THE IMPACT OF AN INTEGRATED CURRICULUM ON

STUDENT SUCCESS IN SCIENCE

by

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ABSTRACT

The impact of an integrated science curriculum was studied in a sixth grade classroom. Prior to the treatment, students attended three different classes at different times. Each class had its own specific content that was not connected to any other class. At the sound of the bell, students had to stop learning about what they had previously spent ninety minutes on and begin learning something completely different.

The purpose of this study was to identify what impact integrated teaching had on students. Rather than stopping their learning at the sound of the bell, students use the knowledge, they just learned in a new way to continue learning about that topic.

According to observations I have made, students often struggle to transfer or connect information from one content area to another. During this research, I taught two different science units to two different sixth grade classes. One science unit was not integrated with other subjects and one science unit was integrated with other subjects. The treatment science unit was integrated with math and language arts content. Students studied about the weather or the water cycle and continued to use those topics to learn in their math class and their language arts class. Students in the control group learned math and language arts skills that did not have a science topic connected to them.

Students' achievement on pre and post tests did not show observable growth. Their attitudes about science, according to a survey, also did not show an observable difference after the units. However, their ability to transfer, connect, and learn was affected, as demonstrated by their responses, which were recorded in their science notebooks about their own learning during the course of those units.

INTRODUCTION AND BACKGROUND

I have been an elementary teacher for over ten years. During that time, I have taught first, second, third and sixth grade. Over the years, I have noticed that the expectations for student achievement have grown and student interest has waned. Seven years ago when I was teaching first grade, I observed that the students were captivated when I was telling them a story or when we were learning about animals. I realized that when learning came in the form of something interesting and not simply a list of facts, students were more engaged. In the following years, while teaching third grade, I began changing my curriculum. If I was teaching about forces in science then the students read about scientists who discovered laws of forces. They also read about objects that demonstrated force like soccer, football, roller coasters, sledding, and cars. We wrote about forces and our observations about them. We created graphs in math measuring the distance our cars were traveling down a ramp while looking for patterns and differences. In one school day, we covered each subject while using one theme. Students didn't know when reading stopped and math started and they all loved science because, in their eyes, we were doing science all day long. I began wondering if student achievement increased when the science content was linked or integrated with all the other content areas. Students still learned math, reading, and writing, but the topic under which they learned those skills was science.

The word "integrated" has many meanings. When I speak of integrating, I mean that one content area is used to teach many skills. Reading, writing, and math subjects are defined by the skills students know. They need to know how to decode words, find meaning, synthesize that meaning, and recall what they read. In writing, they need to be able to formulate their thoughts in a manner that is clear to the reader, they need to use correct grammar and punctuation, and they need to use correct parts of speech and organization skills when preparing large pieces of writing. Students need to know math computational skills and they need to know how to make meaning out of real world math problems. The topic students are reading, writing, or computing about can vary. Integrating science into these other content areas means that students will have an overarching science theme that shows up in all their other subjects.

At the end of the day, they write, read and do math using the same scientific theme. This process resembles the real world and encourages students to apply knowledge that they learn in one area to another area. This application is called transfer. An example of transfer of knowledge is evident in a person's ability to tie their shoes. If a person can tie their shoes, they can tie on an apron or a scarf. He or she does not have to learn how to tie again simply because it is not a shoelace. Students need to understand that once you have the knowledge, it could be used in a variety of different places, not simply in math or reading or science class.

I am now teaching sixth grade. I do not have the same students all day as I did in previous years. There are two sixth grade groups and two teachers. Each teacher teaches three subjects to both groups of sixth graders. I teach Math Tutorial, Language Arts and Science while my teaching partner teaches Pre-Algebra, Reading and Social Studies. I teach at Vision Charter School. A charter school is a public school where parents choose to enroll their children. Students are enrolled in the school based on a lottery system. Some of the demographics are slightly different from the average school in the area. According to the "National Center for Education Statistics," the population in the town is lower to middle class. Approximately 89% of the students are white which is higher than the 75% average for other schools in the area. Of the other ethnicities in the school, 7% are Hispanic, about 1% are Asian, less than 1% are black, and less than 1% are Indian. Approximately 41% of students receive free and reduced lunch. According to numbers from 2013, the median income for the area is about $39,000.

I will be striving to answer how student achievement in science will be affected when the courses I teach are integrated. During the time I am researching this question, students will be learning about the water cycle and weather. I will seek to answer my research with three additional questions. How does integrated teaching in science content impact student learning in a Water Cycle and Weather unit? How does an integrated science unit affect students' attitudes about science? Finally, how does integrated science teaching help students transfer and connect their knowledge to other content areas? I will seek to answer these questions with the two sixth grade classes.

CONCEPTUAL FRAMEWORK

A review of the literature on the topic of integrating science with other content areas can be established by looking at results of different forms of integration in varying classrooms and among different ages of students. Students are often taught subjects separately and expected to transfer knowledge from one subject to the other on their own. Since students' social world is still small compared to an adults' and their brain is continually developing, students are often expected to make that transfer on their own. There are many forms of integration. Some studies show math integrated into science, language integrated into science, different areas of science integrated with one another, and many subjects integrated into each other, often called thematic units. Students need to learn how to make connections and transfer knowledge.

Traditionally, students in all grades, but especially middle school and high school go to a different classroom and often a different teacher for each subject on their class schedule. The math teacher teaches how to do calculations, the English teacher teaches reading, writing and analyzing text, the science teacher teaches science. Dewey (1902) states: “the child’s life is an integral, a total one. He passes quickly and readily from one topic to another, as from one spot to another, but is not conscious of transition or break” (p. 3). It is more beneficial and more meaningful for children if their education mirrors their life. He also states that continuous starting and stopping of activities gets a child ready then pulls them away. The bell rings, the class begins, the students learn, get engaged and perhaps excited about this new knowledge, then the bell rings and they must start all over again. This seems to be a disjointed way to learn.

Many schools in different countries have tried to integrate content more and help students’ learning improve. At the Central Anatolian Turkish University, researchers studied a group of college students to determine if adding multi modal representation would impact science achievement, argumentation and writing skills. Multi modal is a term used to represent the many forms one can use to demonstrate a concept. These modes can be picture, text, diagram, or a mathematical expression. In the study, two groups were given multi modal representations to enhance their learning and two groups were not. According to the test results, the treatment group outscored the comparison group on science achievement tests, writing scores, multi-modal scores and holistic argument scores (Demirbag & Gunel, 2014). These students were given a way to connect their learning with other knowledge. They provided a writing to learn activity and a poster to present to middle school students. Two of the middle school groups were provided with multi-modal representations and two of the groups were not. The groups that received multi-modal representations scored statistically higher on tests. According to Demirbag and Gunel, this study in Turkey had two motivations:

> The need for disciplinary ways of knowing experiences, where students acted, thought and communicated like scientists and . . . the role of meaningful interactions of language components including text, mathematical formulas, graphs, tables, and pictures in building science understanding and science literacy (p. 389).

In wanting to see greater scores in science achievement, Demirbag and Gunel integrated math and language and created a more meaningful learning environment. Students were placed in four groups. They were asked to investigate a research question as a scientist would. The students were required to collect data, generate evidence, construct a claim and reflect on their procedure. Two of the groups were instructed with a variety of modes embedded into the content; two of the groups did not have multiple modes. Students created an activity at the end of the instructional time and were scored based on a rubric. Students were also given midterm and final exams to show their growth. The tests contained five open-ended questions pertaining to the topic they from which they learned. Demirbag and Gunel go on to say, “not only were students’ science understandings scaffolded by multi-modal instruction, but also their ability to understand and use multi-modal representations and to generate better quality arguments” (2014, p. 389).

In another study among seventh and eighth graders in Turkey, researchers investigated whether a program integrating particular aspects of science and technology and mathematics classes in Turkey were effective (Kiray & Kaptan, 2012). They decided to investigate classrooms where science was the central content taught and the math was taught to assist the understanding of the science concepts. They had observed, “In the traditional understanding of the disciplinary program, students are expected to merge knowledge, which they learn separately, where required” (p. 944). Even though this has been the expectation in many schools Kiray and Kaptan state, “It has been found that when students learn a lesson in a manner isolated from other lessons, they have difficulties in transferring the knowledge to other situations” (p. 944). It is important to make connections in learning. The human brain is wired to make connections.

Transfer of information is just as important as connections. If students cannot transfer their knowledge of writing from language arts class to science class, they will be repeatedly learning the same skills. Transfer is described as something learned in a situation that affects or is used in another situation (Kiray & Kaptan, 2012). Knowledge for learning only produces little transfer, knowledge that exceeds learning helps transfer. The results of this study showed that “the integration understanding, which takes the transfer from mathematics to science as the axis, can increase the achievement of the students especially in answering integrated questions exceeding the scope of the class” (p. 954). Both of the examples from Turkey show increased achievement when math and science were integrated together to teach a concept.

Math and science are a common pairing when teachers consider integration, but science and language are also beneficial to each other when integrated. According to Subramaniam (2010), by the time students are in 12th grade, they should know that there are many aspects to the inquiry-based nature of the scientific process. Each part of this process requires students to read and write science, which helps them communicate and express science content, cognitive processing skills, and inquiry skills. Science and writing complement each other and can improve student learning. In a study of different elementary and middle schools over a 15-year period, Ritter (1999) found that students learn better when teachers are using thematic, interdisciplinary instruction. These units would include many different skills taught with one overlaying theme. Among the 25 third and fourth grade students studied, higher engagement rates and content in various intelligences opened up new learning opportunities when taught with thematic units. Activities that activate many areas of the brain will increase learning.

In another study in Turkey, Gunel and Atila (2009) studied the impact of multi modal representation with "Writing to Learn" activities. Sixth grade students wrote letters to fifth grade students explaining what they learned in their electricity unit. One group used text only to explain their learning, a second group used text and any mode, the third group used text and graphs and the fourth group used text and mathematics. Gunel and Atila found that using text and math was the most effective when the math was embedded into the text. They state, "Students are building a richer connection between the modes as well as conceptual structure of the topic under investigation" (p. 183). Language and math enhance the understanding of science content and allow students a mode to explain their thinking. Dewey (1902) reminds us that "somehow and somewhere motive must be appealed to, connection must be established between the mind and its material" (p. 7). When students make more connections, the opportunity for learning may increase.

Thematic units are another name educators give to the integration of content. Thematic units use one type of content to teach many skills. A teacher could create a unit about earthquakes where every activity a student does revolves around earthquakes. Pursitasari, Nuryanti, & Rede (2015) conducted a study of 7th graders in Palu City to determine how promoting thematic-based integrated science would impact learning (2015). They found that during learning with the thematic-based integrated science-learning model “students were involved actively and built meaningful learning” (p. 98). Thematic learning and contextual learning improve critical thinking. These studies illustrate that there are many ways to integrate content.

In many schools, especially low achieving schools, science is not taught to the same rigor as reading and math. “High stakes testing is viewed as having biased schools toward teaching tested subjects and away from less frequently tested subjects” (Bogan, King-McKenzie, & Bantwini, 2012, p. 1054). Schools often do not teach science because they have a lack of resources, time, content knowledge or teacher confidence to teach the content (Bogan et al., 2012). The goal is to integrate these subjects. “Integration connects subjects to ways that reflect the real world and include the interests and inquiry of children” (p. 1055). Since schools are concerned with their test scores, they should consider Vars (1991) perspective on integration, “In nearly every instance, students in various types of integrative/interdisciplinary programs have performed as well or better on standardized achievement tests than students enrolled in the usual separate subjects” (p. 15). Studies have been conducted on integration in the classroom for years. These studies repeatedly show that integration is beneficial to students. Bogan et al. (2012) state, “In today’s dynamic global economy, centered on the development and exchange of knowledge and information, individuals prosper who are fluent in several disciplines and comfortable moving among them” (p. 1055). When educational concepts are integrated, students learn how to fluidly move from one to another and use their knowledge from one to help with the other.

Although it has been established that integration of content is beneficial to student learning, many schools still are not integrating. According to a video study of five different countries, the United States was weaker in the area of making connections than other countries. Among the schools studied, United States schools spent 34% of the lesson they taught making connections compared to 72% of the time in schools in Japan and 58% of the time in schools in Australia. The United States schools spent 27% of the lesson doing activities with no conceptual links, Japanese schools spent only 6% of the lesson with no conceptual links and Australian schools spent 12% of the lesson with no conceptual links. The US spent 30% of the lesson teaching strong conceptual links, Japan spent 70% of their time, Australia spent 58% and Czechoslovakia spent 50% of their lesson on strong conceptual links. Australian and Japanese lessons were skilled at organizing content to encourage making connections and using conceptual links. Over one fourth of the US lessons consisted of students doing activities with no conceptual links (Roth, Druker, Garner, Lemmons, Chen, Kawanaka, Rasmussen, Trubacova, Warvi, Okamoto, Gonzales, Stigler, Gallimore, 2006). These statistics illustrate that United States schools have room for improvement when helping students make connections and learning content in a manner that matches how the real world functions.

In conclusion, these studies have illustrated that students learn better when the curriculum is integrated. Integrating content between subject areas, connecting ideas together, and showing how they support each other helps students integrate and connect those ideas themselves. This integration can be as simple as writing about a scientist that discovered a new element while studying the properties of that element. Students can calculate the area of a glacier that has been receding while learning about how glaciers work. Giving students tools to transfer their knowledge and using thematic units to teach ideas in a more organic, real world fashion will increase student achievement and engagement. If teachers have the tools to teach lessons using these ideas, students will be more successful.

METHODOLOGY

Throughout my years of teaching, there has been a common thread whether students were in first grade or sixth grade. Students do not transfer knowledge and skills from one content area class to another as well as teachers would like. In addition, students struggle to learn content in isolation (math in math class, writing in English class, science in Science class). The purpose of this study was to determine if students' learning in science was increased when they learned skills from different content areas altogether rather than separate. Prior to participating in this classroom research project based on the action research model, I received an informed consent exemption form signed by my administrator and an exemption by Montana State University's Institutional Review Board to ensure compliance for working with human subjects was maintained throughout the study (see Appendix A).

The students who participated in this study were 6th graders. The majority of the students were from middle class families. There were two groups of 6th graders represented in this study. The first group, group A, had 34 students. Three of those students had an ESL background, but were not pulled out for any extra services. One student was on a 504 plan that involved hearing assistance. One student was on an IEP for an extended day and was only in class for the science instruction.

The other group of 6th graders, group B consisted of 33 students. Five of those students had an ESL background, but were not pulled out for any extra services. Four students were on 504 plans and four were on IEPs. Two of the students on 504 plans were pulled out for a portion of their Language Arts class and their Science class.

During the duration of this plan, I tested how an integrated science curriculum affected student achievement, student learning, students' attitudes about science and their ability to transfer knowledge. This treatment spanned eight weeks. Each unit took eight class sessions, lasting about four weeks. Students were on a block schedule. Students attended Math, Language Arts, and Science classes at specified times each week.

In order to measure the difference in student achievement in science with an integrated unit versus a non-integrated unit, students participated in two units of study. One unit was on the water cycle and the other unit was on weather. Both groups had the opportunity to be the treatment group and the comparison group. For the first unit, group A was the comparison group while group B was the treatment. For the second unit, group A was the treatment group while group B was the comparison. Both classes received the same content instruction for the science unit whether they were the treatment group or the comparison group. They received the same notes and took the same tests. The treatment group practiced their skills and applied their knowledge by integrating science, language arts and math together. The comparison group practiced their skills by doing activities that kept science, language arts and math separate from each other.

During the course of the unit, students also had two other classes, a math class and a language arts class. In those classes, students received the same instruction and learned about the same skills and content. The comparison group practiced the skills learned in those classes with individual assignments that focused only on that particular skill they had learned. For example, students in the comparison group learned how to add, subtract, multiply and divide decimals and find percent by using money. They were given a budget and had to calculate their expenses and what percent of their money they needed to save to make a large purchase. The treatment group practiced the same math skills. Instead of using a budget, the treatment group used watershed data. Each part of the watershed used a certain measurement of precipitation. Students added up the totals and calculated the percentage of the total that each part used. Another example in the difference in instruction was the treatment group calculated area and volume using precipitation and the watershed while the comparison group used centimeter measurements on graph paper. During the math practice, the treatment group used science data to practice computation.

In Language Arts they practiced their writing by writing about the science content they were learning. During the water cycle unit, the treatment group wrote about the journey that a drop of water takes through the water cycle using terms and concepts they learned in science. The comparison group wrote a research paper on a career of their choice. The treatment group received the integrated unit, the one integrated with other content areas. The comparison group received the same skill instruction, but the skills were taught in isolation in a manner that is typical of a middle school classroom.

Each unit contained the same content and skills. The difference between the units was in the way the students practiced those skills and applied the content. The treatment unit was created with transfer opportunities built into it. While we were learning about weather, students graphed weather data in math class. When science class came, we used that data to help us solve a case study. The students were able to practice reading data on temperature, wind, and air pressure. The case study asked students to use temperature, wind and air pressure to determine if a group of students should go on a field trip. Students in the comparison group did the same activity in science, but they did not have the opportunity to practice reading and interpreting the data. Students in the treatment group had more opportunities to use knowledge they learned from math or language arts to complete a science assignment. The opportunities were placed in the unit on purpose and students were given time during those other classes to work on these assignments. Students used their math, language arts and science skills to complete learning projects. The comparison group learned the same skills, but in isolation. There was no overlap between different content areas (math, language arts, science). Students in the comparison group were given the exact same skill instruction as the treatment group, but their practice was in isolation of other content areas. They would have a specific activity to practice that particular skill.

In order to measure achievement and learning, students took a pretest measuring their current knowledge in science before the units began. At the end of each unit, they took a posttest measuring their academic growth (see Appendix B). I took the normalized gain between the pre and posttest to compare student growth. I used formative assessments throughout the unit and conducted student interviews as a portion of the assessments (see Appendix C). I randomly chose nine students to interview. Based on students' science grades at the beginning of this period, I created a high achieving male and high achieving female pile of names. Then I created a low achieving male and low achieving female pile of names. I randomly chose one name from each pile. I also had four students who were in a different set of classes than the others and I choose 1 student from that group to interview.

In order to measure students' attitudes about science, I used Likert scale surveys to gather information about their attitudes in general about science and their attitudes about learning science (see Appendix D). I used field notes and observational data during the units to measure students' general attitudes while completing their practice activities. I also used student responses regarding the process and their reflections on their learning (see Appendix E).

In order to measure students' transfer of knowledge to other content areas, I gave students a final project with a rubric where the activities they had to complete required use of skills or knowledge they acquired in their classes. Students also completed a self-assessment on their own learning and ability to do new things. I recorded my observations of this process as we went through each activity.

Table 1
Triangulation Matrix

Focus Question: How will student achievement in science be affected when the courses I teach are integrated?			
Subquestions	Data Source		
Subquestion 1: How does integrated teaching in science content impact student learning in a Weather and Climate unit?	Pre- Test and post-test	Formative Assessments	Student interviews
Subquestion 2: How does an integrated science unit affect students' attitudes about science?	Pre-survey and post survey	student journals	Field notes
Subquestion 3: How does integrated science teaching help students transfer and connect their knowledge?	Self-assessment	Teacher observations	Rubric project

I began these units the week of January 23, 2017. The first unit spanned the time from January 23rd through February 17th. In the beginning of the unit, students took pretests and completed their initial surveys. They had six lessons and practice assignments to go with them. Throughout the span of the unit, students recorded in their journals and I took field notes. During the second to last class on the final week, students were given their rubric assignment. Students had until the end of the last class to have it completed. They could use other class periods if the opportunity arrived. During the last class, students completed a summative assessment. The second unit followed the same pattern. The second unit began on February 23rd and ended on March 17th. At the conclusion of the second unit, students completed a post attitude survey and responded to my questions about their learning experience. This was also when I conducted interviews.

I spent the next week analyzing the data I collected and organizing it so that it made sense and explained the story that was happening during those two science units. First, I looked for an overall story. Second, I looked for patterns and tried to make sense out of it. Third, I identified the data that was most important to my research. Finally, I analyzed the data to determine what it meant to me, to education, and to my school. I also looked for what new questions this data presented.

DATA AND ANALYSIS

Data was collected in varying forms over eight weeks to determine the how an integrated curriculum affects student achievement, attitudes about science, and students' ability to transfer knowledge from one content area to another.

How an Integrated Science Unit Affects Student Achievement

My claim about whether an integrated science unit affects student achievement or not is inconclusive. I performed an unpaired t-test on students' posttests for the weather unit. The comparison group for the weather unit had a mean score of 4.32 with a standard deviation of .94. The treatment group for the weather unit had a mean score of 4.16 with a standard deviation of .82. The difference between the two tests was not significant, t(60)=.7177, p=.4757. The mean of Group 6A minus Group 6B was .16. There is 95% confidence interval of this difference: from -.29 to .61. The first unit the students learned was the Water Cycle unit. Group 6A was the comparison group and Group 6B was the treatment group. The comparison group's mean pretest score was 59%. The treatment group's mean pretest score was about 54%. The comparison group's mean posttest score was 91% and the treatment groups mean posttest score was 84%. Only 16 out of 33 students from the comparison group, 6A, took the pretest. There were 32 of 33 students from the treatment group, 6B, who took the pretest. Figures 1 and 2 summarize pre- and post- test scores for this study.

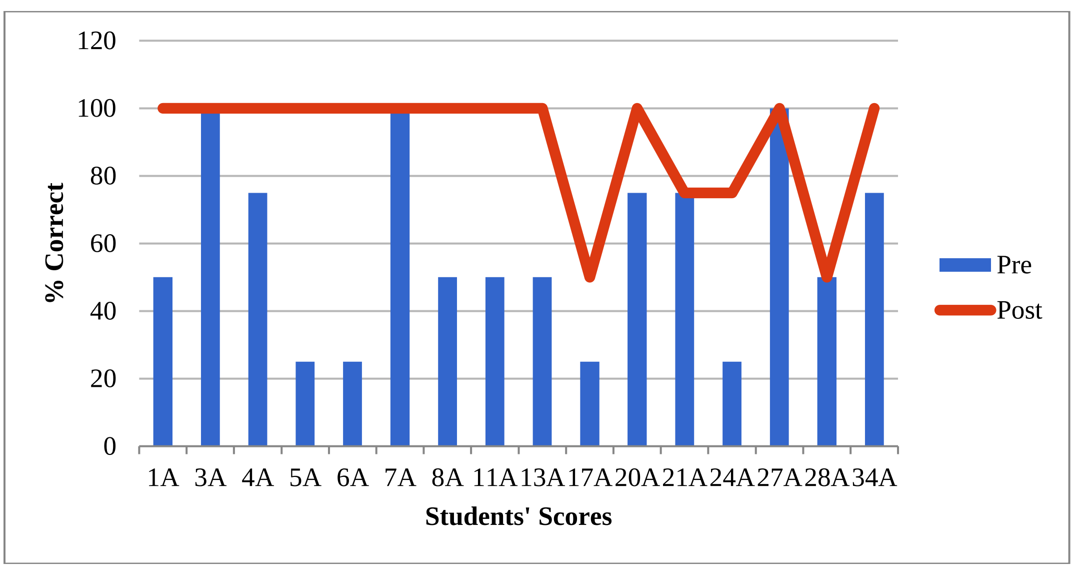

Figure 1. Individual students' pretest and posttest scores from the Water Cycle Unit from the comparison group, *(N*=16*).*

Individual students' Water Cycle pretest scores from the comparison group ranged from 25% to 100% (see Figure 1). Of the students who took the pretest, each one either maintained the same score for the posttest or improved. The average normative gain for the comparison group was 0.63.

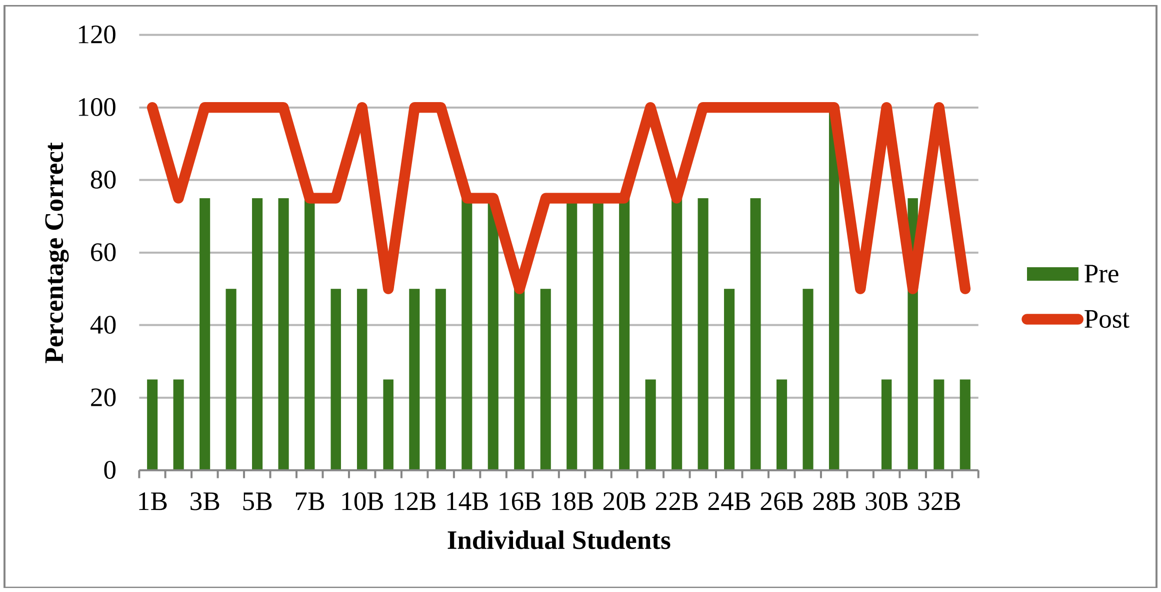

Figure 2. Individual students' pretest and posttest scores from the Water Cycle Unit from the treatment group, *(N*=32*)*.

Individual student's scores from the treatment group ranged from 0% to 100% (see Figure 2). Of the students who took the pretest, one student had a lower score on the posttest. All other students either maintained their pretest score or improved. The average normative gain was .56.

Approximately 55% of students in the comparison group and the treatment group scored 100% on the posttest (see Figures 3 and 4). Approximately 91% of the comparison group and 85% of the treatment group scored 75% or better on the posttest (see Figures 3 and 4).

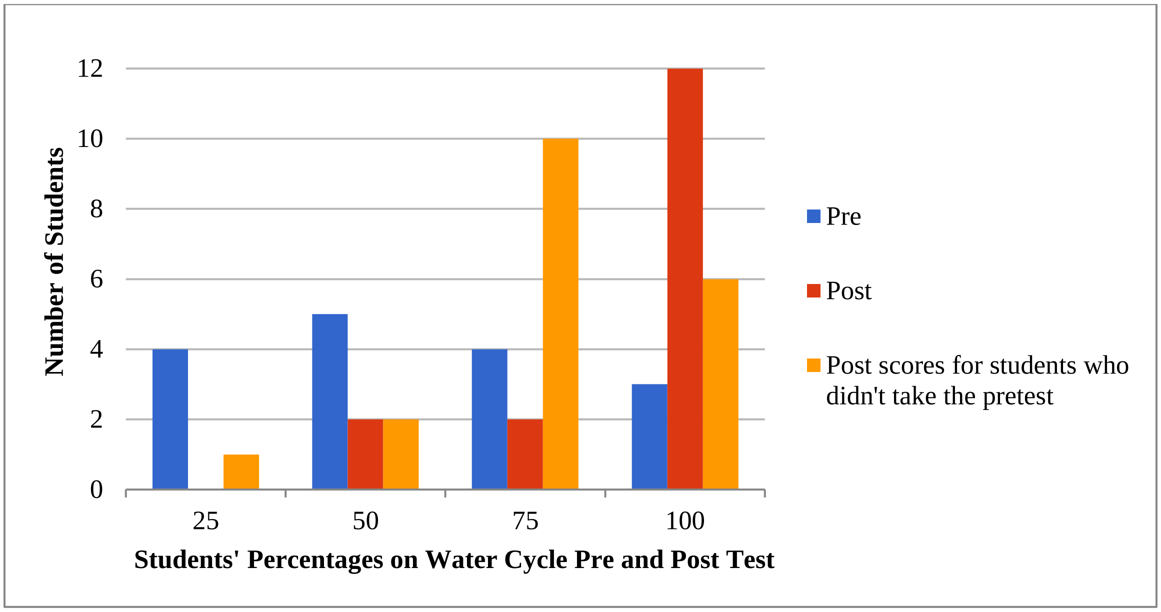

Figure 3. Students' percentages on Water Cycle pretest and posttest as a group for the comparison group, (*N*=33).

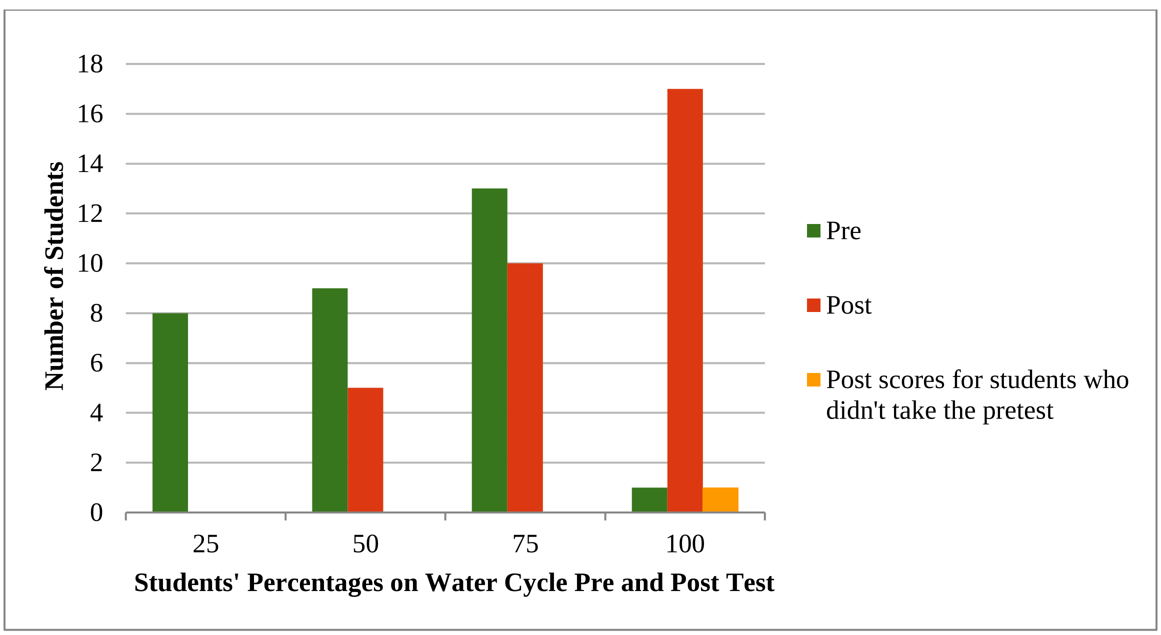

Figure 4. Students' percentages on Water Cycle pretest and posttest as a group for the treatment group, *(N*=33*)*.

The second unit the students learned was the Weather unit. Group 6A became the treatment group and Group 6B was the comparison group (see Figure 5).

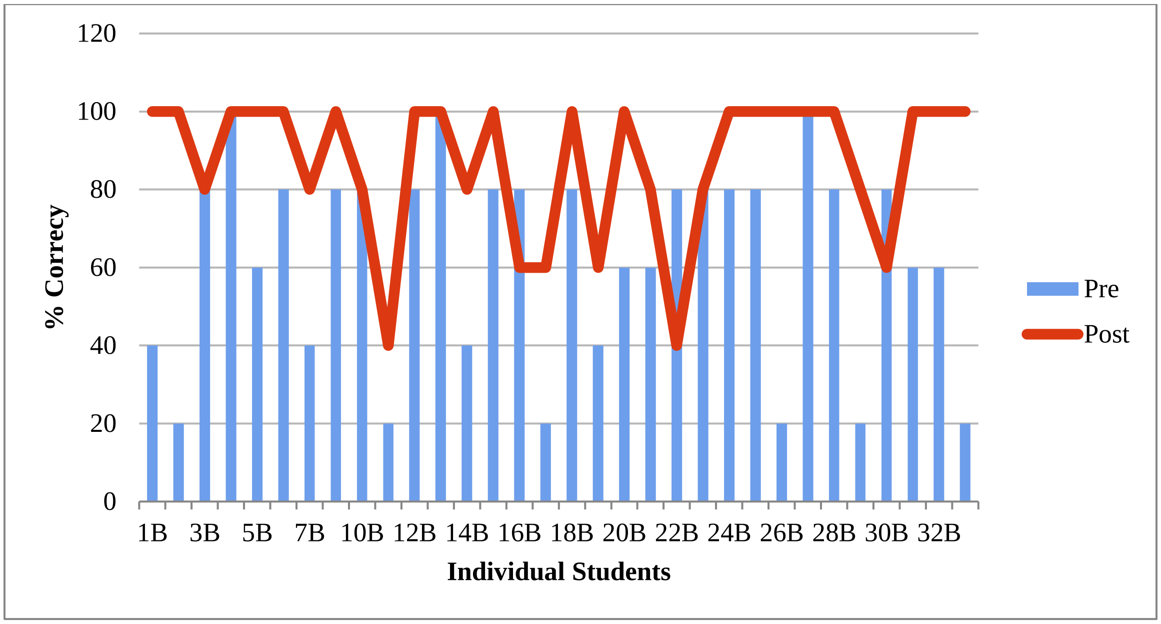

Figure 5. Individual students' pretest and posttest scores from the Weather Unit from the comparison group, *(N=32).*

Individual students' Weather unit test scores for the comparison group ranged from 20% to 100%. All except three students maintained or improved their score on the posttest. The average normative gain was 0.49.

Individual students Weather unit test scores for the treatment group ranged from 20% to 100% (see Figure 6). All except 3 students maintained or improved their score on the post test. The average normative gain was .56.

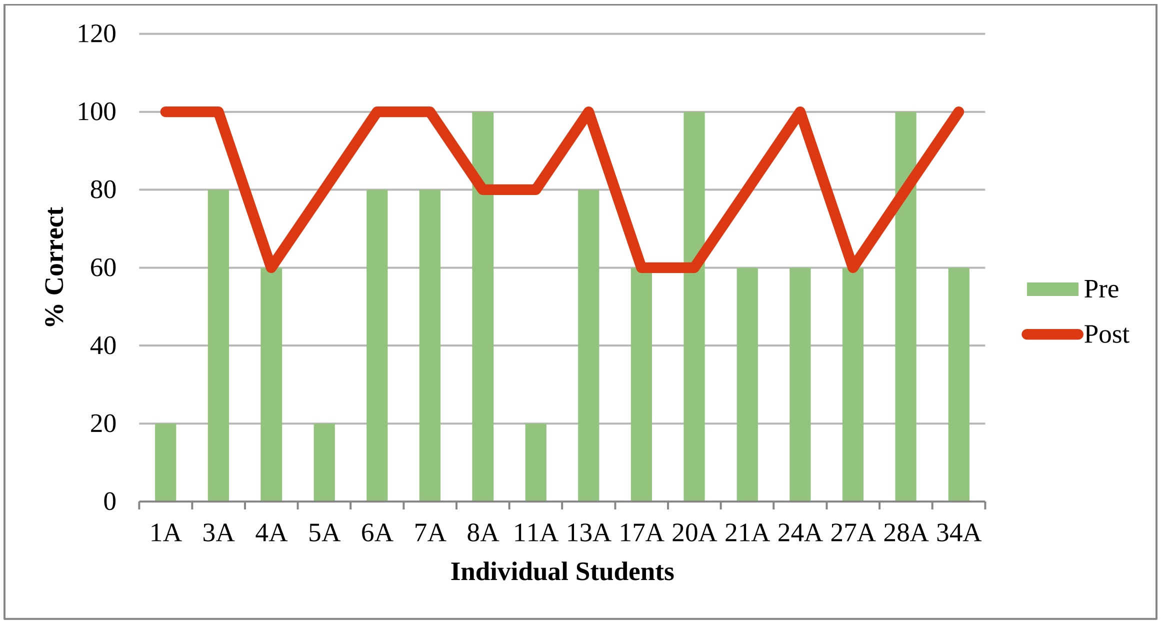

Figure 6. Individual students' pretest and posttest scores for the Weather Unit from the treatment group, *(N*=16*).*

Approximately 58% of the comparison group (see Figure 7) and 42% of the treatment group (see Figure 8) scored 100% on the posttest. Approximately 91% of the comparison group (Figure 7) and 81% of the treatment group scored 80% or better on the posttest (see Figure 7 and 8).

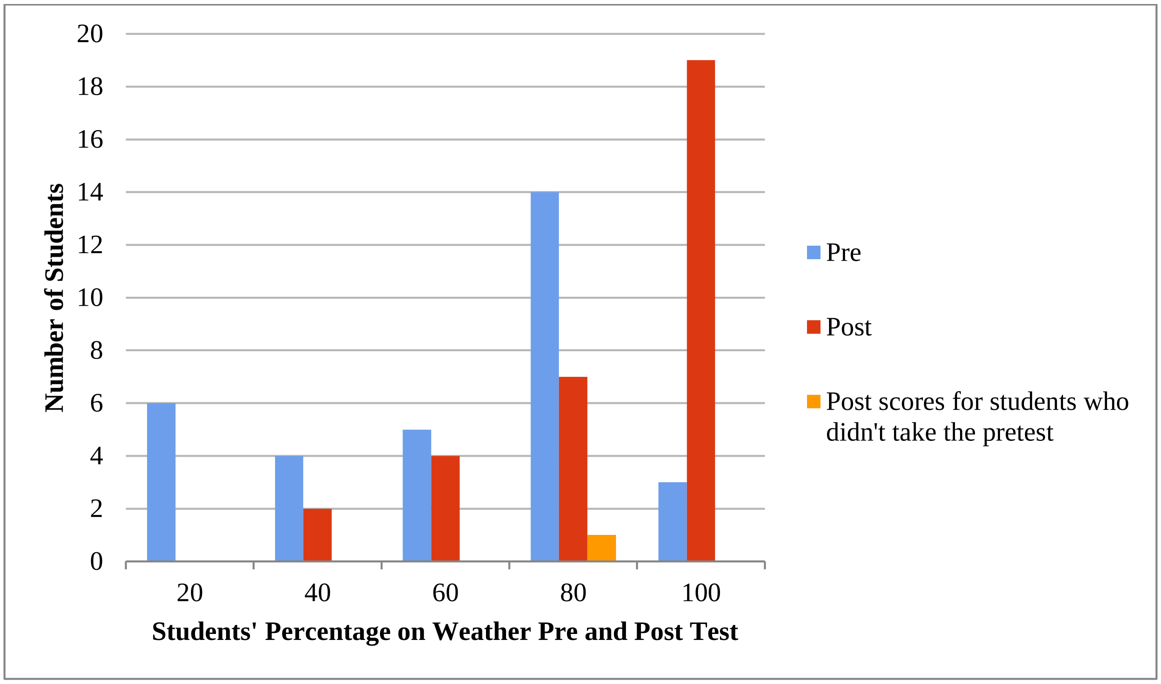

Figure 7. Students' percentages on Weather pretest and posttest as a group for the comparison group, *(N*=33*)*.

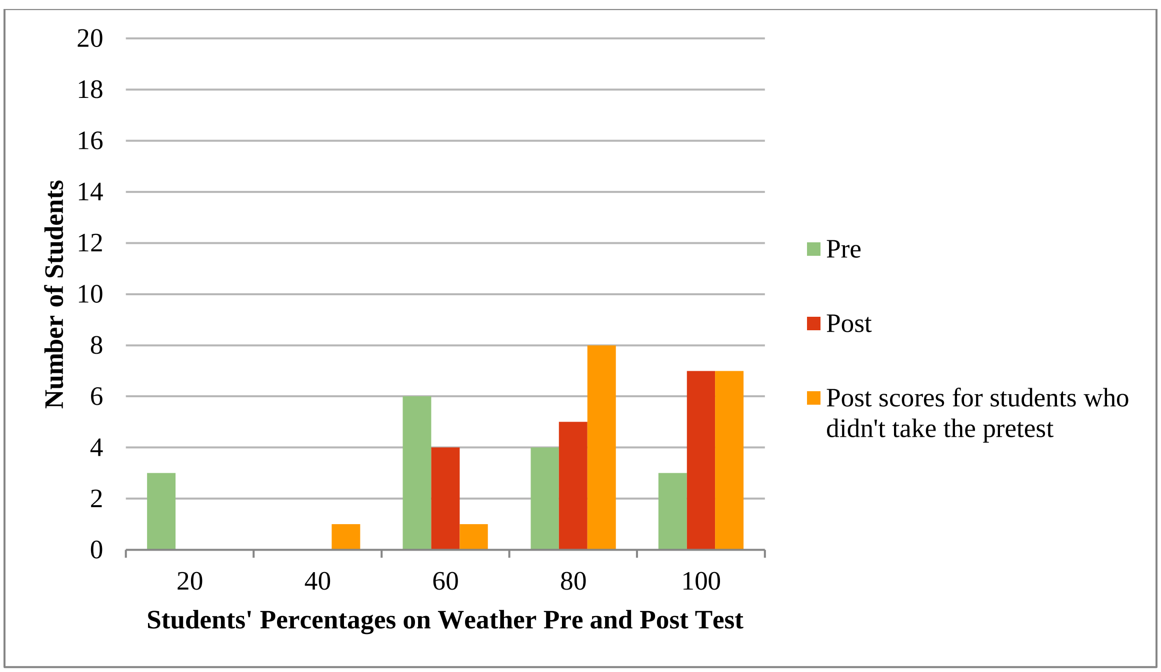

Figure 8: Students' percentages on Weather pretest and posttest as a group for the treatment group, *(N*=33*)*.

Overall, sometimes the comparison group did better and sometimes the treatment group did better. The lack of a complete set of pretest scores for 6A may have skewed the data. Some individual students made great gains between their pre and posttest scores demonstrating a significant amount of learning. As a whole, the data does not show whether an integrated curriculum improved student achievement.

How Students' Attitudes about Science Are Affected by an Integrated Curriculum

Before the units on the weather and the water cycle began, students were given a survey about their attitudes regarding science and its place in school and in their lives outside of school. After the two units were taught, the students took the survey again. Students' attitudes about science according to the survey showed little change after the completion of the integrated units (see Figure 9). Fifty-nine students took the pre unit survey, 66 students took the post survey. Many of the differences between the results may have been the result of seven additional students' opinions.

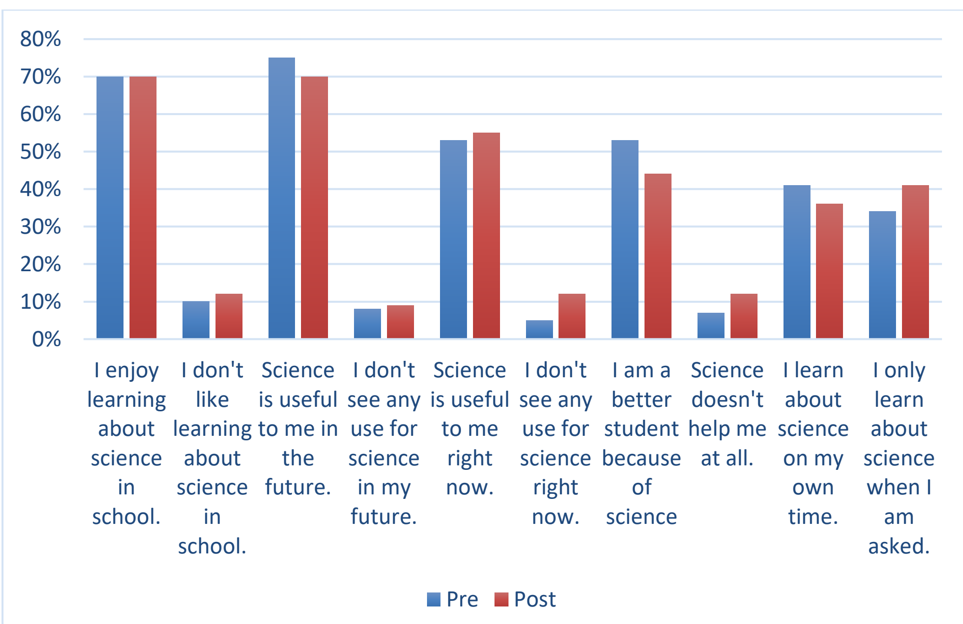

Figure 9: Results of students' pre and post survey about their attitudes about science,

(pre-survey N=59, post-survey N=66).

When students were asked if they enjoyed learning about science in school, approximately 70% agreed or strongly agreed on both the pre and post surveys. All nine of the students I interviewed liked science. Many of them mentioned they liked experiments or learning how things work. Before the units began, 10% of students agreed or strongly agreed with the statement that they “don’t like learning about Science in school.” After the units, that number increased to 12%. Before the units, about 75% of students said that science was useful for them in the future compared to 70% after the units. In an interview with some students, they listed future jobs like engineering and medicine when they discussed how they would use science in the future. Approximately 8% of students said they did not see any use for science in their future while 9% said the same thing after the units were taught. Approximately 53% of students thought science was useful to them right now. Two students I interviewed said that we use science now when we observe our weather or notice the changes in our Earth. After the units were taught, 55% thought science was useful now. About 5% of students did not see any reason to learn science now and 12% said the same thing after the units were taught.

Approximately 53% of students thought they were an overall better student because of things they learned in science and 44% thought the same after the unit. Approximately 7% of students thought science did not help them at all. After the unit was taught, 12% thought science did not help them at all. Finally, when students were asked if they learn about science on their own time without being asked, 41% agreed or strongly agreed. After the unit, 36% agreed with that statement after the unit. Many of the students interviewed could not think of when they used science outside of school unless asked a follow up question about the use of science skills like observation, analyzing and questioning. Then they could quickly identify a time when they used it. Approximately 34% only learn about science when they were asked to and after the units were taught 41% agreed or strongly agreed that they only learn about science when they are asked to. Many of the changes between the pre and post surveys could have been a difference of those 7 students.

How an Integrated Science Curriculum Affects Transfer and Connection of Knowledge

At the end of the units, students were asked to reflect on the two units and the differences between the integrated unit and the non-integrated unit. Students reflected on how the different types of units impacted their learning. My claim is the students' ability to transfer knowledge and connect it across different content areas was increased by an integrated unit. Sixty-one students replied to the question and 61% of them said that the integrated unit positively affected their learning, 18% did not care, and 21% did not like the integrated unit.

Each group of students that liked the integration or did not was a mix of high achieving, at grade level and low achieving students. Of the 37 students who liked the treatment, 12 were high achieving, 10 were at grade level and 13 were low achieving. Students had some common themes. They said it helped them remember or learn, everything was connected, it was easier, and it was more fun. One student said, "It was good to have everything together because we didn't really have to transition our minds a huge amount." Another student illustrated an example of the learning, "I think it was a lot better when it was all connected, especially for learning because we talked about, wrote about and graphed climate." Students commented on how it was less stressful, it helped them to understand because everything was connected and their "brains didn't have to keep crossing between multiple subjects and remember everything."

Some of the students who said they did not care one way or the other said their grade was not affected by the change, but they learned easier or it was fun. "My grades did not differ, but I could recall formulas and subjects faster and easier." Some of the students who said they were not affected by the integration often did not pay attention well in class.

Students who did not like the integration commented that they wanted variety or the way the lesson was taught did not matter because they "already knew everything." One student thought, "We are actually learning more when we don't talk about the same thing in every class." Other students claimed it was overwhelming and they wanted things separate. Some of the students who felt this way had excessive absences. The academic level of students was spread out evenly among the three opinions.

Overall, 61% of students felt that their learning benefitted from integration and they were able to make connections and transfer their knowledge from one subject to another regardless of their grades.

INTERPRETATION AND CONCLUSION

The primary measurable benefit of the integrated science units was that students felt that learning was easier and more fun. The data does not show a significant change between the treatment and comparison group on academic achievement or attitudes about science, but a high percentage of students either enjoyed science more or felt that it was easier to learn throughout the day when learning through integrated units. This data coincides with results from the previous mentioned research. Students were given an opportunity to do activities similar to what a scientist does where they collected data, found evidence and constructed a claim to answer their question. Similar to Demirbag & Gunel (2014), students were able to understand and use their resources to create clear arguments about climate change.

The test scores did not show a significant change in academic success between the treatment group and the comparison group, but students said they felt more successful and they noticed that they were learning math and science about the same topic. Kiray & Kaptan (2002) noticed higher achievement when math and science were integrated. This is supported by Ritter's (1999) research that demonstrated students learn better when teachers use thematic units. Learning became more meaningful for the students when they could see how it was connected to other things and how it was connected to the real world. This is a similar finding to Pursitasarie, Nuryanti, & Rede's (2015) study of seventh graders in Palu city and what Gunel and Atila (2009) found regarding connections. Students participated in activities where they measured and graphed weather data. The read a weather map and interpreted the symbols. These are real life activities. Students were given the ability and the freedom to keep their learning on one topic and avoid stopping and starting throughout the day.

Students' scores on assessments was not significantly affected enough to be able to claim that students scored higher when instructed with an integrated curriculum, but my observations of students and students' own reflections demonstrated that for almost ⅔ of the students they felt that learning was easier when the content was the same. One day, as we were beginning to talk about the amount of water measured coming out of a watershed, one student proclaimed, “We talked about this in math!” They were amazed and a little relieved that this topic was familiar.

Students benefited from math and science integration and they benefited from science and language integration. After learning about the water cycle, one class was assigned to write about a water droplets journey from the ocean back to the ocean. They were allowed to be creative. They could write a poem or a story, they could be creative on what the water droplet might sense along its journey, but they had to include the appropriate scientific path and explain what was happening to the water droplet. Some of the students’ understanding of physical science was evident in their description of the water droplet getting cold as it condensed or getting warm as it evaporated. I provided differentiation by allowing the students to create a complicated water journey or a simple one. They demonstrated their understanding of the water cycle and used writing skills to do so. Once I assigned the assignment, one girl said, “I actually want to do this assignment.”

Students enjoyed learning more and found it was easier when the content was integrated. The day was not broken up quite so much and they had less to remember overall. The integrated unit allowed them to make connections between different lessons rather than adding more to what they needed to learn.

VALUE

This research reiterated the importance of connecting different content areas together for students. I have integrated content in the past, but this was the first time I collected and measured data asking whether it benefited students. The most beneficial data was the students’ perspectives on their own learning when the content was integrated. I will continue to integrate content areas as often as I can. Overall, it will be beneficial to my students and will help them see how their learning helps them in the real world.

The use of data in this research has been eye opening. I appreciate being able to give my administrator and my students concrete evidence to support my educational decisions in the classroom. I will continue to collect data on my students. I have been using pre and posttests, but I am not always consistent with them. I would like to be more consistent in the future. The information that I gained from surveying and interviewing students was invaluable. I want to remember to continue surveying and interviewing students. Students may also feel that their voice is heard and appreciate that I want to know their thoughts and opinions.

Because most students felt that it was easier to learn when content was integrated, I will continue to integrate. Next year, I plan to have a science theme that allows me to teach different aspects of science and different content areas. Implementing this treatment would benefit my students because they can learn deeply about a particular topic and use all their skills to portray their learning.

Overall, my research was beneficial. If I were to conduct this research again, I would use a topic with which students were not as familiar. Weather and the water cycle are topics students were familiar with from early elementary years. They learned new aspects about them in my class, but they had background information that made measuring the growth more difficult. In addition, students took the pretest after returning from Christmas break. One class moved considerably slower than the other did so they did not have as much time to complete the pretest in class. Only the most responsible students remembered to finish it at home. If I had all the pretest data from both groups, the results may have been stronger.

There are many ways to integrate. I am curious if there is a more effective way to integrate content. Is it better to integrate math and science or language and science? Is it better to integrate everything or simply a few things? What effects can the integration of different areas of science: life, physical and earth, have on student achievement? I will continue to try to create a learning environment that mirrors life better than a segmented classroom. I ended this year with an activity where students planned a dream vacation. They had to create a pamphlet advertising their vacation. They used research skills, they had to calculate the cost, designed a postcard, discovered and recorded the climate and created a map of the area. Once they completed the pamphlet, they presented it to their classmates. The students loved the activity and used every content area together to learn about and create their final product. I want to create more projects like the dream vacation project.

This study was very valuable. I found the greatest value in the students' reflections. They felt they were able to learn better and for many, they had more fun. The other valuable thing that came out of this research was that I began a pattern of looking for connections between different content areas. Finding those connections started to come more naturally than it used to. I want to implement more lessons that are integrated in the future; I will be able to increase student learning and their engagement in their own learning. If I can help foster that love of learning, perhaps they will take it with them to future classes.

I have become a better teacher as a result of this action research process. I have learned how to conduct and measure research, how to gather, interpret and use data. I have also become aware of how important it is to try new strategies and measure their effectiveness. I have grown as a teacher because I accomplished things I never would have tried on my own. I did a better job keeping track of individual student growth, classroom growth and student opinions.

REFERENCES CITED

Bogan, B. L., King-McKenzie, E., Bantwini, B. D. (2012). Integrating Reading, Science, and Social Studies: Using the Bogan Differentiated Instruction Model. *US-China Education Review A*, 1053-1060. Retrieved February 21, 2016, from http://files.eric.ed.gov/fulltext/ED539347.pdf

The Child and the Curriculum. Chicago: University of Chicago Press. Retrieved March 8, 2016, from Sophia Project: Philosophy Archives.

Demirbag, M., & Gunel, M. (2014). Integrating Argument-Based Science Inquiry with Modal Representations: Impact on Science Achievement, Argumentation, and Writing Skills. *ESTP Educational Sciences: Theory & Practice*, 386-391. Dewey, J. (1902).

Gunel, M., Atila, M. E., & Buyukkasap, E. (2009). The Impact of Using Multi Modal Representations Within Writing to Learn Activities on Learning Electricity Unit at 6th Grade. *Elementary Education Online*, 8(1), 183-199.

Harrell, P. E. (2010). Teaching an Integrated Science Curriculum: Linking Teacher Knowledge and Teaching Assignments. *Issues in Teacher Education*, 19(1), 145-165.

Kiray, S. A., & Kaptan, F. (2012). The Effectiveness of an Integrated Science and Mathematics Programme: Science-Centered Mathematics-assisted Integration. Energy Education Science and Technology Part B: *Social and Educational Studies*, 4(2), 943-956.

Lehrer, R., & Schauble, L. (2000). Developing Model-Based Reasoning in Mathematics and Science. *Journal of Applied Developmental Psychology*, 21(1), 39-48.

National Center for Education Statistics (NCES) Home Page, a part of the U.S. Department of Education. (n.d.). Retrieved April 16, 2016, from http://nces.ed.gov/

Pursitasari, I. D., Nuryanti, S., & Rede, A. (2015). Promoting of Thematic-Based Integrated Science Learning on the Junior High School. *Journal of Education and Practic*e, 6(20), 97-101.

Ritter, N. (1999). Teaching Interdisciplinary Thematic Units in Language Arts. *ERIC Digests*, d142, 1-5.

Roth, K. J., Druker, S. L., Garner, H. E., Lemmons, M., Chen, C., Kawanaka, T., Rasumussen, D., Trubacova, S., Warvi, D., Okamoto, Y., Stigler, J., Gallimore, R., Gonzales, P. (2006). Teaching Science in Five Countries: Results from the TIMSS 1999 Video Study Statistical Analysis Report. *National Center for Education Statistics*, 5-205.

Subramaniam, K. (2010). Integrating Writing Frames into Inquiry-Based Instruction. *Science Educator*, 19(2), 31-34.

Vars, G. F. (October 1991). Integrated Curriculum in Historical Perspective. *Educational Leadership*, 14-15. Retrieved March 12, 2016.

APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Janelle George and Eric Brunsell
FROM: Mark Quinn *Mark Quinn* cg
DATE: November 21, 2016
SUBJECT: "*The Impact of Integrated Curriculum on Student Success*" [JG112116-EX]

The above research, described in your submission of November 21, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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

APPENDIX B

PRE AND POSTTESTS

Weather & Climate Pretest

1. A student opens a window in her classroom, letting in air that is warmer than the air inside the classroom. What will happen to the warmer air when it comes into contact with the colder air in the classroom?

A. The warmer air does not rise, but the thermal energy of the air does.
B. The warmer air rises, but the thermal energy of the air does not.
C. The warmer air rises, and its thermal energy rises with it.
D. Both the warmer air and the thermal energy of the air rise, but they rise separately.

3. Can the direction air is moving and the speed at which it is moving be measured?

A. Both the direction air is moving and the speed at which air is moving can be measured.
B. The direction air is moving can be measured but the speed at which air is moving cannot be measured.
C. The speed at which air is moving can be measured but the direction air is moving cannot be measured.
D. Neither the speed at which air is moving nor the direction air is moving can be measured.

4. Which of the following statements is TRUE about changes to the amount of water vapor in air at a particular place over time?

A. The amount of water vapor in air can increase, but it cannot decrease.
B. The amount of water vapor in air can decrease, but it cannot increase.
C. The amount of water vapor in air can increase, and it can decrease.
D. The amount of water vapor in air cannot change.

5. Which of the following statements is TRUE about changes to the humidity of air at a particular place over time?

A. The humidity of air can increase, but it cannot decrease.
B. The humidity of air can decrease, but it cannot increase.
C. The humidity of air can increase, and it can decrease.
D. The humidity of air cannot change.

6. What is humidity?

A. A measure of the temperature of the air
B. A measure of the amount of water vapor in the air
C. A measure of the amount of liquid water in the air
D. A measure of both the amount of water vapor in the air and the temperature of the air

7. Can sunlight increase the temperature of land and water?

A. Sunlight can increase the temperature of land but not the temperature of water.
B. Sunlight can increase the temperature of water but not the temperature of land.

C. Sunlight can increase the temperature of land and the temperature of water.
D. Sunlight cannot increase the temperature of land or the temperature of water.

8. What happens as water evaporates from a lake?
A. As water evaporates from a lake, it becomes a gas that spreads throughout the air.
B. As water evaporates from a lake, it becomes tiny droplets of liquid water that spread throughout the air.
C. As water evaporates from a lake, it becomes a gas that moves directly into clouds without ever being part of the air outside of the clouds.
D. As water evaporates from a lake, it becomes tiny droplets of liquid water that move directly into clouds without ever being part of the air outside of the clouds.

9. What makes rain fall from a cloud?
A. Rain falls from a cloud any time wind blows on the clouds.
B. Rain falls from a cloud when two clouds collide, causing them to burst open.
C. Rain falls from a cloud when the air in the cloud cools, causing water droplets to form.
D. Rain falls from a cloud when the pool of water in the cloud becomes too large, so the cloud can no longer hold the water inside.

Water Cycle Quiz

1. Which of the following statements is TRUE about changes to the amount of water vapor in air at a particular place over time?

A. The amount of water vapor in air can increase, but it cannot decrease.
B. The amount of water vapor in air can decrease, but it cannot increase.
C. The amount of water vapor in air can increase, and it can decrease.
D. The amount of water vapor in air cannot change.

2. Can sunlight increase the temperature of land and water?

A. Sunlight can increase the temperature of land but not the temperature of water.
B. Sunlight can increase the temperature of water but not the temperature of land.
C. Sunlight can increase the temperature of land and the temperature of water.
D. Sunlight cannot increase the temperature of land or the temperature of water.

3. What happens as water evaporates from a lake?

A. As water evaporates from a lake, it becomes a gas that spreads throughout the air.
B. As water evaporates from a lake, it becomes tiny droplets of liquid water that spread throughout the air.
C. As water evaporates from a lake, it becomes a gas that moves directly into clouds without ever being part of the air outside of the clouds.
D. As water evaporates from a lake, it becomes tiny droplets of liquid water that move directly into clouds without ever being part of the air outside of the clouds.

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C. Rain falls from a cloud when the air in the cloud cools, causing water droplets to form.
D. Rain falls from a cloud when the pool of water in the cloud becomes too large, so the cloud can no longer hold the water inside.

Weather Quiz

1. A student opens a window in her classroom, letting in air that is warmer than the air inside the classroom. What will happen to the warmer air when it comes into contact with the colder air in the classroom?
   A. The warmer air does not rise, but the thermal energy of the air does.
   B. The warmer air rises, but the thermal energy of the air does not.
   C. The warmer air rises, and its thermal energy rises with it.
   D. Both the warmer air and the thermal energy of the air rise, but they rise separately.
2. Can the direction air is moving and the speed at which it is moving be measured?
   A. Both the direction air is moving and the speed at which air is moving can be measured.
   B. The direction air is moving can be measured but the speed at which air is moving cannot be measured.
   C. The speed at which air is moving can be measured but the direction air is moving cannot be measured.
   D. Neither the speed at which air is moving nor the direction air is moving can be measured.

3. Which of the following statements is TRUE about changes to the amount of water vapor in air at a particular place over time?
   A. The amount of water vapor in air can increase, but it cannot decrease.
   B. The amount of water vapor in air can decrease, but it cannot increase.
   C. The amount of water vapor in air can increase, and it can decrease.
   D. The amount of water vapor in air cannot change.

4. Which of the following statements is TRUE about changes to the humidity of air at a particular place over time?
   A. The humidity of air can increase, but it cannot decrease.
   B. The humidity of air can decrease, but it cannot increase.
   C. The humidity of air can increase, and it can decrease.
   D. The humidity of air cannot change.

5. What is humidity?
   A. A measure of the temperature of the air
   B. A measure of the amount of water vapor in the air
   C. A measure of the amount of liquid water in the air
   D. A measure of both the amount of water vapor in the air and the temperature of the air

APPENDIX C

INTERVIEW QUESTIONS

Students are encouraged to freely share their opinions.

1. How do you feel about learning about science?

2. What will you use science skills for in your future?

3. What do you use science skills for right now, besides school?

4. How can science skills help you?

5. When do you learn about science?

APPENDIX D

SCIENCE ATTITUDE SURVEY

SCIENCE ATTITUDES

What are your opinions about science? (students filled out answers on Google Forms)

1. I enjoy learning about Science in school.

strongly disagree O O O O O strongly agree

2. I don't like learning about Science in school.

strongly disagree O O O O O strongly agree

3. Science is useful to me for my future.

strongly disagree O O O O O strongly agree

4. I don't see any use for Science in my future.

strongly disagree O O O O O strongly agree

5. Science is useful to me right now.

strongly disagree O O O O O strongly agree

6. I don't see any reason to learn science now.

strongly disagree O O O O O strongly agree

7. I am a better student because of things I learn in Science.

strongly disagree O O O O O strongly agree

8. Science doesn't help me at all.

strongly disagree O O O O O strongly agree

9. I learn about Science on my own time without being asked.

strongly disagree O O O O O strongly agree

10. I only learn about Science when I am asked to.

strongly disagree O O O O O strongly agree

APPENDIX E

STUDENT JOURNAL PROMPT INSTRUCTIONS

Prompt at the beginning of class

1. Write today's date on the top of your page in your Science Notebook.

2. Answer both questions completely.

*What did you learn in science yesterday?

*What do you still have questions about?

Prompt at the end of class

Write the answer to the following questions beneath your answers from the beginning of class.

*What did you learn today?

*What was the most meaningful thing you did in class today?