SCIENCE OUTDOORS: DOES THE LEARNING ENVIRONMENT

INFLUENCE STUDENT INTEREST, ENGAGEMENT, 

AND COGNITION?

by

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ABSTRACT

Lack of motivation and engagement are common problems in many high school classrooms. In addition, this apparent lack of interest may lead to low achievement. The purpose of this study was to determine whether bringing students outdoors to learn science can increase student motivation, cognitive engagement, and achievement. A secondary question investigated in the research was the effectiveness of remaining on the school grounds, and within a fifty minute class period, while learning outdoors.

A small student population limited the number of study subjects to seven (N=7). The small population allowed me to treat the research as a case study and acquire detailed information about each participant and their progress.

Research involved two half-day field trips to a local river access and at least sixteen outdoor, on-campus events during student’s normal class periods. Data collection techniques incorporated into the study include: a science motivation survey, individual student interviews, time-on-task tally sheets, pre-and-post tests and quizzes, field notes, observations, and a teacher’s journal. Data was collected before, during, and after treatments in an effort to monitor change throughout the process.

Results from this study indicate that there is a positive relationship between student interest, engagement, and achievement with going outdoors to learn. Class size, age, maturity, and proximity are factors that should be considered when planning such events. Drawbacks included individual student aversion to science as a whole, and applicability of certain domains within science.
INTRODUCTION AND BACKGROUND

Since my first year teaching at Willow Creek School, four years ago, I have been frustrated with a general lack of motivation and interest in high school subjects among many of the students. Subsequently, this observation has led me to ask myself how I can help students develop interest, motivation, and engagement in learning science. Up to 80% of them are living in home situations that consist of single or divorced parents, living with grandparents, aunts and uncles, or are living in a somehow broken family. Many times these situations involve guardians that either are not interested in spending the time to show their young ones the fascination and beauty of the natural world, or do not have the time. My inclination was that bringing students outside, both within the school yard and outside of school grounds, would enable them to become engaged and enjoy learning about science. Hence, the primary Action Research (AR) question behind my study is: What effect does bringing students outside to learn have on student interest, motivation, and cognitive engagement in science? Secondary questions I have researched are: 1. What effect does outdoor learning have on student comprehension of science content? 2. What effect does outdoor learning have on students’ appreciation for the natural world? 3. How does conducting class outdoors affect me, the teacher?

For this AR project I was interested in exploring how going outside to observe and document the impact of “real” science on my students. My expectation was that spending time showing them nature in the actual setting, from the smallest details like fine sediments and microscopic organisms to the larger picture of habitats and landscapes, would foster an interest and develop a connection to not only our amazing
local area, but also to our vast planet. I expected that physically guiding students on how to perform detailed observations and note taking in the field, coupled with identification and comparison employing prior knowledge, would offer them an elevated sense of personal being and value. The goal was to show them how a “real scientist” would conduct field work, and to encourage them that we can do real science in the field.

Support Team

The first person I chose for my support team is my sister. She lives nearby and we see one another often, therefore she is frequently available for feedback and suggestion. She and I have always shared an interest in science together, and she is a master at proofreading, grammatical skills, Word, and Excel. A second team member was my mother. It is true that mothers know their children better than anyone else. She has a great sense of my goals and interests, and we are able to communicate freely. Likewise, she is a retired teacher and offers much insight to the profession from her experiences.

CONCEPTUAL FRAMEWORK

Outdoor learning involves a unique engagement between students, teachers, and the outdoor environment. Individuals that take part in outdoor learning are advocated to use their cognizance and senses in a much different manner than within a traditional classroom setting. Experiencing nature involves engagement of all domains and senses, observation, seeing, touching, hearing, and smelling. Engagement of the mind and senses results in a more thorough connection to learning about the environment and a more meaningful understanding. The following literature supports my action research questions through research and practice in several examples.
There is no mystery why John Dewey, his theories, books, and studies are continuously referenced throughout educational philosophy, psychology and theory. Dewey has been referred to as the most significant educational philosopher of his time and of over the past 100 years. Dewey’s concept of education emphasized meaningful activity in learning, learning by doing, and development of practical life skills. He changed fundamental approaches to teaching and learning. Earlier models of teaching relied on authoritarianism and rote learning. Dewey’s ideas and philosophy were based on pragmatism and true democracy. They were central to the Progressive Movement in schooling. Dewey argued that education should be relevant to students’ lives. John Dewey’s philosophies spawned the development of experiential education. From his point of view education was not simply a teacher lecturing and a student learning. For Dewey education had a broader social purpose, which was to help people become effective citizens and members of a democratic society. Therefore he argued that teachers need to take into account individual differences in students into their pedagogy.

Similarly, students need educational experiences which enable them to become valued, equal, and empowered members of society. In Dewey’s theory of experience he believed humans survive better according to our experiences. Whether positive or negative, experiences shape the way we live and our future experiences. The modern philosophy behind experiential and outdoor education was shaped by Dewey’s ideals. I share similar values and beliefs in my pedagogy, which is my reasoning for using Dewey’s work in my theoretical framework. Dewey’s groundwork has helped me formulate an overall perspective on my goals of this study. It has reminded me that most people truly do
“learn by doing”, and when one becomes involved in something in which they develop interest, it makes the process more meaningful and enjoyable.

In recent history there has been a significant increase of research and findings supporting the practices of place-based education (PBE), environmental education (EE), experiential education, and outdoor education. The focus of my research involved elements of each of the aforementioned disciplines while remaining connected to science education standards. Lock (2007) demonstrates that this is a realistic and attainable goal. He explains indications of the positive impacts, and demonstrated examples of traveling out of the classroom in order to perform fieldwork. Lock (2007) explains “the term fieldwork is used to encompass any practical work occurring outside the school laboratory, be this in the school yard, on the sports field or in the wider environment” (p. 633). Meaning that learning outdoors does not necessarily require, but could include, an all-day field trip. Lock emphasizes throughout the article that “fieldwork” can be accomplished within a normal 50 minute class period on the school grounds.

The rationale for undertaking outdoor experiences is that they can provide a wider range of learning opportunities for students than a traditional classroom or laboratory. Lock (2007) reports:

Work in the laboratory commonly involves the manipulation of single variables while others are held constant or controlled. In contrast, fieldwork addresses the complex of variables involved in the interrelationships between living things and their environment. Such situations provide a genuine open-ended approach to practical work, where answers are unknown to pupil and teacher alike (p. 633).

In other words, the inherent repetitiveness and predictability of the classroom setting is uprooted by going outside to observe and learn.
Lock (2007) then discusses how field work has the ability to improve reasoning and problem solving skills. He suggests an inquiry approach by allowing pupils to negotiate a simple question, determine a plan, collect their own data, then interpret and evaluate it. An elementary example would be to observe a local tree, stream, hedge, or rock, then suggesting the initial problem to find out what is living there. The subsequent step would be to further guide them into inquiry by allowing them to negotiate which questions to ask next. Suggested questions would be: Why is it there rather than somewhere else? Will it survive there? Will it be there tomorrow/next month/next year? How many are there? What is helping it? What is hindering it? (Lock 2007). The inquiry process and questions would be similar to that of an ecologist at any level. This technique is also suggested within the framework of the Next Generation Science Standards (NGSS). A portion of my research followed Lock’s model by determining how much outdoor science can be accomplished within one class period on the school grounds. Implications of this research may allow science teachers to use this model to involve more outdoor science within their curriculum without the extensive planning, preparation, and expense of a field trip.

Subsequently, Lock (1997) discusses ideas on how to incorporate field work into the typical classroom timetable without involving excessive time commitments. He suggests bringing the fieldwork to the class if the class cannot go into the field. For example if a teacher wanted to study freshwater aquatic environments one could use a watering trough or old bathtub, on the schoolyard, for a lab setting. While these are not ideal situations, they are examples of a creative and resourceful thinker. Lock (1997)
offers suggestions and examples of how creative science teachers can administer some amazing science experiments, on a minimal budget, without straying far from a school campus. In addition, the science that pupils perform can make a direct contribution to scientific research.

Additional research that supported my study was based on an environmental education field trip for sixth graders (Louis S. Nadelson and J. Richard Jordan, 2012). The event was a day-long environmental awareness field trip. The study involved 111 sixth-grade students from four different schools, and ten high school students as leaders and organizers of the field event (N=121). Unlike many field trips, the destination was a city park on the proximity of an urban boundary. One of the reasons I value this article is that the trip was orchestrated by a high school biology and environmental science teacher, and his students. According to Nadelson & Jordan (2012):

The high school students had a high level of responsibility for developing the activities for the event, enlisting community organizations to provide demonstrations and educational presentations at the event, and recruiting and preparing the local elementary teachers and students for the event (p. 224).

Not only were the high school students involved in the organization, planning, and leading the trip, but they also were elemental in the assessment portion of the study. Research subjects were assessed the day after the event and one month later.

The day after the field trip, sixth graders’ completed an attitude toward field trip survey (ATFT). Concurrently, the high school students completed an open ended questionnaire assessing their perceptions of the processes and outcomes of the event. The questionnaire was a six item free-response survey. Nadelson & Jordan (2007) acknowledged:
The six survey items asked the high school students to share their motivation for getting involved, how they were involved in the event, what they learned from the experience, and how they might improve Outside Day if the event was to be offered again (p. 225).

Approximately one month later the sixth grade pupils were assessed on their recall of the event. For this assessment they were asked to divide a piece of paper in half horizontally. On the top half they were asked to draw an illustration about what they learned on the field trip. The bottom half was reserved for an explanation of the drawing. The premise behind this strategy was to promote thinking and reflection of the event without introducing bias or leading. In other words the assessment was designed to evaluate recall, not knowledge or understanding.

The conclusions from this study indicate field trips can be very useful and fulfilling for learning in a direct context and provide opportunities to apply prior knowledge. The study indicated that students maintained positive attitudes toward field trips and recalled hands-on activities at a higher frequency than from alternative settings. The results were substantiated by data collected from the high school students involved with the event. Nadelson & Jordan (2007) concluded “We contend that the level of student engagement, interest, and motivation, and the enthusiasm of the field trip guides are substantial influences on students’ attitudes toward the events and what they recall—and perhaps learn—from the events” (p. 230).

An additional resource that is a popular reference source within the fields of outdoor, environmental, and experiential education is the journalist and author Richard Louv. In his book, Louv (2008) coins the term Nature Deficit Disorder. He is referring to an increase in children’s disconnect from nature as a result of modern technology such as
video games, portable tablets, smart phones, etc. The apparent disconnect has been related to increased emotional, physical, and educational difficulties in young people today. Examples are childhood obesity, increased depression and attention disorders. Nature Deficit Disorder is increasingly becoming a more important issue in on a state and national level the United States. As a result, the no child left inside movement was formed and has been endorsed by at least four states, and is catching on in many educational settings. The movement seeks to encourage and provide additional funding for environmental and outdoor education.

Louv (2008) offers practical solutions and simple methods to overcome the deficit and heal the broken bond between children and nature. The book brings together an emerging body of research indicating direct exposure to nature is essential for physical and emotional growth and well-being. Additionally, the book has initiated a nation-wide dialogue amongst health professionals, educators, parents, conservationists, and even policy makers that want to change the way children are raised and educated in relation to the natural environment.

An underlying premise of my research is how people learn in natural settings. Dr. Michael Brody (2005) investigates the theoretical framework, and develops a conceptual framework in the form of a matrix, for meaningful learning in ecological settings. Brody (2005) begins by explaining that educational theory is often overlooked or ignored in EE on the basis that learning is empirical or a result of the outcome of EE activities. His argument is that not all people learn from nature spontaneously and much of the desired leaning content is not obvious or common sense. Brody (2005), with the help of other EE
teachers, selects the most promising learning theories, applies them in an ecological perspective, and combines them with the practical aspects of direct learning.

Brody (2005) continues by discussing variables that affect situated learning in informal settings. Background knowledge, one’s internal conceptual framework, curiosity, opportunity, value development, and exploration during the learning process were considered the most influential. A comparison to learning in museums was used for the fact that a significant amount of research has been completed in this field. An unexpected outcome from his surveys conducted in Midway Geyser Basin in Yellowstone National Park, Brody (2005) discovered that visitors’ values developed and changed throughout their experience in Yellowstone. Much of this development was attributed to building on one’s prior knowledge and the inspiration of the physical setting itself. Brody (2005) states:

In summary of the early development of the learning theory and its first iteration as a result of the Midway Geyser Basin study we believed that: meaningful learning in EE takes place when learning is situated in real world events; it is a personal construction of knowledge through various cognitive processes mediated by social interactions (p. 608). From his findings and experiences Brody (2005) constructed a matrix of meaningful learning in natural settings. The matrix was intended to define the principles of the theory and their relationships.

In the final section of the paper Brody (2005) presents a case study of learning in nature from the perspective of an 11th grade student’s experience in learning about bogs. The study analyzes the student’s field journal and displays the relationship of the student’s learning to each cell in the Theory of Learning in Nature Matrix. The case study-matrix relationship exemplifies the value of direct learning in nature and the
benefits related to meaningful learning. Brody’s matrix and case study analysis proved to be elemental tools in my study. They helped me maintain focus on my AR questions, and gave me an alternative point of view on a very similar research topic.

Orly Morag and Tali Tal (2012) propose a *Field Trip in Natural Environments (FiNE) Framework*. This study proposes a conceptual framework designed to capture the main characteristics of learning in nature. The FiNE framework allows systematic analysis and scoring of several phases of the field trip: preparation, pedagogy, activity, and outcomes. The authors provide rubrics for each section of the framework. Data was collected in the forms of student and teacher interviews, and non-participant observations. Students were interviewed before and after the event (N=22). Morag and Tal (2012) explain:

In the interviews, students were asked about their expectations for the field trip and about the extent to which these expectations were fulfilled. They were asked as well about preparations for the trip in school, the field trip programme itself, its most and least enjoyable features, the most memorable activities during the trip, what they learned or what knowledge was reinforced and their thoughts and beliefs about nature and the environment in the context of the field trip. Each interview lasted 20–30 minutes (p.750).

I started interviewing students almost a year before my project began. I found this to be extremely beneficial in two ways. First, it familiarized my students with the interviewing process. This allowed them to relax, and give thorough, honest responses. Second, it allowed me to adjust my AR and interview questions, prior to data collection, according to their responses.

The expected learning outcomes of this study are presented in two domains. The cognitive domain includes knowledge and understanding, while the affective domain includes feelings, beliefs and attitudes. Students were scored separately in these
categories according their responses during the interviews. Scoring for the knowledge
and understanding domain was based on accuracy of responses and connections between
cause and effect relationships. Scoring of the affective domain was based on four ideas
about nature that emerged from student responses. The four ideas were: (a) nature as a
source of resources for human beings; (b) nature’s spiritual and aesthetic value; (c) nature
as having intrinsic value beyond the spiritual and aesthetic; and (d) nature as a factor in
human health (Morag & Tal, 2012).

The study suggests a holistic framework for assessing an entire field trip from
conception through recall of learning after the event. The article states:

The FiNE framework captures the components of the preparation phase (class
preparation; coordination with the facilitator and connection to the curriculum) as well as
pedagogical aspects of the guided field trip (ensuring that students are aware of the trip’s
goals; using specific aspects of the field trip environment as a source for learning; making
connections to everyday life; enhancing social interactions among learners and the
facilitator’s performance at the interpersonal, didactic and logistic levels). In addition, the
FiNE framework incorporates a professional observer’s interpretation and the
participants’ own reported experience (Morag & Tal 2012).

The setting of my school is rural with a very small student population. This venue
has the opportunity to provide a unique educational environment, but does not present
itself without difficulties. An article from Leanne M. Avery (2013) very closely fits my
current educational situation, concentrating on teaching science in a rural academic
setting. The article addresses many common difficulties, which apply to teachers and
students, found in small rural schools. Isolation, underfunding, attracting and keeping
well qualified teachers, and out-migration are several examples of issues within rural
schools. Students from these schools can experience feelings of lack of motivation,
disenfranchisement, and a general feeling of unimportance or lack of relevance to society.
Incorporating local knowledge into an education curriculum has the ability to counterbalance or avoid these feelings. Building on work from other social and cultural researchers the author developed the concept of Local Rural Knowledge (LRK). Avery (2013) states:

Indigenous knowledge is context-specific because it is related to, and contained within, a group of people who live in a defined geographic region. It is derived from people’s engagement with their environment, and it encompasses the interconnectedness within an ecological system and that system’s relationships to a greater whole. It arises from closeness to the land and living things, growing out of a connection to natural surroundings (p.31). Avery (2013) continues by stating “The legitimization of local knowledges through place conscious pedagogies bridges the gaps between children’s LRK and school/global science” (p.31). The author provides several pedagogical suggestions for integrating LRK and PBE into a curriculum on three levels: student, teacher, and community. On the student level, photo documentation, ethnographic studies, youth stories, and mapping local resources were suggested strategies. On the teacher level, teacher based PBE development programs, scaffolding content including pedagogy across grade levels, followed by providing students with concrete examples was recommended. On the community level, identifying with local resources and elders were suggested in combination with participatory action research. The conclusions from this article confirm that it is possible for students from small rural communities to share resources while maintaining their unique identity. In order to help students succeed, teachers must be committed to alternative methods of teaching, remain open to change, and foster dialogue with parents and community members. In addition, teachers and school staff
members should explore grant funding opportunities and reach out to external organizations to provide students with formal experiences.

According to the literature, outdoor and experiential education has many benefits for students. Learning is more concrete and exciting. Students tend to stay focused for longer time periods and not become bored. Learning through nature is a much more active environment than within the classroom. Students are involved in the context of the situation rather than requiring the use of their imagination to picture how the natural world is or works. A result of learning outdoors is they become more involved and empowered in the learning process.

METHODOLOGY

Participants
The school where I teach is a very small, rural Montana school. At this time there are twelve students between 6th and 12th grades: five seniors, no juniors, one sophomore, two freshmen, one eighth grader, one seventh grader, and two sixth graders. For my study I chose to involve the students ranging from sophomore down to sixth grade. The seniors were not selected for this study because they are not required to take a science course, and none of them had committed to science at the planning stages of this study. That left me with seven total study subjects (N=7) spanning five different grade levels. For anonymity purposes I will refer to them as Student A-Student G. It should be noted that Student A, Student B, and Student F have Individual Education Plans (IEP’s). These students have been designated as slower than average learners with suggestions for the teacher to adjust their curriculum workload to about half of a “normal” student workload.
The two sixth grade students joined my classroom in October of 2015. They were not included in the original planning of this study; however they became part of the data collection during the spring semester of 2016.

At our school, sixth grade science is a general overview of life, earth, and physical sciences, seventh grade is life science, eighth grade is physical science, ninth grade is earth science, and tenth grade is biology. With such a small student population, I felt it necessary to include as many students and grade levels as practical. Following the suggestion of Walt Woolbaugh, my advisor, this project became a case study monitoring individual change over time. Data was collected for over a year and student variation was compared from the onset of data collection in early 2015 through the end of the school year in 2016.

**Demographics**

A majority of my students (≈ 80%) come from broken families that fall into the category of low socioeconomic status. Some may view this as a setback or hindrance on student education potential. I view this as an opportunity for me, as their teacher and mentor, to show students the natural world in a new and exciting fashion, and hopefully expand their learning potential.

Student A comes from a family of poverty level income with many children (at least 10), ages ranging from in their 30’s to less than two years old, and a majority of them adopted. From my experience I would say the parents are not very supportive of the public school system and “create their own rules” when it comes to compulsory education. In other words attending school and doing well is not a prominent emphasis in
the family. Student A’s participation, motivation, and grades reflect this home life. There are many days that he doesn’t want to do anything and is very tired. Motivation has always been a trying factor in my involvement with him. This student was failing most classes two and three years ago, before the IEP was in place. Currently his grades have improved (B’s and C’s), however I would still consider this student to be at a lower than average achievement level.

Student B is an only child living with his mother and her boyfriend, probably median income status. His family is supportive but doesn’t place expectations, such as passing grades, as important. Student B hovers around the (C-) to (D+) range for grades. He very rarely does homework, and often submits incomplete assignments.

Student C is from a mixed race family that is most likely low income status. Student C’s family values education and striving to do well, and it shows. Student C went from a (C) average two years ago to an (A-) average this year. The poorer grades in the past were mainly related to self-confidence and study habits. She had a great deal of test anxiety and poor study habits. In the past two years she has responded to her teachers and parents requests and stepped up her work ethic and study habits. The improvements of her study habits have shown in her grades and participation.

Student D is an only child living with her biological father and stepmother with a moderate income. Student D’s family values education and attending school as important. This student is consistently in the high (B) to low (A) grade range.

Student E lives with his grandparents with a moderate income. Student E’s guardians value education and attendance, but don’t seem to offer much assistance at
home. He is normally in the low (A) grade range, and works hard to maintain his grade. He is on medication for attention-deficit disorder (ADD).

Student F lives with his single mother whom is in a low income bracket. Student F comes from a difficult situation that seems to involve little supervision while at home. He is a case of extreme attention-deficit/hyperactivity disorder (ADHD), and takes medication for it. He has a very difficult time focusing on anything for more than a few seconds, and is just as easily distracted. Student F doesn’t appear to have any concern for getting good grades and puts forth very little effort to complete any assignment. He falls in the (D) and below range for five out of seven classes. He would not have passing grades if his mother wasn’t (admittedly) doing his homework for him.

Student G lives with her mother and stepfather in a moderate income situation. Parents are supportive while education and attendance are stressed as important. Student G consistently maintains A’s and B’s and works hard to maintain her GPA.

The demographics at this school are typical for many rural school settings in Montana and likely throughout the U.S. Many students don’t get much academic support at home while grades and academic success are not stressed as important. I don’t view this as abnormal or unique, it quite simply becomes a majority in such a small student population. For clarification I would rank Students C, D, E, and G as middle to higher academic standing or achievement, and Students A, B, and F as middle-to-low academic standing and achievement.
Treatments

In an effort to familiarize my students and I with the process of going outdoors and my associated expectations, informal treatment for this study began spring of 2015, then continued in September of the same year. During the last several weeks of the 2014-2015 school year, then again near the beginning of the 2015-2016 school year, students were brought outside during their regularly assigned class period on several occasions. A portion of this design was to get the initial excitement of going outdoors behind us, with the intent that students would be better focused on learning and observations for the formal treatment periods. Another aspect of this “trial period” was for me to familiarize myself with the data collection process outside and assess the potential for collection of multiple data types while outdoors.

Additional data collection for this study began in February 2015 with individual student interviews. The purpose of these preliminary interviews was to get a feel for student perceptions of going outdoors and to refine the AR questions associated with the study. A majority of the actual treatments occurred in the spring of 2016. However I have been bringing students outdoors for science class throughout my teaching career, and began to assess them while outdoors with more scrutiny in the spring of 2015. This assessment included mindful observation, journaling their behavior, and assessing student documented observations.

Formal treatment was conducted during two planned field trips and while directing normal class periods, either part or all outdoors, within the school grounds. The half-day field trips were conducted mid-October 2015 and mid-April 2016 at a public
river access site (Williams Bridge) on the Jefferson River about three miles from Willow Creek School in Willow Creek Montana. The purpose of the field trips was for students to perform a general water quality assessment. Five (N=5) seventh-through-tenth grade students were chosen for the field events. The two sixth grade students were not included in this portion of the study because they were added to my class after the initial planning. (Maturity level and technical skills may have been an additional reason for not including younger students if I had known in advance that they were going to be added to my class schedule.)

The day before or previously the same day, students were briefed on the plan for the field event including methods and types of data collection. The event was partitioned into four sections, each involving between 20 to 40 minutes. The individual components consisted of: a general site analysis and description, abiotic characteristics, biotic characteristics, and a site drawing, each with corresponding worksheets (Appendix A). To maintain efficiency and keep students on task, two-to-three students worked on collecting physical and chemical characteristics of the river while others collected biological samples using a D-net and plastic tubs. If students claimed they were out of tasks they were directed to work on their site drawing including observing additional flora and fauna. Importance of accuracy and consistency of data collection were emphasized in the briefing and during the ten minute van ride to the site. Student safety was placed at the highest level of concern before and during the field events.

Once at the site, a general assessment was conducted observing the lay of the land, the size and scale of the river, and a safe and appropriate location for gathering data.
Students worked together in gathering data and filling out blanks on a data sheet workbook as I directed them through the procedures. Preliminary data documenting site location, description, time, date, current weather conditions, stream flow characteristics, stream channel and riparian vegetation summaries, and any other comments were recorded on the first data sheet. The second data sheet contained water quality data information. This data sheet included spaces for time and date, air temperature, water temperature, pH, dissolved oxygen (D.O.), and an estimate of turbidity. There were other technical characteristics displayed on the data sheet, however we did not have the proper equipment for measuring them, therefore they were left blank. The third data sheet was used for quantitative and qualitative counts of freshwater macroinvertebrates. Students used what I refer to as a D-net shuffle method to collect samples. In the D-net shuffle one participant shuffles along the river bottom, stirring up rocks and substrate, while a second stands just downstream with the D-net placed to catch macroinvertebrates. For consistency, students shuffled with similar frequency for thirty seconds each collection period. D-net samples were then emptied into a twelve quart Sterilite plastic tub. Subsequently, samples were separated into ice cube trays according to family or genus, then further grouped and identified using a dichotomous key. The last worksheet used was a Site Map Drawing. The drawing was intended for students to highlight the prominent and important features of the site. Features may include a riffle or pool, side channel, gravel bars, log jams or debris, vegetation, roads or bridges, irrigation diversions or dams, and other landscape features. The assessment portion of the worksheet packet was based mainly on completion and accuracy of information.
Instrumentation

Throughout the treatment period I implemented six data collection methods in an effort to include data triangulation and to ensure validity and reliability in the study. A Likert-Scale survey: the Science Motivation Questionnaire (SMQ-II), Time on Task Tally sheets, pre- and post-tests, individual interviews, direct observation, and a personal reflective journal were incorporated as data collection techniques. The SMQ-II provided both qualitative and quantitative data related to student interest levels in learning science. This questionnaire fits with my primary question allowing me to evaluate whether or not bringing students outside throughout the school year affects their interest and motivation levels to continue learning science. Time on Task tally sheets allowed me to compare classroom behaviors with outside behaviors, including engagement. Teacher made pre- and post-tests provided an additional source of quantitative data, allowing me to track comprehension of science content. Individual student interviews offered a significant amount of insight into interest, motivation and acquisition of science content. Although somewhat difficult to document, direct observation provided me with a significant amount of evidence related to the effectiveness of going outdoors for science. The observation provided insight to student learning, comprehension, and engagement through informal inquiry probes and questions. Finally, my personal journal allowed me to document and reflect on student behaviors including interest levels, motivation, engagement, and appreciation of nature.
Table 1 below lists my AR questions and the methods used to answer them. Detailed explanations of the six methods are explained on the following five pages.

Table 1

**Action Research Process: Questions and Methods Applied (Data Triangulation Matrix)**

<table>
<thead>
<tr>
<th>Focus Questions</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>What effect does outdoor learning have on student motivation, interest, and engagement?</td>
<td>SMQ-II Survey</td>
<td>Individual Student Interviews</td>
<td>Time on Task Data Sheets</td>
</tr>
<tr>
<td>What effect does outdoor learning have on student comprehension?</td>
<td>Pre and Post Tests and Quizzes</td>
<td>Individual Student Interviews</td>
<td>Student Field Notes and Observations</td>
</tr>
<tr>
<td>What effect does outdoor learning have on student appreciation of nature and the environment?</td>
<td>Teacher Observations and Field Notes</td>
<td>Individual Student Interviews</td>
<td>Survey Supplemental Questions</td>
</tr>
<tr>
<td>What are the effects of outdoor education on the classroom teacher?</td>
<td>Teacher’s Journal</td>
<td>Teacher Observations and Field Notes</td>
<td>Post Event Reflective Journal</td>
</tr>
</tbody>
</table>

*Note.* (N=7)

**Survey Method**

The Science Motivation Questionnaire (SMQ II) survey (Appendix B) incorporates a Likert scale survey to assess components of students’ motivation to learn science. Survey questions are separated into five different component categories of: intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. The goal in using this style of survey was to accurately assess and quantify any change in students’ feelings and perception of science during the treatment period. The survey was administered to five of the seven study subjects on two separate occasions throughout the school year. (The survey was not appropriate for the sixth grade students, mostly related to maturity level, likewise they were not part of the treatment field trips.) The survey was first administered in the end of October 2015, prior to a majority of the treatments. Then, for conclusive evidence, the survey was administered near the end of the treatment period in April of 2016. Four supplemental short answer
questions (Appendix C) were added to the second survey treatment. The supplemental questions were designed to allow students to explain why they responded the way they did within the survey, in relation to learning science outdoors. Comparisons of pre-treatment and post-treatment responses are displayed in Figure 1.

**Time on Task Method**

Time on Task Data Sheets, (Appendix D) were incorporated in the classroom beginning February 2016. Student behavior was observed and recorded for each ten minute interval of a fifty minute class period. Students received a plus (+) for on-task behavior, a minus (-) for off-task behavior, and a plus / minus (+/-) for behavior that was partially on task and partially not on task during each ten minute interval. Indoor classroom behavior was monitored a minimum of eight class periods, on random days, throughout the months of February, March, and April. Outdoor behavior was monitored in the same fashion, for both outdoor time within the school grounds and while on a field trip. Furthermore, outdoor time within the school grounds was denoted with an “O” placed within the corresponding time frame box on the tally sheet. The information gained from this data source was beneficial in comparing quantitative data related to student engagement and motivation, indoors versus outdoors.

**Pre-and-Post Test Methods**

Teacher made pre-and-post tests were implemented to assess cognition of the content material to be covered while outdoors. The Water Quality Assessment test (Appendix E) was specifically designed to assess student knowledge, pre-and-post treatment, of testable physical and chemical aspects relating to water quality. I knew
going into the test that it would be difficult for most of my students, considering it was adapted from a college level curriculum. I had addressed the concepts and related information with each student in the past, however it had been more than a year since we talked about water quality in class for some. The test was administered just prior to, and about six days after the April 2016 water quality field event on the Jefferson River.

A second and completely unrelated pre-and-post-test was administered to sixth and seventh grade students before and after a unit focusing on identification of birds. At least twelve different species of locally found birds were introduced in the classroom, including pictures and audio recordings of their calls or songs. Each day for six consecutive class days, the same selection of birds were introduced during the first part of class. Sometimes I would begin with the call or song, then show an image and give the name of the bird. On other occasions I would begin with the image, then play the call and state the name. After reviewing the species indoors, we would go outside to look and listen for birds around the school campus. At times we could only hear the birds and other times we could see them before we heard them. The importance of being able to mentally separate and decipher different bird calls was emphasized while outside. The pre-test was given in class by randomly showing the image or by playing the call / song of twelve common, local birds. Students were required to write the common name after the prompt. The second test was administered the same way, with the same twelve species, in a slightly different order. The final test was given outdoors with representative birds in the order we saw or heard them. For example if I repeatedly head a bird calling, and it was from an obvious location or direction, I would ask students to write down the
common name. If we saw a bird and all agreed that we saw the same bird, I would ask students to write down the common name. The outdoor identification quiz lasted for about twenty five minutes and eight different species of birds were selected for identification.

**Interview Methods**

I have found personal interviews to be a very effective method of collecting qualitative data collection from students. I used a semi-structured method to probe into student knowledge and interest levels in a more open ended fashion than the SMQ II Survey. This process allowed student feelings and emotions to be expressed and evaluated while speaking about what and how they learned. Interviews were conducted for pre-treatment data, mid-treatment, and post-treatment. Interviews were transcribed in the form of notes for accuracy. Questions in the pre-treatment interviews asked students to speculate about going outdoors to learn science. Middle-and-post-treatment interviews focused more on the content they learned and how that applies to their individual situation. Interview questions were fairly short, relatively few in quantity, and generalized to maintain interest and allow students to express their views. This procedure was also effective in avoiding “guiding” them into responses. Interview questions allowed me to probe deeper into qualitative descriptions by prompting students to further explain their responses. This technique would sometimes lead to secondary questions or responses that would explain student feelings about fieldwork and going outside in more depth.

**Observation and Journaling Methods**
Direct observation combined with a personal journal provided me with significant information regarding student engagement, motivation, and interest. These factors were readily observable and documented while outdoors. In addition, I was able to compare outdoor student behavior to that in the classroom. Observation was documented at the time of the event or directly following the event. The direct observations were combined with my personal journal, however journal entries were not always directly after an outdoor event. This type of formative assessment is practiced by teachers continuously, I simply made a point to document and reflect on the observations with more intent.

In an effort to ensure validity and reliability, the aforementioned data collection techniques were triangulated according to each AR question (Table 1). In addition a summary of data collection techniques was presented to three colleagues for review prior to data collection. The research methodology for this project received an exemption by Montana State University’s Institutional Review Board (Appendix F), and compliance for working with human subjects was maintained.

DATA AND ANALYSIS

Implications from the data show that outdoor learning is beneficial in increasing student motivation and engagement. Increasing motivation and interest may then complement student comprehension and achievement in a similar fashion.

Achievement

Four of the five participants (80%) in the water quality field trips increased their scores on the written test after the event. The average increase in test score was 11.78%,
with the highest increase of 20.6%. Meanwhile no participants scored poorer on the post-test than the pre-test (see Figure 1).

![Water Quality Fieldwork Pre-and-Post Test Results](image)

*Figure 1. Water Quality Knowledge Before and After Treatment as Drawn From Test Results for Students A through E.*

Regarding achievement, there was a strong correlation between individual student water quality post-test scores with their overall class grade (See Figure 2). Exceptions to this correlation were Student A and Student B. As previously mentioned, Students A and B’s class grades may not accurately reflect overall achievement, related to IEP curriculum adjustments. (Students A and B’s classroom curriculum was suggested to be about half (50%) of the normal work load according to their IEPs.)
The data above indicate that overall achievement in the classroom only, and achievement related to learning outcomes from field events are parallel among students. This indicates to me that achievement may be more related to ability and engagement / interest levels of each student regardless of learning environment. It was my expectation that learning outdoors may bring the lower achievers up by providing an active and engaging environment for learning. According to the results from the Water Quality Post Test, this in not as effective as I had hoped.

I present a second test of student achievement. A unit on local bird identification was included in the study. The unit involved both indoor and outdoor identification and testing student learning. The bird identification pre-and post-tests were administered to Students E, F, and G. only (N=3). A pre-test was given before the unit, then an indoor post-test was given after the unit, directly followed by an outdoor post-test. 100% of participants exhibited dramatic improvement for each test (see Figure 6). Part of the
explanation behind the improvement was that this was the first time these middle schoolers had studied bird identification. Additionally, these students were very excited about the “game” of going outside and seeking out birds while applying their new found knowledge. According to my journal notes and observations, the outside portion was very effective in capturing and maintaining students’ attention and focus, and was most effective with the student that has ADD and ADHD (Student G).

![Bird Identification Test Scores](image)

**Figure 3.** Bird Identification Test Results for Students E, F, and G.

The average increase for the indoor portion from pre-to-post-test was 18%, while the average score increase from the indoor to the outdoor post-test was 33%. Student G displayed the greatest increase (50%) from indoor post-test to outdoor post-test, followed by a 37.5% rise from Student E.

The results from this portion of the study conclude that identification of birds outdoors, in a natural setting, can be much more effective than in the classroom. Students enjoy the process and in turn become much more involved and focused in their learning.
Motivation

Results from the SMQ-II survey exhibit increased overall motivation for sixty percent of participants (N=5). The survey, consisting of 25 questions, was designed to assess specific components of students’ motivation to learn science in high school and college courses. The survey questions are categorized according to intent. Categories include: career motivation, grade motivation, self-determination, self-efficacy, and intrinsic motivation. Several categories were evaluated with more significance than others, considering age of population and relatedness to this study. The combined scores for intrinsic motivation, self-determination, and self-efficacy were more closely analyzed and compared, while the categories of grade and career motivation were considered less influential in the analysis. Results from the survey are shown on the following page according to category (see Figure 4).
Figure 4. Effect of Field Studies on Motivation of Students A through E as Measured by the SMQ-II Survey.

Student A was the only participant with an overall decrease in score (48%) from before to after treatment. Each category showed a decrease in value for Student A. (It should be noted that Student A’s attitude and motivation in school varies greatly day-to-day depending on mood. Therefore the post-survey results may not be a reliable measure). Student A’s responses all decreased on the survey, however I observed and documented this student wanting to go outdoors on a regular basis, and piquing interest in learning and observing while we were outside.

Student B revealed the greatest overall increase at 38%. Intrinsic motivation and self-determination categories both increased by over 60% for this student. The survey
questions addressing intrinsic motivation contained adjectives such as: meaningful, enjoyable, interesting, and relevant, related to learning science. Student B’s increase in this (intrinsic motivation) category indicates that he became more attentive and involved in learning science throughout the treatment period. The apparent increase in self-determination for Student B indicates that he put forth more time and effort into science class during the treatment period. I observed a similar increase in these disciplines, both in the classroom and in the field, throughout the treatment period.

Student C displayed equal overall scores, however increased by 6% in the categories of self-efficacy and self-determination, and decreased by about 6% in grade and career motivation. The slight increase in self-efficacy and self-determination indicates improvement in confidence and comprehension in learning science as well as time spent studying for science class. The slight decrease in grade and career motivation indicates a possible change in viewpoint of the importance of grades and the importance of science based skills in a professional career setting.

Student D’s score increased by 1.5% overall, showing a 27% increase in career motivation, equal scores in intrinsic motivation and self-efficacy, and a slight decrease in self-determination and grade motivation. The increase in career motivation indicates a potential long-term interest in science and the realization of the importance of science driven careers.

Student E displayed a 13.4% overall rise, increasing scores in all categories, with the greatest influence resulting in a 36% increase in the grade motivation category and a
30% increase in the career motivation category. The increase both grade and career motivation shows an upswing in overall motivation toward learning science.

The relationship between the survey results and my AR questions shows that bringing students outdoors as a supplement to their classroom education has the potential to increase interest and motivation in learning science. Three of five students’ survey scores increased following the treatment period (Students B, D, and E). Meanwhile Student C’s score remained the same and Student A’s score displayed a dramatic decrease from before to after treatment. The results show that the outcomes may not be similar for all students, however the benefits of bringing students outdoors outweigh the drawbacks.

Motivation levels on the survey are very similar to motivation levels displayed in class by each student on a daily basis. There was a very close correlation between class grades and apparent motivation levels in the survey (see Figure 4).

![SMQ-II Survey Results versus Class Grade](image)

*Figure 5.* Relationship of Motivation to Overall Class Grade for Students A through E.

Students that scored higher on the survey had higher average grades. This motivation and interest is evident in the classroom and on field trips. Student A was an
exception to the correlation. Once again Student A is the type of person that would randomly answer questions on a test without even reading the questions if he was having an off day. Therefore I interpret the downturn in results from the second survey as a possible result of “having a bad day” and not accurate according to my observations.

**Time on Task: Engagement**

The Time on Task Data Sheets revealed an increase in on-task behavior, while outdoors, for six out of seven study participants (86%). The seventh (Student E) had nearly equal on task behavior inside and outside (see Figure 5). Interestingly, the greatest increase in on task behavior occurred with the two students that are diagnosed with ADD. Student B’s on task behavior increased by 24.4 percent and Student E’s on task behavior increased by a whopping 40.5 percent while outdoors. The data shows that outdoor learning may be especially beneficial for students that have a difficult time focusing or staying on task in the classroom.

**Percent (%) TIME ON TASK INDOORS VERSUS OUTDOORS**

![Bar Chart]

*Figure 6. Engagement Indoors vs. Outdoors as Indicated by Time on Task for Students A through G.*
Student Impressions of the Treatment

Individual student interviews provided qualitative information addressing each component of my AR questions. Interviewing provides a much more “affective” context than tests or surveys. Interview questions were matched into specific categories aligning with the AR questions, including examples of student responses (see Table 2).

<table>
<thead>
<tr>
<th>Interview Question Category</th>
<th>Interview Question</th>
<th>Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icebreaker/ General Question</td>
<td>1. What kinds of things interest you in school?</td>
<td>Learning new information and being with friends. “Probably the projects.”</td>
</tr>
<tr>
<td>Category A: Interest and Motivation</td>
<td>2. How has going outside affected your interest in science? Can you give me some specific examples?</td>
<td>Q2. “It makes some things more interesting since you can see and experience everything” Q3. 80% would rather go outside more often than currently, the remaining student was comfortable with the current amount. Why? “It keeps me awake”</td>
</tr>
<tr>
<td>3. Would you rather go outside more or less often to learn science? Why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category B: Engagement and Comprehension</td>
<td>4. Do you feel distracted when we go outdoors?</td>
<td>Q4. “Depends on others, you know, kids goof off.” Another student responded: “More distracted indoors, because I’m kind-of bored” A third responded: “I just don’t get distracted outside….and it’s fresh air.”</td>
</tr>
<tr>
<td>5. How does going outside to learn science affect your understanding of the subject? Can you give me an example?</td>
<td>Q5. “Well… I like hands on things, and when we go outside it’s really hands on.” “Um… I think I’m able to learn inside, but understand better by going out and seeing first hand.”</td>
<td></td>
</tr>
<tr>
<td>6. Do you remember what you learned the last time we went outside during science class? (Probe specific to content)</td>
<td>Q6. Most students remembered all of the four main concepts from a field trip a week prior. One student failed to mention one of the concepts</td>
<td></td>
</tr>
<tr>
<td>Category C: Self Efficacy and Connectedness to Nature</td>
<td>7. Does going outside help you do better on science tests? Can you give me an example?</td>
<td>Q7. General response from all three subjects was “I don’t know.” Q8. “First you have to go outside to appreciate it…and to look at the scenery…” Another student: “I got to learn something new, so I have a better appreciation. I never realized the bugs that are out there when I go swimming in the river…”</td>
</tr>
<tr>
<td>8. How does going outside affect your appreciation for nature and the environment? Can you give me an example?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Interest and Motivation Questions (Category A)
The results from Category A, interest and motivation, showed that five out of six participants (83%) believed going outdoors to learn science was beneficial. All students
agreed that hands-on learning and learning in the natural environment were more interesting and engaging. Students stated that “…being outside you’re surrounded by science” and “I get to see it in real life”. This data shows that most students become more interested and involved in learning when placed in a stimulating environment. Being outdoors involves all of their senses. It offers an opportunity for students to apply themselves in a different manner than the classroom. Not only do they enjoy it more, the learning outcomes are more enhanced as well.

**Engagement and Comprehension Questions (Category B)**

Results from Category B, engagement and comprehension were mixed. While some students were confident they would not be distracted on a field trip, others claimed it was dependent on their peers. (This correlation was found to be true in the Time on Task Data Sheets as well. Students tend to be excited and potentially distracted at the beginning of a field trip as a result of the initial excitement.) For example Student B claimed in our interview that he did not get distracted while outdoors, however when out on a field trip he was generally the person distracting others and goofing around.

Eighty percent of students commented that going outside to see science concepts first hand was beneficial in their understanding. Similarly, three students mentioned that being up walking around outside and “breathing fresh air” was favorable in keeping them awake and alert. Memory retention was similar. A majority believed they would remember themes and conceptual information better after seeing them in the true, natural setting. To confirm this, I asked students what we learned about while on a field trip or outside on campus, in the form of additional informal probing questions. Students indeed
did clearly remember specific activities and details of the activities throughout the interviews. The data points to a more firm conceptualization when learning about an environment in its true setting as opposed to from a book or lecture. It stimulates the senses and allows for first person observation into as much detail as desired.

**Self-Efficacy and Connectedness to Nature Questions (Category C)**

Results from Category C were clear that students didn’t make a solid connection between test taking and their outdoor experiences. There was confusion as to whether the content of the test would be directly related to the experience, or material from their text, or the classroom. However, sixty percent of students agreed that their outdoor experiences generated a stronger connection and appreciation to nature and the environment. For example Student C commented “I got to learn something new, so I have a better appreciation. I never realized the bugs that are out there when I go swimming in the river…” Another commented that they “…already spend a lot of time outdoors, but now I look at things more”, meaning they observe nature in more detail. An example of increased appreciation came from Student E. He began to report to me, unprompted, about the nature he observed on his walk to and from school and over the weekends. He would come to my classroom each morning and tell me about the birds he spotted, ant mounds, and any other natural phenomena he came across on his way. Not only does this behavior indicate increased appreciation, it also indicates the desire to learn more about the natural world through observation.

Teacher’s Journal
Notes from my personal journal indicate that both my students and I were excited to go outdoors and practice science. We were excited about the possibilities of what we may find and see. The anticipation and associated excitement from the teacher and students sets the platform for engaged, active learning. Both parties want to be present and involved in the process. It was evident that my increased interest and motivation levels conveyed to student study subjects. In turn this set the stage for increased awareness and cognition of science content. Feedback from students made it clear that they enjoyed going outside as a supplement to their education. The fact that they enjoyed class time more then led to more productive learning.

INTERPRETATION AND CONCLUSIONS

The purpose of this study was to evaluate both the effects on 6th through 10th grade students learning science outdoors as a supplement to the classroom setting. And how it affected me. The action research based study focused on effects related to the affective domain, including student attitudes, interest, motivation, and engagement. Secondary questions included how the effects on the affective domain listed above would affect student achievement and comprehension. In addition, information was gathered in regards to how bringing students outdoors affects their appreciation for nature.

The overarching theme from the quantitative data indicated that bringing students outdoors has a positive impact on their learning progression in both subject comprehension and attitudes. Water Quality Test results indicate an overall 12% average increase in student test scores (Figure 1). SMQ-II survey results indicate only a slight (1%) overall average increase in motivation. However when the outlier (Student A) was
removed from the average, students displayed a 13.2% average increase in survey results (Figure 3). Time on task increased by an average of 12.7% when comparing outdoors versus indoors (Figure 5). And the greatest change was displayed by the middle school students (Students E, F, and G) that participated in the bird identification unit with an average increase of 33.3% when comparing the indoor post-test to the outdoor post-test (Figure 6).

Student responses from qualitative surveys and interviews indicated that going outdoors for class was especially interesting and enjoyable. The effect of being more enjoyable and interesting assists in stimulating student engagement and motivation, which may lead to increased achievement as well. Data from this study concludes that students are more engaged and on task on occasional outdoor events than in the classroom (Figure 5). Similarly, reinforcing classroom concepts with outdoor events indicates an increased understanding of material. Student responses indicated that they like going outdoors because it involves hands-on learning in a true natural environment as opposed to learning from textbooks, lecturing, and looking at pictures. One mentioned that it “gives me a better perspective of what we’re learning,” and “technically it does help my learning process because I’m awake and doing stuff.” Another point of view that I hadn’t thought of, but reinforced reliability for me was a student stating: “It’s made me believe what my teacher has told me about this earth.”

Four of five students interviewed responded that they would be less distracted by going outdoors for science class because it was active and less boring. The third responded that, “It depends on others, like if they are interested or not.” I completely
understand this response according to the grade level and maturity level of students. When students anticipate a field trip and load up into a van or bus there is a natural excitement of something new and different from the normal routine. This excitement may lead to distraction or troublemaking. This brings back the importance of being well organized and keeping participants busy with engaged learning activities. After a couple of outings, students were able settle down quicker and get back to learning and engagement. The more interested (and mature) students helped me guide others in the right direction so we could continue to go outside and learn.

Eighty three percent of participants agreed that understanding and comprehension of science content was amplified or solidified by going out to “look at things” first hand. One student replied, “Um, I think I’m able to learn inside, but understand better by going out and seeing first hand.” Another responded “Yes because you get to use things you learned in a real life situation”. Others commented that they already understand or know concepts from classroom instruction or reading. Even those students that claimed they already knew the concepts did agree that there were times that going outdoors helped solidify or enhance their prior knowledge.

Three out of five students agreed that they would like to go outside more often while the remainder concluded that they would only like to go outside to learn when it was “warm and sunny.” Likewise, teacher journal entries supported the notion that going outdoors when the weather was more pleasant was much more advantageous. On the other hand, field trips need to be planned weeks or more in advance, making it difficult to
predict the weather. For example the pre-planned field trip in April ended up being a rainy afternoon. The event was carried out as planned, however we ended up spending thirty minutes sitting in the van waiting out the rain.

Three prominent conclusions came about from these observations. First, field trips that involve being outdoors for most of a day should be planned early or late in the school year. Late summer when the school year first begins or late spring towards the end of the school year are when we would have the most pleasant weather in Montana for field trips. Second, even during favorable seasons a class or school could experience inclement or dangerous weather on the day of a field trip. For that reason a good backup plan or raincheck day planned in advance is a good idea.

A third resolution that came forth was that there is much more flexibility when remaining on school grounds and within one class period. The commitment only relied on my decision, and could be changed in short notice. For example when planning out my treatments, I had a plan of what we would do when the weather was better for going outside. And when that happened, I could postpone the scheduled plan for the class period and instead go outdoors. In regard to staying on the school grounds, students were able to get right on task and focus much better than when leaving the school grounds. Students knew their job or assignment before leaving the classroom, and would apply themselves almost immediately upon arriving at our preplanned location. Similarly, they were aware that we were going outside to make observations or collect data, then returning to class when the task was completed. This structure and routine proved to be very effective in maintaining student focus.
Extremely small class sizes and student population certainly made going outdoors on field trips and the school grounds much easier than a setting with thirty or more students per class. I understand why teachers with large class sizes don’t want to plan and organize field trips. During our field events, I maybe had one or two students off-task or goofing around at times. One or two out of five equates to 20% to 40% of the population. I cannot imagine if I took thirty students on a field trip and ten to twelve of them were off task and goofing off! It would be very frustrating and could get dangerous as well. A well planned field trip with tasks to occupy participants the entire time is imperative. Similarly, in a situation with larger groups, I would ensure there were plenty of chaperones or assistants present for safety and to monitor and keep groups on task.

**VALUE**

The implications of the study for me, as a teacher, compel me to continue bringing students outdoors for learning science. A well planned and efficiently executed outdoor lesson has great potential for increasing content comprehension, curiosity, and the desire to learn more. In this there are many unexplored opportunities for learning science outdoors. The benefits far outweigh any deficiencies of these experiences.

I now know that daylong, off campus field trips must be reserved and planned out mostly for the beginning and end of the school year when the weather in Montana is more conducive to outdoor learning. And even with perfect planning things may go wrong or not as planned, therefore there should be a solid back-up plan in place as well.

I have also come to appreciate on campus field events. There are at least four advantages of on-campus field events are over off-campus field events. First, on-campus
field events involve less time commitment and are less disruptive to the daily schedule. Second, remaining on campus eliminates any need for transportation or additional costs. Third, the school rules are already in place and easier to enforce, reducing the potential for behavior problems. Fourth, there is much more flexibility in planning, therefore if there is a bad weather day, the event can simply be postponed for a better day. Remaining on the school grounds has great potential for learning and is minimally disruptive in students daily routine.

In the coming year, I will apply my findings in at least four ways. First, I will schedule a daylong field trip at the beginning or end of the school year. The weather is normally fairly predictable and comfortable. And there is less pressure on myself to stay on track with my curriculum, and less pressure on students like end of semester exams or maintaining grades. Second, I feel that I have a better appreciation of the potential of on-campus outdoor learning, and will be taking advantage of the opportunities to go outdoors on a more regular basis. Third, to accompany outdoor events, an in-class briefing or overview of expected content coverage as well as behavioral expectations will be emphasized. Fourth, I will use a detailed plan in order to keep students on task and involved as well as achieving the desired educational outcomes.

I will continue to monitor engagement and interest with my students both in the classroom and while outdoors to further develop my teaching. There are at least three practices that I will incorporate into my curriculum. First, I have begun modifying the Time-on Task spreadsheet to include more behavior tracking such as student response frequency and student feedback. In the future I may include behavior tracking as part of
students’ grades. The intention is that they will recognize the importance of good behavior and be rewarded for it. Second, I will continue to monitor and explore how outdoor learning affects student understanding and achievement. Incorporating nature and the outdoors into my lessons will always be an invaluable tool. Third, my lifelong love and appreciation for nature and the outdoors becomes patently obvious when given the opportunity to show and teach others. My goal is to encourage others to be as fascinated with the natural wonders of our planet as I have been, and provide them the inspiration to drive their ongoing curiosity.
REFERENCES CITED


APPENDIX A

WATER QUALITY DATA SHEETS
<table>
<thead>
<tr>
<th>Comments</th>
<th>Organism</th>
<th>Total Number of Organisms</th>
<th>%</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Total</th>
</tr>
</thead>
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### Percent Composition

Percent Composition $= \frac{\text{Number of Organisms in each Group}}{\text{Total number of Organisms}}$.

1. Enter your final score on the Summary Data Sheet.
2. Sort organisms from your sample into cube tabs to major groups. Count the number of organisms in each of the major groups. This is an excellent measure for developing charts of graphs.
3. The percent provides information about the relative abundance of different groups of organisms within a sample.
No text content available for this document.
APPENDIX B

SMQ-II SURVEY
Participation in this research is voluntary and participation or non-participation will not affect a student’s grades or class standing in any way. In order to better understand what you think and how you feel about your science courses, please respond to each of the following statements from the perspective of “When I am in a science course…”

<table>
<thead>
<tr>
<th>Statements</th>
<th>Never 0</th>
<th>Rarely 1</th>
<th>Sometimes 2</th>
<th>Often 3</th>
<th>Always 4</th>
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<tbody>
<tr>
<td>01. The science I learn is relevant to my life.</td>
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<td>02. I like to do better than other students on science tests.</td>
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<td>03. Learning science is interesting.</td>
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<td>04. Getting a good science grade is important to me.</td>
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<td>05. I put enough effort into learning science.</td>
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<td>06. I use strategies to learn science well.</td>
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<td>07. Learning science will help me get a good job.</td>
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<td>08. It is important that I get an “A” in science.</td>
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<td>09. I am confident I will do well on science tests.</td>
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<td>10. Knowing science will give me a career advantage.</td>
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<td>11. I spend a lot of time learning science.</td>
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<td>12. Learning science makes my life more meaningful.</td>
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<td>13. Understanding science will benefit me in my career.</td>
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<td>14. I am confident I will do well on science labs and projects.</td>
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<td>15. I believe I can master science knowledge and skills.</td>
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<td>16. I prepare well for science tests and labs.</td>
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<td>17. I am curious about discoveries in science.</td>
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<td>18. I believe I can earn a grade of “A” in science.</td>
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<td>19. I enjoy learning science.</td>
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<td>20. I think about the grade I will get in science.</td>
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<td>21. I am sure I can understand science.</td>
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<td>22. I study hard to learn science.</td>
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<td>23. My career will involve science.</td>
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<td>24. Scoring high on science tests and labs matters to me.</td>
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25. I will use science problem-solving skills in my career.

Note. The SMQ-II is copyrighted and registered. Go to [http://www.coe.uga.edu/smq/](http://www.coe.uga.edu/smq/) for permission and directions to use it and its discipline-specific versions such as the Biology Motivation Questionnaire II (BMQII), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words biology, chemistry, and physics are respectively substituted for the word science. Versions in other languages are also available.
APPENDIX C

SURVEY SUPPLEMENTAL QUESTIONS
SURVEY SUPPLEMENTAL QUESTIONS

1. How has going outside for science class affected your overall interest in science? Please explain.

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2. Do you feel more motivated or less motivated to learn science when we go outdoors? Why?

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3. Does going outside help you understand the concepts and information that we have learned in science class? Why or why not? Please explain.

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4. How has going outdoors affected your appreciation and connection to nature and the environment?

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APPENDIX D

TIME ON TASK DATA SHEET
Student:
(+)= on task, (-)= not on task, (+/-)= on task 50% of the time

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<th>Time</th>
<th>Date</th>
<th>Location</th>
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<th>30-40</th>
<th>40-50</th>
<th>(%) + / (%) -</th>
<th>Event / Conditions</th>
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APPENDIX E

WATER QUALITY PRE AND POST TEST
Field Biology Water Quality Pre-Assessment

This assessment requires a serious effort and you should answer all the questions as fully as possible, including educated guesses. Points will not be taken away for incorrect answers. Points will be taken away if it is obvious that you did not do your best to answer each question. If you just write down “I don’t know” for an answer, you will not get any points for that question. This will not affect your grade.

1. The lowest range of dissolved oxygen levels which will support a diverse population of organisms is:
   a. 1-2 ppm
   b. 3-4 ppm
   c. 5-6 ppm
   d. 7-8 ppm
   e. 9-10 ppm

2. Which of the following would not affect the dissolved oxygen levels of an aquatic ecosystem?
   a. The number of times a reading is taken.
   b. The time of day.
   c. The weather.
   d. How the sample is collected.
   e. The temperature.

3. A decrease in dissolved oxygen levels is usually an indication of an increase in this type of pollution.
   a. Inorganic pollution.
   b. Organic pollution.
   c. Petroleum-based pollution.
   d. Sulfur-based pollution.
   e. Insoluble pollution.

4. A pH value is an assigned number which is based on a scale which ranges from:
   a. 0-6
   b. 0-7
   c. 0-14
   d. 7-14
   e. 8-14
5. A pH of 7 is _____________.
   a. natural.
   b. acid.
   c. base.
   d. neutral.
   e. alkaline.

6. A pH of 2 is ____________ times more acidic than a pH of 4.
   a. 0
   b. 1
   c. 2
   d. 10
   e. 100

7. In the United States, the pH of natural water systems normally fall within the following range:
   a. 1.5-7.5
   b. 1.5-3.5
   c. 4.5-5.5
   d. 6.5-8.5
   e. 10.5-13.5

8. Which of the following is not influenced by the temperature of an aquatic ecosystem?
   a. Dissolved oxygen levels.
   b. The rate at which photosynthesis takes place.
   c. The metabolic rate of aquatic organisms.
   d. How organisms are affected by pollutants, parasites and pathogens.
   e. The pH.

9. Which of the following water samples would have the highest dissolved oxygen levels?
   a. A water sample collected on a winter day (temperature is 35 degrees F).
   b. A water sample collected and left sitting in the sun for two hours and then tested.
   c. A water sample which was heated and then tested.
   d. A water sample collected on a summer day (temperature is 82 degrees F).
   e. A cloudy water sample.

10. As the temperature increases, the rate of photosynthesis _________________.
    a. decreases.
    b. increases up to temperatures of 32 degrees Celsius.
    c. stops.
    d. stays the same.
    e. decreases and then stops.
11. As the temperature increases, the metabolic rate of aquatic organisms
___________.
   a. decreases
   b. stops
   c. increases
   d. stays the same
   e. decreases and then stops

12. Why do you think high dissolved oxygen is important for trout but not for drinking water?
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13. Why do you think low temperatures are important for trout?
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14. Why do you think low turbidity is important for trout?
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15. What is water quality?

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16. What is “non-point source” pollution? What is “point source” pollution?
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17. What is “water quality monitoring”?
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18. Why is it important to take thorough and concise notes and observations for fieldwork?

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19. What is the purpose of documenting the current weather conditions for fieldwork?

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20. Why is it important to document the condition and type of vegetation, and current land use practices adjacent to a river or stream?

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21. If someone tells you that the water quality of the Jefferson River is excellent, what does this mean? What kinds of questions might you ask this person?

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Portions of this test were adapted from:

http://kristinajerry.name/jerry_teaching/work_sample_2/Work%20Sample%20Materials/Assessment/Original%20Assessment/Pre-Assessment.doc
APPENDIX F

IRB APPROVAL
MEMORANDUM

TO: Jason Garver and Walter Woolbaugh

FROM: Mark Quinn, Chair

DATE: December 1, 2015


The above research, described in your submission of December 1, 2015, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

(b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

(b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

(b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

(b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
APPENDIX G

INTERVIEW QUESTIONS
STUDENT INTERVIEW QUESTIONS

Participation in this interview is voluntary and participation or non-participation will not affect a student’s grades or class standing in any way.

1. What kinds of things interest you in school?

2. How has going outside affected your interest in science? Can you give me some specific examples?

3. Would you rather go outside more or less often to learn science? Why?

4. Do you feel distracted when we go outdoors?

5. How does going outside to learn science affect your understanding of the subject? Can you give me an example?

6. Do you remember what you learned the last time we went outside during science class? (Probe specific to content)

7. Does going outside help you do better on science tests? Can you give me an example?

7. How does going outside affect your appreciation for nature and the environment? Can you give me an example?
APPENDIX F

ADMINISTRATOR APPROVAL
Administrator Approval

I, Bonnie Lower, Principal of Willow Creek School, verify that I approve of the classroom research conducted by Jason Garver.

(Signed Name, Title of Position)

Bonnie Lower

(Printed Name)

12/11/15

(Date)