils' knowledge of environmental issues and problems than traditional in-class methodology.

Montgomery and Millenbah (2011) also found that students learned significantly better when the same lesson (knot tying) was taught in an outdoor setting versus an indoor classroom. He noted however, that student retention of information 65 days out was the same from both settings, indicating that repeated exposure to information also plays a significant role in student learning.

The issue of student safety and risk management in the outdoors requires discussion. Stan and Humberstone (2011) found that:
on occasion, teachers take a controlling approach when facilitating outdoor activities in order to manage the perceived risk of being in the outdoors. This tended to result in the disempowerment of the children and put the teachers in a position of power, which had serious implications for the pupils' learning experience. By giving the children specific instructions, and mainly focusing on maintaining discipline during the activities, teachers do not allow their pupils to workout how to deal with risk] (p. 213).

He argues that this had a negative impact on the educational process by taking away opportunities for learning from the children.

**Project Based Learning**

**Biodiversity studies.** Almeida, Bombaugh, and Mal (2006) designed and implemented an outdoor program that exposed students to biodiversity by implementing a long-term plant study of three urban green spaces. Students selected three 20 meter by 10 meter plots and designed an experiment that required them to identify, photograph, and count the plant species in each plot. Students created spreadsheets that allowed them to calculate biodiversity indexes on each plot. The study presented the students with three purposes:

- an initial assessment of plant biodiversity
- a longitudinal study that documented the effects of habitat fragmentation.
- a culmination of yearly data to allow for long term monitoring.

(p. 2)

Glasgow, Cheyne, and Yerrick (2009) used an examination of aerial photographs to demonstrate how biodiversity changes over time. His goal was to raise awareness of the importance of forests and to accomplish the following three goals:

- To illustrate trend in forest distribution
- To raise awareness of modern land use practices
- To generate student interest in the content of his course.

(p. 88)

Mapping is an essential skill for any field researcher. The skill requires students to not only be able to construct a two-dimensional representation of an area, but also to be able to make observations of things within the study area. Kastens (2010) used flag sticker mapping to test how students recorded map specific observations. Her conclusions were that students had difficulties gathering task-relevant information. They had greater success when the instructor modeled how visible information should be shown on a map. While her study was conducted with fourth grade
students, these skills may still be lacking in older students, given the lack of outdoor-based curriculum in today’s schools.

Scientific Inquiry

The National Science Education Standards (NSES) describes inquiry as authentic questions generated from student’s experiences (1996). NSES also states that when engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, student activity develops their understanding of science by combining science knowledge with reasoning and thinking skills. Most of the tasks described above are not covered heavily in today’s science classroom. We seem very focused on memorization of fact and theory and we have been criticized heavily for this practice for a long time. In 1910, Dewey argued, “Science Teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject matter of fact and law, rather than as the effective methods of inquiry into any subject matter” (p. 394). Weeks (2001) agrees with this statement. He states, “science is often misrepresented to students as a remote and static body of facts and truths rather than a process for developing knowledge and
an activity in which all people can engage” (p. 5). Weeks states, “inquiry learning is more consistent with our growing awareness of cognitive processes and how students learn” (p. 6).

Windschitl (2003) breaks inquiry based education in four types:

- confirmation experiences or “cookbook” type labs that verify a known fact or concept.
- structured inquiry where students are given a question and a procedure to discover unknown answer.
- guided inquiry through which the teacher allows students to investigate a prescribed problem using their own methods.
- open inquiry where student form their own questions and conduct independent investigations. (p. 114)

The goal of science education should be to enable students to observe their natural environment and to develop skills required to understand and explain both themselves and their environment (Marx, Blumenfeld, Krajcik, Blunk, & Crawford, 2004). True inquiry based education has to go beyond the traditional classroom setting. Students must be encouraged to push boundaries and to explore the interconnectivity of the environment. Project based learning is a teaching model based on the presentation of a complex question or problem that allows students to investigate, question, draw
conclusions, and design a path to a solution (Marx, et al., 1994). In a comparison study of both project-based learning and inquiry based learning, Mookdaporn and Nuangchalerm (2010) concluded that both approaches helped students to “build new understanding through interactions with their environment” and helped students “construct knowledge through real world problem-solving based on information gained through experimentation” (p. 254).

Project-based learning has the power to change student’s attitudes towards learning science. Faris, in his study of ninth grade students, found that a majority (23 out of 25) of students in his study group went from having a “weak negative attitude towards learning science” (p. 2) to having a “strong positive attitude towards leaning science” (p. 6), after implementation of a project-based learning curriculum. He found that by allowing students to explore a large issue in their own way allowed students to develop a deeper understanding of the issues being studied.
Curriculum Design

Hungerford (1980) defines and outlines four goals that should be considered when developing curriculum for environmental education. The curriculum should take into account the following four considerations: ecological foundation, conceptual awareness of issues, investigation, and environmental action. Each goal is broken down to identify specific considerations that should be taught to achieve each goal.

When Hungerford’s 1980 goals are compared with the national standards, a huge discrepancy can be seen. The national standards lack emphasis on investigation and inquiry. This lack of emphasis may be caused by the sheer mass of material that the curriculum requires environmental educators to cover.
Figure 3: Student photograph of the fencerow.
Methodology

Setting

I teach in a large high school that supports both an urban and suburban population in Eastern Pennsylvania. The school has 9th through 12th grade with a population of approximately 2800 students, and became a Title 1 school at the beginning of the 2011-2012 school year. The school has a teaching staff of 176 teachers and 69 supportive staff and has 2 head principals and 4 assistant principals.

During the course of this study, I utilized both an inside lab classroom and an outdoor educational facility. The laboratory style classroom contains desk seating for 28 students and six lab tables. Each lab table has propane and electrical supply and lockable storage for long-term projects. The room is equipped with a digital projector, interactive white board, Elmo document camera, and student laptop cart that contains 28 Apple Mac Books.

A majority of class work took place on the schools 34-acre wildlife habitat. The site includes a walking path, bird blind, outdoor classroom, wetlands, fields, woodlots, and a small 2-acre pond. The pond has a plastic liner and provides drainage for a large section of the campus parking lots. One large drainage culvert drains into the pond at the south-east end. The pond also has a well on the southeast corner that could be used during times
of low rainfall. The pond and the surrounding fields serve as a biological filtration system for the school campus and the surrounding community (T. Evans, personal communication, April 19, 2012).

Participants

My study group is an Honors level class consisting of 16 students. Twelve of the students are female and 4 are male. Four of the students are 18 years old, 10 are 17 years old, and 2 are 16 years old. One student is identified as gifted.

Procedure

The intent of my study was to examine how the use of outdoor education, centered on a local ecosystem, impacted student motivation and engagement. I began my study by gaining permission to conduct my research from Moravian College’s Human Subjects Internal Review Board (HSIRB) (Appendix A). After I gained HSIRB approval, I approached my building Principal and requested his permission to conduct the study (Appendix B). I then explained the project to my students and distributed consent forms (Appendix C), which explained that all students would conduct the class work, but if parental consent was not given to participate, I would not use those students’ information in my thesis. Students were also
provided a brief explanation of the project and an explanation of what would be expected of them (Appendix D).

The data collection pieces I used to measure the impact that utilizing outdoor educational techniques had on student connection were: an introductory survey, a mapping project, water and soil testing, calculation of a biodiversity index, a photo project, a student opinion piece, and a written report on the project. The written report was used as a replacement for a traditional mid-term examination for the study group.

**Data Collection**

**Introductory survey.** The introductory survey (see Appendix E) was designed to explore my student’s current beliefs and understandings of the outdoors, and the impact we have on a local environment. The survey consisted of 10 questions. Students were to respond to each question by indicating, on a scale of one to 10, how much impact each scenario had on the local pond ecosystem. Questions included examples of human pollution, introduction of invasive species, pesticide usage, habitat fragmentation, destruction of wetlands, and removal of animals. Student responses were tabulated and ranked.
**Mapping.** The mapping project was the first large scale outdoor activity we conducted. Students were instructed in the use of the tripod mounted Brunton Transit, and tasked with mapping the pond, trail, and wetlands. The students began by setting a series of base stations, and then recording bearings and distances to each station, which created a framework from which student were to gather location data on the study area. All the base stations were then marked with fiberglass delineator poles. Students were then arranged in two teams, and began gathering bearings and distances to key features (trails, pond edges, trees) from each station. Once all key features were recorded, students plotted the stations on poster paper and created a base map of the Environmental tract. Raw data from the mapping project can be found in Appendix F.

**Water testing.** Students collected and tested water from the pond on several occasions during the study. Samples were taken from the pond’s edge and from the middle of the pond using a rowboat. Students also sampled water from the bottom of the pond using a Niscan bottle. The goal of the water testing was to determine how certain parameters change throughout time and as the seasons change. The students tested nitrate/nitrogen, phosphate, and precision pH using LaMotte testing modules. Tests were repeated at regular intervals throughout the study and
after a major rainfall to examine the impact of runoff water on the pond. Students kept track of all data and compiled and interpreted that data in the final report (Appendix G).

**Soil testing.** Soil testing was conducted twice during the study in a similar fashion to the water testing. Students selected an individual spot for their sampling and returned to the same spot for subsequent samplings. Tests were conducted to examine nitrogen, pH, potassium, nitrate, and phosphate. LaMotte test modules were used for all testing. Students tabulated all data and interpreted their results as part of the final report (Appendix G).

**Biodiversity indexing.** Students identified and counted all the trees within the study area and calculated the Simpson biodiversity index on the tree population of the area. The Simpson biodiversity index is a mathematical calculation that relates the number of each species to the total number of species in the environment. The index is a way to examine how diverse the ecosystem is, with more diverse systems being healthier than less diverse systems. After students counted and identified the trees in the study area, they tabulated the data and calculated the Simpson index.

**Photo project.** Students were each given a digital camera and told to explore the study area and shoot photographs that described “the
Environmental Tract” from their point of view. The goal was to allow students to explore the study area on their own, without my intervention. Students then downloaded their pictures and constructed a PowerPoint presentation that includes no words and showed me the pond from their perspectives. Samples from the photography project can be found throughout this document as chapter dividers.

**Project opinion pieces.** Students were asked to write a brief reflection, one to two pages in length, describing their thoughts and opinions of the outdoor educational techniques they have done. They were encouraged to express their thoughts openly and to include both positive and negative views of the project.

**Dye tracing.** Students conducted a study of the drainage patterns of the surrounding parking lot storm drains by placing fluorescent dye tables into the storm drains before a major rain event. After the event, the student traced the storm runoff by following the flow of dyed runoff water. The purpose of this activity was to demonstrate the impact of parking lot runoff on the study area.

**End of study.** Students constructed a detailed report on the study area, which replaced a traditional mid-term exam. The report included all the data they collected and interpretations of that data. The report included
a discussion of human impacts on the study area and suggestions for further study (Appendix G).
Figure 4: Student photograph of the boat launch.
Trustworthiness Statement

The first step in my research was to receive permission from the Human Subjects Internal Review Board (HSIRB) (Appendix A). The HSIRB reviewed and approved my study in June 2011. I met with my building principal and he gave permission to conduct my study (Appendix B). Students were informed about the study and presented with a consent form to be signed by both the parent and the student. Parents and students were also notified that all materials would be securely stored and destroyed at the conclusion of the study. Students were assigned a pseudonym for use in this document, for their privacy.

In order to ensure that my research results are trustworthy I used three different strategies. The first strategy I used was data triangulation, as discussed by Ely, Vinz, Downing, & Anzul (1997). I collected a series of documents throughout the study that were designed to assess how students were responding to the instruction. I began with a survey that documented both background knowledge and attitudes towards the importance of aquatic ecosystems, threats to local water bodies, and background knowledge of local plants and animals. The study concluded with a similar assessment. I used a double entry journal as a second source of data, as well as several projects completed throughout the study. The study required students to compose a
complete field report of the study area that would look similar to a professional site characterization.

The second strategy I used was participant feedback. The surveys, as well as a semi-structured student opinion piece, was used to gauge how students responded to the instruction. The surveys sampled student knowledge and opinion of environmental issues related to the site. The survey results were tabulated and compared to examine how student viewpoints changed during the course of the study.

The third strategy I used was extended fieldwork. My project was completed over a 12-week period. Outdoor work was conducted three times per week, with data analysis taking up the other two days. My hope was that by increasing the length and variety of the outdoor experiences, I would be able to reach a much more trustworthy conclusion. Since my goal was to study the impact of outdoor experiences, I believe that extending the study to include several seasonal settings would add to the experience. Projects were planned to take place throughout the fall so that seasonal changes in the site could be witnessed and studied. Water sampling, soil sampling, journaling, and biodiversity indexing took place at selected intervals to increase the impact of the experiences for the study participants.
Figure 5: Student Photograph of the row boat.
The Year’s Story

The Introductory Survey

I began my study with an introductory survey. The survey was designed to sample the students’ opinions and feelings concerning outdoor environments and human impacts on the outdoor world. The survey consisted of 10 statements that the students ranked based on the impact of each statement.

Environmental Tract Project

Pre study Survey

Rate the following on a scale of one to ten. One having no environmental impact and 10 having far reaching environmental impacts.

1) A fella changing his cars motor oil in the parking lot.
2) Somebody releasing a few goldfish in the pond before they move to P-burg
3) Planting a pretty flowering plant by the pond in order to “liven up the place”.
4) Spraying pesticides on the soccer field to control moles.
5) Spraying the Pond with pesticides to control insect populations
6) Allowing an invasive plant species to spread through the wetlands.
7) Introducing a non-native animal to the pond.
8) Putting a fence around the pond to keep vandals out.
9) Cutting down the cattails in the wetlands because they are considered by the school board to be unsightly.
10) A student sees a skunk while walking the path. Fearing a rabies incident the school sets traps and removes 2 skunks, 3 raccoons, and one muskrat.

Figure 6: Pre-study student survey
Once the surveys were completed, I tabulated the data and compared student responses based on frequency of opinion. See the table below

Table 1

*Student Pre-study Opinion Survey*

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When I looked at the data, several things struck me as important:

- The students did not understand the importance and impact of runoff from parking lots (question #1).
- Students understood that the introduction of invasive species has a negative impact on an ecosystem (question #6), however, they do not
recognize the goldfish as a potential invasive species (question #2) or “pretty flowers” as potentially invasive (question #3).

- The students recognized that spraying pesticides within the pond ecosystem would have a negative impact (question #5), but felt that spraying pesticides on the adjacent soccer fields had less of an impact (question #4).

- The student response to the introduction of a non-native animal to the ecosystem was mixed, but responses leaned towards having a negative impact (question #7).

- Most of the students did not view the construction of a fence around the pond as having a negative impact (question #8).

- The student response to cutting down the cattails in the pond were mixed with responses on both ends of the scale (Question #9).

- Several students felt that the removal of several animals due to the fear of rabies would have an extremely negative impact on the pond (question #10).
The Outdoor Experience

Our outdoor activities began with the map. A few years back, I was rooting around an old storage closet in the school and I came across two old leather cases. Inside were two complete Brunton transit sets, a fantastic find. I asked around the building and nobody seemed to know anything about them or expressed any interest in using them, so I prepared to use both transits.

The Brunton Transit was designed for backcountry mapping and fieldwork. It is extremely lightweight and simple to use. The tripod is collapsible and constructed from aluminum. Today, they are very hard to find. The compass is a standard Brunton pocket transit. Students can construct a relatively accurate field map using the transit and a 100-yard tape measure. This simple piece of equipment became the principal

Figure 7: The Brunton Transit.
tool of my study.

Day 1 - The first step to the mapping project was to establish a set of base points. We selected a starting point, point 1, and began the process of selecting base stations that would allow us to accurately map the majority of the study area's main features. Each base needed to be within proximity to the previous station and allow for mapping coverage of the surrounding area. I emphasized that the base stations were the most important “points” we would be shooting because they are the starting points. I described the process to the students and everyone seemed to understand. We concluded with an understanding that mapping would begin the following day.

Day 2-3: Rain for two straight days. I was surprised to discover that the students were just as disappointed as I. However, we did not waste the time inside. Together, we opened the water and soil testing kits, went through all the tests, and ran samples on fish tank water and soil from my garden as “practice runs.” We conducted two days of hands-on work, but inside, not outside.

Day 4: The rain finally stopped on Thursday and provided us the time to head outside. However, two days of straight rain provided an opportunity that I could not pass up. I decided to keep with the
water testing and have the students collect their first water samples while the pond was high from all the rain. I figured that the numbers would be interesting and also the collection would be messy, since everything was still wet. Even though everyone knew that we would be going outside, most were not prepared. We needed to come to an understanding that high heels and skirts are not functional outside clothing. Anna and a few others learned a lesson about surface area and applied force by having to repeatedly pull heels from the mud. In the end they were able to collect their samples, run the tests, and get their first numbers with only one major issue.

That issue was unexpected but easily correctable. Turns out, we do not teach titrations in our chemistry classes. Since this is a necessary skill for some of the water and soil tests, I demonstrated the technique as a class demonstration.
Day 5: The next outdoor day was a double period, 90 minutes in length. I figured it would be the perfect time to teach the students how to use the rowboat. We would be using the boat to collect samples from around the pond and to study the pond’s depth. Teaching the students to use the rowboat was an entertaining experience. The activity began with me pulling the boat from the

*Figure 8.* LaMotte Water Test Kit with Nitrate test.
storage shed and trying to locate the oars, which were under a massive pile of four by four posts. As I was looking for the oars, I remember a quote from a former boss: “Prior planning prevents poor performance.” I should have considered that the shed would be a mess.

Once the boat was out and the oars were located, I went over the boat with the students. Most had never seen a rowboat outside of a movie. I showed them how to put on the life jackets, and we took the boat down to the boat launch. Since none of the students had ever been in a rowboat, I took the boat out myself and demonstrated how to maneuver the boat, how to launch, and how to return to shore.

I asked for volunteers to take the boat out. I figured that all the students would jump at this opportunity and I was wrong. Only two students, Jill and Stephanie, wanted anything to do with the boat. Time to see if they were listening. Once they had life jackets on, I pushed them out into the water. Secretly, I hoped the jackets were not needed.

The pair rowed around the pond for about 15 minutes without any real issue and prepared to return to the boat launch. They failed to generate enough speed, and the boat stopped short of the shore,
requiring me to put on my hip waders and go get them. Everyone had a laugh, took a few pictures of me in waist deep water retrieving two girls stranded in a rickety boat. No one got hurt.

Day 6: We used our time today to start setting base points for the mapping. We set base #1 just off the trail by the shed. It is the easiest point to get to and would serve as our meeting place. I demonstrated, again, how to pick a base point and sight it in from the current point. We discussed the importance of keeping accurate data, why we needed and bearing (angle) and a length, and how to set up the transit and move it. This went very easily. The students seemed to understand how to set the bases; I am not sure if they fully understood why they were setting bases, but we covered that later. We were able to “shoot in” most of the base points with little problems. I decided that we would use 4-foot fiberglass rods to mark the base stations, this would turn out to be the first major mistake.

Day 7: Today students began to shoot objects from the base stations. We started, from base one, with a brief discussion concerning what we were doing. The students were to pick objects of importance that could be reached from the base station and shoot bearings and distances to those points. Individual objects, trees, poles, birdhouses,
are identified by a single point while paths, pond, wetland edges, and fence rows are identified by a series of points that could be plotted on the map as a line. Each base station with its objects became a piece of the bigger picture. After a few examples from base one, I allowed the two groups to go their separate ways. One group would work clockwise from base one, while the other group worked counter-clockwise starting at base 13. I spend the remainder of the day running back and forth through the humidity and 80 degree heat. The kids enjoyed the day and several requested to “stay outside for the rest of the day.” I wish I could have let them.

I noticed several things during this initial mapping session. First, the groups were working very well together, and students were taking turns reading the compass and recording. I was afraid that one or two students would do a majority of the work while the rest watched, however, this was not the case. Clothing choices were beginning to improve. Hands were getting dirty and nobody complained about that.

Day 8: And we are back to rain. The students worked on setting up data tables for data collection. Many of the students have never had to design their own data sheets. I needed to tell the students that the
design of the data tables was part of their responsibility. The tables went through a few revisions before everyone was happy with the results. I tried not to judge, but gave casual advice.

Day 9: The rain continued until September 19. The study area was now officially water logged. We still went out to continue mapping. Upon arrival, the students noticed that several of the base station markers were gone. The students were not pleased. We sat together and tried to figure out what happened. We concluded that the stakes were most likely pulled by gym classes who run around the pond. I explained that these things happen when you do field work, and we just need to move on. I was surprised at how well they rose to the occasion. Tyrone suggested that we should do a complete walk around and identify what stakes were missing and reshoot them in from the last remaining station. I think they now understand how important keeping accurate data is. We were successful in relocating the missing points, and everyone was exciting to try to finish the job.

Day 10: September 21 saw the class working under sunny skies and warm temperatures. Today, I was hoping to be as hands off as possible and allow the students to spend as much time mapping as possible. They did not disappoint. The counter-clockwise group
managed to completely map three stations (13-11) and the clockwise group managed to completely map the first station. Station 1 was probably one of the most difficult, since it contained a large amount of objects. We gathered points for the path, pond edges, wetland edges, the shed, the wellhead, and several trees all within the reach of the first base station. Stations 13-11 had far less detail. Both groups worked very well together. Casey complained a little concerning the wet grass and a fear of the groundhog that inhabits the bank around station 12. He has never hurt anyone, and we were able to discuss how he has built several entrances and exits to his burrow in order to evade any danger. Overall it was a great day.

Day 11: Our next outdoor session was, again, rained out. However, I took this opportunity to show the students how we take our field data and turn it into a map. I got out the poster paper and we started playing with borders, legends, and scaling. Since getting the scale right is one of the most difficult things, I figured that we would have difficulty here. We did, but the students took it well. I expected several small scale revolts when I told them that we needed to shift a point one inch to the left or two inches up. Those revolts did not happen. They were beginning to see that you do not always get things
right the first time, and that in order to make something real requires a little trial and error. The process fascinated the students. Their data set consisted of nothing more than a location, a bearing, and a distance from the base. They plotted the point on the map and then that point has a meaning, a value. As the points for the path were plotted, they began to see the picture emerge. We did not have a whole lot of data at this point so the picture was nowhere complete. I was curious how seeing a little bit of the picture would affect how they worked outside. I was hoping that they would take to the rest of the mapping with a better understanding of what they were doing and with a little more direction.

Day 12: September 23 was another nice day, weather wise. My plan for today was to introduce the students to the soil tests that we would be conducting. Like the water testing, we used a LaMotte Soil test set that included test modules for soil phosphorus, nitrogen, soil potassium, and pH. I demonstrated how to use the sampling probe, how to collect the sample, bag it and label it, and briefly discussed how to pick a spot for sampling. I indicated that I wanted them to use the same location each time we sampled. Since we only had 9 students out today, I broke them into three groups and sent them off
to select sampling sites and gather samples. This went without problems and the students worked well. After all the groups returned, we returned to the lab to run the tests.

The soil test takes a longer time to run than the water tests. Each of the modules requires you to saturate the soil sample and then filter the water off for testing. Each test takes between 20-35 minutes to complete. The highlight of the day was how surprised the students were concerning the filtering process. They were intrigued that you could take muddy brown water and filter it to clean clear water with

Figure 9: LaMotte Soil Test Kit showing Soil Potassium test and soil sampling probe.
little more and an ultra-fine coffee filter. Gwynne broke one of the plastic spoons and was afraid that I would be upset with her. When I laughed and gave her another spoon she was surprised. I wondered why?

Day 13: We went back out on September 30 to test the dissolved oxygen in the pond. I wanted to focus more on the process of sampling water and less on the test itself, so I elected to use Hach AccuVac dissolved oxygen ampoules instead of a traditional mixed chemistry test. The AccuVac ampoule is a small self contained, pre-mixed test unit. All you have to do is hold the ampoule under water and break off the tip. Once the ampoule is filled, you wait 5 minutes and compare the color of the water in the ampoule to a color wheel to determine the dissolved oxygen content of the water.

I divided the class into four groups and sent them around the pond to gather a sample, knowing that there was no way through the cattails to the pond edge. I was curious to see how long it would take them to stop and think. At this point they were getting better at working in the outdoors with guidance, so I felt that they needed to start thinking about how to work in the outdoors without guidance. It took 20 minutes, two ruined pairs of shoes, one cut, and four used
ampoules before Kathy remembered the rowboat. I called everyone back and we discussed the importance of stopping, thinking, and planning when working outdoors. Janice managed to cut her finger on a broken ampoule. It was a minor cut, but it allowed us to discuss why working carefully is important. Once I took the boat out of the shed, she refused to go back inside for first aid despite my protest.

We retrieved the rowboat, Kathy drove, and each group gathered a dissolved oxygen sample from around the pond. I also took the opportunity to demonstrate how to use a Niskin bottle. A Niskin bottle allows you to take a water sample from the bottom of the pond in order to test water parameters at depth and compare them to surface conditions. I had Kathy and Jill collect a bottom sample to compare the dissolved oxygen levels at depth. Hopefully, after the minor frustration of today, we had a better understanding of how to plan to work outdoors.
Day 14: While their planning might have improved, mine had not. Our next day out was October 3\textsuperscript{rd}. Somewhere along the way, I failed to communicate what we were doing, so some students went outside and some stayed in the lab. By the time we figured out what went wrong, most of our class time was wasted. With the time remaining, we discussed setting up a Google group and posting schedules on the
door so everyone would know what was going on and where we were supposed to be.

Day 15: I decided early on that I wanted to design an activity that allowed the students to be creative. I ran through several ideas and finally settled on a photography project. The parameters for the assignment were kept simple. The students were to shoot pictures of the study area that demonstrated what the pond means to them. They were to select their favorite 10 photographs and construct a PowerPoint or keynote that demonstrates the goal of the assignment; however they were not allowed to use any words in the presentation.

I presented the photography project to the students on October 4 and told them that we would be going outside to shoot photographs on the following day, October 5th. We spent the remainder of the class going over the use of the cameras, ensuring that they were all charged and had memory cards, and discussing the few questions that they had. I was just as excited as they were to get into this aspect of the study. Kathy is going to school to be a photographer, so she requested to use her own camera. A couple other students asked to use their iphones since they had better cameras. I agreed to that request.
Day 16: When we met on the pond the following day, everyone was excited and ready to get going. I passed out cameras and told them that I would not be interfering or interacting with them during the shooting time. I wanted them to have the time entirely to themselves. As the class started to spread out and explore, I noticed that nobody was walking on the path. They were all in the grass and heading towards the more remote parts of the study area. A few of the students disappeared into the wetlands in search of subjects to photograph. Everyone was dressed to get dirty. At the end of the class, I had to retrieve students since most lost track of time. Everyone had a good time shooting pictures, and those who used their iphones started to send me photographs attached to text messages. I was very interested in how they related to the study area and how they viewed their place in the big picture.

Day 17: We spend the next day in the lab downloading pictures and constructing presentations. The results of the activity revealed several key observations. First, the pictures were amazing. They really demonstrated an understanding of photography and how to capture images. It was interesting looking at the perspective that the students took. Students who are more introverted, like Erica, tended
to have photographs that captured the life of the pond. She had close-ups of butterflies, birds, and footprints on the paths. Her presentation focused on the life of the pond. Tyrone, on the other hand, took a completely different approach. He is generally the most talkative and extroverted student in the group. His pictures showed the large picture of the pond. He went to the higher point in the study area and captured the pond from the perspective of an outside observer.

Almost all students included a picture of themselves in the environment or of some of their peers in the environment. I was curious when I noticed this in the first presentation and I started to really consider what the inclusion of those photographs meant when they started to show up in the other students work as well. I want to believe the students were all showing themselves as part of the environment and not outsiders that had no real connection to the study area. I wonder if they would have included themselves in the photographs if I stated the study with the photography assignment instead of having them do this assignment in the middle of the study. It should be noted that all of the student photos placed throughout this document are photos from the student photography project.
Day 18: October 6th saw the group facing their first real setback. We intended to resume mapping with a hope of completing the mapping project within the next few days. However, when we arrived at the pond, we found that the schools maintenance crew mowed down all but four of the base point markers. The students were really upset and frustrated, and I understood their anger. Several of the markers were in a straight line, and there is no way that the mower operator could have missed the bright yellow marker poles. We took a little time to discuss what we should do and how we should proceed. I offered them the option of remarking the base stations, since we had the data, however they noted that that did not prevent the markers from being removed again. We decided to set the remaining base points as we progressed around the pond. So, the students would shoot all the points from the current station and then move to the next station, recording its bearing and distance before moving the transit. They dubbed this method, “Shoot and scoot.” To tell the truth, they came up with this method; I did not even consider it. This way we did not have to mark the stations as long as they had the data. We agreed that we would resume mapping on our next day out.
Day 19: October 7th – We completed mapping all points except two. I had no input in the day. They took complete control and worked to get the job done. It seems that the destruction of the first base stations had shown the students that they needed to work more diligently. They worked fast and efficiently. I was really surprised and encouraged by the students’ initiative over the past few days.

Day 20: October 8th – Students working on plotting points on maps inside. Work went well. The students were starting to get interested in seeing the maps develop. Considering the magnitude of the map, I was surprised at the enthusiasm. At the end of the class, Erica indicated that she was concerned that her group was falling a little behind. She requested to come back during her study hall and get caught up. I agreed.

Day 21: It was raining again. We worked on the map inside. As the complexity of the map increased, the students’ pace slowed down. Most of the groups began to have problems keeping track of the huge data set. Maddie’s group accidently plotted the data for point number 12 from station number 1. “We wasted a whole days work” – Sally. Gwynne’s group did not keep track of what base station they were at when they were outside and had to take time to figure out what points
went where. I expected a few issues and the students adapted and overcame those issues. They needed a day outside, as they were a little overwhelmed.

Day 22: The students began the biodiversity index of the ponds trees. The students broke up into three groups with Janice, Sally, and Gwynne taking the lead. Sally’s group worked counter-clockwise from station 1 to the spillway, while Gwynne’s group went clockwise from station 1 to station 5. Janice and her group also worked clockwise from 5 to the spillway. The students were all very engaged in the activity. Kathy collected samples of all the leaves they identified and gave them to me. I did not ask her to do this and I appreciated it. The catalpa leaves distracted Sally’ group. She commented, “This leaf is as big as my face.”

Day 23: October 17 – Students calculated the biodiversity index from the tree inventory and continued to work on plotting map data. They tabulated the data from the inventory and created an excel data table to share and compile the data. However, they chose to calculate the index by hand instead of using excel to do the math for them. The index was calculated at 7.2 on a scale of 1 to 10, with 1 signifying a planting of only a single species and 10 signifying a diversity level
comparable to that of a tropical rainforest. A value of 7.2 was higher than I expected. We talked a little about why the value was higher than expected.

*Figure 11:* Student whiteboard showing biodiversity data from the tree study.

Day 24: Student continued to work on the maps. Kristen’s group plotted all the points without trying to draw lines as they went. The result was a frustrating mess that would take a lot of time to figure out. Janice’s group was having the same problem. Gwynne’s group was going well and getting close to completing plotting all the points.
Day 25: We collected soil samples and conducted testing. Students went out and collected second round of soil samples. They were very quick about getting the samples. It was starting to get a little chilly in the mornings.

Day 26: We collected water samples and ran water tests. Surprisingly, there were no issues. The students seem to have a much better understanding of how the water tests work than the soil tests.

Day 27: Most groups were finishing up with outlines of major features and were moving on to add borders, labels, trees, and color to the maps. They looked good. Kristen’s group was a little behind. They had been a little behind for a week or so.

Figure 12: Student example of completed map.
Day 28: October 26 – I found a bottle of dye tablets in a drawer. I decided to wait until a rainy day and take the group out to conduct dye tracing on the pond. We were going to dump tablets into the storm drains and see where the storm water ends up.

Day 29: We went out to load dye tablets. It was a cold morning. Everyone was moving fast and anxious to return indoors.

Day 30: November 15 – We went out to reload storm drains for dye testing. There was not enough rain on the 9th to get results.

Day 31: November 16 – We walked down to the pond to check the dye tracing. Upon arrival, we could see a band of fluorescent green working out into the pond. The students traced the dye back to the storm drain exit, and we discussed why the storm drains empty into the pond and the impacts this

*Figure 13: Storm Drain showing dye from dye tracing.*
has on the health of the pond. Mike stated, “We are turning the pond into Gatorade.”

Day 31: November 18 – We completed the maps today. Everything was done. We took the time to talk a little about what we accomplished. I wanted to give them the opportunity to express their feelings concerning the project, so I assigned them a two-page review of the process.

**Project Opinion Pieces**

At the conclusion of the field work, I had each student write a two-page discussion of the project. I wanted them to focus on how they felt the project went, what they liked or disliked, what could have been better, and how the project compared with other science courses they had taken.

As I analyzed the opinion pieces, several themes kept appearing. First, students felt that the outdoor approach and the interaction was a positive experience.

“This class has definitely opened my eyes to a new way of learning and retaining information. I think being shown things up close and in person helped me a lot more than just reading off a notebook or computer screen” – William
"The experience of this environmental science class has been something I have never experienced before. It has definitely been a learning experience that I will appreciate for a long time. There has never been a class where I have been able to have the hands on experience of being an environmental analyst." – Kristen.

Most students felt that the mapping portion was the most challenging. However, after the incident with the lawn care professionals, the students became more focused.

"Out of all the activities in this project, the mapping part tended to be the most challenging and stressful. In the beginning, none of us seemed to know what was going on. We were pretty much clueless on how to use all the different mapping instruments. Then, when all of the stakes on the outer path were removed, everything else seemed even more confusing. But once the situation was resolved, I feel like we all started to catch on and visualize what we were supposed to be doing. In the end we all pretty much knew how to use the instrument correctly".

- Janice

Several students felt that the one of the most interesting activities was the dye tracing. This was interesting to me because this activity was not part
of the original study design. I just happened to come across the tablets while searching through an old drawer.

“The coolest thing that we did while we were outside was putting the dye tablets in the drains. It showed us where the water flows to, and how when we see someone put something in them or dumps something in the drains that it will end up in the pond.” – Thomas

End of Study Assessment

We decided that instead of a traditional midterm, we would complete a lab report detailing the results from all the tested conducted and count that as an “alternative assessment.” The assessment was broken down into 5 parts: an introduction, data sets and interpretations of water and soil testing, a discussion of human impacts on the pond, a discussion for suggested future studies, and a conclusion that addresses the big ideas of the study. The section on future studies was used as a driving force behind the future studies section of this document because I wanted to take their ideas into account when I designed the remainder of the school year. A sample of the assignment document and rough results of the soil and water tests can be found in Appendix G.
The next six pages is a complete example of one of the student created End of Study reports.

**Example of Students’ End of Project Report**

Janice, Stephanie, Thomas, Ashley
Period: 2/3

**Introduction**

The project began as a mapping project. We went out to the pond and cinder track on the side of the school. As a class we marked certain points surrounding the pond. We then shot measurements with a compass and measuring tape. Hoping to get an exact layout of the pond, trees, birdhouses, and wetlands surrounding it. Some complications did arise. The stakes on the outskirts of the pond area were pulled out, leaving us unable to complete our measurements. However, that did not stop us from coming up with a solution. We remarked the vacant spots and carried on with our project. Once all of the measurements were taken and recorded we came up with a scale and started to plot the points on paper. As the points were plotted we began to draw lines and connections to each of them. When everything was plotted and connected we came up with a key that gave the symbols for birdhouses, trees, wetlands, pond edges, and other various things found on the Environmental tract.

While the mapping was being done we performed various tests on the soil and the water. By taking soil samples from different locations around the pond we were able to measure the nitrogen, potassium, and pH levels of the soil. These tests could explain why some of the plants are there and why they are dying or thriving. The water tests were conducted by riding in a rowboat and taking samples from different areas of the pond. By doing this we were able to test the nitrate nitrogen, precision pH, and the phosphate levels of the water. These tests could explain the animal life in and surrounding the pond. Throughout the course of the project we also studied the plant and animal life around the pond and Environmental tract. We also experimented with the dye tablets, to find out where the rainwater drains into the pond. Every part of this project gave us a better understanding of the environment surrounding us everyday at school. It has opened up many new ideas and questions about nature. This newly learned information would be great for our future endeavor.
Data Sets

Soil Tests

All of these soil samples were taken from various points around the boat shed then taken inside to conduct these tests.

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<th>11/10/11</th>
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<tbody>
<tr>
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<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Potassium</td>
<td>160</td>
<td>370</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>6</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Nitrogen in the soil is what helps plants grow. Soil with a low nitrogen level is not going to have good growing conditions for plants. Sometimes nitrogen is washed away with rain into the water. For example the first test would be a normal nitrogen level. Then the second test was taken after rain so some of it was washed away.

Potassium is an essential plant nutrient that helps plants grow healthy. The potassium test shows how well the soil can produce and apply potassium to plants in the area. If our soil has between 160 and 370 pounds per acre then the soil is able to deliver potassium at a steady rate to the plants in the area.

Phosphorous is another of the three important elements in soil to support plants (the other two being nitrogen and potassium) phosphorus in soil helps plants grow by supporting the transfer of energy between plant cells. To grow healthy plants soil needs a phosphorus level between 6 and 7. Our soil has 6 to 6.5 so the level is adequate enough to grow healthy plants around the tract. Overall our soil is healthy enough to support a variety of plants around the tract.
Water Tests

All of these samples were taken from the pond by the boat launch. They were then taken inside and tested for different levels of nitrate, phosphate, and precision PH. All the data from the three days we tested are in the table.

<table>
<thead>
<tr>
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<th>9/12/11</th>
<th>10/20/11</th>
<th>11/3/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate</td>
<td>0</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Phosphate</td>
<td>0.2</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Precision PH</td>
<td>7.5</td>
<td>7.5</td>
<td></td>
</tr>
</tbody>
</table>

In the data the nitrate level went up the farther we went into the testing days. Nitrate leeches into ground water from runoff after it rains. The first test was taken before rainfall so there is no nitrate in the water because no runoff recently occurred. The second test was taken a day after rainfall so the water would have nitrate in it because runoff recently occurred. The last test seemed to have been taken when rainfall happened the night before. I assume this because the nitrate level is a bit higher.

Phosphate is a cause of plant life building up in a pond or lake. If there is a high phosphate level there will be a startling buildup of algal bloom. If the phosphate level is low there will be very little aquatic plant life. Our pond’s phosphate level averages between 0.01 and 0.03, which is a normal healthy level for this kind of pond.

Precision PH is a level of how acidic the water is. The precision PH of our pond water is a little less acidic then normal pond water. Norma pond water is a 7 and ours is 7.5 so our pond water is pretty good when it comes to balances of acid and base chemicals. Overall our pond passes all of these tests and is very healthy.
Human Impact

Water dye tracing was a process the class performed to see where rain, run off water, and pollutants dumped in the parking lot ended up. To find this, the class first went out side with water tracing dye tablets. As we headed down to the Environmental tract, dye tablets were dropped in all of the storm drains in the vicinity of the Environmental tract. This is done with the intent of rain that day or the next. The falling rain would take the dye, and ultimately lead the class to where liquids end up. After doing this, we concluded that substances flowing through the storm drains eventually lead to the pond.

Knowing this, there is a large window to discuss human impact. A good majority of the storm drains are located in the parking lot. This leaves room for poured beverages, gasoline, and other car fuels to run through the system and pour into the pond. Another portion of the storm drains are located in the field area. Being surrounded by grass leaves room for the potential harmful effects of pesticide. With all of these common occurrences, there is no doubt that as a school, we have impacted the ecosystem of the pond.
Future Studies

This project cannot be complete without future studies. Continuation of these studies should include more soil tests because two is not enough for a conclusive result. Also, more studies should include; water tests, a plant study, and possibly seeing the impact that all of the rain/snow had on the environment over the winter. We could also include an animal study of the species around the pond including insects, which would coincide with a study of the plant life around the pond. A study of the impact of the goldfish in the pond has on native fish species, and plant life, and a composting experiment would be helpful to the class in showing how to aid the environment.

Many of these experiments seem new and unrelated to the experiments that the class has already completed. On the contrary, many of these experiments have a practical application to outdoor life, are easy to accomplish, and give an inside look as to how to be a greener citizen. The goldfish study would connect to the study of invasive species, which was briefly looked at in class. This would give a glimpse of a deeper look at the impacts of invasive species in a local setting. This study would also connect with the Cane Toads, and invasive species in Australia, that was studied in class. The composting experiment can be quick and easy set up with a definite way to show students how to be greener in their own homes. Studying animals in the local area would demonstrate to students just how fragile the animal kingdom is, while making students more conscientious of the harmful impact their actions have on nature. These experiments would be helpful to the class, as well as having a real life application while being beneficial to the students of environmental science.
Conclusion

During this project we learned how to collect water and soil samples and draw conclusions from our findings. Our class learned from the dye experiment the negative impacts humans can have on the pond through pollution that runs through the storm drains and how humans should be more aware of the effect they have on the environment. Something that seems as small as spilling something in the parking lot could adversely affect the pond next to it. From our soil and water tests we’ve discovered our pond is overall healthy.

We’ve learned what we could improve on during our next project like how to obtain more consistent and accurate results. Our class also learned about the effects of human impact on the pond such as pollution and releasing invasive species into the water. It’s wiser to learn about human impact on nature and testing methods on a smaller scale like the Kunkle Pond first because we now have first-hand knowledge on how scientific studies work. We can’t understand what’s going on in the world if we don’t first understand what’s going on in our own backyard.
Figure 14: Student Photograph of Honeysuckle.
Data Analysis

During the course of this study, I gathered data from a variety of sources. I gathered information using a field log, student work samples, a student opinion piece, and extended field-work and observation. Each source provided data from different perspectives and allowed me to see the study from a multitude of angles.

Field Log

My field log was used to record the day-to-day functions of the students as they worked outside. I used it to record what the students were doing, how they were working together, what issues arose, and what we accomplished. I also used it to document student comments and discussions. During my preparation period, I would look over my field log and record my thoughts and reflections on the day’s work.

As my study evolved, so did the comments that I was making in the field log. At the beginning, my comments centered on how the students were progressing with the assignments and tasks they were given. I noted what they got done, and I did not pay much attention to how they interacted the process. Towards the middle of the project I noted that my entries were more centered on the students themselves and their interactions with the pond and less centered on how much progress they made. In this regard I
believe that I evolved as an educator at least as much, if not more than, the student evolved as learners.

**Student Work Samples**

Considering that a large portion of my study centered on a large outdoor field project, the student work samples became a major source of information. The students collected data almost daily. I was able to study how they worked together and how involved in the work the students were by looking into the quality of the data they were collecting and analyzing.

The student work samples centered on the construction of a working field map. The map was generated from student gathered surveying data. The map was used to keep track of sampling locations, and to allow the student to become intimately familiar with the study area.

**Student Opinion Piece**

The student opinion piece allowed me to gauge how the study affected the students on a personal level. I encouraged them to include what they enjoyed about the study and what they did not like. The piece allowed me to understand the impact of replacing the traditional curriculum with the outdoor education curriculum has on student learning and motivation. The student option piece provided the students an opportunity to express how the outdoor experience affected them both positively and negatively.
Most student responses were extremely positive. The students felt that they ended the experience with a better understanding of the study site and a better appreciation for the natural world.

Field Work and Observations

This project was really about conducting fieldwork from the students’ perspective. They were learning to work outdoors while I was learning how the outdoors affected their learning. Their fieldwork, and how they adjusted to it, became a central theme of the study. The nature of the field work allowed me to step back and observe the students from a distance. The nature of the study allowed me to observe how they handled success and how they handled mistakes, and setbacks.

Codes and Bins

I began to code my observations about halfway through the study. As the amount of information began to increase, the coding process allowed me to keep track of what was going on. I noticed during the study that my mindset began to change with regard to the goal of the study. At the beginning, I was too focused on the student part of the study and not really concerned with observing them. I was more interested in producing a good result. I was focused on the product and needed to start paying more attention to the process. I needed to adopt the mindset that “the process is
the product” (Ely, Vinz, Anzul, & Downing, 1997, p. 52). As I developed codes I began to place codes into bins based on similar themes. This process continued throughout the study, and my theme statements were developed from those bins.

**Theme statements**

- Utilizing outdoor educational techniques promotes student engagement and provides opportunities for dialogue.
- Outdoor education increases student connection to the world.
- Outdoor education increased teamwork and teaches students how to work together to solve complex problems.
- Utilization of outdoor education requires planning for weather, equipment concerns, and human interference to minimize both student and teacher frustration.
Figure 15: Graphic organizer showing bins.
Figure 16: Student Photograph of the Weeping Willow.
Findings

Throughout this study, the impacts of taking students outside and using outdoor educational techniques was explored. Students were exposed to nature in order to determine what impacts this simple act has on student motivation and engagement. Following are the major themes that emerged.

*Utilizing outdoor educational techniques promotes student engagement and provides opportunities for dialogue.*

The simple act of taking students outside had a positive impact on their learning and levels of motivation. During the course of this study, I did not have a single student discipline issue. Every student was motivated and engaged in the activities, and that engagement carried over back into the classroom. I found that during outdoor time, student motivation was no longer teacher driven, rather, that the activities were enough to ensure that the students were engaged and motivated.

Taking students outside provided opportunity to engage in student/teacher dialogue. Several times during the study, the students would come across objects they did not recognize, an animal they had never seen or noticed, or some other phenomenon that they wanted to ask about. Seeing a groundhog run into its hole can become a 45-minute discussion, and the arrival of a migratory bird can provide the opportunity to discuss the
importance of pond ecology. When we conducted the dye tracing activity, we spent about an hour discussing the impacts that we have on the pond through runoff from the parking lots and the effect that using salt in the winter has on the life of the pond. While all of these discussions could have taken place in the classroom, I doubt that the impact on the students would be as strong if the discussion had taken place inside a traditional classroom, without actually visualizing the impacts in the real world.

*Outdoor education increases student connections to the world.*

Louv notes that students today have very little connection to the outside world, and discusses the negative effect that trading real world learning for the security of the classroom has had on our students (Louv, 2005). He defines a phenomenon known as “Nature Deficit Disorder” which he claims may be a factor in the increase in some behavioral problems.

It is not enough that students understand that invasive species are a threat to native populations. That knowledge is of no use if the students do not know how to recognize an invasive species in the outdoors. It is one thing to describe the impact of invasive plants and animals to our students, and it is another thing to take them outside and show them banks covered with Crown Vetch and ponds filled with released goldfish.
Using outdoor educational techniques and taking students outside provides the opportunity for students to see the impact that our management practices have on the world in which they live and explore.

*Outdoor education increases teamwork and teaches students how to work together to solve complex problems.*

The activities used in this study could not have been completed without teamwork and problem-solving skills. The students had to work together on a daily basis in order to complete almost every aspect of the project.

The water and soil sampling activities required students to work together to select and access collection sites, and promotes planning skills. The students had to carefully plan out a course of action in order to be successful and safe. At times, it is beneficial for the teacher to allow the students to flounder a little in order to encourage planning, and at times, the teacher must provide strict instructions. The level of instruction should match the safety risk. For example, when the students were selecting sampling sites, I chose to allow the students to explore and figure things out on their own. However, when in the boat, more supervision was needed.
Utilization of outdoor education requires planning for weather, equipment concerns, and human interference to minimize both student and teacher frustration.

I could never fail to pay attention to the weather. Several times during the study, weather disrupted our plans. It always seemed to rain on days that we planned to be outside. I quickly learned that I needed to have lessons in place for unexpected weather, both good and bad. Several times, we anticipated staying inside only to have fantastic conditions that required us to shift plans.

Human interference can also cause issues for outdoor education. A teacher using outdoor spaces needs to plan on things being changed or utilized by other groups using the space. Maintenance to the study area can also throw off plans. It became difficult to have students working in certain areas while mowing crews were also working in the same areas. Once during the study, we had to be inside due to maintenance applying herbicides to an adjacent soccer field. Gym classes often disrupted momentum, and caused a distraction to students collecting data.

All of these issues needed to be anticipated in order to prevent student and teacher frustration. Several times during the study we were kept inside when we planned to be outside and vice versa. Interference by
other groups created setbacks, but also provided opportunity for problem-solving and student engagement.
Figure 17: Student Photograph of an American Bullfrog.
Next Steps

I believe that since the students drove the study of the pond, they should decide what should be done next. I included a section in the end of the study report entitled “Future Ideas”. The suggestions below came directly from student written reports.

Casey, Rebecca, and Kristen suggested the following:

*During the spring, other species of animals come out to eat. Also, many other types of plants begin to grow. In the warm weather so much new life comes out. We could look at all the different types of plants and study what each one does in the environment.*

*Other activities could include animals. Since the first half of the year we learned about the causes and effects of human activity on the pond, we could spend the spring learning about the different species of animals around the pond.*

Gwynne, Mike, Tyrone, Russel and Jill suggested:

*We believe for the second semester that we should do something with the snow, and continue the water and soil testing. We should also go fishing when it gets warmer because that would be so much fun! Other than that we should continue the trend we have been on and continue to be outside and doing hands on activities as much as possible.*
References


*Journal of Experimental Education. 28*(2), 147-163.


Appendixes

Appendix A – HSIRB Consent Form

July 12, 2011

Richard Orner
3370 Lehigh Drive
Northampton PA 18067

Re: HSIRB proposal by Richard Orner

Dear Richard:

The Moravian College Human Subjects Internal Review Board has accepted your proposal: “What Impact Does Utilizing Outdoor Educational Practices Have on Student Motivation.” Given the materials submitted, your proposal received an expedited review. A copy of your proposal will remain with the HSIRB Chair.

Please note that if you intend on venturing into other topics than the ones indicated in your proposal, you must inform the HSIRB about what those topics will be.

Should any other aspect of your research change or extend past one year of the date of this letter, you must file those changes or extensions with the HSIRB before implementation.

Please do not hesitate to contact me by telephone (610-861-1348) or through e-mail (caroluccarr@moravian.edu) should you have any questions about the committee’s requests.

Sincerely,

Carol A. Traupman-Carr, Ph.D.
Dean of Curriculum and Academic Programs
Interim Chair, Human Subjects Internal Review Board

cc: R. Grove, J. Shosh
Appendix B – Principal Consent Form

Dear Mr. ___________

I will be completing a Master's Degree in Curriculum and Instruction at Moravian College during the 2011-2012 school year. This degree will assist me in implementing the most effective teaching strategies in order to provide meaningful learning experiences for my students.

I am required to conduct a systematic study of my own teaching practice. The focus of my research is how the use of outdoor education affects student motivation. The study will run from September 1 to December 24, 2011. By completing this study I hope to improve my student's abilities to apply classroom knowledge in the "real world".

I will be gathering information to support my study using student questionnaires, learning station labs, outdoor activities and journaling activities. The data collected will help me determine how I can better meet my student's needs. All of the student's names will be kept confidential as well as the names of teachers, other staff, and the school. Only my name, the name of my sponsoring professors, and Moravian College will appear in the study. No names will be included on work samples or in any reports of my study. Minor details of students writing may be altered to ensure confidentiality. All research materials will be kept in a secure location in my home and all data gathered during the study will be destroyed at the conclusion of the study.

All the students in my classroom will receive the same instruction and assignments as part of the science curriculum. Participation in this study is entirely voluntary and will not affect the student's grade in any way. Any student may withdraw from the study at any time by writing me a letter or sending me an email stating that he or she would like to do so. The parent of guardian may also withdraw the student through a letter or email. If a student is withdrawn, or the parent or guardian chooses not to have him or her participate in the study, I will not use any information pertaining to that student in my study and the student will not be penalized in any way.

I thank you for granting me approval to conduct this study. Any questions you have about the research or about the process for withdrawing can be directed to me, Richard J. Omer, or my advisor, Dr. Joe Shoshb, Education Department, Moravian College, jshoshb@moravian.edu.

Sincerely,

Richard J. Omer

I am the school principal and I understand the research Project that will be conducted by Richard J. Omer. She has my permission to conduct her study as described. I have read and understand the consent form and received a copy.

[Signature]

Date

EASTON AREA SCHOOL DISTRICT MISSION STATEMENT

The Easton Area School District recognizes the diversity of its student population and is dedicated to the importance of developing our students into responsible citizens. We will provide each student with an innovative, challenging program that enhances curiosity, develops an ability to use technology, and encourages critical thinking and problem solving. In support of this mission, we will create a safe instructional environment and promote lifelong learning.
Appendix C – Student Consent Form

Easton Area High School
Environmental Sciences • 2601 William Penn Hwy • Easton, PA 18045
Voice: 610-250-2481 • Extension 2315 • Fax: 610-250-2485

Dear Parent/Guardian

I will be completing a Master’s Degree in Curriculum and Instruction at Moravian College, during the 2011-2012 school year. This degree will assist me in implementing the most effective teaching strategies in order to provide meaningful learning experiences for my students.

I am required to conduct a systematic study of my own teaching practice. The focus of my research is how the use of outdoor education affects student motivation. The study will run from September 1 to December 24, 2011. By completing this study I hope to improve my student’s abilities to apply classroom knowledge in the “real world”.

I will be gathering information to support my study using student questionnaires, learning station labs, outdoor activities and journaling activities. This data collected will help me determine how I can better meet my student’s needs. All of the student’s names will be kept confidential as well as the names of teachers, other staff, and the school. Only my name, the name of my sponsoring professor, and Moravian College will appear in the study. No names will be included on work samples or in any reports of the study. Minor details of students writing may be altered to ensure confidentiality. All research materials will be kept in a secure location in my home and all data gathered during the study will be destroyed at the conclusion of the study.

All of the students in my classroom will receive the same instruction and assignments as part of the science curriculum. Participation in this study is entirely voluntary and will not affect the student’s grade in any way. Any student may withdraw from the study at any time by writing me a letter or sending me an email stating that he or she would like to do so. The parent or guardian may also withdraw the student through a letter or email. If a student is withdrawn, or if the parent or guardian chooses not to have him or her participate in the study, I will not use any information pertaining to that student in my study and the student will not be penalized in any way.

You can contact me at Easton Area High School by phone at 610-250-2481 or by email at eromer@eastonisd.org.

My faculty sponsor for this project is Dr. Joseph M. Stith. He can be contacted at Moravian College by phone at 610-801-442 or by email at jstith@moravian.edu.

If you have any questions or concerns about my project, please feel free to speak with me or email me. If you have no questions, please sign and return the bottom portion of this letter. Thank you very much for your help.

Signed,

Richard Omer

I attest that I am the parent or guardian of _________ that I have read and understand this consent form, and that I have received a copy. Richard Omer has my permission to use my child’s class work as part of this study.

Students Name
Parent’s signature: ___________________ Date: __________________
Appendix D – Introductory Student Sheets

Kunkle Study Project

Introduction
Lets do something different. What do Environmental Scientists really do? Well, This fall you are all going to find out. We are going to complete a field study of the Environmental Tract - That pond out back. We are going to be exploring what makes an aquatic ecosystem function. We will be spending a lot of our class time outside while the weather holds.

Getting there
Several days out of the week we will be meeting at the outdoor classroom on the Tract. I understand that it is a walk. I expect you to make an effort to get there quickly. You will have the normal allotted 5 minute passing time plus 5 minutes before I consider you late. So if the bell for 2nd period rings at 8:17 I will be started at 8:22. I will not wait for you. You are sitting on the benches and ready to go like good students. If you believe that this is too much responsibility you should change classes now.

What to wear
Clothes that WILL get dirty. Dress for the weather. Keep a jacket handy. A spare set of shoes would also be a good idea. I would highly advise against the following items:
1) High Heels
2) Sneakers you don’t want to get dirty - (I don’t care about your Kicks)
3) Pretty clothes - Mud on your $150 pants is on my list of things that are not my problem.
4) Anything valued more than my paycheck. I am not diving into the pond after any reason for your I-pod.
**Medical Concerns**
If you have a bee sting allergy I NEED to know about it NOW.

**Timeline**
This project will run up to Thanksgiving so be prepared to spend at least 3 days per week outside. Physics stays indoors and does not require a walking component. They will take you if you don’t think environmental science is for you. Do not worry, You will not offend me.
Introduction.

In order to begin a study of an aquatic ecosystem we need a really good map. This map needs to contain more than just roads. We will be mapping the following things:
   1) Elevation (Topography)
   2) Water bodies
   3) Roads
   4) Trees
   5) Wetlands
   6) Drainage areas

We are going to start this study by producing what is called a base map. A base map is the starting point. All the above information is placed on the base map and it becomes the foundation of our study.

The Brunton Transit.

To produce our base map we are going old school. The Brunton Transit is a simple way to take map data. It works in heat, cold, rain, sun. It works any time of the year and is not affected by leaf cover like GPS is. We have two Brunton Transit sets and will be using them to complete this step of the project.

Timeline

1 day for instruction - Outside
3 days for data collection - Outside
2 days for map making - Inside.
Appendix E – Introductory Survey

Kunkle Tract Project

Pre study Survey

Rate the following on a scale of one to ten. One having no environmental impact and 10 having far reaching environmental impacts.

1) A fella changing his cars motor oil in the parking lot.
2) Somebody releasing a few goldfish in the pond before they move to P-burg
3) Planting a pretty flowering plant by the pond in order to “liven up the place”.
4) Spraying pesticides on the soccer field to control moles.
5) Spraying the Pond with pesticides to control insect populations
6) Allowing an invasive plant species to spread through the wetlands.
7) Introducing a non-native animal to the pond.
8) Putting a fence around the pond to keep vandals out.
9) Cutting down the cattails in the wetlands because they are considered by the school board to be unsightly.
10) A student sees a skunk while walking the path. Fearing a rabies incident the school sets traps and removes 2 skunks, 3 raccoons, and one muskrat.
Appendix F - Student Generated Map Data.

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**Notes:**
- Bearing (deg) represents the angular direction.
- Length (7) and Length (m) represent the distances in feet and meters, respectively.
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(Length (deg)): Bearing (deg)
Appendix G: End of study write-up and data

Honors Kunkle Project Write-up/Mid term

Part 1: Introduction

The introduction should describe the study site, what was done, and why it was done.

Length: no more than 2 paragraphs.

Part 2: Data Sets - Water Tests, soil tests.

Table containing the parameter, data, dates, and tests run

A discussion of trends seen in the data. Did values go up, down, or stay the same? Why did they change?

Length: One page for water tests, one for soils.

Part 3: Human Impacts

Discussion of water dye tracing and impacts of human activity on the pond.

Length: 2 paragraphs

Part 4: Future Studies

Suggestions for activities to complete in the spring.

Length: 2 paragraphs

Part 5: Conclusion - Sum up your results. Address the big ideas.

Length 1-2 paragraphs.
Location: end of small fence by water

1st: nitrates: 2  
Phosphate: 2

2nd: n: below 2  
Ph: below 2

3rd: n: below 2  
Ph: below 2

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tests

Water tests
5/12 nitrate nitrogen: 0
10/30 nitrate nitrogen: 1 or .5
11/3 nitrate nitrogen: .5

Soil tests
9/26 Nitrogen: 26
11/8 Nitrogen: 15
soil pH: 5.5 6
Water Tests
Phosphate:
9/12/11- 2
10/20/11- 2
11/3/11- 0

Soil Tests
Potassium:
9/26/11- 160 pounds per acre
11/10/11- 370 pounds per acre

Carbon Dioxide Level: 34 parts per million

Water Tests
Precision PH:
9/12/11- 7.5
10/20/11- 7.5

10/18: Ph: 7.5
Nitrate: 0
Phosphate: 0

11/10: Phosphorous: 100 ppa