

THE EFFECTS OF A RIVER STUDY PROGRAM ON STUDENTS'
COMPREHENSION, SKILLS AND ATTITUDES IN SCIENCE

by

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Analea Hronek

July 2014

DEDICATION

This paper is dedicated my grandma Erna Pidwerbecki. She has supported me throughout this entire capstone. She encouraged many of her children to get their masters and understands the hard work and dedication completing a masters program requires. She has always asked thought provoking questions about my research project and possesses a calming and understanding demeanor through all the exciting and frustrating times of completing this project. I would also like to recognize a friend and colleague of mine, Jason Olson who inspired and encouraged me to work towards obtaining my masters degree in the first place.

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ABSTRACT

Outdoor environmental education is a fun and exciting way to teach classroom science curriculum. This study focused on if an outdoor river study program increased students' science comprehension and skills more than the normal classroom science curriculum. It also sought out to measure whether students' attitudes towards science and the environment changed from being a part of the study. The data show that while students' knowledge of science concepts did not increase significantly when compared to the indoor classroom unit, students retained the river study concepts better and longer than the classroom science concepts. Students' attitudes towards science and the environment were shown to be more positive post-river study. Students also showed an increased awareness of themselves as learners after the post-river study.

INTRODUCTION AND BACKGROUND

For the past six years I have taught in a primarily rural educational setting, schools population of less than one hundred students. These settings have always been next to prairies, mountains, rivers and streams, and the students and their families have connections to the area through farming and ranching. Being someone that loves the outdoors and teaching in this type of rural setting influences my passion in teaching my students about the natural world around them. I feel by living in Montana, there are many opportunities to teach our students about literature, math, social studies and science in the context of the outdoors.

The idea of starting my own river study project with my class came from my first year teaching when I was helping out the seventh and eighth grade teacher on her weekly trip to the stream with her students to conduct water quality tests. Seeing the enthusiasm and independence of these students conducting their experiments was inspiring, and I hoped one day I would be able to implement something similar in my classroom.

Teaching outdoors and about the natural environment is fun for students and teachers alike. When I first started thinking about my action research project, I knew I wanted to incorporate some type of outdoor education. A main question I had to ask myself was, “does teaching outdoors and in the natural environment really affect how and what my students learn and retain information?” In looking at this main question, I developed my action research questions for my action research project.

My primary action research question is “what are the effects of a river study project on students’ comprehension and skills in science?” My two sub questions are as follows:

1. How will a river study project affect students’ attitudes towards science and the environment?
2. How will teaching a river study project affect me as a teacher?

These questions are significant because it is important to align a teaching method, such as teaching outdoors, with how well students learn science to create a well-developed, successful program. I want students to be learning outside and enjoying nature; but more importantly, I want them to comprehend the science content they are learning, the procedures and skills required to do field tests in the project, and have that experience increase their enjoyment and satisfaction in science class. These research questions will provide valuable information about how students best learn outdoors, how their comprehension of science content and skills are comparable or different to learning science in the classroom, and how it affects their attitudes towards learning.

The results from this project and these questions will be shared with my fellow teachers and administrator and possibly be used to influence future curriculum instruction and planning within our school. When I first came to Belfry, MT to teach, I frequently heard my students say during science class, “this is science? Aren’t we going to read out of the book?” This thought process from my students came from years of not “doing science” and instead just reading about concepts out of a book and doing worksheets. Currently, Belfry school is developing a cross-curricular framework that will hopefully focus on

teaching students the curriculum standards in a format that is mainly geared toward making the content applicable to their daily lives. The results of my project will encourage this real world application instruction.

CONCEPTUAL FRAMEWORK

My passion for outdoor education led me to study its effects on students' comprehension and skills in science along with student attitudes. To begin this process I researched literature from other studies pertaining to outdoor education. The following is a review of articles that focus on the theory of outdoor education, and what previous researchers found on its affects towards student comprehension. Other articles discuss what previous research studies examined on the effects of outdoor education on students' attitudes towards learning science and the outdoors.

Does outdoor education really affect student comprehension and learning, not just in science, but in other areas as well? As educators, we are always looking for ways to increase student achievement and learning. One way we do this is by understanding how children and people learn. In the 1970's and 1980's Howard Gardner developed a theory of intelligences that humans possess. Individuals draw on these intelligences, individually and corporately, to create products and solve problems that are relevant to the societies in which they live. In 1999, Gardner developed another theory of intelligence called the environmental or naturalistic intelligence. Naturalistic intelligence is "an ability to identify and distinguish among different types of plants, animals, and weather formations that are found in the natural world" (2013, p.6). Naturalistic intelligence can be an important aspect in how students learn and absorb information, especially in science.

However, in a case study on teachers perceptions and practices of Gardner's theories, the two intelligences practiced the least in the classroom were musical and naturalistic (MacLeod, 2002). This supports Gardner's own findings that, "only two intelligences—linguistic and logical mathematical—have been valued and tested for in modern secular schools" (MacLeod, 1991, p. 2). Despite this value on two of the eight intelligences, more and more studies are trying to determine the value of the other intelligences; naturalistic intelligence included, within mainstream education.

Research and case studies about outdoor education and how it affects student performance illustrates how positive a strategy for student comprehension and understanding it can be. One study examined if a knowledge-rich outdoor setting helps prepare students for learning better than a classroom setting alone (Simmons, 2000). This study is very similar to my own in that it tested students inside and outside the classroom with pre- and post-content tests to gauge student understanding and science concept knowledge. The study had two treatment groups, one inside the classroom and another outside the classroom. A summary of the results stated that, "the outdoor treatment resulted in a greater ability to transfer the existing knowledge and better learn the new, more advanced concepts than the classroom setting did" (Simmons, 2000, p. 96). The results stated that while the indoor treatment group was a little more advanced to begin with than the outdoor group, the two groups performed at about the same level on their post-tests. This study also suggests for future research how studying the importance of attitudes and emotions of both the teachers and students in science and the outdoors affect how the students learn and transfer concepts (Simmons, 2000). This focus on how

outdoor education affects student and teacher attitudes towards science is illustrated in many other case studies.

A study done in Ankara, Turkey in 2008 showed that, “ecology-based nature education program contributed significantly to children’s responsible environmental behavior” (ERDOGAN, p.1). The study consisting of a sample of 26 females and 38 males taken from 64 elementary schools showed an increase in students’ behavior towards the environment but not an increase on their environmental knowledge. The study used a Likert survey, pre- and post-test assessments, tested dimensions of environmental knowledge, willingness to act, environmental attitudes, environmental sensitivity, and responsible environmental behavior (p.2235). This study illustrated how I could use the Likert style survey to gauge my own students’ attitudes towards science and their environment. This study also separated the different test dimensions in a clear, organized and useful way. I will use a similar method to collect data about students’ attitudes towards science and the environment.

I researched other outdoor capstone papers to learn how data was collected and analyzed. A fellow Masters of Science in Science Education (MSSE) student implemented an outdoor education program in 2011. This program centered on how such a program would increase her students’ science comprehension and affect her students’ care and attitudes towards the environment, and affect her as a teacher. The action research project compared traditional teaching and classrooms to outdoor classrooms and learning (Bartlett, 2011). Bartlett used pre- and post-assessments, a Likert survey, and journaling to gauge students’ attitudes. Her study showed that her students had improved 29%

overall on some of her outdoor treatment units. Increased comprehension was recorded and observed, and the students expressed through interviews and journals an increased awareness. The students remarked that they felt good about improving the environment (2011). The author stated that the action research, “had a positive effect on my teaching, attitude towards students and learning” (2011, p. 45). This further elaborates and supports the idea that outdoor education can have positive affects on teachers and students alike. This capstone has guided me in answering my own sub action research questions on the possible effects of my river study project.

Alanna Piccillo wrote another capstone, which focused on whether or not science concepts being taught in an outdoor setting where students made connections with those concepts affected students’ comprehension more than science concepts being taught in an indoor setting (2011). She divided her 46 students into two groups, one group that would experience the outdoor labs (treatment) and another that would focus on indoor labs (comparison). Piccillo wondered if, “...making science more relevant to the students’ lives, by having them make connections between science concepts and the outdoors, would enable them to understand and apply concepts, and therefore attain higher comprehension” (p.1). Piccillo has a very similar question to what I am trying to ask with my river study project about how it will affect my students. Piccillo did not see an increase in student comprehension when more challenging concepts were taught, but she did see an increase in all students with the lower level difficulty concepts. Again, I was interested in how she gauged students’ comprehension levels using student interviews, pre- and post-tests, and a focused listening Classroom Assessment Technique (CAT). I

thought it was interesting how she organized her treatments to include an indoor portion and an outdoor portion from which she gathered data. This is similar to how I formulated my treatments in order to answer my action research questions.

Lastly, since I will be using student journaling as a form of data collection, I reviewed an article from 2012 on student journals by Dilek Erduran Avci and Dilek. Since comprehension and attitudes will be expressed through my students' use of journals, I wanted to review a study that focused on journaling and how to use and collect journals as part of research on student comprehension and attitudes. The purpose of the study, "was to investigate upper primary school students' academic development in science courses and to evaluate their views and feelings about self-learning processes through journals" (p.177). I found it interesting that the study showed that journals were not only a great way to analyze and gauge students' attitudes, but they are also a great way to evaluate students' science comprehension and understanding. The researchers designed a rubric to evaluate the student journals. The rubric was made up of seven criteria which included, "use of scientific language, relationship to daily life, creative thinking, layout/composition, use of scientific process abilities, use of diagrams and figures, formulas, equations, drawings etc." (p.180). The researchers then scored each category using a four point system, with 4 being perfect and 1 being poor. This study showed that students can express a great deal of reliable and valid information about their science understanding and comprehension through journals. I felt that designing a rubric or finding a rubric to use for my own journal analysis would be beneficial in assessing not only student attitudes but also their science comprehension.

In conclusion, I have looked more comprehensively at methods I will use for the following treatments. I now believe that the connections between student comprehension, attitudes, and outdoor experience are linked. These connections are not one-way but flow back and forth, complimenting and affecting each other. According to Hofstein and Rosenfeld (1996), "future researches in science education should focus on how to effectively blend learning experiences in formal and informal learning in order to significantly enhance the learning of science" (p. 107).

The methodologies I used in answering my research questions and treatments has been affected and influenced greatly from the research, papers, and case studies that were reviewed above. By reviewing the literature, I gathered strategies, tools and assessments to use as instruments to measure student comprehension, skills, and attitudes. This research has influenced and affected my treatment by providing tools to measure my own students success through pre- and post-tests, individual and content interviews, questionnaires, journal and observational and skill rubrics.

METHODOLOGY

To answer my main research question I implemented a river study program into my combined class of 5th and 6th graders. The purpose of my study was to understand the effects of an outdoor river study project on students' science comprehension and skills when compared to normal indoor class curriculum. I also gauged how the treatment affects students' attitudes towards science and the environment.

Belfry school is a small rural public school located in southeastern Montana. The students range in socio-economic status from lower-middle class to upper class. The entire school,

including students and staff, as well as any community member, can come and have a free breakfast and lunch. The student to teacher ratio averages about one teacher to every four students. Almost all students in the elementary school possess high motivational levels and a willingness to learn, whereas the high school students' motivational levels vary greatly, from highly motivated to possessing little or no motivation. Traditionally, students have done science in the classrooms with few labs and hardly any time exploring and doing science outside. Most science classes have consisted of reading out of the book and doing worksheets pertaining to the lesson. However, in the past couple of years new teachers have replaced old teachers, and the ideas about how to teach curriculum, let alone science curriculum, have changed and adapted to more hands-on, active, project-based and student-led approaches.

The group of students that I used consisted of my entire 5th and 6th grade class. In this class, there are two 5th grade girls, two 6th grade boys, and two 6th grade girls. I have given each student a letter A through F instead of their individual names. The demographics of my class include: one Native American female (Student C) who is currently in foster care. The five other students are Caucasian, and one of these male students, Student F, came into the class half way through my treatment plan. Student A, a female student, currently has a 504 plan for her Attention Deficit Hyperactivity Disorder (ADHD) and attention problems. All students perform at grade level or above grade level in reading.

There have been three critical teachers, who are trustworthy, and have provided constructive feedback throughout the research process. Jason Olson is a colleague of

mine as well as the school principal. He provided great insight into designing and implementing my action research project and has provided advice on how I have designed my treatment with my students. He has been a great advocate for the development of the river study program and the use of the outdoors to teach school-wide curriculum. Secondly, Jessica Felchle, a recent MSSE graduate and the wife of a fellow teacher here at Belfry, has always given me advice and suggestions for writing my Capstone and in planning and implementing the Action Research process. The completion of her own capstone project with MSSE and the advice she has freely given during all stages of this process have helped me understand the flow and design of my own capstone. Finally, Dan Johnson, the Belfry junior high and high school English teacher helped me proofread and edit my capstone paper. His enthusiasm and knowledge of the English language has been extremely beneficial in the completion process of my action research project and paper.

To answer my action research questions, I have developed a Treatment and Comparison unit to compare how well my students learned the science content, and their attitudes towards science and the environment throughout the units of study. I have only one science class and only six students so I have used the same students for both the Treatment and Comparison group.

Treatment Unit

The Treatment Unit, herein referred to as treatment, focus was to see how an outdoor river study program focusing on the science of water quality would affect how students learn and comprehend the science content taught when compared to the normal, indoor

school science curriculum. My treatment was implemented one day a week for nine weeks until November 2013. Every week, usually on a Wednesday, the students learned a new water quality test and the science behind the test. At the beginning of the day, I displayed a Power Point with images and bullet points about the test and why it is important to water quality. We then read a short informational text about the test. Next, we had a brief discussion about the information we covered, gathered our testing equipment, and headed out to our river site. When we got to the river site, the students performed one water quality test at a time.

The first day of the treatment, we had an observational day and took a temperature reading and measured stream flow. The students then wrote in their journals about what they learned and observed that day. The following week, I displayed a Power Point on temperature and the students read some information on temperature and we discussed why temperature would be an important test to implement for water quality. Then at the river site, we solely focused on the temperature test, reviewing what we learned in the classroom as we did our test. After the test, the students recorded their results and wrote in their journals about temperature, what they learned, and any observations they made.

The third week, we repeated the process with dissolved oxygen. In the field we measured the stream flow and temperature of the water and then also added the dissolved oxygen test. The students recorded the results from each test, and wrote in their journals about what they learned and observed.

For eight weeks, the students learned a new water quality test and performed that new test in addition to the previous weeks' tests. On the ninth week, the students performed

all nine water quality tests on the final day of the river study unit. These water quality tests and the design of the treatment are illustrated in Table 1.

Table 1
Treatment Plan Outline (Water Quality Tests)

Week	Date	Water Quality Tests Performed
1	9/4/13	Stream Flow
2	9/11/13	Stream Flow, Temperature*
3	9/18/13	Stream Flow, Temperature, Dissolved Oxygen*
4	9/25/13	Stream Flow, Temperature, Dissolved Oxygen, pH*
5	10/2/13	Stream Flow, Temperature, Dissolved Oxygen, pH, Macroinvertebrates*
6	10/8/13	Stream Flow, Temperature, Dissolved Oxygen, pH, Macroinvertebrates, Nitrates*
7	10/15/13	Stream Flow, Temperature, Dissolved Oxygen, pH, Macroinvertebrates, Nitrates, Turbidity*
8	10/24/13	Stream Flow, Temperature, Dissolved Oxygen, pH, Macroinvertebrates, Nitrates, Turbidity, Total Phosphates*
9	11/4/13	Final Day (no new test added) Stream Flow, Temperature, Dissolved Oxygen, pH, Macroinvertebrates, Nitrates, Turbidity, Total Phosphates

*Signifies new water quality test performed that day.

The treatment continued for nine weeks, following the same procedure and format of classroom instruction and outdoor application. Immediately, following the end of the treatment I began the Comparison Unit, herein referred to as comparison.

In the comparison, I taught the same group of students, but in the classroom with the normal 5th and 6th grade science curriculum. Unlike the treatment, the comparison lessons were taught during the duration of five weeks and none of the comparison lessons took place outside. The science curriculum centered on asexual and sexual reproduction and the human body system and consisted of 11 lessons. The science content taught was based on textbooks, worksheets and assessments. Out of the 11 lessons, lessons 1 through

4 content were on asexual and sexual reproduction, genes, and heredity and traits.

Lessons 5 through 11 were on the eleven human body systems and their functions. Every lesson the students read the material in the textbook out loud, discussed vocabulary and concepts presented in the text, did a review worksheet, and did one activity or lab per 11 lessons as the book described. The students wrote in their journals about what they learned during that specific lesson.

Instrumentation

Throughout my treatment and comparison, I used the same instruments to measure students' science content comprehension, and attitudes towards science, and the environment. The instruments that I used to answer my research questions are a collection of pre-and post-content tests, student journals, procedure and skill observations, content interviews and pre-and post-questionnaire (Table 2). Each instrument uses a written, oral, and observational technique to measure each student's understanding of the content, skill and performance, and attitude towards science and the environment.

Table 2
Triangulation Matrix

	Pre-river study program	Treatment	Comparison	Post-river study program
Q1: What are the effects of a river study project on students' comprehension and skills?	Pre-program questionnaire and individual interviews	Pre- and post-tests, student journals, skill and procedure observations, content interviews, student/ teacher	Pre- and post-tests, student journals, content interviews, student/ teacher perceived	Post-program questionnaire and interviews, final content/ comprehension and skill test

		perceived difficulty CAT	difficulty CAT	
Q2: How will a river study project affect students' attitudes towards science and the environment?	Pre-program questionnaire and individual interviews	Student journals, content interviews, observations	Student journals, content interviews, observations	Post-program questionnaire and interviews
Q3: How will teaching a river study project affect me as teacher?	Self-reflection journal	Self-reflection journal	Self-reflection journal	Self-reflection journal

Each instrument, as seen in the table, uses a written, oral, and observational technique to measure each student's understanding of the content, skill and performance, and attitude towards science and the environment.

Before starting the treatment, I administered a pre-treatment questionnaire (Appendix A).

This questionnaire consisted of 13 questions that asked the students about their feelings and attitudes towards science, science class, and their environment, and this was used to measure attitudes towards science and the environment before the treatment began.

Secondly, I conducted an individual interview with each student (Appendix B). These interviews consisted of open ended questions designed to see how students felt about their learning preferences, attitudes towards science, science class, and their environment, as well as, how they felt about participating in a river study unit. I hoped that this instrument would provide good qualitative data on student responses to their attitudes and

feelings that would possibly compliment the quantitative data collected from the pre-treatment questionnaire.

After administering the first two instruments, I began my treatment. To answer my first research question about student science content comprehension, I developed pre- and post-content tests that were administered to each student before and after each lesson (Appendix C). These content tests measured what content the students had prior knowledge of, and also how much content they learned and retained during the lesson. Each pre- and post-content test consisted of the same questions and pertained to the content that was taught during that lesson. During the treatment, I also developed a procedure, skills, and attitude observational rubric for each student during each lesson (Appendix D). This rubric measured how well the students followed the lesson or test procedures, the science skills they learned or displayed, and their attitudes towards science and the environment during the lesson.

At the end of each post-test, I asked the students to write about what they learned, observed, liked and did not like in their journals. I usually gave them between 5 to 10 minutes to complete this task, and I also used this time to self-reflect in my own journal. To assess the student journals I developed a student journal rubric (Appendix E). This rubric was used to measure each journal entry written by the students the journal requirements of date, time, weather, field observations, and data collected at the river. The rubric was also used to measure if the students used scientific vocabulary or explained any of the concepts learned during the lesson. Finally, this rubric also measured the students' attitude towards science and the environment. At the end of the

treatment, I administered the post-treatment questionnaire to see if there was any change in how the students answered questions about their feelings and attitudes towards science and their environment after the treatment (Appendix A). In this post-treatment questionnaire, I allowed spaces for open ended answers that would allow students to answer why they answered in a particular way to a question. I also conducted another individual interview with each student to measure if their learning preferences and attitudes towards science, science class and the environment changed or was affected after the treatment unit.

Finally, over the course of a couple weeks, I administered a content interview (Appendix F). The content interview instrument for the treatment group was administered after the treatment unit was completed. In a recorded interview, I asked each student about every test performed during the river study unit. This interview was done in order to measure how well the information and content was learned and how well it was retained overtime.

In my comparison I used exactly the same instruments as in my treatment; however, the content changed from a river study program to the normal, indoor science curriculum that I am required to teach to reach 5th and 6th grade science standards. The flow of the lessons was the same as the treatment, as well as the rubrics I used to measure student journals and student procedures, skills, and attitudes.

A month to two months after my treatment and comparison were complete, in order to measure student retention I administered two final content assessments, one for the treatment and one for the comparison (Appendix G). I used this assessment to gauge overall student retention of the science content taught during the two units.

I also asked three fellow teachers to review sample lessons from both my treatment and comparison and rate each on how difficult they thought it was in comparison to the other. I also had the students complete a CAT on how difficult they thought each unit was as well (Appendix H). These perceived difficulty CATs were administered to measure teacher and student perception on how the two units compared to the other on difficulty level for 5th and 6th graders. Table 3 below is a unit outline illustrating the treatment and comparison group instruments that were used to measure my research questions.

Table 3

Treatment and Comparison Unit Outline

Treatment	Comparison
-River study unit	-Normal science unit
-Once a week for 11 weeks (9 lessons)	-Asexual and sexual reproduction
-Pre-treatment questionnaire	-Human body systems
-Individual interviews	-Two units (11-12 lessons)
-Pre- and post-tests	-Pre- and post-tests
-Student journals	-Student journals
-Rubrics	-Rubrics
Skill and procedure observations	-Skill and procedure observations
-Rubrics	-Rubrics
-Content interviews (recorded and transcribed)	-Content interviews (recorded and transcribed)
-Post-treatment questionnaire	-Final content assessment
-Individual interviews	-Teacher/student perceived difficulty CAT
-Final content assessment	
-Teacher/student perceived difficulty CAT	

For each research question, there are at least three different instruments used to collect and measure student responses and observations during the lessons. For example, to answer my first research question, “what are the affects of a river study program on students’ science comprehension and skills?” I collected data in various ways. The instruments are triangulated because they are measuring the same data in a variety of different ways. The data collected from these instruments about the treatment and comparison have accurately shown the effects of the treatment on these six students. I achieved reliability with my instrumentation by using the same instruments to measure both the treatment and comparison groups’ scores and attitudes, as well as using the same group of students for my treatment and comparison. I was able to achieve formative validity through my instrumentation because my instruments allowed me to see what

concepts the students understood and where their knowledge and understanding was lacking. I also used multiple instruments to measure the two criteria of student learning and attitudes, so that they overlapped and one criterion was measured by at least three different instruments. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix K).

DATA AND ANALYSIS

The instruments I used to collect data during the treatment and comparison enabled me to answer my three action research questions. In looking at the two questions regarding my students, "what are the effects of a river study project on students' science comprehension and skills?" and "how will a river study project affect students' attitudes towards science and their environment?" I analyzed the data according to two main themes; student learning and student attitudes. I chose these themes because the student learning and comprehension can be influenced and affected by students' attitudes towards the learning process, content, and their attitudes towards themselves as learners. I feel that good triangulation between my two main research questions would allow for a deeper analysis of how a river study program can affect my students' education.

Student Learning

My first research question focuses on student learning and comprehension of the science content and skills learned throughout the treatment and comparison. The quantitative data that I collected pertaining to this research question consists of analyzing pre- and post-test scores, final content assessments, science content in student journals, and the

procedure and science skills observational rubric. Throughout the data analysis, I looked to see if there are any differences quantitatively and/or qualitatively between the treatment and comparison scores and student responses. A summary of treatment and comparison data, as well as data figures can be found in Appendix J.

After collecting the pre- and post-test scores, I analyzed the pre- and post- treatment and comparison scores to see if they were similar. Below is the figure of pre- and post-treatment and comparison scores.

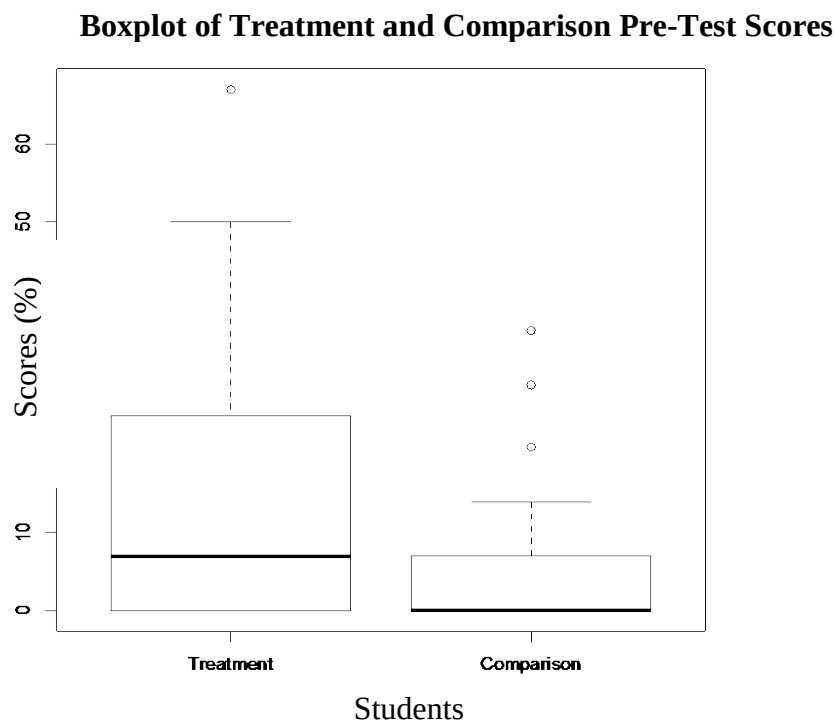


Figure 1. Boxplot of Treatment and Comparison Pre-Test Scores, (N=6).

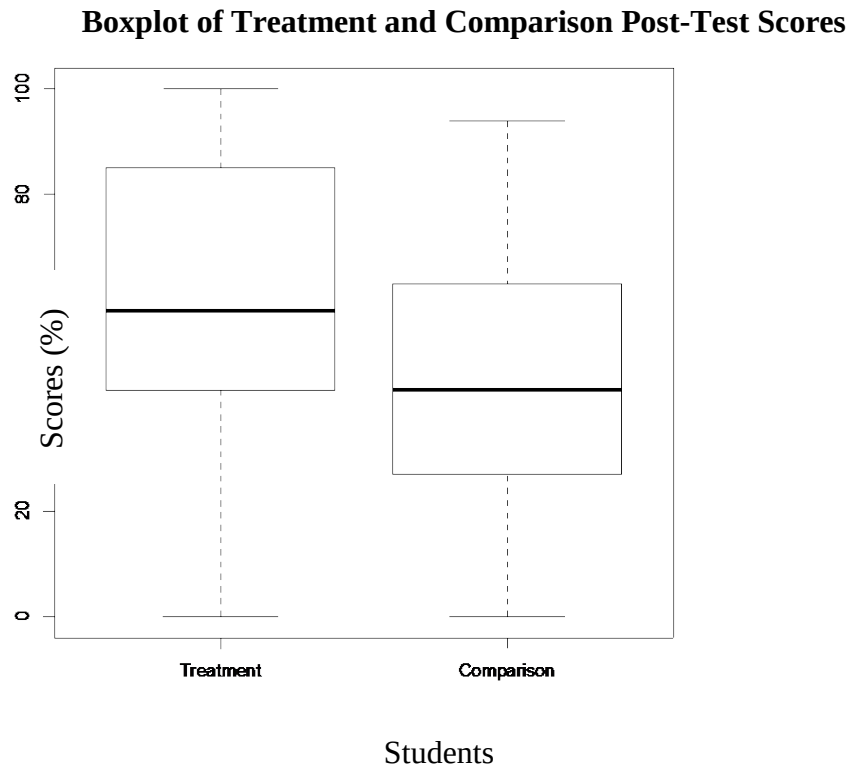


Figure 2. Boxplot of Treatment and Comparison Post-Test Scores, (N=6).

In the pre-test answers, I did not notice a difference in the number of unanswered responses or incorrect responses in the treatment and comparison. In the pre-test scores, the treatment and comparison mean differed greatly (T=14.02%, C= 4.98%). However, the range (T= 67, C=36) and variance (T=314.1, C=85.6) of the treatment group's pre-test scores was significantly higher as was the standard deviation (T= 17.72%, C= 9.25%). This indicates that from the start my treatment test scores were significantly more varied and farther from the mean, than my comparison pre-test scores. The same result trends were apparent in the post-test scores. The treatment mean (T=61.57%, C=

45.1%) differed significantly, and also had a higher range ($T=100$, $C=94$), variance ($T=733.4$, $C=649.0$), and standard deviation ($T=27.0$, $C=25.4$). This indicates that like the pre-test scores the data was varied and far from the mean, even though less than in the pre-test scores. The post-treatment and comparison answers were very similar in length and attention to detail if the student answered the question correctly, and both were the same in brevity and unanswered responses if the questions were unknown or answered incorrectly.

Since my variance and standard deviations were so different from the mean, I decided to look at some common themes among the outliers in the pre- and post-tests. I looked at the individual students' test scores and students A, B, C, and F all had means that were below the standard deviation during the pre-test treatment test scores. All of these students then rose above the standard deviation during the post-test treatment test scores. The comparison pre- and post-test scores of students A, B, C, D, and F are all below the standard deviation of pre-test scores; however on the comparison post-test only student C had a mean score of 25.4%, which matched the group standard deviation. All of the other students were still individually below the standard deviation of 25.4%. I also administered the Welch Two-Sample Test for pre- and post-test scores. The p-value of the pre-treatment and comparison test scores was 0.005 and the p-value of the post-treatment and comparison test scores was 0.003. This shows that there was not a significant difference between the treatment and comparison pre- and post-test scores to show that the treatment caused a significant difference in their test scores. However, the outliers suggest that the treatment possibly helped them to rise above the mean more than

the comparison did. This is possibly due to the repetition and the hands-on experiences that are prevalent throughout the river study unit and less so throughout the comparison unit. Generally, my outlier students need more time in their normal classes for accomplishing their work. They also need more explanations, examples, and real world application to really understand a concept. However, the students that are not considered outliers can read and write well, need less instructional time, and seem to grasp concepts across subjects rather quickly without hands on activities or labs.

Next, I analyzed the final content assessment given for both the treatment and comparison units approximately one month after the comparison unit and two months after the treatment unit (Figure 3).

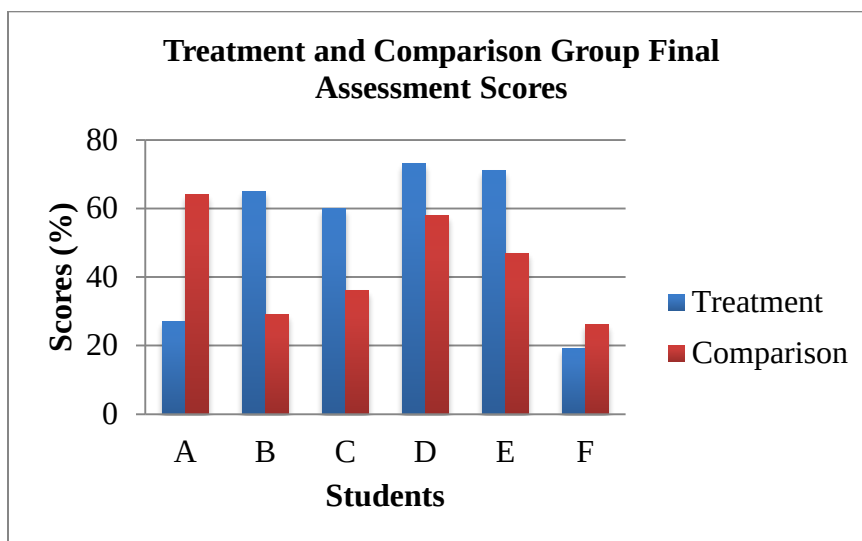


Figure 3. Histogram of Treatment and Comparison Group Final Assessment Scores, (N=6).

This test was to measure whether student retention over time was different or similar for both groups. As in the pre- and post-treatment and comparison test scores, the mean for

the treatment (52.5%) was greater than the comparison (43.33%). Also similar was the range (T=100, C=94) and the variance (T=549.5, C=243.06) was still higher in the treatment than the comparison. The standard deviation (T=23.44, C=15.59) was also higher in the treatment group. I did not notice any difference in length, context understanding, and explanation in student responses. Students' responses were either marked for a question mark or "I don't know" for questions they did not remember or understand, and if they did get the questions correctly, they either explained it fully or understood the concept in each test equally. However, when looking at how the students did individually, the students generally did better on the treatment final assessment than the comparison final assessment.

Only student A and student F, two of my outliers, did better on the comparison tests than the treatment tests. Student A has a difficult time staying on task and sometimes performed poorly on tests. This is mainly due to her attention span and desire to work through a test carefully; I believe it was for this reason that she left a lot of questions unanswered on the treatment test compared to the comparison test. Another possible reason could be that she really enjoyed the genetics and heredity content that we learned during the comparison unit. Student F had missed four lessons of the treatment and still scored a 19% on the treatment test, compared to the 26% on the comparison test, in which he missed no lessons. Even with my outlier students, I applied a paired T-test and had a p-value of 0.44. This shows that there is a 44% chance that there is a difference between the treatment and comparison final assessment scores. This combined with the fact that there was a longer duration for the treatment (two months) than the comparison

(one month), shows that the students retained more information about the treatment than the comparison.

After each lesson during the comparison and treatment unit, I had the students write in their student journals for approximately 5 to 10 minutes. They were asked to journal about something they learned, understood, liked, did not like, and observed during the duration of the lesson. Generally, the students' responses were brief and did not have much elaboration. However, student D generally spends more time writing and explaining her thoughts in the written form, so she had longer excerpts than most of my students. I scored these journals for scientific content or concepts that they used or explained in their journals using the student journal rubric. There was a max score of 8 for each journal entry and it was graded on whether or not students had the correct journal requirements, included field observations, use of scientific vocabulary and concepts mentioned or explained. The students' journals mean score ($T=5.1$, $C=4.4$) and standard deviation ($T=1.77$, $C=1.39$) were not very far apart. I applied a Welch Two-Sample T-test and got a p-value of 0.03. Statistically, there was not a difference in how the students explained the material they learned in their journals. Students generally explained the content they learned in the same fashion and length and used the same amount of vocabulary terms in both units. An example of student E's journal treatment excerpt included, "I learned dissolved oxygen, turbidity, nitrates, and temperature, and pH." A comparison unit excerpt by the same student stated, "learning about different veins, cells, respiratory and circulatory system." These excerpts show that while the student is using the scientific vocabulary in both the treatment and comparison, he does

not take the time to explain exactly what he learned about the vocabulary in his excerpts. In this way, student elaboration and expansion of the science content learned during the comparison and treatment is very similar. This shows that the students retained the information very similarly in the short term whether it was outside or indoors, and that they either grasped a concept.

Lastly, I analyzed the students' science comprehension through the procedure and skills observational rubric of which there was also a max score of 8. There was not a large difference between the mean scores ($T=6.4$, $C=5.9$), however the range ($T=2.28$, $C=0.46$) and the standard deviation ($T=1.5$, $C=0.68$) were very different, which indicates how different the students performed when compared to each other. A p-value of 0.05 was observed with the Welch Two-Sample T-test, and this shows that there was not a significant difference in how the students performed the procedures and skills required to complete the field tests and labs required during either unit.

Using the perceived difficulty CAT, I had three teachers grade the following treatment and comparison units on science concepts, vocabulary, and procedure and skill difficulty for 5th and 6th graders. Overall, the mean ($T=3.66$, $C=3.16$) was very similar with the treatment average being scored as slightly more difficult. The range ($T=3$, $C=4$), variance ($T=0.7$, $C=1.0$) and the standard deviation ($T=0.88$, $C=1.02$) show that there was not a lot of variance in the scores for between the two units. The comparison unit (max score of 5) was rated higher for vocabulary ($T=3.6$, $C=4$) with a very low and similar variance ($T=0.3$, $C=1$) and standard deviation ($T=0.5$, $C=1$). One teacher stated about the comparison unit was, "the actual vocabulary they are learning are things they have

probably heard before at least in conversation, but there is a lot of vocabulary and concepts covered in what appears to be a short amount of time.”

The teachers also graded the skills and procedure portion, with a max score of 5 ($T=3.66$, $C=2$). The data showed a slightly more varied but low variance ($T=2.3$, $C=1$) and standard deviation ($T=1.5$, $C=1$). This slight difference possibly represents the fact that two of the teachers had witnessed the actual stream field trip and the tests the students did, and the other teacher did not. This could represent a misunderstanding of the actual skills and procedures the treatment required. Overall, this shows that the skills and tests needed to be performed by the students was perceived by teachers to be harder in the treatment than the comparison, and the students scored similarly on the observational rubric in both units even though one has been perceived to be more difficult for students to perform and correctly complete. This could possibly be due to the fact that the students also observationally enjoy doing labs and tests, and despite the level of difficulty follow the correct procedures and master the skills in order to perform the tests correctly.

Overall, using the perceived difficulty CAT the teachers anticipated that the treatment would be slightly more difficult than the comparison ($T=3.6$, $C=3.1$) with similar variance ($T=0.7$, $C=1.0$) and standard deviation ($T=0.8$, $C=1$). The teachers all made similar observations, such as, that while the concepts and tests seemed to be more difficult in the treatment, one teacher noted, “If the students are out doing the tests themselves and repeating the procedures I would expect them to have an easier time grasping the concepts.” Similarly, another teacher noted, “after teaching the process of how to run samples, it would get easier.”

Overall, I feel that the data focusing on student learning shows what students learn and how well they learned during the treatment and comparison units are similar and do not have significant enough differences to be recognized as substantial. However, in analyzing student attitudes towards science and the environment and comparing attitudes in the treatment and comparison, one might gain more insight into the learning process for students and their science education.

Student Attitudes towards Science and the Environment

I also analyzed student data in relation to my research question, “How will a river study project affect my students’ attitudes towards science and the environment.” I analyzed student attitudes towards the science content learned and the environment through a pre- and post-treatment questionnaire, student interviews, student journals, observational rubrics, and student content interviews. All of these instruments have displayed accurate data of how my students’ attitudes towards what they learned and how they felt when they learned it during the two science units.

Prior to the actual data collection process, I administered a pre-treatment questionnaire followed by a post-treatment questionnaire (Appendix A), to gather baseline data on student attitudes. Questions from the pre-and post-treatment questionnaire ($N=6$) focused on student attitudes and feelings towards science and science class and how they felt about being outside and in the environment. The questions were divided into two clusters: cluster A-attitudes towards science and science class and cluster B-attitudes towards environment and outside preference. I compared the results of the pre-and post-questionnaires to observe any similarities and differences. In the post-treatment

questionnaire, I also added two questions about the river study unit and open-ended questions so the students could further explain their feelings.

Table 4
Pre- and Post- Treatment Questionnaire Results (N=6)

Cluster	Pre-treatment average score	%	Post-treatment average score	%
A-Attitudes towards science and science class questions 6,7,8,9,10,11,12,13, one open answer question (post-treatment only) Max Point Value=40	26.6	66.5%	30	75%
B-Attitudes towards environment and outside preference Questions 1,2,3,4,5 Max Point Value=25	18.4	73.6%	18.4	73.6%
C-River study specific question 14, 15 two open answer questions (post-treatment only) Max Point Value=10	N/A	N/A	9	90%

Note: Student F was excluded from these results since he did not take a pre-treatment test.

Results showed that student attitudes towards science content and science class improved by 8.5%, from 66.5% before the treatment to 75% post-treatment. Student D wrote in response to the open ended portion of question 8, “I love the river. I love going to the river, I don’t enjoy science class without some kind of experiment.” These details demonstrate that these students had not done many previous science experiments before in class in the years past and truly enjoyed the tests and experiments that the river study provided.

Cluster B results did not show any change attitude towards the environment and being outside. One reason could be that these students being from farming and ranching families spend a lot of time outside, so I wonder if that is the case for this lack of change. One student remarked, the environment is an important topic to her because, “I am a farmer and I spend a lot of time outside.” Student E, however, responded to question 4 by stating that the environment was important to him as a person because, “then I know how to fix the environment, if it goes wrong and I like being outside.” This illustrates that the content he learned during the river study unit was important in that it was teaching him to notice changes in his environment and how to fix problems should they arise.

Cluster C had a 90% approval rate of the river study unit. Student responses to the river study unit stated that, “I love the river study. The river study is my favorite thing to do all week...I love nature and I believe river study is fun and makes it easier to learn.” Another student said, “I liked looking at minnows under the microscope...because doing helps me know what it is.” I do believe that while the attitudes towards the environment did not change, the treatment of the river study unit did affect how students view learning science and science class. The frequency of more positive responses to science, environmental and river study questions changed from the pre-and post-treatment questionnaire were administered (Figure 3).

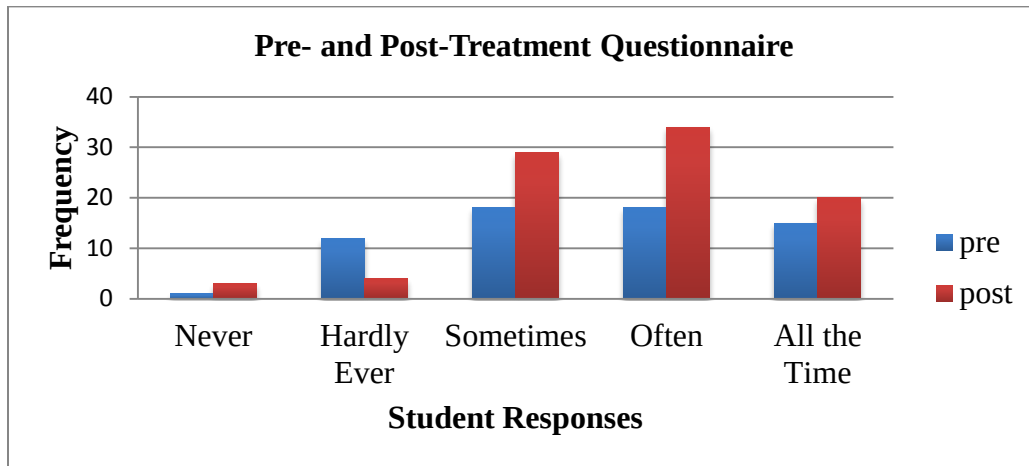


Figure 4. Histogram of Pre-and Post-Treatment Questionnaire Overall Results, (N=6).

Taking note of the change in attitudes towards learning science and looking forward to science class and the frequency to more positive responses after the treatment is an important factor to consider when analyzing data results on student science comprehension and skills and their performance in the treatment and comparison groups.

After administering the pre-treatment questionnaire, I administered individual interviews, and after the treatment, I administered another individual interview to collect students feeling and responses before and after the treatment. In analyzing both the pre- and post-treatment individual interviews I focused on three major themes. These themes included: students' attitudes towards themselves as learners, their attitudes towards science, and their attitudes towards their environment. Focusing on how students learned, and how they thought they learned well, before and after the treatment might give some insight into if they actually felt that they learned science content and their attitudes about the environment during this time.

Overall, students' attitudes and feelings towards themselves as learners were very much classroom focused. Each student remarked that some type of memorization and reading was how they learned the best; however some did express possibly "doing" things as an option to learning something well. When asked the question, "how do you know when you have learned something well?" one student responded, "when I don't have to look it up and I know I won't forget it." Another student responded by, "maybe when I do things and by reading." Most students' responses in this area were very brief and lacked detail or insight into how they preferred to learn and how they learned well.

My students expressed a desire to do more experiments in science class, and because of this there was generally an uncaring or negative attitude towards science class that stood out. Responses varied to the question, "how do you feel during science class?" Students responded with, "I like science," to "I don't like science very much" and, "I am interested in science, I like it a lot. Maybe, I get a little bored when I have already learned it," and "bored, just because". Despite these comments, all students expressed an interest in actually doing science, or science experiments. If I could do more things in science class, one student said, "I would do experiments, and actually do the things we read." Another stated, "I would like to do more experiments." This theme of actually "doing" science was apparent in almost all of the pre- interviews.

A final theme apparent in the interviews was students' attitudes towards the environment. Every student felt that the environment was important and felt that learning about it was important. "If you didn't know about [the environment] you wouldn't know how to take care of it," and, "you can tell when it is healthy and unhealthy and what we

can do to make it healthier.” This theme and students positive responses towards learning about the environment illustrates the fact that they are a group of students that is very aware of their surroundings and sensitive to environmental issues, like pollution. One student noted, “I really would be mad at people that litter.” This shows that this group of students already feels that the environment is an important aspect of science and the world to learn about and is something that needs respect.

Finally, addressing the theme of participating in the river study unit, all the students were enthusiastic and, “[felt] good about learning about what nature does.” Another student stated that participating in a river study unit would be, “pretty fun, it’s cool to learn about water and the measurements.” This shows that all of the students were excited and had a positive attitude about learning about water quality.

After the nine week river study unit ended, I administered another individual interview to each student. I analyzed the interviews using the same themes apparent in the pre-interview regarding students’ perceptions as learners and attitudes towards science, the environment, and participating in the river study unit.

After the treatment, I noticed that students’ responses towards themselves as learners became much more elaborate and understanding of their own learning styles. One student said she learned the best by, “going outside and doing it. Because that is how I learn things...I need examples...whenever we do the river stuff and you do the PowerPoint and then I actually do out to the river and do stuff that really helps me learn it.” Another student stated that she learned information well when, “I just get it stuck in my head when we keep doing it over and over. Like when we keep adding something on at the

river.” This same student also stated, “Sometimes it’s hard when we are just reading it and kind of hard to understand. I think that actual doing part of it helps me understand.” These responses illustrate that fact that the actual “doing” part of the river study and going to the river to do experiments helped them learn the material better than just reading it.

After the treatment students’ responses about their attitudes towards science were lengthier and illustrated more understanding and enthusiasm for the subject. Students’ responded that they thought learning about science was important because, “we learn about different things and see how the nitrates affect the water and the plants and see how living things affect life.” One student gushed that, “I would do the magic school bus and actually get inside a body” in response to what she would like to do more in science class. “It’s important to know about science,” one student said, “because if we don’t know about it we can’t fix problems and its just fun to learn about.” Overall, students’ responses reflected enthusiasm about science topics and the importance of learning science inside and outside of the classroom.

Responses to the environment illustrated an importance of understanding the environment and learning about it to be able to take care of it. “It’s important because we can know more about our surroundings and how to take care of them.” Another student offered, “we need to know what things want, how to give it to them, like plants. Everything on this earth is giving us life for whatever we do. The ground, the sun, the clouds, everything in our natural environment is giving us life.” Students felt that the environment was, “fun to learn about and explore. I like to find out how animals live and act.” All of the students

expressed that the environment was an important thing to learn about, and most stated this was because if they didn't learn about it how could they protect it and make it and keep it healthy.

All of the students also expressed enjoying learning about water quality and participating in the unit. "It was really fun, I really liked it." Another student stated, "It was fun and cold. I like when we actually get to do the experiments and work together as a group."

They all expressed in the interview or informally that, "I wish we could learn more about bugs and the bugs that live in the river." The interviews showed that the students' attitude towards the river study unit was overall a positive experience.

In analyzing student journals, I gave each journal entry a max score of 4. I then analyzed the journal entries for both the treatment and comparison units for positive or negative language and vocabulary written by the students. The mean scores for both the treatment ($T=3.06$) and the comparison ($C=2.66$) units were not very different and their standard deviations were very similar as well ($T=0.80$, $C=0.75$). When a Welch Two-Sample T-Test was applied to all of the journal entry data collected a p-value of 0.01 was assigned to the data. This shows that the likelihood of seeing a difference of attitudes in the dataset would be very minimal. However, when looking at the different journal entries for the treatment group I noticed that as the unit proceeded throughout the fall and early winter, students started writing less about what they learned and more about how cold and freezing it was. This could have been a contributing factor into why the treatment group attitude scores were not a lot higher than the comparison group scores. Student B in her journal stated, "I really, really like going to the river when it is nice out

not cold.” In another journal entry student D stated in response to the river trip, “I had a great time. I can’t wait for next Wednesday. I love it here it’s so quiet and peaceful. I would like to catch minnows and watch them change.” This same student during the comparison unit wrote, “I learned about traits. I like learning about traits. I still miss the river.” These journal entries, while quantitatively did not score very different from each other, shows that while cold weather might have negatively impacted what they wrote about in their journal entries, overall they seemed more positive during the treatment unit than in the comparison unit, despite the cold weather.

In analyzing the data from the observational rubrics, I observed each student’s attitude during the duration of the lesson in the treatment and comparison units. I observed time on task, general attitude, how much I needed to redirect the student and how often I heard positive or negative responses from the student. The max score a student could have received on the rubric was a 4, and the mean ($T=3.46$, $C=3.07$) was higher for the treatment than the comparison group, with the standard deviation ($T=0.54$, $C=0.90$) being higher for the comparison group. I did not observe a significant difference using the Welch Two-Sample T-Test ($p\text{-value}=0.008$) to say that the data was statistically different from one group to the next. However, I felt that the students displayed a much more inquisitive and positive attitude about going to the river (even when they had to bundle up because it was so cold out) than when doing the normal science curriculum during the school day. The students, generally, were more focused and attentive during the treatment unit than in the comparison unit. Student C, when asked what she thought about the day, stated “really cold, but I really liked the new tests we learned today.” This

student, as was most of the students besides student A at times, always listened to directions and followed the procedures carefully and stayed on task. Student A would often be found playing in the dirt if she was not directly involved in handling a piece of testing equipment at the river, but she overall had a really positive attitude during the river unit.

Lastly, I administered the content interviews and transcribed the student responses to the 7 treatment and 7 comparison lessons. These recordings and interviews were done a couple weeks after the treatment and comparison units were completed. Overall, the student elaborated and answered the treatment unit questions more thoroughly than when asked questions pertaining to the comparison unit. In analyzing the transcribed interviews, I documented how many questions had negative or no responses and also counted how many words were spoken in each unit. The following table illustrates how many negative or unknowing responses each student said and also compares how many words were spoken by each student.

Table 5
Content Interview Table of Negative Responses and Words Spoken (N=6)

Students (Treatment)	A	B	C	D	E	F	Total
I don't know, I'm not sure, Nope, No	7	11	9	3	5	6	41
Words spoken	1,560	1,124	886	1,220	852	822 *	6,464
Students (Comparison)	A	B	C	D	E	F	Total
I don't know, I'm not sure, Nope, No	10	15	18	6	5	16	71
Words Spoken	1,280	648	658	776	803	854	5,019

**Student F came in half way through treatment unit.*

Overall, in looking at the content interview data, the students said more “negative” or “not knowing” or “not understanding” words or phrases in the comparison group than the treatment group. The students also spoke more words and for a longer time when asked questions about the treatment than the comparison unit. Students in the treatment group spoke in more complete sentences and explained their thinking and knowledge more than in the comparison group. In general, my outlier students (A, B, C, and F) all had the highest negative words spoken but also spoke more words explaining their treatment answers than their comparison answers. However, student F missed four of the seven lessons of the treatment unit because he transferred from another school. He only spoke 32 words less in answering the treatment unit than the comparison unit questions, even after missing half of the treatment unit.

Lastly, I administered a perceived difficulty CAT to the students. The CAT asked students to rate how difficult they thought the science they learned was during the river study unit compared to normal science lessons. The treatment unit and the comparison unit averaged a 2.3 on a scale of 1 to 5, with 1 being easy and 5 being hard. When asked to explain their answers, the student quotes on the treatment unit stated that, “I thought it was easier because we were out and doing the test.” Reiterating this point was, “I think it was easy because doing it and studying and actually explains it more.” In response to the comparison unit, the students responded by saying, “I don’t think I learn a lot when we can’t actually experience it and see what it does.” Or, another student said, “I learned a lot but it was a lot more fun and I learned a lot more outside.” One student said that the comparison unit was, “a lot harder because most of the time we didn’t understand it. If

we did the experiment it was easier to understand.” These quotes all show that while the two units were rated at the same difficulty level as each other, the students perceived that they learned and understood more actually doing experiments and labs, which was an everyday occurrence during the treatment process, and less frequent during the comparison unit.

Overall, the student’s attitude towards the river study unit was a very positive one. All of the students expressed enjoyment of the river study lessons and experiments, and favored the hands-on nature of doing the water quality tests. Most felt that they learned more during the treatment unit and elaborated more on the concepts they learned during the treatment than they did when asked about the comparison unit lessons.

My third and final research question was, “how will teaching a river study project affect me as a teacher?” To answer this third question, I analyzed a teacher reflective journal that I completed throughout the duration of the treatment unit. After each trip to the river I took time that day to reflect on three main questions and wrote down a response to each of the following.

1. What went well today?
2. What improvements can be made from today?
3. Other thoughts related to my first and second research questions?

In response to these questions and looking back at the river study program that I implemented and will be continuing in the spring and fall school years to come, there was rarely a day where something did not go well. Overall, I felt that each lesson I taught down at the river taught my students and me something new. Sometimes the tests went

well and other times it didn't but we were able to work as a group to solve the problem and figure out a solution. The implementation of the unit took quite a bit more planning and preparation for me as a teacher. However, I do feel that as I become more and more comfortable and knowledgeable about the water quality science and content, this should get easier. I feel overall I learned a lot about the quality of instruction that I give and what is important in that quality of instruction. I learned that my students really do enjoy doing more labs and experiments, whether we are outside of the classroom or not, and these types of activities to explain and understand concepts do improve their attitude towards learning. What interested me most about what I learned about my self and my instruction is that repetition of the content really does matter. I feel that this is partially why my students felt that they learned and remembered so much more about the river study unit. The make up of the unit was such that each test was learned, performed and then repeated during the next lesson. The students had to follow strict procedures, but as the weeks continued they became more and more comfortable and confident with the water quality tests. This shows that as teachers we need to be patient with our students as we try out new and different teaching strategies. The students might not get it on the first try and this doesn't necessarily mean that the strategy or idea is ineffective; it just means that the students possibly need more time and practice with that method or strategy.

My overall goal was to be able to guide them in performing the water quality tests as a group without my guidance at the end of the unit. They were able to do this perfectly during the last lesson of the river study. This shows that they gained confidence throughout each trip to the river. One quotation stuck with me throughout this process, "I

just get it stuck in my head when we keep doing it over and over. Like when we keep adding something on at the river.” Upon hearing this from the student I thought that that was something whether I was inside or outside the classroom I would have to start making a point to include into my instruction. I feel that consistent and continually retouching on content and skills, with an emphasis on hands-on learning throughout the entire school day and in all subjects really help students learn and understand more. This research project has helped me learn these skills that I can implement more into my indoor and outdoor curriculum to help my students become the best and confident learners they can be.

INTERPRETATION AND CONCLUSION

In summary, the treatment consisted of a river study program where the science subject matter was taught inside and then the classroom moved outside to perform water quality tests. The comparison unit consisted of being solely indoors and was textbook driven with labs and activities throughout the lessons. When comparing and contrasting my treatment and my comparison to form conclusions for my research questions, the data suggests that outdoor education does not necessarily increase students’ science comprehension and understanding.

My first sub-question addresses the effects of a river study program on students’ science comprehension and skills. Data results indicate that in the students’ post-test scores for the treatment and comparison units were not statistically different enough (p-value of 0.003) to suggest that the outdoor river study unit influenced an increase of test scores more than the comparison did. The data did, however, show that the outlier students were

all below the standard deviation (17.72) pre-treatment but they were all able to rise above the standard deviation post-treatment (27.08). Whereas, pre-comparison all outlier students were below the standard deviation (9.25), and post-comparison all the student were below the standard deviation, except student C (25.4) who only matched the group standard deviation (25.4). I believe this shows that while both groups of students were below the standard deviation before they learned the content from the treatment or comparison units, the students after the treatment lessons were all able to improve their scores above the standard deviation, unlike the comparison group that did not rise above the standard. This shows that while the students' individual scores were not very high, they were able to improve their scores more during the treatment group than the comparison group. Furthermore, the final assessment test scores shows that the data between the treatment and comparison groups on how much content they retained from each unit had p-value of 0.44 or a 44% chance that there was a difference. All students, except student A, retained more treatment content than comparison content.

Student science journals analyzed for science content understanding showed very similar results between the treatment and comparison. The means ($T=5.1$, $C=4.4$) are extremely close, with a close variance and standard deviation ($T=1.77$, $C=1.39$). Students did not explain concepts more elaborately or better in either of the two groups. This could possibly be because of students' not understanding and utilizing these journals as I expected them to; full of eloquent passages of science concepts learned. Instead the journals often named what they learned and if they liked it or didn't but they did not go into hardly any detail about what they understood about the concepts learned in either

unit. Considering this, if I was to do student journals again for a method of collecting data, I would ask students to explain one concept they learned about that day, instead of the “free write” form that I asked them to do. In this way I feel I would get more data from the students about what they specifically learned about the concept or field test, and this would show their depth of understanding on the day’s lesson.

While my students did not elaborate much during their journal writing, as I would have hoped, they did elaborate more about the concepts they learned during the content interviews that I administered orally, recorded and transcribed. They spoke overall, 1,445 more words about the treatment unit than the comparison unit. The students also said more “negative” or “I don’t know or understand” words and phrases (C=71) when talking and explaining concepts about the comparison unit than in the treatment unit (T=41). I feel that this shows that while they might not be active writers and elaborate when writing in journals, I felt that they are extremely apt at explaining what they know and have learned orally.

My second sub-question addressed how the river study unit would affect my student’s attitudes towards science and the environment. Overall, the data suggests that the river study program did have a positive affect on students’ attitudes towards science. On the pre- and post- treatment questionnaire students attitudes towards science content and class improved by 8.5% from 66.5% to 75% (N=6). However, their attitudes towards the environment did not change. I feel this is because the students are from ranching and farming families and spend a lot of their time outside normally so their pre test scores were quite high.

Responses to individual interviews pre- and post-treatment responses showed that they grew and learned about themselves as learners. While most of the students pre-treatment remarked that they learned the best by memorization or reading, afterwards, all of the students remarked that they learned the best by doing hands on activities. All of the students expressed a desire to do more experiments and activities “like we do at the river” in the classroom. These responses show that students were drawn to the very active and hands-on approach that the river study program provided, and they felt it helped them learn and comprehend the content better. All of the students expressed how important it was to take care of the environment and were aware of some environmental issues (pollution).

The student journals when analyzed for potential differences in student attitudes were very similar statistically for treatment and comparison. The mean ($T=3.06$, $C=2.66$) along with an extremely small variance ($T=0.6$, $C=0.5$) and standard deviation ($T=0.8$, $C=0.7$) was not different enough. The reason for this was that while all of the entries were positive in nature with expressions like, “I love the river!” or, “I love science!”, the treatment unit also had expressions like, “It is very cold.” quite frequently as the treatment extended into the fall months. Overall, the expressions of loving science were still prevalent even though it was cold, when compared to the comparison unit.

Students also scored very similarly during the observational rubrics that I filled out for each student after each lesson. The treatment mean ($T=3.4$, $C=3.0$) was slightly higher than the comparison mean. However, there is no significant difference between the treatment and comparison group (p-value of 0.008). While the students’ attitudes during

the treatment and comparison group were statistically similar, I felt that they were always eager and willing to go outside (even when it was cold) to go do the river tests. This added difficulty during the treatment they did not have to deal with during the comparison and shows that they were still able to be equally as positive. The extra challenge of staying warm did not deter them from wanting to go to the river and I feel is representative of their positive attitude and interest in the content during the river unit.

Lastly, I had three teachers and all of my students ($N=6$) fill out a perceived difficulty CAT where they rated each unit for difficulty. The two units were rated by the students with relatively the same difficulty with a mean of 2.3. However, their quotes reiterated how much they learned during the river study and an emphasis on how they much they enjoyed the “doing” of science and needing to actually “do things to understand it.” Teachers felt that while the river study may initially have more difficult science content to learn ($T=3.66$, $C=3.33$) the repetition and layout of the unit would lend itself to being easier as students grasped procedures and concepts. However, they rated the vocabulary of the comparison unit to be more difficult than the treatment ($T=3.66$, $C=4$), because there “was a lot to be covered in a short amount of time.” This shows that the two units were not very different in terms of difficulty level because they each had things that were perceived as more difficult or easy than the other. This is important because it shows that each unit was relatively equal to the other, with the consistent change being that the treatment unit took place outside (and incorporated hands on learning and experiments every field day) and the comparison unit did not.

Overall, I feel that the quantitative and qualitative data show that while the results were comparable between the treatment and comparison unit involving science content and comprehension, the students mean scores show that they performed slightly better on the final content assessment ($T=52.5$, $C=43.3$) and content interviews. The content assessment given two months after the treatment and one month after the comparison showed a p-value of 0.44, and a difference between student treatment and comparison scores. The content interviews, also given a month after the treatment and comparison units were completed showed that the students were able to speak 1,445 more words about the river study and say less than 30 “negative” or “I don’t know” phrases and words when answering the content interview questions.

In analyzing student attitudes, the students’ mean scores measured similarly during the different units ($T=3.0$, $C=2.6$) with similar standard deviations ($T=0.8$, $C=0.7$). They were similar despite the added obstacles and challenges (i.e. weather, cold) that were present during the treatment, which I thought would have normally drop students attitude levels towards what they were learning. However, this data, along with student observations shows what a positive learning experience the river study unit was for them.

My final sub-question focuses on how teaching a river study unit would affect me as a teacher. As a teacher that has taught two years in Nicaragua in multi-grade classrooms, and four year state-side also in multi-grade classrooms I still feel that I have a lot to learn about the art of teaching. The river study project affected my attitude towards instruction. I realized from student quotes to the question during my individual interviews post treatment, “how do you feel you learn the best?” That many of the

students responded with “when we do it over and over again...like in the river project...it just gets stuck in my head.” Another student stated, “I like when we do experiments...I like when we actually do it, I really don’t understand when we don’t.” Quotations like these show that the level of retention was not necessarily about the content taught but by the way it was taught. I realized that students need repetition and hands on instruction consistently throughout the school day, in all subjects, in order for concepts to be truly learned. I realized that if I want as one student said it, “it just gets stuck in my head and I know it,” to really happen with my students I need to become better at teaching my students a concept and continually coming back to that concept for clarification and understanding. Another aspect I realized was that I need to incorporate more into my teaching is the hands on learning with activities and student application. When I had my fellow teachers review the treatment and comparison material with the perceived difficulty CAT, one quote stood out to me, “the assessments seem to be a lot of recall questions. Anyway to tie data and procedures done into it? Ask them to draw conclusions about and apply what they learned to another set of data.” This quotation made me think about the level of critical thinking I hold my students to and how much I have them actually practice the concepts I have taught in different situations or with different material.

I also learned that some of my methods of collecting data, for example the student journals, provided poor results on student science content comprehension and attitudes. If I were to assess my students using this method again, I would not have a free write where the students could write whatever they wished. I would instead ask the students to,

“explain the importance of the test you learned today.” Or, “describe the main concept learned today. What did you understand about it and what do you still not understand?” I feel that just allowing the students to free write about the day, yielded poor results, whereas with guiding questions and giving the students more of a focus to write about I possibly could have received some more interesting and thought provoking data during the project. I also feel that I could have had students do a quick Likert survey each day pertaining to their attitude during the lesson. They could have answered questions like, “how did you feel during the lesson today?” or, “how do you feel towards what you learned today?”. They would have then responded with a numerical value and then explained why they felt that way. This way I could have captured students’ attitudes more precisely and accurately, instead of just looking for positive wording and then giving them a score based on “positive” or “negative” words in the journals.

One strategy that I used and felt that I need to incorporate more into my overall teaching was the content and individual interviews. I liked being able to take each student one at a time and have them explain a concept to me. While this takes effort and time on my part as a teacher I feel that it really gives me an accurate picture of what the students understand and where they do not understand concepts. During one student interview, a student was talking about how bacteria need oxygen to eat dead things. As a probing question, I asked her “what do bacteria eat?”. She responded by asking, “isn’t bacteria moss stuff?” I was able to understand that she (and possibly other students as well) understood that bacteria would eat the algae and use up all the oxygen, but they did not quite understand what, where, or why the bacteria was there. If I had not asked this

question and other questions like this, or even taken the time to talk individually about the concepts learned in class I would not have been able to find out this information. I feel that I will start including focus or individual content interviews into my classroom understand and assess my students' comprehension level.

In conclusion, I feel that while implementing a river study program with my students most likely will not increase student achievement in science to nationally ranked status, I feel that this method of teaching is notable because of the process and expectations it puts on students as well as keeping them engaged and interested in science. The water quality program has in fact increased my students' attitudes towards science, their environment, and has made them feel apart of something special. The program has given them real world application and real world knowledge out of reading science from a textbook and expanded their understanding of what "doing" science is. Implications of this study for my students and myself are that we will continue with the river study program in the springtime. The data from the content and individual interviews that emphasized repetition and hands-on activities as the methods that students said they responded the best to and final content assessments that repetition and re-teaching of the content is what really benefits student learning and understanding. I feel that continuing the program in the spring would increase the repetition of the material from the fall. It will also allow my students to practice the concepts they learned with different data gathered during the springtime, where the river will have changed. This will give them the opportunity to apply the knowledge they learned in the fall to the different water quality that could possibly be present in the springtime. Throughout this project, my students were able to

gain independence, self-direction, teamwork and problem solving skills. I learned that students seem to retain and learn knowledge better in small stages, but those small stages need to be frequently retaught and touched on and then elaborated upon for students to really retain and comprehend the concepts being taught. I feel that this was most apparent by the quotation one of my students gave, "I just get it stuck in my head when we keep doing it over and over. Like when we keep adding something on at the river." This is a process that I can apply not only to science and the water quality unit, but into other areas of my teaching and other subjects as well. I feel that this small, but worthwhile lesson for me; hands-on activities, real world application, and finally consistent repetition and relearning would be a good habit for all teachers to try and adopt into their daily practice. Parents and community members that are excited about the results that their children and studying and finding on a river in their town. I feel that this program could have the potential to keep parents and community members interested and possibly volunteer with it as it grows and develops because the river is a main part of the life in Belfry and there are many factors that the community can do to influence the quality of the river. Finally, I feel that my research leaves off at the main question of what does affect student comprehension and skills in science. While a river study program may not be the answer to increased student test scores, I feel that the answer most definitely lies in teacher instruction and how we teach content, not necessarily what program we teach. Possible next steps in the research process would be for a researcher/ teacher to ask the question, "What affect does repetition of science content knowledge and skills throughout a semester/year have on student comprehension and retention?" The focus could be min-

lessons or mini-review sessions on previously learned content throughout the year instead of the normal, learn a concept, move on to the next one, and forget the old one routine. I feel like this would be an interesting project that could possibly yield some interesting and substantial results on student comprehension and learning.

VALUE

Action research has helped me grow as a teacher through reflection and observation of my students. This process has helped me to pinpoint where my teaching and instruction is lacking and what I can do to improve. It has helped me to understand what students really need to understand and comprehend the standards they are supposed learn and be able to do.

When I first began my research, I felt that the excitement and enjoyment of going outside and learning about the outdoors in a real and practical way would be such a great experience and so important that it would be hard to miss on my students' test scores.

However, the research and data indicate that it isn't so much the place, where learning takes place; whether it is inside or out, but it is more important how learning takes place.

The how, is the important part, that will influence student learning and eventually scores.

I realized that this can be used in a couple questions to guide teacher planning and instruction to produce the best student outcomes. How can I teach the concepts I want my students to learn so they can understand it? How do I insure that they remember the information they are given? How can I be sure they understand the content I have taught? How can the students practice and use the material they have learned? How can they apply it (real world and or other situations)? I feel that these are important questions that I

can use to guide my instruction and planning to insure a quality education for my students.

I feel that there can be a lot of improvements that I can make to my river study program, when I start up again in the late spring and early fall. I feel that I would actually have more class time inside the classroom learning the science behind each water quality test they performed at the river. For example, for the nitrates test, an extension activity I would like to do in the classroom is grow their own algae bloom to show how nitrates affect the aquatic plants and explain how that affects temperature, dissolved oxygen levels and the various other tests that are used to study the quality of the water. I also would like the students to not only record and analyze the results of the river each trip, but I would like to start giving them hypothetical situations where they would apply what they know about the readings and results to a different situation and then speculate, why that would be that way. Since this was my first time teaching a water quality unit, I felt that I was learning a lot along with the students. My focus was much more on getting the students to follow the correct procedures and working on the skills of collecting data, than it was of analyzing it or applying their knowledge to different situations and critically thinking about their results. This is a goal that in the future I hope to accomplish in my students. I still consider myself a new teacher and I would like to get better and show my students to critically think about what they are learning, and lead them to a higher level of thinking.

My tendency with outdoor education was that if I was able to get them outside the students would learn. However, I have realized that this is not the case. Outdoor

education, I feel to be truly beneficial and able to reach its full potential has to have the curriculum and the knowledge base behind it. I feel that my students would have learned a lot more outdoors during the river study trips if I had taken more time explaining, and doing application labs and scenarios indoors to prepare them for what they would see outdoors. My students throughout the research project stated constantly how they needed or loved doing the experiments and hands on activities. I think this is because they were able to apply the information that they learned through the lecture portion of it to the actual river and were able see real results that meant something to them.

I feel that I can walk away from this experience knowing that my students and future students will receive thoughtful and purposeful instruction. I feel that this project has helped to me set measureable goals within my own instruction that I can be purposeful about and try to include into my daily instruction. I know that if I had taken the time to prepare my students more for each water quality test, not just through lecture but by application as well, my students would have taken a lot more out of each trip to the river. This possibly would have resulted in more accurate data collected from my students in their journals, where they would have a more in-depth knowledge of the tests they were performing. Overall, this was a positive experience for me as a teacher and it has given me a lot of critical suggestions that I can incorporate into my own classroom and instruction. This process has helped me reflect on the things I can work on to better my method of instruction and to become a better teacher.

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APPENDICES

APPENDIX A

PRE AND POST TREATMENT QUESTIONNAIRE

Pre-Treatment Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Directions: The statements in this survey have to do with your opinions and beliefs about nature and the importance of science in your life. Please read each statement carefully, and circle the number that best expresses your own feeling.

1. When you are not at school or work, how often do you spend time outside?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

2. When you spend time outside, how often do you wonder about the science behind nature?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

3. Do you consider yourself someone that enjoys spending their free time outside?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

4. Do you feel that the environment is an important topic to you as a person?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

5. If given the choice, how often would you choose to do a project or learn outside?
- Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time
6. How much do you look forward to science class?
- Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5
7. How often do you think about why or how something works in science?
- Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time
8. Do you ever feel like you are excited to learn about a science?
- Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5
9. How often do you talk to your parents about science or what you are doing in your science classes?
- Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5
10. How often do you talk to your friends about science or what you are doing in your science classes?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

11. How positive or confident do you feel about your science grade?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

12. How confident do you feel when taking science tests?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

13. How confident do you feel when learning new science topics or material?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

Post-Treatment Questionnaire

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

Directions: The statements in this survey have to do with your opinions and beliefs about nature and the importance of science in your life. Please read each statement carefully, and circle the number that best expresses your own feeling.

1. When you are not at school or work, how often do you spend time outside?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

2. When you spend time outside, how often do you wonder about the science behind nature?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

3. Do you consider yourself someone that enjoys spending their free time outside?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

4. Do you feel that the environment is an important topic to you as a person?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

Open Answer: Why do you feel this way?

5. If given the choice, how often would you choose to do a project or learn outside?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

6. How much do you look forward to science class?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

7. How often do you think about why or how something works in science?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

8. Do you ever feel like you are excited to learn about a science?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

Open Answer: If you are excited about science, why or what things make you excited about it?

9. How often do you talk to your parents about science or what you are doing in your science classes?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

10. How often do you talk to your friends about science or what you are doing
in your science classes?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

11. How positive or confident do you feel about your science grade?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

12. How confident do you feel when taking science tests?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

13. How confident do you feel when learning new science topics or material?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

14. Do you feel that participating in the river study unit is something you
would like to continue?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the
time 5

Open Answer: Please express your thoughts, feelings, what you liked and didn't like about the river study unit.

15. Do you feel that participating in a river study unit changed how you understand science?

Never 1 Hardly Ever 2 Sometimes 3 Often 4 All the time 5

Open Answer: Please explain your answer above.

APPENDIX B

INDIVIDUAL INTERVIEWS

Student Interview Questions

Participation in this research is voluntary and participation or non-participation will not affect a student's grade or class standing in any way.

1. How do you feel you learn the best?
2. How do you know when you have learned information about a topic well?
3. How do you feel during science class?
4. Do you think learning about science is important?
5. If you could do more things in science class, what would you do?
6. What topics in science interest you, if any?
7. What do you think about the environment?
8. Do you think learning about the environment is important?
9. How do you feel about participating in a river study unit?
10. What are some things you would like to learn about during the river study unit?

APPENDIX C

PRE AND POST CONTENT TESTS

Dissolved Oxygen Pretest

1. What is dissolved oxygen in water?
2. What are two sources that oxygen in the water comes from?
3. Why is oxygen important to aquatic animals?
4. Why is oxygen important to bacteria?
5. Where are two areas that **supersaturated** water can be found?
6. Which type of water holds more oxygen, cold or warm water?

Dissolved Oxygen Posttest

1. What is dissolved oxygen in water?
2. What are two sources that oxygen in the water comes from?
3. Why is oxygen important to aquatic animals?
4. Why is oxygen important to bacteria?
5. Where are two areas that **supersaturated** water can be found?
6. Which type of water holds more oxygen, cold or warm water?

APPENDIX D

PROCEDURE, SKILLS, AND ATTITUDE OBSERVATIONAL
RUBRIC

River Study Procedure, Skills, and Attitude Rubric (Treatment)

	1	2	3	4
Procedures (Following teacher directions, test directions, time on task)	Student does not follow directions from the teacher and/or does not follow the procedure for the test /experiment. Student has to be redirected and reminded to stay focused and on task.	Student partially follows direction from the teacher and the procedure for the test /experiment. Student has to sometimes be redirected or reminded to stay focused and on task.	Student mostly follows directions from the teacher and/or the procedure for the test / experiment. Student rarely has to be redirected or reminded to stay focused and on task.	Student always followed directions from the teacher and/or the procedure for the experiment. Student did not have to be redirected or reminded to stay focused and on task.
Skills (Science skills, recording and analyzing results)	Student did not demonstrate the science skills necessary to perform the experiment. Student did not record results, and analyze data correctly and accurately.	Student partially demonstrated the science skills necessary to perform the experiment. Student partially recorded results, and analyze data correctly and accurately.	Student mostly demonstrated the science skills necessary to perform the experiment. Student mostly recorded the results, analyzed the data correctly and accurately.	Student always demonstrated the science skills necessary to perform the experiment. Student always recorded the results and analyzed the data correctly and accurately.
Students Attitude towards science and environment	Student has poor or negative attitude about the experience and content learned during the rivers study lesson and trip.	Student has a neutral or uncaring attitude towards the experience and content learned during the river study lesson and trip.	Student displays a liking or somewhat positive attitude towards the experience and content learned during the river study lesson and trip.	Student displays very positive attitude and positive experience and content learned during the river study lesson and trip.

Procedure and Skill Score _____/8 Attitude Score _____/4

APPENDIX E
STUDENT JOURNAL RUBRIC

River Study Journal Rubric (Treatment)

	1	2	3	4
Journal Requirements	Journal has no requirements; date, time, and weather conditions, or field observations. No summary or brief summary with no detail or data and recordings of tests performed.	Journal has little of journal requirements; recordings of date, time, and weather conditions, or field observations. Brief summary with some detail about data and recordings of test performed.	Journal has most of journal requirements; date, time, weather conditions, field observations, with a summary including details and data or recordings of tests performed.	Journal has all requirements; date, time, weather conditions, and summaries with good details about the river study trip, with accurate and detailed field observations, data and recordings of tests performed.
Science Vocabulary	Journal has no scientific vocabulary in excerpts and does not explain or give details about concepts learned during the river study lesson and trip.	Journal has brief use of scientific vocabulary in excerpts and gives a little detail about the concepts learned during the river study lesson and trip.	Journal displays a use of scientific vocabulary and gives details about the concepts learned during the river study lesson and trip.	Journal displays understanding and uses scientific vocabulary in excerpts in a knowledgeable way to explain the river study lesson and trip. Gives thorough details about the concepts learned.
Students Attitude towards science and environment	Journal has poor or negative attitude about the experience and content learned during the rivers study lesson and trip.	Journal has a neutral or uncaring attitude towards the experience and content learned during the river study lesson and trip.	Journal displays a liking or somewhat positive attitude towards the experience and content learned during the river study lesson and trip.	Journal excerpts portray very positive attitude and positive experience and content learned during the river study lesson and trip.

Journal Science Content Score _____ /8

Student Attitude Score _____ / 4

APPENDIX F
CONTENT INTERVIEWS

Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student C</u> Why is nitrogen important? So the water, I'm not sure if I remember. Do you remember why we put nitrates on plants? To give them oxygen. Nope your family might put nitrates on your crops and why would they do that? Oh to make them stronger and taste better. Ok, and why is that important? So the plants can be good to eat and if they didn't they just wouldn't get strong. What is more abundantly found in nature, nitrogen or phosphorous? I think nitrates. What two elements does algae convert nitrogen into? I have no idea. Maybe oxygen. Doesn't it have to do something with the algae bloom? Yes. Oh it helps them make algae blooms and into bundles. You can find nitrogen in the atmosphere where else you might find it? In the water. How does it get in the water? I don't know. If your family uses it for crops then how does it get on the crops? The manure. And what else? When we fertilize. So if they are added to the crops where are they coming from? The fertilizer And how does that get into the water? When it rains the fertilizer will just be washed down into the river. Ok, and what is that called? Erosion. Why might there be a lot of nitrogen in the water and why might that be bad? Um because there will be a lot of yucky stuff and that might clog the fishes gills and makes it hard for them to breathe. What do you mean by yucky stuff?	

Since it is little particles in the water it is like a gas to them and makes it hard for them to breathe. It makes them get to big and then they die and then it takes up all the oxygen and then they die and then the bacteria has to use all the oxygen and then there is nothing left for the fish. What aquatic plant readily uses nitrogen for plant growth? The algae	
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Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student B</u> Why is nitrogen important? I don't know. What do you know about nitrates? That they are bad for the water and if there is a lot then that is bad. Ok and what are they? Ummm, they are things that make the water bad. I don't know. How do they make the water bad? Like when there is fertilization that can get washed into the river and the fertilizer can make it bad. How does it make it bad? Because the fish might want to leave because the water is getting all clogged up. Getting clogged up with what? Algae and stuff. How does it affect the algae? It gives the algae too much and gets bigger and bigger and starts to die. What is that called when that happens? Or what does that look like? It looks like a green carpet, an algae bloom. What two elements does algae convert nitrogen into? I don't know. Where does nitrogen in the water come from? Fertilization and cow manure and when they are herding cattle. How does that get into the water? When it rains it will get washed down into the river. What is that called?	

I forgot. Why is nitrogen is important? It helps the plants grow. And what plant uses nitrogen for its food and plant growth? Algae.	
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Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student A</u> Why is nitrogen important? It's kind of like pH it helps if there is too much of it there are algae blooms. Why would it cause algae bloom? Because if there is more nitrogen and then there will be more plants which means the plants will get on the top and then there will be more algae blooms and then the stuff at the bottom won't get any sunlight and no fish will be there because their lungs will be all clogged up if there is too much. But if there is a little there will be enough for the plants at the bloom and the algae, but in the winter there is hardly any nitrates because the fields aren't getting any stuff on them but in the summer when they are getting sprayed and it rains and the river collects it then there will be nitrates in the water. Ok, so what are nitrates? They are fertilizers. So why is it important? So the plants at the bottom can give oxygen to that water and the fish can live and the fish can give CO₂ and everything live. Why do farmers put fertilizers on their fields? So the plants can grow faster and not be covered by snow because we do live in Montana. What is a human-caused source of nitrates in a water source? Fields, cornfields, pretty much anything that has plant growth in it. The rainfall getting the fertilizers into the water. What is that called when the fertilizers and dirt go into the water? That goes with turbidity, but I'm not sure what that is called. What happens to plant growth what happens?	

There will be a lot of algae blooms that will soak up all the sunlight and then that will block the atmosphere from getting into the water and there will be no waves.	
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Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student D</u> Why is nitrogen important? It's important for plant growth but too much can cause a algae bloom and will take all the oxygen and kill all the plants and animals. What is more abundantly found in nature, nitrogen or phosphorous? Nitrogen. What two elements do algae convert nitrogen into? No. How do nitrates get in the water? Feed lots, fertilization and it gets in the water after its sprayed and washed down into the water after it rains. And why might nitrogen in the water be a bad thing? Because it is good to have some but not a lot, it can cause algae bloom and kills the fish cause it takes up all the oxygen. How does it do that? It takes up all the oxygen that plants and fish need. How does it do that? Umm, they...the more they get the nitrogen the more they grow and the more algae the more dead plants and animals there will be and then there is too much algae. Why is too much algae bad? It blocks the sunlight and it can cause, it's just a big difference the dissolved oxygen runs low and plants and animals die and keeps getting worse and then there wont be any plants or animals left. Why is the dissolved oxygen less when there is an algae bloom? Because the algae starts growing rapidly from nitrogen it block the sun and then it dies and takes up a lot of oxygen and then there is nothing left for it to survive. What aquatic plant readily uses nitrogen for plant growth?	

Ummm, Algae.	
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Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student F</u> What do you know about nitrates? I really don't remember. It's maybe a gas that causes algae blooms and then causes animals and plants to die. How does it cause algae blooms? Because the plants need nitrogen to survive and the algae needs and they keep eating it and they grow so much that they cover the area like a green carpet and then it blocks out the sun and the plants can't survive and the plants die and the bacteria comes and eats them. Why does the bacteria come and eat them? Because they need nitrogen. How do nitrates come from? Oh it's like that picture you showed us, with the waterfall with cows and it might come from bacteria in the manure and from farms and stuff. How does it come from the farms? Umm, from the fields and stuff and when it rains it will get washed into the river. What might happen if there is a lot of nitrogen in the water? Umm, it feeds the algae and it becomes an algae bloom and no sun gets to the plants, the fish can't eat the plants and then the bacteria eat them. What is a human-caused source of nitrates in a water source? Umm, the manure thing and the spray stuff that I was talking about. What aquatic plant readily uses nitrogen for plant growth? Algae.	

Student Content Interviews (Nitrates)	Teacher Notes/ Patterns
<u>Student E</u> What do you know about nitrates? It helps plants grow. What do you think happens when there is a lot of nitrogen found in the water? Umm, there will be more plants and will make more of them grow. What is a human-caused source of nitrates in a water source? Cow manure and when they spray their crops and it leaks down into the water. What aquatic plant readily uses nitrogen for plant growth? Algae What is that called when the algae reproduces really rapidly? An algae bloom Do you remember how we took the nitrate test? No I don't.	

APPENDIX G
FINAL CONTENT ASSESSMENT

Please answer the following questions about information you learned during the river study unit.

1. What is dissolved oxygen in the water? (2)
2. Why is oxygen important to bacteria? (2)
3. What type of water holds more oxygen, cold or warm water? (2)
4. What happens to water temperature throughout the day? (2)
5. What is thermal pollution? (2)
6. What happens to the life cycles of aquatic insects as the temperature of the water increases? (2)
7. What does pH stand for? (2)
8. The pH scale is from 0 to 14. What is acidic, basic, and neutral reading? (3)
9. What are some possible causes of a very acidic pH test sample? (2)
10. What is a macroinvertebrate? (2)
11. How do macroinvertebrates tell us about water quality? (2)
12. Why are macroinvertebrates different from fish when it involves an unhealthy river or stream? (2)

13. What is nitrogen? (2)
14. Why do we test for nitrogen in the water during our river study unit? (2)
15. What are some human-caused sources of nitrates in a water source? (2)
16. What can high levels of nitrates in the water cause? Explain what this can cause and how it is harmful. (3)
17. What is turbidity? (2)
18. What are some examples of suspended solids? (2)
19. What does a lot of suspended solids in the water affect the temperature of the water?
20. How do suspended solids affect fish and their eggs? (2)
21. Why is phosphorous called a “limiting nutrient”? (2)
22. What happens to plants and algae when there is too much phosphorous in the water? (2)
23. Where does phosphorus in the water come from? (2)

Please answer the following questions about information you learned during the river study unit.

1. What is asexual reproduction? (2)
2. What are four ways that organisms reproduce asexually? (2)
3. Why does asexual reproduction produce offspring with identical DNA? (2)
4. What does a strand of DNA look like? (2)
5. Does the number of chromosomes a species has determine the size of the individual organism? (2)
6. What happens when DNA “unzips”? (2)
7. What is the first cell of a new organism called? (2)
8. Why are there generally more egg and sperm cells produced during external fertilization than during internal fertilization? (2)
9. What are the advantages and disadvantages of sexual and asexual reproduction? (2)
10. What is the difference between a dominant and a recessive trait? (2)
11. What is an organism with one dominant and one recessive trait called? (2)

12. Name 3 organs found in the body. (3)
13. Name 5 body systems? (5)
14. What is the function of red marrow in the spongy bone in your body? (2)
15. Name 3 types of joints. (3)
16. What are the two kinds of branches that extend from the cell body of a neuron?
(2)
17. Which system of the body takes in materials and breaks them down into simpler substances that the body can use? (2)
18. What are the 5 parts of this system? (5)
19. Where does most of the digestion of food take place? (2)
20. What are the three types of blood vessels? (3)
21. What system carries blood throughout the body? (2)
22. What parts make up this system? (2)
23. What is the job of a white blood cell? A red blood cell? (2)

APPENDIX H
PERCIEVED DIFFICULTY CAT

Circle the number 1-5 to answer the following questions.

1. How difficult was the science that you learned during the river study unit?

1=Easy

3=Some was hard/ some was easy

5=Hard

Please explain.

2. How difficult were the tests you took before and after each lesson?

1=Easy

3=Some was hard/ some was easy

5=Hard

Please explain.

3. How much did you feel like you learned during the river study unit?

1=Not a lot

2=I learned an average amount

5=I learned a lot

Please explain.

4. How much did you feel like you learn during normal science units?

1=Not a lot

2=I learned an average amount

5=I learned a lot

Please explain.

Thank you for taking the time to look over these two units and answering these questions. After looking over the two units provided...Do you feel that one unit is more difficult than the other? Or are they the same in difficulty? Please explain. Please rate the following units on difficulty, for a fifth and sixth grade class.

River Unit

The vocabulary used in this unit is _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

The science concepts learned in this unit is _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

The science procedures and skills required for this unit would be _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

I would anticipate this unit to be _____ in difficulty for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

Normal Science Unit

The vocabulary used in this unit is _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

The science concepts learned in this unit is _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

The science procedures and skills required for this unit would be _____ for the students involved.

1=Easy

3=Average

5= Difficult

Thoughts:

I would anticipate this unit to be _____ in difficulty for the students involved.

1=Easy

3=Average

5= Difficulty Thoughts:

APPENDIX I

SELF-REFLECTION JOURNAL

Self-Reflection Journals

My third AR question was, “How will teaching a river study project affect me as teacher?” I collected data for this question through mainly journal entries that I wrote after every river study lesson. In these journal entries I focused on how the lesson went, and answered the following three questions.

1. What went well today?
2. What improvements can be made today?
3. Other thoughts related to my first and second AR questions.

9/4/13

1. *What went well today?*

This was the first day of the river study project with the fifth and sixth grade. I felt like it was a good introduction to the river study unit. We went to the river and took the temperature, velocity, and we looked at some water skippers. I had the students observe and journal about what they observed. The students noticed that the water wasn't moving very fast and they found bubbles coming up out of the water that was probably from an underground pipe. I felt that they were very observant and kept making remarks about the birds and how “peaceful” it was by the river. I felt good to be outside on such a nice warm day and think about nature with the students.

2. *What improvements can be made today?*

A couple of the students remarked that the shore was really rocky and that maybe we should choose a different spot on the river to do our river study tests. So we decided next week that we would go upstream about a fourth of a mile where the bank is more gradually sloped and sandy, instead of the gravel and large rock portion that we were on today. The students really enjoyed watching the birds scoop up bugs off the water and it made me think of an extension activity for bird watching that would be fun to do with the students since they weren't sure what types of birds they were.

3. *Other thoughts related to my first and second AR questions?*

Overall, it was a very good productive day to introduce them and get them curious about the water quality unit. I felt like some of their comments like, “it is so peaceful,” and their questions of “why is it like that?” or “what birds are those?” and “what is the name of these bugs?” sparked their curiosity that we then took back to the classroom to see if we could find any information about the bird and bugs. I felt that even the small timeframe we spent at the river made them excited about what they were seeing and made them eager to come back and learn about water quality. I think this answers to some degree, my second AR question about how does it affect their attitude towards the environment and science. There was an air of excitement and curiosity that the students had about the tests and coming down to the river every week to do water quality tests and what they learned. I feel that this first trip peaked their curiosity and excitement for the unit.

9/11/13

1. *What went well today?*

Today we took a good look at temperature and why temperature is important to water quality and aquatic life, insects, and fish. Almost all of the students thought that maybe fish like warmer water, but throughout the beginning of the lesson they realized that most aquatic species like colder water for their living conditions. I am hoping that throughout this unit, they might be able to see how one test, something as simple as temperature is linked to every other test, and can influence so many other factors...especially temperature. They seemed to understand why water might be warmer or colder and why stream banks with trees are important in keeping the water temperature colder and protecting it. I chose this test first because of its simplicity and I really wanted my students to be able to follow instructions perfectly even when it is something as simple as taking the temperature of water. We discussed where to place the thermometer and the correct procedure for taking temperature. At the end of the lesson I felt the students were happy to be outside by the river and they all knew the correct procedure for taking the temperature of the river.

2. *What improvements can be made today?*

I noticed that none of the students really retained what thermal pollution was. I think this will have to be something that I either go over again or find some way to make it more relevant to their thinking. I also think that when I am introducing a new vocabulary word or concept that I need to be better about trying to constantly say that word and ask the students about that word

throughout the lesson in order for it to go into their long term memory. I think that this simple teaching strategy would help in them retaining information better during and after the lesson.

3. *Other thoughts related to my first and second AR question.*

Overall the students were very excited to be at the river again. I feel that they are really enjoying the trips and are excited to learn about the river and doing new tests and what they mean. I feel good about how they are following procedures and that they are taking the things they are learning seriously, especially when it comes to performing the tests even if it is just temperature. I feel that they have learned things previously about temperature and how important it is, and how it affects other things, especially in water quality from this lesson than they knew beforehand.

9/18/13

1. *What went well today?*

Today was the second day to the river and we started it off with the dissolved oxygen test (DO). We also continued to take the temperature and velocity tests. Today was very much of learning the routine and procedure of what we do on river study days. They all were given a task and a tool that they were each responsible for. This day I tried to go slower than usual and tried to be very specific about what type of expectations I had for the students when we come down to the river and how we work in groups and as a team. They all really enjoyed doing the DO test because the group leader was instructed to give each teammate a task to complete the experiment. The students really wanted to test the water at school afterwards to see if there was any difference in the DO of the water compared to the river. Student A, who usually likes to go off and do her own thing and who has a hard time participating actively and well within groups, seemed more attentive and active in her class participation today, which I felt was exciting to see her want to be more involved. Overall, the students performed very well within their group and were able to conduct the tests together. I was happy with their performance even with a tricky test like the DO test that has many steps and has a lot of directions to be followed.

2. *What improvements can be made today?*

I felt like the students did very well doing the DO, temperature, and velocity tests as a group. This being the second day of the river study program I felt that I was modeling and showing them my expectations of how they should act within the group and how they should work as a team. I am hoping that possibly each day to the river the students will be able to become more and more familiar with each water quality test and become more self sufficient at doing the test on their own within their group. I will have to be diligent at giving each student a chance to be a leader in the group and the one that directs the test. I feel that this way they will all get a chance to be in charge and feel important. I also feel this will be a good way for them to learn social skills they need to work within groups, even when they might not like other people in their group. I feel that each trip to the river I should make a mental note to focus on the group dynamics and making sure each student is involved and engaged in the activity at hand.

3. *Other thoughts related to my first and second AR questions?*

Pertaining to my second AR question, all the students were still very engaged and enthusiastic when we went down to the river. They all really enjoyed doing the tests because it is very hands on and very different from what they do during normal science time. They all said the DO test was their favorite because it changed into the blue color and then back again. Pertaining to my first question and how my students are learning water quality vocabulary and are applying it when we are out in the field. I feel that even just the more hands-on nature of the river study unit helps them utilize that scientific vocabulary more orally, because they are identifying, reading, and recording data each trip and after each test. I feel that this is exposing them to more of the actual nature of “doing science” than our normal science curriculum from the textbooks do.

9/25/13

1. *What went well today?*

Today was a colder day, but the student kept on track for performing their experiments in spite of the cold. Each lesson and trip to the river I am adding

one more test to the repertoire of tests that we do each week. Today's water quality test was pH. The students understand the flow and procedure of the tests, and they really like the DO test the best. I think that the addition of a new test each week in addition to the previous tests helps them remember the flow and what each test is testing and the procedure that needs to be followed for each test.

2. *What improvements can be made today?*

Overall, I was a little disgruntled today with how my students followed procedures today. I am not sure if this is because I slacked on my communication of those expectations or if it's because they are trying to test the boundaries of what can be done and not done when on the river trip. I also think that I should have done the pH test at a later date and possibly done a refresher on what pH is. During the beginning part of the lesson they didn't remember what acids and bases were and what I should have done was do a simple pH lab that showed them what actual pH is and what types of things are acidic and basic. I think in the future the students will comprehend what the tests actually are measuring if I take the day previous and do some sort of inside lab about the actual test that we will be doing out in the field instead of assuming they know things about pH when I start the lesson. I think that some type of pretest before the actual lesson whether it is a day or two before will give me a better idea of where each student stands in their knowledge of the subject and will give them a better understanding of what they are testing the water for.

3. *Other thoughts related to my first and second AR questions?*

While the students were ok during this lesson, I felt that the cold changed their mood on being outside and doing the water quality tests. They had a harder time today following directions and procedures directly which I feel is very important when doing field tests. Their enthusiasm seemed to wane a bit today in response to the cold weather. I also feel that I could have increased their knowledge and understanding of pH if I had done a pre lesson on pH before actually doing the test down at the river site. I didn't realize that their knowledge of pH was so minimal especially on acids and bases before I started the lesson for the day. I think this shows that while I am taking them out to the river and doing more outside lessons with this unit, I think that sometimes the outside lessons compliment and help solidify the content

learned in class, but sometimes it is very hard for the specific content learned to be done solely outside. I felt that this would have been a much better lesson and the students would have had a deeper understanding of pH and the science content if I had done a pre lesson on what pH, bases and acids were. Therefore, I felt this lesson wasn't as well prepared as it could have been to maximize the science content that was learned.

10/2/13

1. *What went well today?*

Today was the class studied macroinvertebrates and they were really enthusiastic with the prospects of finding the different types of bugs in the streambed. It was a fun day and the students enjoyed looking around for the different bugs and we even expanded our search to the minnows along the shoreline and a garter snake. They liked using the tweezers and microscopes to look at the water skippers we found. The days are getting colder however and we were unable to find very many macroinvertebrates of different species, just mainly water skippers.

2. *What improvements can be made today?*

I think that next year I will be doing this lesson most likely at the beginning of the year. I felt that the weather was getting too cold to find any macroinvertebrates and we possibly would have had better luck during the summer or early fall when the weather is still warm. Again, I feel like a pre lesson a day or two before the river outing would help the students retain information about the bugs and what types they were. For their science content on the subject to be mastered I think that the brief lessons before the trip would be better utilized if I had done a full lesson on the bugs and had them do some type of indoor categorization of the macroinvertebrates and then the next day go down to the river for the field tests. However, the students really enjoyed studying the macros that we did find and they were enthusiastic and had a very fun time using the keys and trying to match the different bugs under the magnifying glass to the descriptions in the key.

3. *Other thoughts related to my first and second AR questions?*

I felt that the student's enthusiasm in spite of the cold picked up because of the interesting nature of looking for the "bugs" in the water. They were all really engaged and had a fun time looking though the bugs and trying to categorize and name them. We didn't find very many but overall it was a fun experience trying to find the macroinvertebrates with the students. While they had a lot of excitement and enthusiasm I would have liked to see their retention of the material taught during the pre lesson expanded upon because of the river trip.

10/8/13

1. *What went well today?*

The weather is definitely getting colder now. Today we did the nitrate test and we also had a new student so the kids were eager to show off their skills to the new student (Student F). This was actually student F's first day of school, so the students were excited about having him in their classroom. They all did very well on following the procedures and directions of the tests even Student A took a lead role today by reading the directions for the DO test and lead the group in performing the test. They didn't get a reading on the DO test the first time so they decided as a group that they would do the test again to see if they could get results. I thought this was a good thing because they decided as a group and were all enthusiastic enough to get the reading that they decided to do more work in spite of the cold weather to see if they could get an accurate reading. I felt that this showed their enthusiasm for the test. However, the second try also led to no results, so they recorded this in their data. The new student seems really interested and asked lots of questions which the other students readily answered.

2. *What improvements can be made today?*

I felt that today was a very good day and it was fun seeing the students share their knowledge about the river study tests we have done with the new student. One of the improvements I would have made today is to figure out why sometimes the DO test does not show an accurate reading. This seems to be a bummer for the students since they really enjoy seeing the water change different colors in response to the chemicals. Having a new student come in half way was a little difficult to catch him up to speed on everything that we

have learned but the other students seemed eager to explain each test and what the procedure was.

3. *Other thoughts related to my first and second AR questions?*

I felt that the students' attitudes and enthusiasm was very high today despite the cold because they were able to share their information and knowledge they have learned the last couple of weeks with the new student. I felt that is accurately showed how enthusiastic they were in doing the river study unit and they felt important talking about what they learned. Overall, I feel that my students have learned a lot about water quality so far, especially since they didn't know anything at the start of it. However, I am not sure if the new information they are learning is greatly compounded because of the fact that it is outside the classroom. I think their enthusiasm is definitely affected and different when inside or outside the classroom, but I am unsure if their retention of science knowledge and comprehension is greatly influenced or changed just because it is an outdoor river study project. I wonder if student's science content comprehension is more influenced by repetition, and consistent revisiting of the material learned (i.e. how the river study program is designed), rather than the fact of the unit being outside or within environmental education.

10/15/13

1. *What went well today?*

Today we did the test on turbidity, and all the students were excited when we got to start the new test, especially since it involved a big piece of equipment called the turbidity tube. They all tried this test and worked together and listened together to tell when to release the water and when to pinch it in order to get an accurate reading. They were all very active in all the tests and each student participated, even when it was a cold day. They seem to really respond to the fact that we learn about and how to do a new test every week.

2. *What improvements can be made today?*

Well for one thing, I was the first person today to break a piece of science equipment. I broke the holding glass for the DO test on the ground, so we were unable to do that test. I feel that while the students have a positive

attitude while we are doing the tests, their journals are not reflecting much in the way of scientific content learned and attitude. Most of the students talk about how cold it is, and the tests we learned, but they hardly ever explain what they know about the test they just did or why it is important. So I am a little disgruntled with the data that my journal entries are giving me. They seem to like to rush through the journaling part of the lesson at the end, and like it the least. Most of their entries are brief and lack any detail. I am not sure how I can make the journaling a more positive experience that will gauge stronger results. Maybe in the future the students will be asked to respond to certain questions like, "What did you learn about the experiment you did today?" and "Is this an important thing to learn about? If so, why?" Instead I just did an opened journaling entry and asked the students what they learned, what did they like or dislike about the river trip, and these questions didn't seem to yield a lot for results and/or encourage the students to elaborate on their knowledge or experiences. I also have realized that to keep Student A more on task, I feel that I need to start putting her in more leadership positions and working with her on interacting with the group, to keep her focused. She has been having a hard time staying with the group and following directions sometimes and has to be constantly reminded to come back to the group and participate. I am thinking that I need to always make sure she has a definite role and job that she needs to fill, will possibly help solve this problem.

3. *Other thoughts related to my first and second AR questions?*

I feel that the students are generally excited and enthusiastic about what they are learning; however I feel that their journals haven't been the best way to get a grasp on what they learned and retained during the lesson involving science content and comprehension. Instead of doing video interviews I have decided that I am going to do content interviews with each student over the science content that they learned over the unit. I feel that this will be a better way to gauge retention of science content and measure understanding in relation to my first AR question.

10/24/13

1. *What went well today?*

The students had a lot of enthusiasm today, even though it was cold. However, this enthusiasm eventually resulted in the students not taking the time to go

through the procedure of the tests carefully. A ball during the velocity test was almost lost because one student wasn't paying attention to make sure they were ready to catch the ball and one of our measuring beakers was broken. The same student did both and I had to get after him about why it is important to follow the directions and procedures carefully, so these accidents wouldn't happen.

2. *What improvements can be made today?*

Overall, it was a fine day and cold. The events of almost losing the ball and breaking the beaker reminded me that even though we are repeating the same tests week after week, I need to be more diligent in reminding my students about the expectations I have before each trip out to the river. Even little reminders of what is expected before we go out to the river, or stopping a procedure and refocusing the group before they continue would be beneficial. It reminds me of an old adage that a fellow teacher has said to me, sometimes slow is fast, and fast is slow. We ended up losing equipment and time because I didn't slow the group down and refocus them on correct procedure skills. This is something that I can be more aware of and work on. I also realized the importance today of always having a back up plan in case something doesn't always go the right way. For example, I should carry an extra ball, just in case one is lost down the river and an extra beaker or two should one be broken. These precautionary steps could save me time and instructional time for my students.

3. *Other thoughts related to my first and second AR questions?*

Student enthusiasm in relation to question two was high today, and since I did not rein it in in time it was at the detriment of the student science comprehension because we were unable to perform the DO test because one student broke one of the beakers. However, this did make me understand the importance of having back up materials and instruments when doing field trips and labs, so as not to waste instructional time by being unprepared.

11/4/13

1. *What went well today?*

Today was the final day of the river study unit. The colder and colder weather was making some trips out unpleasant and harder to do, so I felt that this was a good stopping point weather-wise and content-wise for the treatment unit to end. I started the lesson by telling the student that this was their final day and that I was not going to help them at all through the tests. That they were going to be required to do each field test as a group, without me and I would be watching and observing them during this process. All of the students preformed each test and behaved very well. They executed the tests in an organized and efficient manner without my help. All the students had a positive attitude and I only had to remind Student A to participate and help out her teammates once. I feel that overall my students became independent and capable of doing each water quality test accurately by themselves. As a teacher, I want to teach my students the proper skills and knowledge so they can be as independent as possible from my direction and instructions, and I feel that the past 11 weeks accomplished just that. The students overall had a very positive experience with the lessons, content, and field work that we accomplished over this time frame. They went from having no knowledge about water quality, to preforming some very important tests and understanding material that they knew little to nothing about beforehand. Overall, I am very pleased with the results of the river study unit and how the students progressed in their attitudes and procedure skills.

2. *What improvements can be made today?*

Improvements overall, on this river study unit mainly lies in the pre lesson content that I give the students before we head out to do the actual field tests. Their content knowledge in some areas were not as high as I would like and I feel that this gap could be closed by doing one lesson the day before the field trip to the river on the actual science content behind the test they would be performing. For example, before doing the pH test and learning about why it is important to water quality, I would do a lesson or a couple lessons on what pH is, what acids and bases are, and possibly a pH lab of different materials in the classroom. Then I would do the water quality lesson as it pertains to pH and go out to the field to do the test. I feel that this would raise the level of student science content comprehension to a better level than just doing the pH water quality lesson alone.

3. *Other thoughts related to my first and second AR questions?*

Again, I feel that my students learned a lot of new information about water quality and the field tests to test water quality and that they always had a generally good attitude about going to the river even when it was really cold out. It will be interesting to see how their knowledge retention and how much they learned will compare to the normal science curriculum in the classroom. I feel that the outdoor river study unit was very beneficial and important for student attitudes towards their environment and what actual science is. However, I am not sure how it compares to the normal science classroom curriculum and if it increases or decreases, or affects at all student science comprehension of the content learned. A couple things I noticed about what does affect the comprehension of the content learned is repetition and re-visitation of the material taught and learned. Hands-on activities also seem to make the science concepts learned more applicable for each student to understand and as one student said, "Makes it stick in my brain." I am interested in learning how the student pre and post test scores, journal entries, and attitude levels will compare when doing the comparison unit.

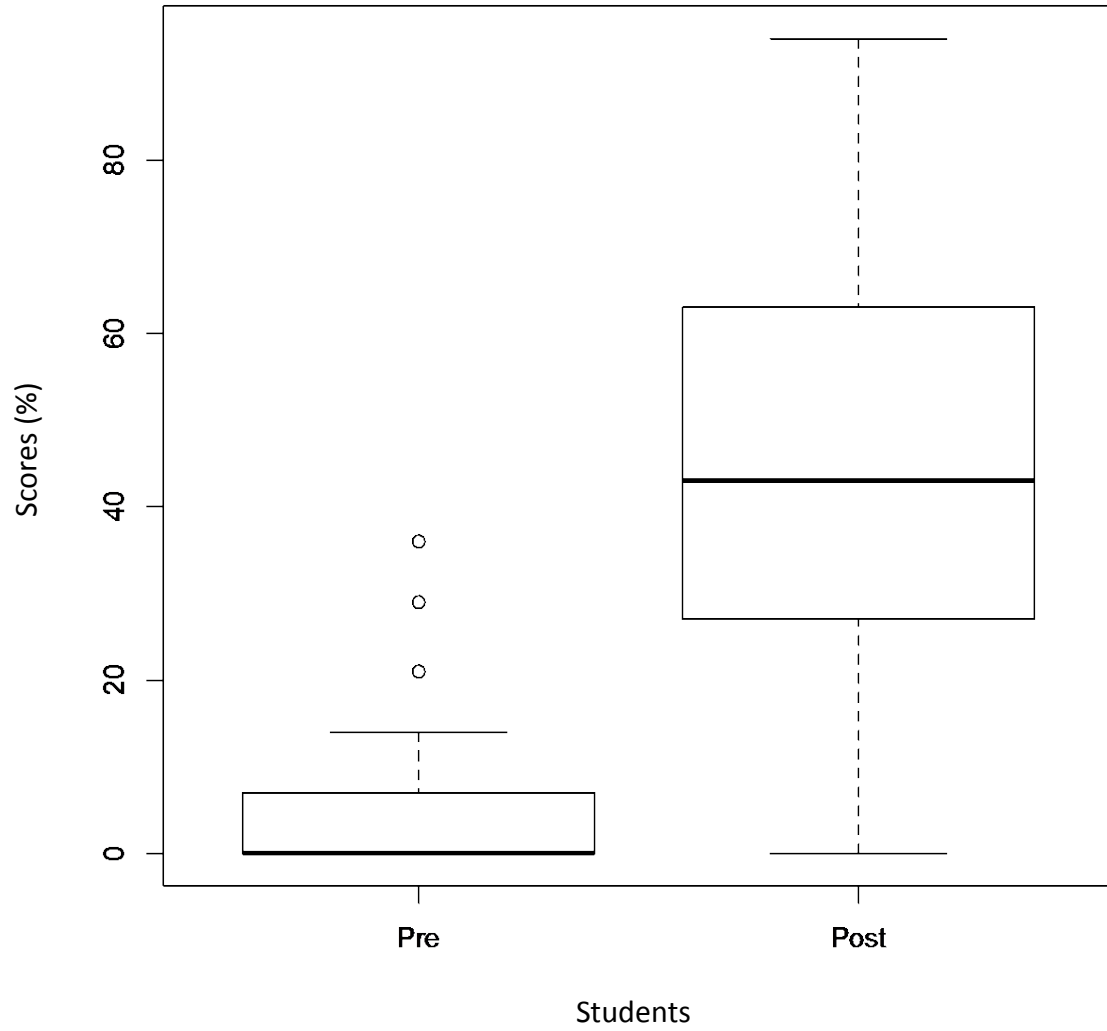
APPENDIX J

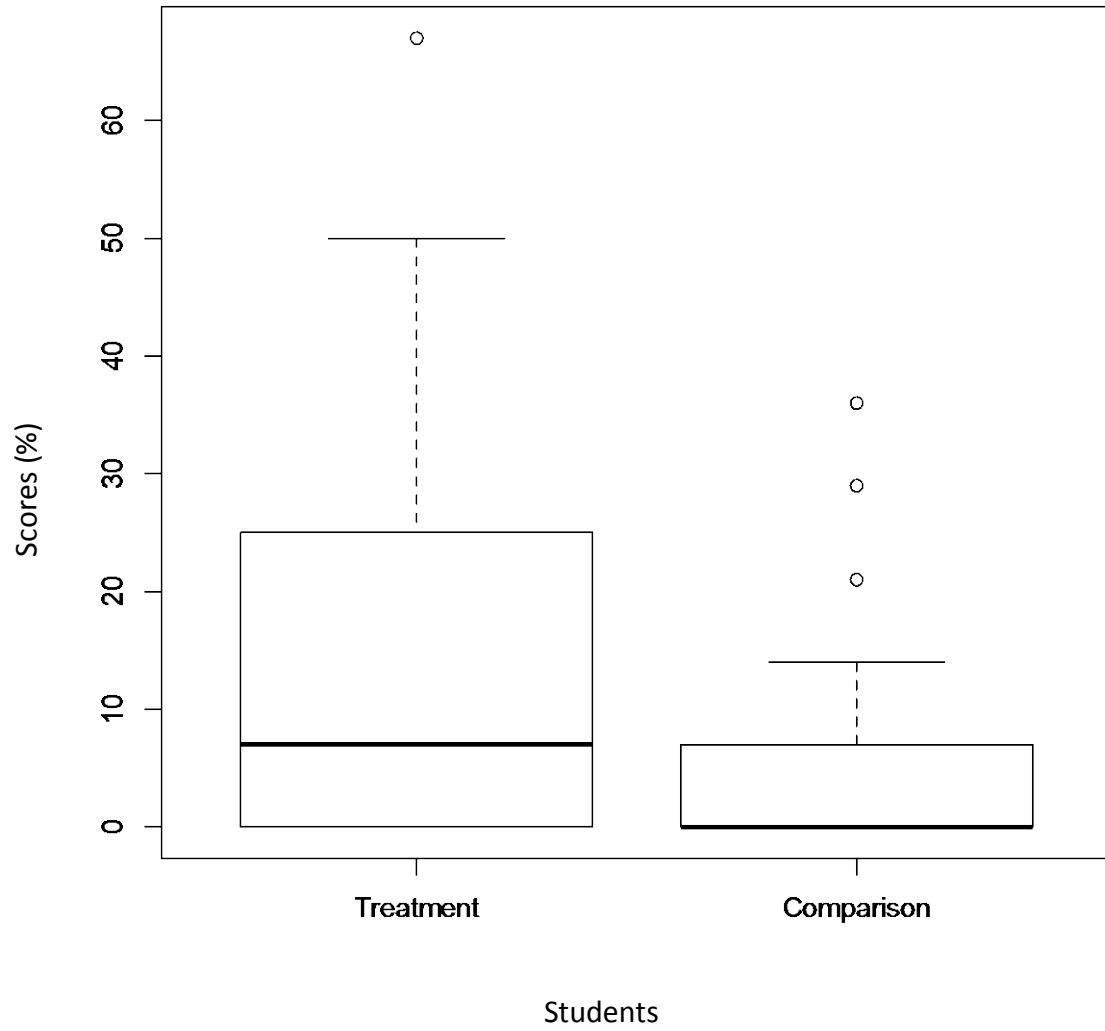
TREATMENT AND COMPARISON DATA AND FIGURES

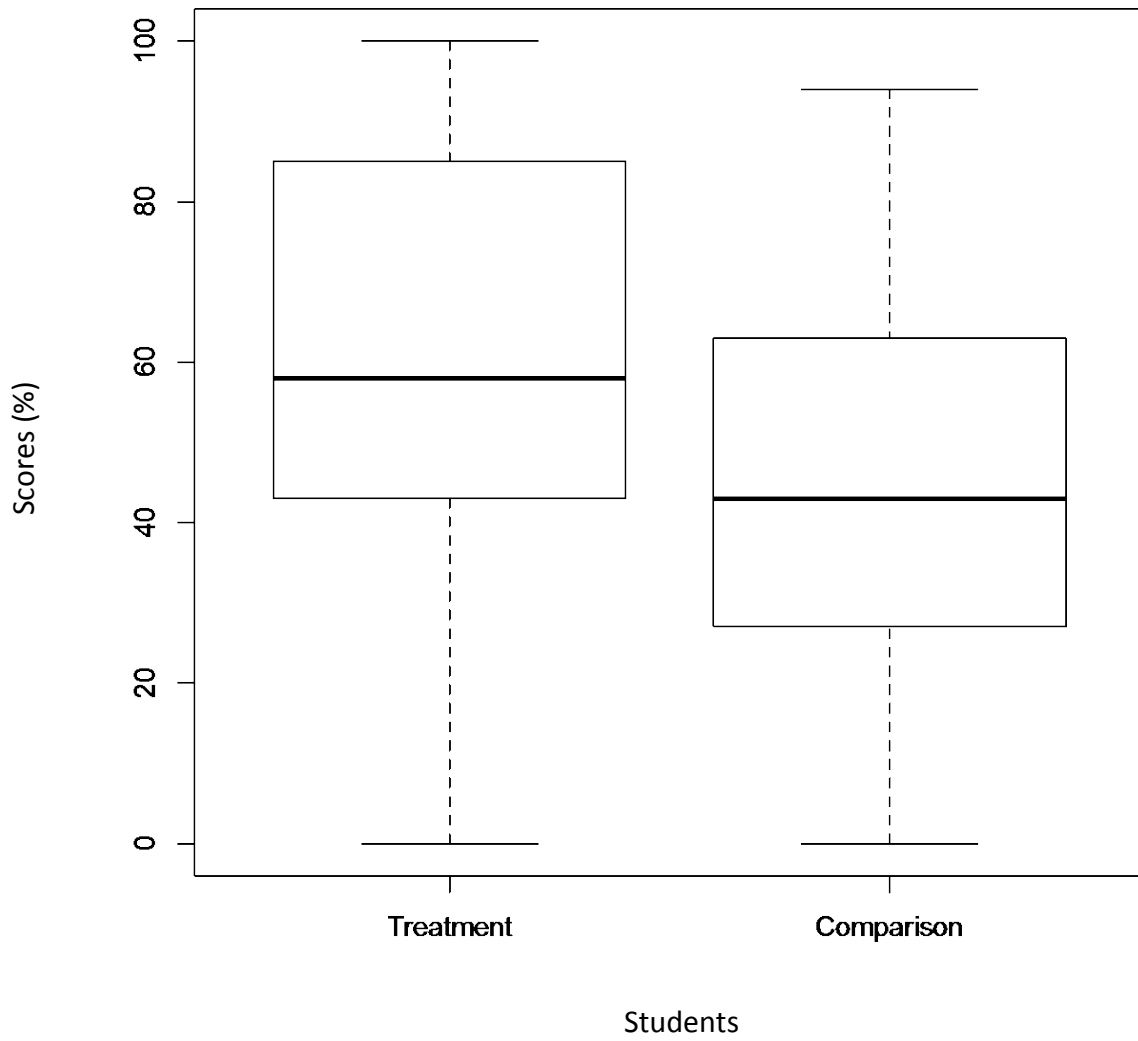
	Mean	Median	Range	Variance	SD
Pre- test scores					
Treatment	14.02632	7	67	314.1344	17.72384
Comparison	4.983333	0	36	85.60989	9.252561
Post- test scores					
Treatment	61.57895	58	100	733.4395	27.08209
Comparison	45.1	43	94	649.0068	25.47561
Pre- and Post-test scores (pre- and post-difference)					
Treatment	47.55263	44.5	100	729.9296	27.01721
Comparison	40.11667	38	94	559.0201	23.6436
Final Assessment Test Scores					
Treatment	52.5	62.5	54	549.5	23.44142
Comparison	43.33333	41.5	38	243.0667	15.5906
Student Journals (Science Content) Max=8					
Treatment	5.102041	5	6	3.135204	1.770651
Comparison	4.407407	5	4	1.944095	1.394308
Observational Rubric (Procedure and Skills) Max =8					
Treatment	6.408163	6	7	2.288265	1.512701
Comparison	5.944444	6	4	0.4685535	0.6845096
Student Journals Rubric (Attitude) Max=4					
Treatment	3.061224	3	3	0.6420068	0.8012533
Comparison	2.666667	3	3	0.5660377	0.7523548

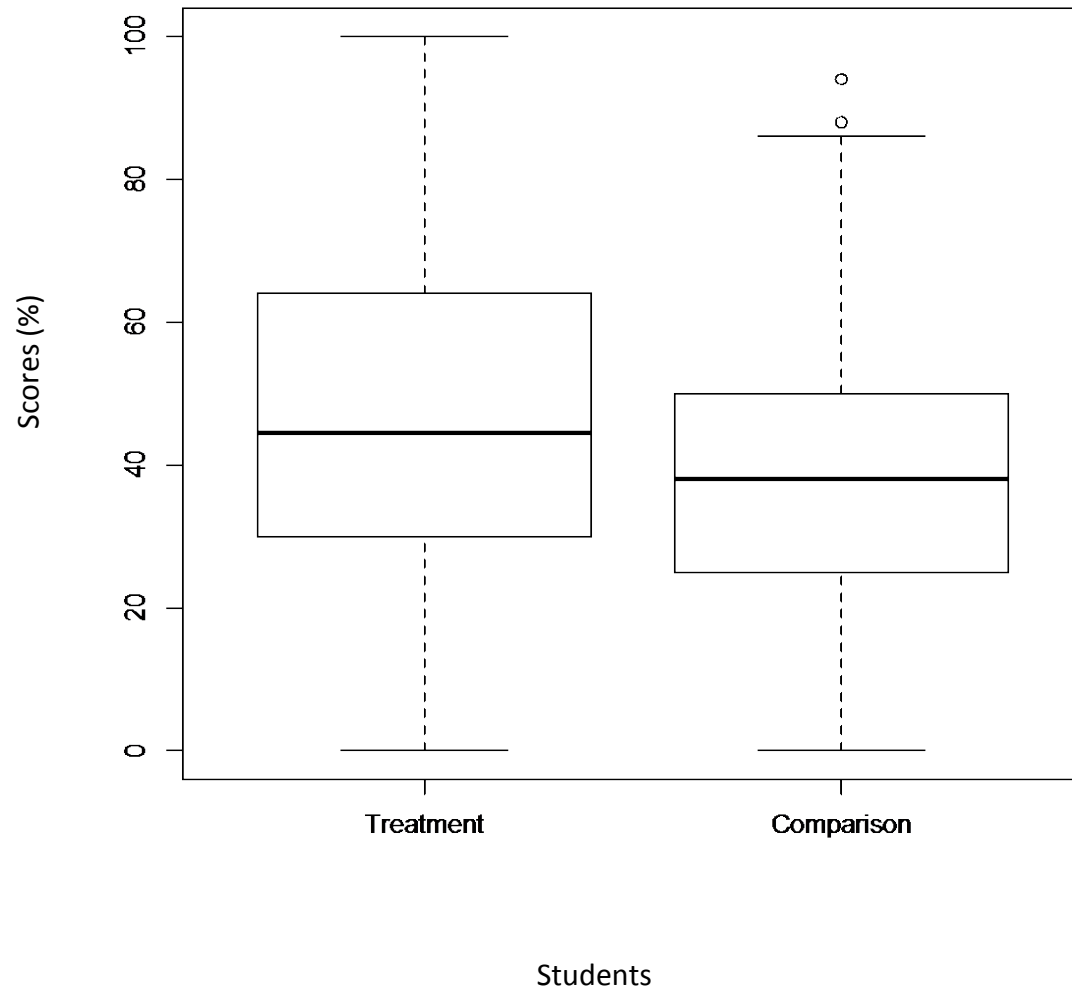
Observational Rubric (Attitude) Max=4					
Treatment	3.469388	3	2	0.2959184	0.5439838
Comparison	3.074074	3	7	0.8245982	0.9080739
Perceived Difficulty CAT					
Treatment	3.666667	4	3	0.7878788	0.8876254
Comparison	3.166667	3	4	1.060606	1.029857
Pre-test, Post-test Scores (Treatment) Welch Two Sample t-test data: Pre1 and Post1 $t = -9.0568$, $df = 63.782$, $p\text{-value} = 4.639e-13$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -58.04240 -37.06286 sample estimates: mean of x mean of y 14.02632 61.57895			Pre-test,Post-test scores (Comparison) Welch Two Sample t-test data: Pre2 and Post2 $t = -11.4649$, $df = 74.299$, $p\text{-value} < 2.2e-16$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -47.08828 -33.14505 sample estimates: mean of x mean of y 4.983333 45.100000		
Comparison of Pre-test Scores (Treat and Comp) Welch Two Sample t-test data: Pre1 and Pre2 $t = 2.9045$, $df = 49.942$, $p\text{-value} = 0.005467$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: 2.789267 15.296698 sample estimates: mean of x mean of y 14.026316 4.983333			Comparison of Post-test Scores (Treat and Comp) Welch Two Sample t-test data: Post1 and Post2 $t = 3.0027$, $df = 75.267$, $p\text{-value} = 0.00363$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: 5.546986 27.410909 sample estimates: mean of x mean of y 61.57895 45.10000		

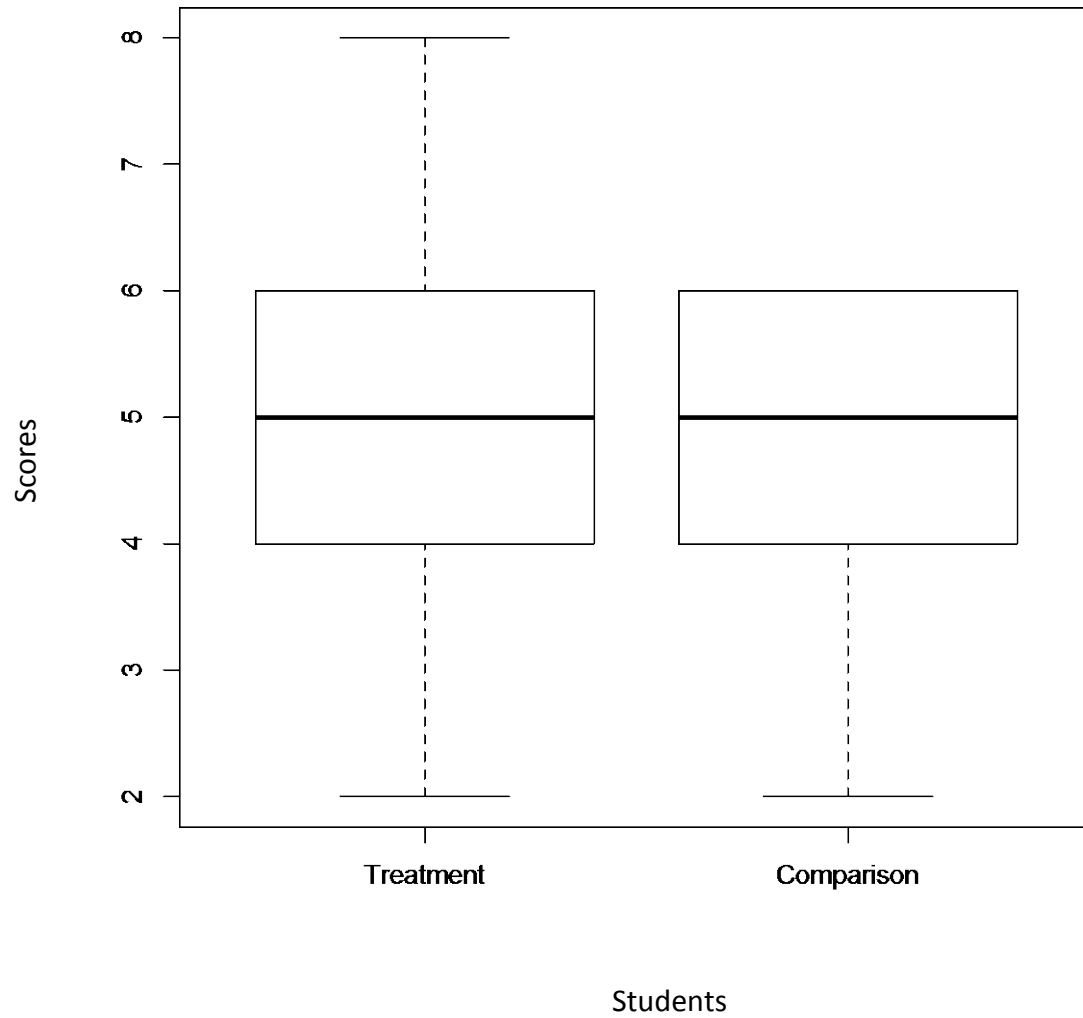
Pre- and Post- (Differences) Welch Two Sample t-test data: Treat and Comp $t = 1.3923$, $df = 71.107$, $p\text{-value} = 0.1682$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -3.213296 18.085226 sample estimates: mean of x mean of y 47.55263 40.11667	
Science Journal Content Welch Two Sample t-test data: contentt and contentc $t = 2.1968$, $df = 91.094$, $p\text{-value} = 0.03057$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: 0.066540 1.322727 sample estimates: mean of x mean of y 5.102041 4.407407	Procedure and Skills (Observational) Welch Two Sample t-test data: skillst and skillsc $t = 1.9706$, $df = 65.448$, $p\text{-value} = 0.053$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -0.006189689 0.933627330 sample estimates: mean of x mean of y 6.408163 5.944444
Journal Attitudes Welch Two Sample t-test data: jour.attitudet and jour.attitudec $t = 2.5692$, $df = 98.455$, $p\text{-value} = 0.01169$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: 0.08981677 0.69929888 sample estimates: mean of x mean of y 3.061224 2.666667	Observational Attitudes Welch Two Sample t-test data: obser.attitudet and obser.attitudec $t = 2.708$, $df = 88.011$, $p\text{-value} = 0.008131$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: 0.1052142 0.6854132 sample estimates: mean of x mean of y 3.469388 3.074074
Final Assessment Paired t-test data: treatment and comparison $t = 0.8383$, $df = 5$, $p\text{-value} = 0.4401$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -18.94110 37.27444 sample estimates: mean of the differences 9.16666	Perceived Difficulty CAT Paired t-test data: pdtreat and pdcom $t = 1.4832$, $df = 11$, $p\text{-value} = 0.1661$ alternative hypothesis: true difference in means is not equal to 0 95 percent confidence interval: -0.2419519 1.2419519 sample estimates: mean of the differences 0.5

Boxplot of Comparison Pre and Post test scores

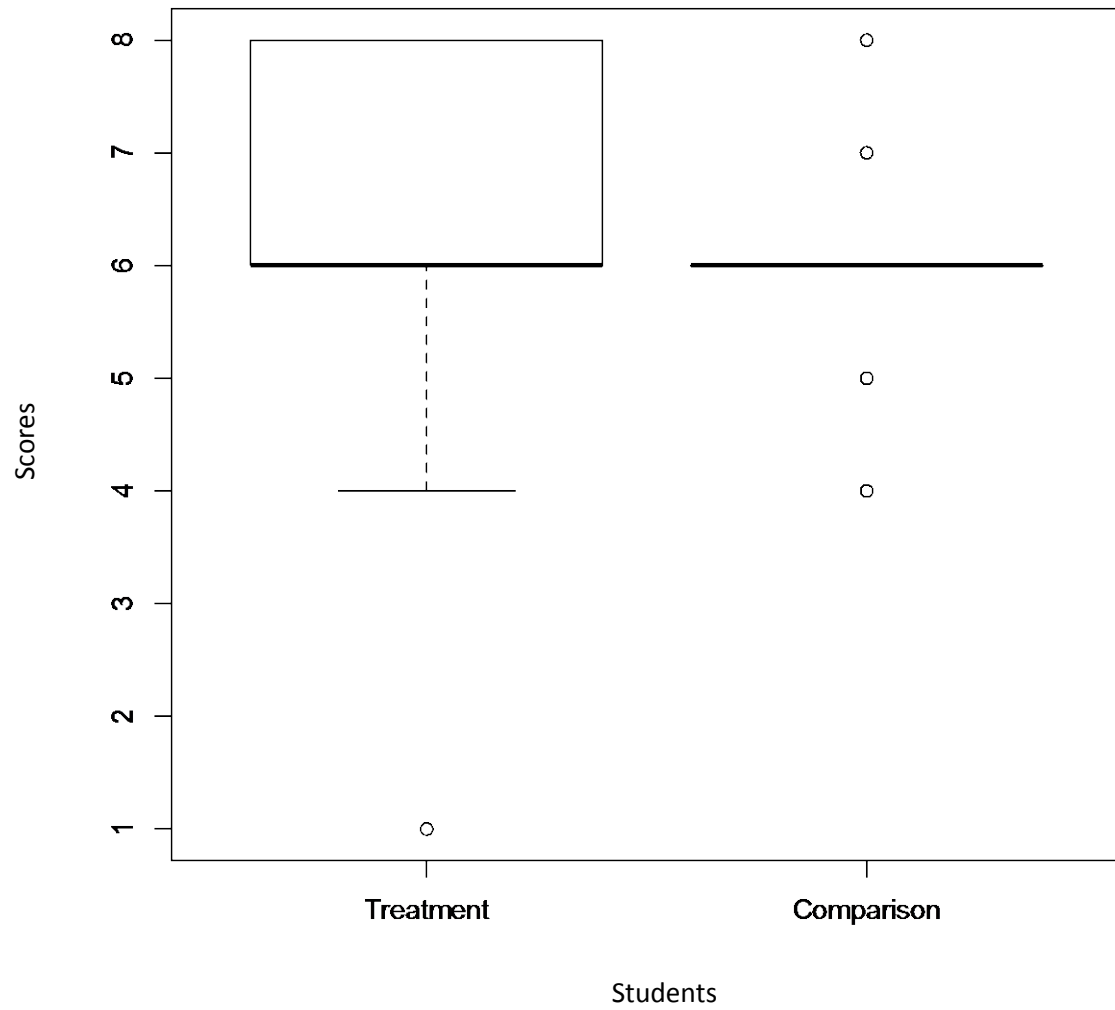
Boxplot of Treatment and Comparison Pre Test Scores

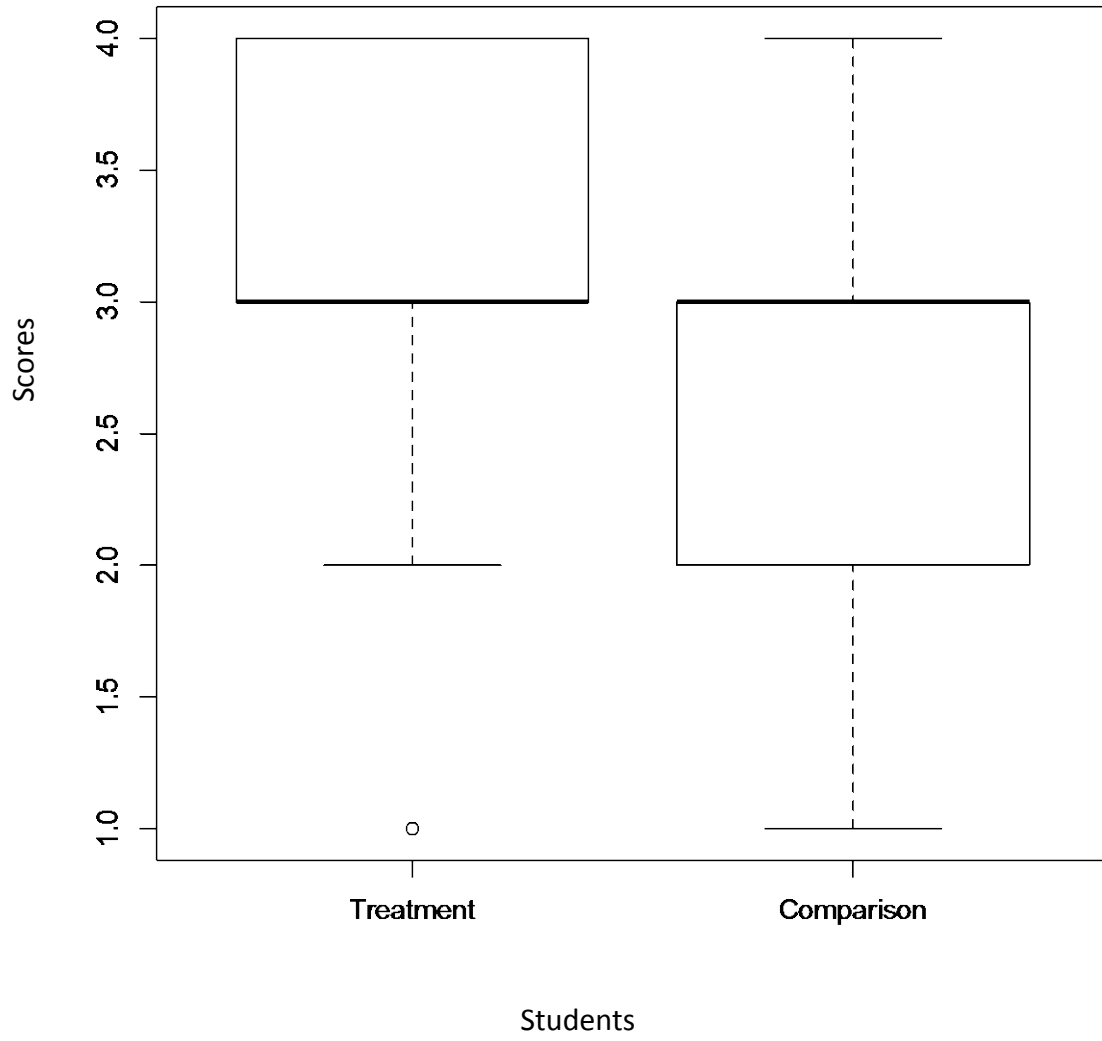
Boxplot of Treatment and Comparison Post Test Scores

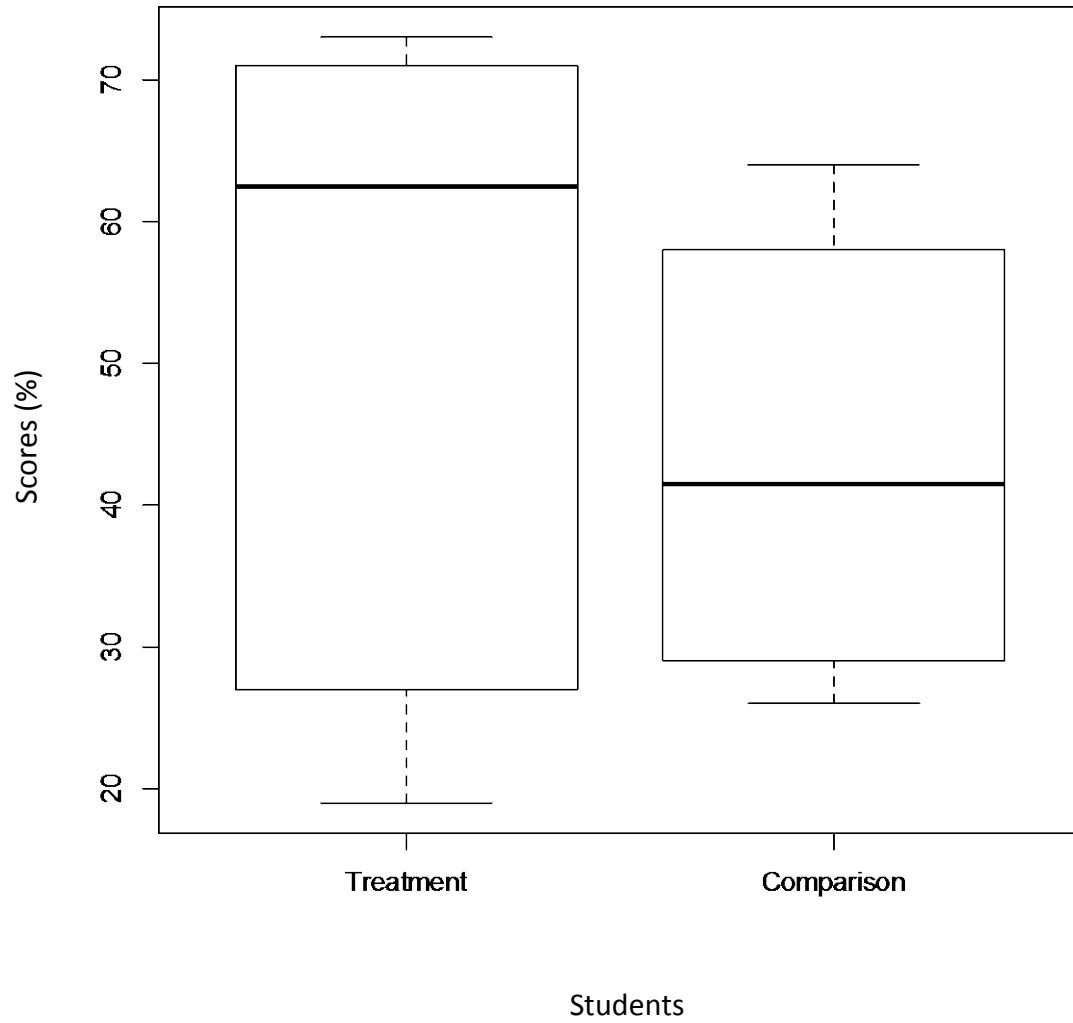
Boxplot of Treatment and Comparison Group Growth from Pre to Post Test

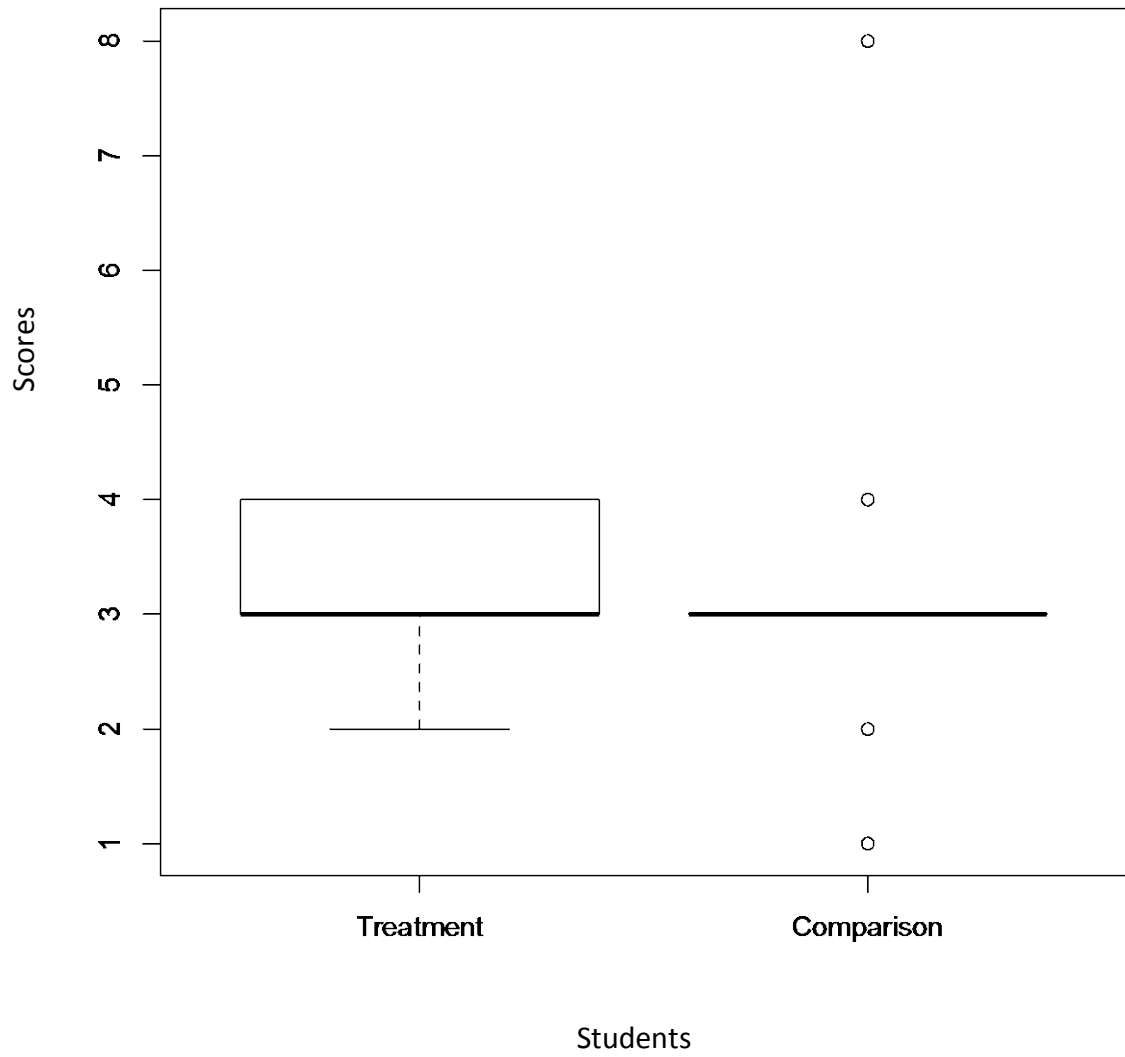
Boxplot Comparing Treatment and Comparison Science Content Journal S

Comparison of Treatment and Comparison Groups Science Procedure and



Plot Comparison of Treatment and Comparison Groups Attitudes in Journal

Treatment and Comparison Group Final Assessment Scores

plot Comparison of Observational Attitudes of Treatment and Comparison

APPENDIX K

IRB EXEMPTION FORM



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
 c/o Immunology & Infectious Diseases
 Montana State University
 Bozeman, MT 59718
 Telephone: 406-994-6783
 FAX: 406-994-4303
 E-mail: cherylj@montana.edu

Chair: Mark Quinn
 406-994-5721
 mquinn@montana.edu
Administrator:
 Cheryl Johnson
 406-994-6783
 cherylj@montana.edu

MEMORANDUM

TO: Analea Hronek and Walt Woolbaugh
FROM: Mark Quinn, Chair *Mark Quinn CJ*
DATE: October 18, 2013
RE: "How Does the Implementation of a River Study Unit Affect Students' Science Comprehension and Skills in Science?" [AH101813-EX]

The above research, described in your submission of October 18, 2013, 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.

MONTANA STATE UNIVERSITY
Request for Designation of Research as Exempt
MSSE Research Projects Only
(10/14/11)

THIS AREA IS FOR INSTITUTIONAL REVIEW BOARD USE ONLY. DO NOT
 WRITE IN THIS AREA.

Confirmation Date:

Application Number:

DATE of SUBMISSION: 10/12/2013

Address each section – do not leave any section blank.

I. INVESTIGATOR: Analea Hronek

Name: **Analea Hronek**

Home or School Mailing Address: **PO Box 1689 Red Lodge, MT 59068**

Telephone Number: **406-231-4592**

E-Mail Address: **analea.hronek@gmail.com**

DATE TRAINING COMPLETED: **3/4/2013** *[Required training: CITI training;
 see website for link]*

Investigator Signature **Analea Hronek**

Name of Project Advisor: Walter Woolbaugh

E-Mail Address of Project Advisor: walter.woolbaugh@ecat.montana.edu

II. TITLE OF RESEARCH PROJECT: How does the implementation of a river study unit affect students' science comprehension and skills in science?

III. BRIEF DESCRIPTION OF RESEARCH METHODS (If using a survey/questionnaire, provide a copy).

For my research methods I will be using attitude surveys, interviews, pre and post assessments, student and teacher journals, observations rubrics, pre and post treatment questionnaires.

IV. RISKS AND INCONVENIENCES TO SUBJECTS (do not answer 'None'): **I am anticipating that any risks during my research will be minimal in regards to what the students will learn and do. I am anticipating some small level of frustration on my students' part because the research will be based on how well they learn and accomplish tasks during the river study unit. I will also be taking these students to a river and they will be playing in the water, getting dirty, touching macroinvertebrates, and using chemicals to do certain water quality tests (i.e. E. coli coliform). There is a possibility of risk that students will come into contact with these chemicals and dirty substances in nature. I am CPR and first aid certified. And I will be carefully monitoring students during this river study unit to see that all tests are performed with safety and for accuracy.**

V. SUBJECTS:

- A. Expected numbers of subjects: **5-6**
- B. Will research involve minors (age <18 years)? **Yes** No
(If 'Yes', please specify and justify.) Research will involve students from **5th and 6th grade, ages 10-12 years old.**
- C. Will research involve prisoners? Yes **No**
- D. Will research involve any specific ethnic, racial, religious, etc. groups of people?
(If 'Yes', please specify and justify.) Yes **No**

VI. FOR RESEARCH INVOLVING SURVEYS OR QUESTIONNAIRES:

(Be sure to indicate on each instrument, survey or questionnaire that participation is voluntary.)

- A. Is information being collected about:

Sexual behavior?	Yes	No
Criminal behavior?	Yes	No
Alcohol or substance abuse?	Yes	No
Matters affecting employment?	Yes	No
Matters relating to civil litigation?	Yes	No
- B. Will the information obtained be completely anonymous, with no identifying information linked to the responding subjects? Yes **No**
- C. If identifying information will be linked to the responding subjects, how will the subjects be identified? (Please circle or bold your answers)

By name	Yes	No
By code	Yes	No
By other identifying information	Yes	No

- D. Does this survey utilize a standardized and/or validated survey tool/questionnaire? (If yes, see IRB website for required wording on surveys and questionnaires.) Yes No

VII. FOR RESEARCH BEING CONDUCTED IN A CLASSROOM SETTING INVOLVING NORMAL EDUCATIONAL PRACTICES:

- A. This research project must be approved by your Principal or School Administrator, unless there are circumstances or policies that do not make this possible. **Provide a copy of the principal's signed approval.** If such approval is not possible, please explain.
- B. **Participation of your students in research must be voluntary** and can never affect their rights. Please make this issue clear on all of your research surveys (use introductory text, see below) and/or interviews (use introductory verbal statement, see below). The following wording or something similar can be used for the introductory text or statement: **Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**
- C. Extra credit should not be used to encourage participation. If you absolutely need to use extra credit, then an alternative activity involving the same amount of time and effort must be provided for those who choose not to participate. This must be clearly described in your IRB application.
- E. Depending on your school policies, **consent forms may or may not be required for your research.** Please indicate whether you will be using consent forms or not. If you are not using consent forms, please justify (e.g., school policy, etc.). **If you do use consent forms, you must include signature lines for parental consent AND student assent.** (Please use accepted format from our website and provide a stand-alone copy. Do not include form here.)

Administrator Approval Sign-off
(MUST be included with all classroom projects)

Administrator Approval

I, Jason Olson, Principal of Belfry School, verify that I
approve of the classroom research conducted by Analea Hronek.

Jason Olson Principal Analea Hronek s/o teacher
(Signed Name, Title of Position)
Jason Olson Analea Hronek
(Printed Name)
10/14/13
(Date)

Administrator Exemption Regarding Informed Consent

I, Jason Olson, Principal of Belfry School, verify that the classroom
research conducted by Analea Hronek is in accordance with established or
commonly accepted educational settings involving normal educational practices and
that I approve the project. To maintain the established culture of our school and not
cause disruption to our school climate, I have granted an exemption to
Analea Hronek regarding informed consent.

Jason Olson Supt. Analea Hronek
(Signed Name, Title of Position)
Jason Olson Analea Hronek
(Printed Name)
10/14/13
(Date)

September 3rd, 2013

Dear Parents and Guardians,

This fall, the fifth and sixth grade class will be studying and learning the science behind water quality in a River Study unit that will expand for almost 11 weeks, on Wednesday mornings. I will be taking your child to the Clarks Fork River to study and record data of the water including; temperature, pH, dissolved oxygen, biochemical oxygen demand, phosphates, nitrates, and macroinvertebrates. This will be a great experience for your child to experience, learn, and perform real science in their own backyard. I will be taking them Wednesday mornings, generally starting at around 8:15 am and the group will be back before or at 11am. Please return this permission slip tomorrow, September 4th, because we will be going to the river tomorrow to set things up for our unit.

Thank you,

Ms. Hronek

River Study Unit Permission Slip

I _____, allow my child,

_____ to go on all field trips pertaining to the River Study Unit, on Wednesdays.

(parent/guardian signature)

APPROVED
MSU IRB
10/18/2013