INTEGRATING SCIENCE

AND TECHNOLOGY

by

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STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE program shall make it available to borrowers under rules of the program.

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DEDICATION

 I dedicate this paper and work to all of the people who were there to assist me when I needed help. Most importantly, I dedicate this to my wife, Janell, and son, Braiden, who were there to help me through the long process from making the decision to start working on a master's degree all the way through the final presentation of this paper. You kept me going and focused on what was important when things were difficult.

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ABSTRACT

Science plays an important role in students' education, even when time is limited by restrictions from other subject areas such as reading and mathematics. In this study, students' computer classes were integrated with a current and relevant science topic (alternative energy resources) to gauge 1) whether students were able to better understand the content presented and 2) how their attitudes towards science were affected by the science instruction.

Students completed nine lessons that focused on the use, benefits, and drawbacks of two types of alternative energy: wind energy and algae biofuel. Each lesson was integrated with technology-based activities to enhance student understanding. Student interviews, unit pretests and posttests, journals entries, and attitude surveys were used to monitor student learning and progress throughout the project.

The data collection indicated that students came into the project with little science background knowledge and an average interest in science. As the study progressed, students developed a deeper understanding of alternative energy resources. Student attitudes towards the science learning process improved a small amount as well. At the conclusion of the study, all of the students had increased scores on the content tests and most students had small increases on the attitude measures.

INTRODUCTION AND BACKGROUND

Background and Demographics

Lame Deer Elementary School is a small kindergarten through sixth grade school with 335 students enrolled at the spring 2012 count date. The school's population included 97.3% Native American; the majority of students were Northern Cheyenne, followed by Crow and other tribes. Lame Deer, Montana, is a rural community of about 2000 people located on the Northern Cheyenne Indian Reservation approximately 100 miles southeast of Billings, Montana. Although most of the students live in the town of Lame Deer, some students travel from other locations on the surrounding reservation to attend the school. Lame Deer is a high poverty area and all of the students participate in the free lunch program.

The class I taught had 19 students (ten girls and nine boys) at the beginning of the study. Eight of these students were identified as limited-English proficient (LEP) and three of those students also had individual education plans (IEP) in place for various learning disabilities. During the study, two boys (one from another class and one from another district) joined the class and one boy and three girls transferred to other schools, leaving a total of ten boys and seven girls in the class at the completion of the study.

Purpose and Implications of the Study

Lame Deer Public Schools was one of four school districts in Montana identified as in need of academic assistance, and the schools were operated under School Improvement Grants (SIG) during the past two school years. These schools failed to

make adequate yearly progress as outlined by *No Child Left Behind* and the Montana Office of Public Instruction (OPI). The SIG implementation process brought a strong focus to the areas of reading and mathematics in recent years, primarily at the expense of science and social studies.

Lame Deer Elementary School's scripted reading program consisted of a 90 minute reading block, 45 minute language art block, and 45 minute small-group reading time. In addition, the math program included a one hour block with a separate 45 minute small-group time. The small-group time for both reading and mathematics consisted of students working with other students in their grade level who had tested at similar ability levels. Teachers were also required to be at a certain part of the curriculum on specific days and not allowed to supplement the scripted teaching program with other enrichment activities. As a consequence, Lame Deer Elementary School provided a very limited science curriculum. The reading lesson included a small amount of science in the reading lessons, but teachers had a very strict timeline for implementation. Science was sometimes included only once a week for twenty minutes in a section of the reading lesson called "Science/Social Studies Connection".   In addition, the Macmillan/ McGraw-Hill science textbooks were old, outdated, or missing, and no time was built into the daily schedule for their use. Teachers, however, incorporated small amounts of science into the classroom, typically by creating their own units of study and using other resources whenever possible.

Each year, public schools in the state of Montana complete a set of standardized exams known as the MontCAS (Montana Comprehensive Assessment System) exams. Students in 3rd through 10th grades complete three tests each in reading and mathematics,

and students in 4th, 8th, and 10th grades complete three science tests as well. In 2011, science scores at Lame Deer Elementary School dropped when compared to the previous two years, while math and reading scores remained at the same level. These scores likely began to plateau because of the lack of variety in content from day to day. When subjected to only reading and math for the entire day, students lost interest in school and, therefore, underperformed in all areas. Although reading and mathematics comprise a major part of what is necessary for a well-rounded student, it is also important to focus on other subject areas as well so that students can be successful after high school. If the students are exposed to science, in addition to the math and reading, I believe they will show more interest in school overall and their scores will then begin to increase. To achieve this, it is important to provide students with quality science experiences to help them develop an interest in science-related fields and eventually, career opportunities. My study, therefore, focused on science enrichment activities that utilize technology to increase science content knowledge and student enthusiasm and involvement.

<u>Focus Questions</u>

To assess academic growth and the efficacy of hands-on, inquiry-based science in the fourth grade computer class, my study focused on three questions:

1. In what ways do integrated technology/science lessons impact students' ability to learn new science content?

2. Are students' attitudes towards science changed by the integration of technology and science instruction?

3. What interventions are most effective with the study group?

CONCEPTUAL FRAMEWORK

Introduction

Teachers are always looking for ways to maximize student learning in the classroom. One of the ways that this can be done is through the use of integrated curricula. Since science education has been marginalized in many districts due to more emphasis on reading and mathematics, many teachers are looking for ways to include science in the everyday learning plan. One way to accomplish this is through the integration of different content areas and learning methods. The integration of science with technology can produce a deeper understanding of the science concepts presented and build connections that students will remember for years (Kumar & Bristor, 1999). There are many possible ways and several important factors to consider when working with an integrated curriculum.

Creating Active Learners

In order for students to achieve success in academics, they need to be actively engaged in the subjects they are studying. This engagement can often be achieved through examining material that the students are learning about through inquiry activities. Inquiry is an important part of the scientific learning process.

Students must understand the process of science – how information is gathered, evaluated and communicated to others. Learning by inquiry mirrors the process of science itself. The knowledge and skills related to scientific inquiry enable students to understand how science works. Inquiry allows students to construct

an understanding of scientific facts, principles, concepts and applications. In

addition, scientific inquiry stimulates student interest, motivation and creativity.

(Montana K-12 Science Content Standards Framework, p. 7)

Students learn a great deal from first hand experiences (Clayton, Hagan, Ho, &

Hudis, 2010) and motivating students is another key to student learning. It is important

to help students reach a state of intrinsic motivation. Intrinsic motivation occurs when

the student feels motivated from within themselves, and this can lead to higher levels of

achievement than extrinsic motivation, such as rewards or praise from others (Harlen,

2001). Research also shows that motivation positively affects the learning process in

almost all subjects including science (Bandura, 2001). Teachers should, therefore, focus

on engaging students by shifting from passive to active instruction in their classrooms.

Greater understanding of science content also depends on the students' willingness to

investigate and figure things out for themselves. By encouraging students in these

directions, they will be more willing to take part in quality learning experiences (Clayton

et al, 2010; Harlen, 2001). Engagement and motivation help lead students towards the

ultimate goal for the learning process, which is a permanent change in their knowledge

base (van Joolingen, de Jong, & Dimitrakopoulou, 2007).

<div align="center">Curriculum Integration</div>

One way to increase student engagement is through the use of curriculum

integration. Curriculum integration can be defined as teachers' purposeful inclusion of

techniques and experiences that aid in learning across important educational disciplines.

Curriculum integration, from the students' perspective, is shown through the

demonstration of knowledge, talents, principles, and attitudes that go beyond any single

subject area (New South Wales Board of Studies, 1996). This approach can be connected

to not only higher levels of student motivation, but also higher levels of academic success

(MacMath, Roberts, Wallace, & Xiaohong, 2010). Students will reap more benefits

when they become the focus of the lesson and are allowed to help drive their education

(Kaufman & Brooks, 1996). The integration of science with other subjects will also

increase student response and discussion, which will lead to higher academic

achievement as well (Venville, Sheffield, Rennie, & Wallace, 2008). Students in

integrated science classrooms outperformed those who are only exposed to the core

science curriculum. Furthermore, the results of curriculum integration are reflected in

testing as well. More than 80 normative and comparative studies show that students in

integrated classes were able to do at least as well as, and in most cases outperform,

students taking separate classes (Hurley, 2001; Vars, 1991).

Important Factors to Consider

One of the most common reasons for planning an integrated curriculum is that

information found in real life does not fit into neat categories like school subjects are

typically organized (Case, 1991). Integration of curriculum is important; however,

several things need to be done correctly to produce positive results. To start, an

integrated curriculum requires cooperation from the teachers implementing the program.

The teachers must also agree on what the core learning goals will be throughout the

curriculum. To accomplish this and coordinate the teachers' intentions, the teaching team

must meet and establish a curriculum chart that will show connections among different

subject areas (Clayton et al, 2010). While creating the integrated curriculum, teachers need to work not just to devise a set of lessons designed around a particular theme, but to design fully integrated units where the separate subject areas are difficult to separate from each other (Beane, 1992). Specific knowledge of how to implement subject integration and an understanding of different educational techniques are also important (Shriner, Schlee, & Libler, 2010). Finally, teacher commitment to the integration process is key as well. Studies show that, over time, teachers will revert to the ways they feel comfortable teaching. Typically this is nonintegrated, single discipline teaching instead of staying focused on integration of the subject areas (Venville, Wallace, Rennie, & Malone, 2002).

<u>Integrating Science and Computers for Educational Purposes</u>

There are many possible definitions for technology integration in an educational setting. Hew & Brush (2007, p. 225) defined technology integration as "the use of computing devices such as desktop computers, laptops, handheld computers, software, or Internet in K-12 schools for instructional purposes." With the new Common Core State Standards Initiative that is starting to be implemented across all grade levels and curricula around the country, there is a much stronger focus on technology integration, thus increasing the importance of a quality technology integration process (Common Core State Standards Initiative, 2012). Technology integration can be implemented in a myriad of ways, with varying goals and forethought. Some teachers integrate technology to improve the objectives and goals that they already have in place, while other teachers simply add technology into the curriculum with no predetermined objective (Ertmer, 1999; Norton & Wiburg, 1998). Determining the level of integration that a teacher has

obtained can be tricky. We cannot simply look at the number of computers or how often

they are used. The level of integration is seen when observing how the technology is

used to enhance learning (Ertmer, 1999). When it comes to how teachers utilize

technology in the classroom, it has been found that the most common use of technology

for teachers is in lesson preparation and the least common use is for student products

(Babell, Russell, & O'Dwyer, 2004). This trend needs to change in order to achieve a

higher level of quality technology integration in the classroom.

Even with all the advances in technology during the twentieth and twenty-first

centuries, computer technology remains mostly underutilized in the classroom and has

not been implemented in appropriate, successful ways (Cuban, 2001). By using

technology, teachers have the opportunity to change science learning in the classroom so

that it will better represent the scientific processes that were intended to be addressed by

the specific learning activity (Hakkinen, 2002). Computers also allow for the creation of

computer-based inquiry environments where students can participate in authentic inquiry

tasks and thereby learn the discipline, along with learning the scientific inquiry process

(van Joolingen et al, 2007). One extensive study concluded that the integration of

technology-enhanced inquiry resulted in significant gains by the students (Lee, Linn,

Varma, & Liu, 2010). Another study (Zacharia, 2007) examined the effect of introducing

a simulation instead of using a real laboratory setting when teaching electric circuits. By

carefully replacing part of the real laboratory with a virtual laboratory, the instructor was

able to show that the students in the virtual laboratory outperformed those in the real

laboratory. O'Bannon and Judge (2004) also found that the integration of technology and

science produced statistically significant gains on student tests. Involving students in the

processes of science brings them into the closest possible contact with the nature of scientific understanding, including its strengths, problems, and limitations, which can all lead to further student learning (Dunbar, 1999).

There have been many reasons given for not integrating technology into the classroom. Some teachers are overwhelmed with all of the barriers or obstacles to technology integration, such as limited money for technology or lack of training with technology implementation, and feel the need to overcome each one before implementing the integration process (Ertmer, 1999). Other teachers do not feel comfortable with the additional classroom management knowledge and skills required when implementing technology integration (Hew & Brush, 2007). Many teachers also feel they will never truly have an understanding of technology because it is always changing (Ertmer & Ottenbreit-Leftwich, 2010).

To compound the issue, each school and grade level within that school also has their own culture. If that culture is strongly rooted in traditional methods, teachers will often implement technology in only low level tasks or not at all (Ertmer & Ottenbreit-Leftwich, 2010). Teachers and administrators need to confront the problems that come with creating a school environment that is different from their own school experiences (Sheingold, 1991). Cooperation among all parties involved (teachers, administrators, parents, students, etc.) can lead to a better implementation process (Ertmer, 1999).

"Teachers need opportunities to observe *models* of integrated technology use, to *reflect* on and discuss their evolving ideas with mentors and peers, and to *collaborate* with others on meaningful projects as they try out their new ideas about teaching and learning with technology" (Ertmer 1999, p. 54). For teachers and students to reap the full

benefits of the technology they use, they must better understand the correlations among technology, pedagogy, project-oriented programs, and student learning (Windschitl, 1998).

At the school or district level, it is important to create a culture that supports the proper use and integration of technology in the educational setting and provide teachers with further education about technology integration. Providing access to the proper training, support, and time to implement technology integration is another key for administration to keep in mind when working towards technology integration (Ertmer & Ottenbreit-Leftwich, 2010). For individual teachers there are many ways to begin implementing technology in the classroom. Having a plan that focuses on teaching and learning with technology is one way to begin the implementation process (Hew & Brush, 2007; Rogers, 2000). Integrating one lesson or unit and providing effective management for students by modeling activities and setting boundaries are also keys to successful integration (Ertmer & Ottenbriet-Leftwich, 2010; Hew & Brush, 2007; Lim et al, 2003). Teachers also need to prepare themselves to utilize the technologies correctly and show a level of proficiency with the technology found in their lessons in order to teach the students (Ertmer & Ottenbreit-Leftwich, 2010). Extra scaffolding is important for enhancing the learning experience of the students (Hakkinen, 2002). Scaffolding provides just enough support so that the student feels they can succeed when learning challenging content. Scaffolding is essential to properly utilize the technological tools and maximize the students' learning. It is also imperative for the teacher to build support into the computer activities so that students are not simply skipping through the assigned work quickly or guessing until the correct answer is found. This can be done by utilizing

computer activities or other assignments geared to lead students to work closely with the teacher (van Joolingen et al, 2007). If all of these factors are taken into consideration throughout the implementation process, there will be a much better chance of success.

Summary

An integrated curriculum that is strongly rooted in technology use that enhances student learning is important for helping students make new connections between what they have learned previously and the things they will still need to learn for their future. To positively affect student learning, an integrated curriculum needs to adhere to several key principles, including lessons that are designed to blur the lines between specific content/subject areas while helping students to gain understandings of everyday problems, lessons that are taught by knowledgeable teachers that are committed to the integration process, and a high level of cooperation from all parties involved. When students are exposed to integrated subject areas, they are able to build stronger relationships among the disciplines and make stronger connections to real life experiences (Caine & Caine, 1995). These connections become the foundation of the learning process. The teacher then expands the students' knowledge base for each subject area, either through further integrated teaching or teaching to a specific content, such as life science or earth science. The learner obtains more benefits when the teacher adds meaningful material that will create a longer-lasting impression on the learner and link information to previous connections.

METHODOLOGY

Pre-Treatment

Examining the MontCAS (Montana Comprehensive Assessment System) questions and NWEA MAP (Northwest Education Association Measures of Academic Progress) test results showed that students at Lame Deer Elementary School needed to improve in every area of science. In addition, MontCAS statewide science exams are given in 4th grade, further increasing the importance of the group of students in this study. My treatment plan, therefore, involved the implementation of nine science-rich technology lessons for the experimental group, which consisted of 4th grade students at Lame Deer Elementary School. I chose to work with the 4th grade students because they scored in the eighth percentile in both *General Science* and *Concepts and Processes* on their fall 2011 NWEA MAP tests. A positive correlation existed between the NWEA MAP Testing and MontCAS exams. It was important, therefore, to help the students gain the knowledge they needed to be successful in science.

Before implementing the treatment, I met with the regular classroom teacher who was participating in the study. I informed him of the types of activities that the students would be doing, and we agreed that it would be beneficial for the students to learn about emerging alternative fuel resources. Although there is currently substantial interest in alternative energy, it will be up to future scientists and consumers to help reduce the world's demand for nonrenewable energy resources. We also discussed the individual students, their background, and academic achievements in science. This information was somewhat limited however because of the lack of science content taught at the school.

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.

To gauge student knowledge and attitude prior to the implementation of the lessons, the students were given a pre-unit interview (Appendix A). The lack of information the students were able to provide during these interviews was revealing. Very few of the students could remember science experiments or activities that took place in the classroom. This information gave me a baseline to work with when analyzing the students learning experiences throughout the study.

Next, I administered the Test of Science Related Attitudes (TOSRA) 2 Survey (Appendix B) before the lessons were taught. This pretest provided a guide for monitoring student interest in science related activities.

Finally, students also completed a content pretest and posttest (Appendix C) for each of the two units. These tests were designed to gauge students' background knowledge and understandings on the key concepts presented throughout the unit of study. These tests were given before and after each of the wind energy and algae biofuel units.

<u>Treatment</u>

For the treatment portion of the study, I adapted and incorporated several hands-on activities and inquiry-based computer lessons focusing on renewable energy resources that I had helped develop as part of a larger group of science teachers. These lessons were made available to the pilot group of teachers through the Montana State University

Science Inquiry Learning in the Classroom (SILC) Project and the Experiences in

Emerging Energy Concepts (E3C) website (Science Inquiry Learning in the Classroom,

2011. These lessons were implemented during the students' weekly 50-minute visit to

the computer lab. Students completed these lessons between November 2011 and

February 2012.

Wind Energy Unit

The first unit of study, the use of wind energy (Appendix D), included interactive

activities, group discussions, a visiting scientist, and creating their own wind turbines to

test energy efficiency.

Lesson one was an introduction to the idea of renewable and nonrenewable

energy resources. The students were shown a piece of charcoal and asked what it is used

for. After student responses were recorded, the class looked at online pictures of coal,

coal miners, and a coal mine and discussed the students' thoughts about the pictures.

Next, the students looked at a YouTube video showing wind blowing through and

moving tree branches and were asked to describe what they were viewing. The class then

discussed the differences and similarities of renewable and nonrenewable energy

resources. Next, the students were instructed to locate unifix cubes (small three-quarter

inch cubes that can be attached together) that had been hidden around the classroom. The

students worked in groups of two and had four, 30-second opportunities to locate as

many cubes as they could. After each search opportunity, the students recorded how

many cubes they were able to find. When the four searches were completed, students

created online graphs depicting how many cubes they were able to find during each

search so that they could better visualize the drop in the number of cubes they found.

When the graphs were completed, the class discussed what had happened throughout the lesson and what the graphs represented. Some of the questions covered included the following questions: 1) in which search did you find the most cubes, 2) did the number of cubes you found go up or down, and 3) if you were really searching for coal, what do the results from the graph tell you?

The second lesson of the unit took the class outside to explore the local settings around the school. In this lesson, the students examined the school grounds looking for examples of renewable and nonrenewable resources. Examples identified by the students included wind and rocks that appeared to be coal. We also noticed the propane tank next to the school and the power lines nearby. There is also a pond near the school that is filled with algae-type plants, and I mentioned to the class that algae biofuel is another form of renewable energy that we would be discussing in our next unit of study. After completing the exploration of the school, we returned to the classroom to document and discuss what we had observed. We recorded our observations on a Microsoft Word document, printed it out, and posted it in our classroom so we could look back at it throughout the rest of the unit.

The third lesson revolved around how a wind turbine works. After reviewing what was learned in the previous lesson, students watched a YouTube video showing the construction of a wind farm. When the video was finished, students went to a website that described how the different parts of a wind turbine operate. The site also provided a simulation that allowed students to manipulate the different variables that control how a wind turbine produces electricity (i.e., height, blade radius, elevation, and wind speed). When the students had had ample time to explore, we came back together to discuss and

record their findings. We also began to generate questions that would be submitted for a

Montana State University wind energy scientist to answer. This gave the students a

chance to interact with someone outside the classroom that works in the field of wind

energy.

In the fourth lesson of the unit, the class explored recent wind data from across

the state of Montana. We looked at wind speed maps of the United States and Montana

and discussed where ideal locations for wind farms may be. Working in groups of two,

students then chose a Montana city to monitor wind speeds for using the NOAA

(National Oceanic and Atmospheric Administration) weather website. The students

looked at wind speeds in that area over the past two weeks and developed tables to record

their data using Microsoft Word or Excel. The students then made a determination if that

city could be an ideal place to collect wind energy and shared this information with the

rest of the class.

For the unit's fifth and final lesson, the students had an opportunity to create their

own wind turbines. The students completed a guided inquiry in which I created an

example set of turbine blades to use in our power generating apparatus and we generated

wind movement using a fan. Students observed and discussed what happened at different

wind speeds and what happened at different distances from the fan. Next the students

had an opportunity to complete an open inquiry in which we brainstormed investigable

questions as a class, and the students were able to choose a question they would like to

try and answer. The students worked in pairs so that they could help each other with

designing their experiments.   This lesson took two days and at the end of the second day,

we discussed the findings and reviewed what we had covered throughout the unit.

This unit had a combination of technologically integrated lessons that would give the students an opportunity to manipulate and work with things they might not get a chance to experience in a laboratory setting. The lessons also included hands-on activities that would further teach the students to develop and use their inquiry skills. Creating realistic simulations of real life events was one method that researchers suggested to help students gain a better understanding of scientific events. For example, the wind turbine simulation allowed students to manipulate wind speed, elevation, turbine height, and turbine width to see how those factors would change wind energy production. However, with the wind turbine blade activity it was important for the students to not just hear about how wind turbine blades are created, but to experience the activity first hand through open-ended inquiry. By combining the technology-oriented lessons and the hands-on inquiry activities, I hoped the students would gain a deeper understanding of renewable energy resources.

Algae Biofuel Unit

The second unit of study, algae biofuel (Appendix E), included several activities geared towards introducing the students to the use of algae as a fuel source. The first lesson in the algae biofuels unit was about Native American uses for the buffalo. They used every part of a buffalo to conserve the resources available, much in the same way alternative energy resources are starting to be used as a method to utilize renewable resources with as little waste as possible. Students first looked at two different websites that showed how all parts of the buffalo were used. We then discussed how it was important for Native Americans to use all parts of the buffalo and not let anything go to waste. After exploring the websites, students listened to a legend about the importance of

the buffalo. This story was then discussed and we tied in how Native Americans used the entire buffalo as a renewable resource and compared it to our need to conserve our natural resources by using renewable energy today. We then introduced algae farms and algae biofuel as a way to help utilize all of the resources we have available today. After watching a YouTube video from a leader in the area of algae biofuel production, we discussed questions the students had about how algae biofuel could be used. At the end of the lesson, we began growing our own algae sample in a small test tube and monitored it for several days following the lesson. The sample required a couple of tries in order to grow the algae, therefore this part of the activity continued throughout the entire unit. Towards the end of the unit our second algae sample was beginning to show signs of life and the water was visibly greener than when we started.

The second lesson of the algae biofuels unit focused on the pH levels in which algae and other microscopic organisms are able to grow. The students learned about the intervals on the pH scale and how the distance between the numbers grows by a factor of ten when the pH level is further from neutral. We also discussed safety issues related to handling strongly acidic or basic substances. Students then explored an online interactive site that allowed them to manipulate pH levels of a liquid. The students created their own virtual substance using the online site, giving it a name, specific pH level, and use. After creating their substance, students created a computer-based presentation to explain their substance to the rest of the class. One of their required tasks was to discuss whether or not their substance would support algae growth.

For the third lesson of the unit, students reviewed what they had learned about algae biofuel and watched the video *Invisible Yellowstone* from the Montana State

University Thermal Biology Institute. This video gave the students an opportunity to see

how some microorganisms can grow in extreme environments and pH levels. When the

video concluded, we discussed what the students had learned and came up with a set of

questions to ask a scientist who works in the field of algae biofuel. This provided an

opportunity to interact with a scientist who works with algae biofuel on a daily basis in a

real-world setting.

For the fourth and final activity of the unit, students were able to view algae under

a microscope. After all students had examined the algae, we discussed how small the

algae were and where the oil is stored in the algae.   We then reviewed what the students

had learned about algae biofuel throughout the unit and how this source of energy will be

beneficial to us.

At the end of the treatment period, the students were given the post-test

assessment for the algae biofuel unit (Appendix C), as well as the posttest for the TOSRA

2 (Appendix B). They were then interviewed again about their experiences with science

education.

Throughout the algae biofuel unit and the conclusion of the study, I wanted

students to see that there are many different ways for humans to change the world's

dependence on fossil fuels and nonrenewable energy resources. I would often refer back

to things that were discussed or activities that were completed in the wind energy unit

when teaching about the different factors associated with algae biofuel production. This

gave students an opportunity to compare and contrast various types of not only renewable

energy, and all types of energy production, building a deeper understanding of the

content presented. This unit also contained activities that allowed the students to learn

from different types of lessons, such as video/media learning (*Invisible Yellowstone* and

YouTube videos), basic lab activities (growing algae and viewing algae under the

microscope), and creating their own technology-based product (creating a substance and

presenting to the class). Research shows that actively engaging the students in the

discussions and activities and making relevant connections to their lives would help them

not only learn the material, but retain what they had learned longer (Kumar & Bristor,

1999). Table 1 below shows a timeline of how the study was completed.

Table 1
Integrating Science and Technology Study Timeline

Date	Activity
November 7-9, 2011	Student Interviews conducted.
November 11, 2011	TOSRA2 Pretest administered.
November 15, 2011	Wind Energy Content Pretest administered.
November 16, 2011	Wind Energy Unit Lesson 1
November 30, 2011	Wind Energy Unit Lesson 2
December 6, 2011	Wind Energy Unit Lesson 3
December 8, 2011	Wind Energy Unit Lesson 4
December 14-15, 2011	Wind Energy Unit Lesson 5
December 16, 2011	Wind Energy Content Posttest administered.
January 4, 2012	Algae Biofuel Content Pretest administered.
January 11, 2012	Algae Biofuel Unit Lesson 1
February 8-9, 2012	Algae Biofuel Unit Lesson 2
February 22, 2012	Algae Biofuel Unit Lesson 3
February 29, 2012	Algae Biofuel Unit Lesson 4
March 1, 2012	Algae Biofuel Content Posttest administered.

March 2, 2012	TOSRA 2 Posttest administered.
March 5-7, 2012	Student Interviews conducted.

<div align="center">Data Collection Tools</div>

Student Interviews

The students were interviewed both before and after implementation of the treatment. This teacher-developed interview (Appendix A) was designed to determine what types of science learning experiences, if any, the students could remember participating in previously. The follow up interview asked the same questions to determine whether the treatment had changed the students' beliefs about science education.

TOSRA 2 Science Attitudes Survey

The TOSRA 2 (Appendix B) represents an updated version of the TOSRA developed by Barry Fraser in 1981. This new version has a separate pretest and posttest with different questions for each. The pretest and posttest also includes only 35 questions for each test, whereas the original version is 70 questions for each.

This version of the TOSRA was selected because the shorter format would be easier for the students to complete without losing interest in the assignment, and it also provided a better "snapshot" of what the students' attitudes were about science education. Validity in qualitative data collection was addressed with this survey because the results can be generalized to the rest of the fourth grade, because the sample size was approximately 50 percent of the population and the students' ability levels were fairly evenly distributed between the two classes. To further validate the tests, I monitored the

students as they completed the survey to make sure they were not simply guessing or copying another student's answers. I also asked follow-up questions to check for understanding.

Pre-Unit and Post-Unit Tests

Students completed a teacher and researcher developed content pretest before each of the two units and an identical content posttest (Appendix C) after completion of each of the units. The pretest and posttest for the wind energy unit consisted of 11 multiple choice, fill-in-the-blank, and short answer questions based on the main ideas presented within the unit. The pretest and posttest for the algae biofuel unit consisted of nine multiple choice, fill-in-the-blank, and short answer questions that focused on the ideas presented in the algae biofuel unit.

"What Did You Learn?" Journal Forms

Upon the completion of each lesson, students filled out a "What Did You Learn?" journal form (Appendix F) for that week's lesson. Compared to the pre- and post-unit test alone, these surveys provided a better assessment of whether the students understood the science concepts presented during each lesson. It also allowed more data analysis by giving students the opportunity to express what they learned during each specific lesson.

Teacher Observation Journal Forms

I recorded my impressions of the students' reactions to science concepts in an observation journal (Appendix G). These weekly journal entries kept track of interactions that were not shown on tests or other assessments. I was able to take notes

on which students participated during each lesson and whether there was any change in their outward attitudes towards the science topics being discussed.

Table 2 shows how the data collection tools were triangulated in order to address validity and reliability within the study.

Table 2
Data Triangulation Matrix

RESEARCH QUESTIONS	DATA SOURCES		
Integrating Science and Technology	**Source 1**	**Source 2**	**Source 3**
In what ways do integrated technology/ science lessons impact student ability to learn new science content?	Content Pretests & Posttests Administered to Students	Student Pre- and Post-Interviews	Teacher Observation Journal
Are students' attitudes towards science changed by integration of technology/science instruction?	TOSRA 2 Science Attitude Survey (Pretest and Posttest)	"What Did You Learn?" Journals	Teacher Observation Journal
What interventions are most effective with the group?	Student Pre- and Post-Interviews	"What Did You Learn?" Journals	Teacher Observation Journal

Validity and Reliability

Validity can be defined as "how we know that the data we collect accurately gauge what we are trying to measure" (Mills, 2011, p. 102), whereas reliability is "the degree to which a test consistently measures whatever it measures" (Mills, 2011, p. 112). Both validity and reliability were maintained throughout my action research project by using multiple forms of data collection that were developed through research and standards-based methods of assessment.

There are several issues faced when conducting action research with students: the effects of students' home lives on their efforts at school and how their performance in other classes affects their learning during the research project. For example, if a student was having a difficult time in mathematics, he might not put much effort into other subjects. Contact with the students participating in this study was also limited; therefore,

I was often unaware of some circumstances that might influence student achievement. Issues like these could have negatively impacted the validity and reliability of the study results.

As stated above, the students' performance was analyzed in several ways throughout the study. The students' weekly "What Did You Learn?" journal provided evidence of what the students learned during each class period. In addition, I developed pre- and post- tests related to the topics covered. The TOSRA 2 also provided a summative look at what information the students were able to retain throughout the study and how their attitudes towards science changed. By using several different methods for analyzing the students' learning and attitudes towards science, it was possible to construct a fuller understanding of students' science learning and attitudes, and to cross-check results to ensure that my interpretations were accurate.

DATA AND ANALYSIS

Student Interview Data Collection & Analysis

The students were given a pre-unit interview on November 7-9, 2011. These interviews were conducted during a time of the day when I was able to bring the students to my classroom individually. Each interview lasted between four to ten minutes, depending on how talkative the students were during the interview. During the first set of interviews, 14 of the 19 students, or 73.7%, could not recall any science activities that they had taken part in during school. Three of the remaining students (15.8%) mentioned that their teacher had given them lectures about science topics before and the remaining two students (10.5%) said that their teacher from the previous school year had conducted an experiment with them. When asked whether they would like to learn science through the use of computer-based lessons, lecture, or collaborative group work, students were somewhat divided. Twelve (63.2%) of the students said they would like to learn using a computer-based lesson or model, two (10.5%) said they would prefer to learn from a lecture, and five (26.3%) said they would like to work in a group when learning. One student replied, "I like to learn science when we get to use computers, but group work is also fun because I get to work with my friends." I included this student in the computer-based lesson or model count, because that is what he chose first, but he could be included in the group learning count as well. Only four students provided an answer when asked about their favorite science subject. Two said they like learning about space, one student said he liked rocks, and one student said she liked animals.

The students then participated in a post-unit interview on March 5-7, 2012. These interviews were also administered at a time when I was able pull the students out of their regular classroom for individual interviews. If students had difficulties coming up with answers during this set of interviews I prompted them to think about the activities we had done during the wind and algae biofuel units. When asked about what science lessons they remembered, 16 of the 17 students (94.1%) in post-unit interviews mentioned energy alternative lessons they experienced during this study, with four of the students requiring prompts to make this connection. One student that said, "I don't remember any science lessons," in the initial interviews, stated "I liked the windmill blade activity. It was really fun to make our own blades and test them out," in the final interview. The most popular lessons in the study were the wind turbine blade inquiry (five votes) and creating their own substance (four votes). Ten of the students (58.8%) said they liked to learn science using computer lessons, while five (29.4%) said they enjoyed learning science in collaborative groups. The remaining two students (11.8%) said they preferred to learn from a teacher lecture. I probed further into these two responses and both of these students said they do not like to do class work and only wanted to sit and listen to the teacher. When it came to their favorite science subjects, students said alternative energy, four liked learning about space, one student liked rocks, and the remaining three did not provide an answer to this question.

TOSRA 2 Data Collection & Analysis

The TOSRA 2 Pretest was given on November 11, 2011. Fifteen of the original 19 students in the action research project class were present and took the pretest (seven

boys and eight girls). The remaining students made up the pretest the following Monday (November 14). Because of time constraints, the pretests were administered in the students' regular education classroom, whereas the lessons for the project were completed during the students' time in the computer lab. The students completed the 35-question survey in about 20 minutes.

The surveys used a Likert scale. The possible responses were strongly agree, agree, not sure, disagree, and strongly disagree. Some of the questions awarded five points for strongly agree, four for agree, three for not sure, two for disagree, and one for strongly disagree. Conversely, about half were scored in the reverse order (five for strongly disagree, four for disagree, etc.) according to the scoring rubric provided. The survey was structured so that a score of five, whether it was for strongly agreeing or strongly disagreeing, showed a strong interest in science and a score of one showed little to no interest in science.

The students' scores ranged from 70 (an average of 2.00 points per question) to 128 (an average of 3.66 points per question). The average and median scores for the class on the pretest were 102.86 (2.94 points per question) and 101 (2.89 points per question), respectively. These two point values show the class had a medium interest in the area of science at the beginning of the study.

The TOSRA 2 Posttest was administered on March 2, 2012. Fifteen of the 17 students who were still in the class at the end of the study were present and took the posttest. The remaining students completed the posttest the next school day (March 5). The posttest was also administered in the students' regular education classroom and took the students approximately 20 minutes to complete.

The posttests were scored using the same Likert scale and scoring system as the pretests. The students' scores on the posttest ranged from 76 (an average of 2.17 points per question) to 139 (an average of 4.26 points per question). The average and median scores for the class were 106.24 (3.04 points per question) and 110 (3.14 points per question), respectively.

From the pretest to the posttest, the mean score per item increased from 2.94 to 3.04 points out of five, while the median score per item increased from 2.89 to 3.14. While this increase is encouraging, the students' post-treatment attitudes towards science, as measured by the TOSRA, remained in the neutral zone. Of the 16 students that took both the pretest and posttest, the scores of only ten students increased, one remained unchanged, and four decreased. Table 3 below shows the score changes for the students participating in both the pretest and the posttest.

Examining how students learned about different types of science and how these learning experiences affected their attitudes towards science represented a primary benefit of the research. When quality technology-based science activities were used to enhance student learning, the result was a more engaging, positive learning environment for the students, and this allowed me to monitor how these changes affected their attitudes.

Table 3
TOSRA 2 Score Changes

Student	Pretest Score	Posttest Score	Change
Student 4	110	133	+23
Student 1	92	114	+22
Student 6	112	129	+17
Student 10	124	139	+15
Student 5	101	110	+9
Student 18	119	126	+7
Student 8	70	76	+6
Student 15	106	111	+5
Student 9	95	98	+3
Student 13	90	92	+2
Student 17	113	113	No Change
Student 16	90	87	-3
Student 19	101	98	-3
Student 12	103	92	-11
Student 11	128	116	-12

Unit Content Pretest and Posttest Data Collection & Analysis

The students were given a content-based pretest and posttest for each of the wind

energy and algae biofuel units. The content pretest for the wind energy unit took place

on November 15, 2011, and the content posttest took place on December 16, 2011. Due

to student transfers, 19 students took the pretest for the wind energy unit and 16 took the

posttest. The mean and median scores for the wind energy content pretest were 3.6 out of

17 and 4 out of 17, respectively. The mean and median scores for the wind energy

content posttest were 14.1 out of 17 and 14 out of 17, respectively. These scores show

that the students' scores increased by approximately ten points between the pre- and the

post-tests. As anticipated, the students' scores increased dramatically on the short answer

questions. When asked to draw a wind turbine and label the parts, virtually no points

were awarded in the pretest, whereas students averaged 3.1 out of 4.0 on the same

question for the posttest. Table 4 shows the students' pretest and posttest score changes

for the wind energy unit.

Table 4
Wind Energy Content Test Score Changes

Student	Pretest Score	Posttest Score	Change
Student 4	3	16	+13
Student 5	5	17	+12
Student 10	5	17	+12
Student 9	4	16	+12
Student 11	2	14	+12
Student 17	2	14	+12
Student 8	1	13	+12
Student 18	4	15	+11
Student 12	3	14	+11
Student 6	2	13	+11
Student 15	2	12	+10
Student 1	7	16	+9
Student 3	6	15	+9
Student 13	3	12	+9
Student 16	3	11	+8
Student 19	4	11	+7

During Christmas break, one student transferred out of the class and one student

transferred into the class. The content pretest for the algae biofuel unit took place on

January 4, 2012, and the content posttest was administered on March 1, 2012. There

were 16 students present to take the algae biofuel content pretest and 17 students in the

class at the conclusion of the unit that took the content posttest. The mean and median

scores for the algae biofuel content pretest were 2.5 out of 17 and two out of 17,

respectively. The mean and median scores for the algae biofuel content posttest were

13.3 out of 17 and 14 out of 17, respectively. These scores show that the students' scores

increased by approximately 12 points each between the pretest and the posttest. Like the

wind energy tests, the algae biofuel short answer questions produced very few points on

the pretest, but scores increased significantly on the posttest. Table 5 shows the students'

scores for the algae biofuel unit.

Table 5
Algae Biofuel Content Test Score Changes

Student	Pretest Score	Posttest Score	Change
Student 1	4	17	+13
Student 20	2	15	+13
Student 12	1	14	+13
Student 10	4	16	+12
Student 9	3	15	+12
Student 18	3	15	+12
Student 6	2	14	+12
Student 8	2	14	+12
Student 5	5	16	+11
Student 4	4	15	+11
Student 11	2	13	+11
Student 17	2	12	+10
Student 15	1	11	+10
Student 13	2	10	+8
Student 16	2	10	+8
Student 19	1	9	+8

"What Did You Learn?" Journal Data Collection & Analysis

Students that were present for each lesson completed a "What Did You Learn?"

journal form at the conclusion of that lesson. There were a couple key themes that came

up throughout the study. The first theme I noticed in the data was that the students began

to understand what was expected of them regarding completion of the journal. At the

beginning of the study, most students would simply write one-word responses or

incomplete sentences when explaining what they had learned. With prompting, however,

students improved with regard to writing out their answers and giving thorough

explanations of why they thought a certain concept was important to their science education. One student (#18) in the first lesson responded "renewable energy" to the question, "What big ideas did you learn about today?" As the unit progressed, however, his answers changed to include more information. During the third lesson of the algae unit, his answer to the same question was "I learned algae live in dangerous places like Yellowstone Park." For the question about why this is important, he said "Because it can help us grow algae in different places."

When it came to the part of the "What Did You Learn?" journal that asked about the students' positive and negative experiences with the lesson, the results were somewhat varied throughout the study. Throughout the wind energy unit, the positive experiences went up for the most part, but the total number of positive experiences during the algae biofuel unit trended upward, but then dropped towards the end of the unit. Table 6 shows the percentage of students' self-reported positive experiences for each lesson.

Table 6
Positive Experiences with Science

Lesson	Students Present	Positive Experiences	Percentage
Wind Lesson 1	13	7	53.8%
Wind Lesson 2	15	11	73.3%
Wind Lesson 3	16	12	75.0%
Wind Lesson 4	14	10	71.4%
Wind Lesson 5	15	13	86.7%
Algae Lesson 1	15	10	67.7%
Algae Lesson 2	14	12	85.7%
Algae Lesson 3	17	13	76.5%
Algae Lesson 4	14	10	71.4%

Teacher Observation Journal Data Collection & Analysis

Throughout the study, I maintained a teacher observation journal. I used the observation journal to keep track of behavior problems, participation, and any other out of the ordinary events during the lessons. I made several interesting and note-worthy observations.

Students were well-behaved throughout most of the study and the main issue was reminding students to stay on task. The off-task students were typically the same group of students during each lesson. For purposes of this study, I identified off-task students as those students who were not engaged in the lesson and caused disruptions to the other students' learning process. This was evidenced by their talking out of turn, not keeping their hands to themselves, or trying to use the computers when it was not time yet. Four boys and one girl received multiple warnings for being off-task in multiple lessons. In total, the off-task students were typically boys as well (24 of the 32 total student warnings throughout the study). These students were also the ones who typically caused disruptions in other computer lab lessons. Although the format of these lessons was different than some of the other computer lab lessons, the same group of students was generally responsible for a majority of the disruptions. Table 7 shows how many students required two or more reminders to stay on task during each of the lessons. The lessons that lasted two days were treated as one consecutive lesson for the purposes of this data collection tool.

Table 7
Off-Task Students

Lesson	Students Off-Task two or more times	Percent of Students Off-Task During Lesson
Wind Lesson 1	5 of 13	38.5%
Wind Lesson 2	6 of 15	40.0%
Wind Lesson 3	2 of 16	12.5%
Wind Lesson 4	3 of 14	21.4%
Wind Lesson 5	2 of 15	13.3%
Algae Lesson 1	3 of 15	20.0%
Algae Lesson 2	3 of 14	21.4%
Algae Lesson 3	4 of 17	23.5%
Algae Lesson 4	4 of 14	28.6%

INTERPRETATION AND CONCLUSION

This action research project was designed to examine the effectiveness of curriculum integration on both content knowledge acquisition and student attitudes towards science. The research presented in the Conceptual Framework section of this study supported curriculum integration if it was correctly implemented. To do this, the curriculum integration must create active learners and use scaffolding to challenge the students to learn. Although there were some issues that will be discussed in the following sections, this study successfully integrated science and technology in a meaningful and educational manner in three ways.

1. Science/technology integration and learning new science content

The interviews at the beginning of the project showed that students had experienced very little science throughout their school careers thus far. This experience generally involved textbook related work and did not create meaningful connections between science and the students' lives. Both unit pretests also reflected little knowledge of the subjects that would be covered in each unit.

The data from before, during, and after the units reflected gradual change in the students' content knowledge understanding. As students progressed through the lessons, they were better able to describe what the important points were from each lesson when filling out the "What Did You Learn?" journals. Student scores increased dramatically from the content pretests to the content posttests as well. This is evidence that the students' content knowledge acquisition was very high throughout the study. Changes in

student participation and performance were also noted in the teacher observation journals and it was noted that student participation increased as the study progressed and they began to adapt to the science learning process.

Overall, the students had a much deeper understanding of alternative energy resources, as evidenced by the content test results and student journals. This increased science content knowledge was also detailed in the post-unit interviews, as students were able to recall several examples of science concepts they had learned and list topics that they thought were interesting in the world of science.

2. Science/technology integration and student attitudes towards science

The TOSRA 2 showed that students had a low to medium interest in science. This is not surprising given that the small amount of science that they had been taught in recent years. As noted in the Data and Analysis section, the mean score by item increased by .10 on a 5-point scale (from 2.94 to 3.04), and the median score increased by .25 points on a 5-point scale (2.89 to 3.14). This would indicate a slightly stronger interest in science at the end of the study than at the beginning. However, only 10 of the 15 students that took both the TOSRA 2 pretest and posttest increased their scores. This data would indicate that some students' attitudes towards science remained unchanged. When all three of these data points (changes in mean and median scores and number of students who increased their scores) are analyzed together, it appears that the students with increasing scores slightly outweighed those that dropped.

The "What Did You Learn?" journals also showed that the students' attitudes towards the science lessons increased from the beginning to the end of the study. The

number of positive responses increased during each of the wind energy lessons.

However, the number of positive responses for the algae biofuel unit showed an increase

from lesson one to two, and then dropped for the lessons that followed. This fluctuation

in positive responses could be due the more extended period of time in which the algae

unit was taught. This resulted from a NWEA MAP testing window that occurred after

the first lesson and lasted for three weeks.

The teacher observation journals showed that the percentage of students that were

off-task during each of the algae biofuel lessons increased as well. This could have

contributed to the decrease in positive science learning experiences. The increase in off-

task behavior was likely due to the students initially having a better idea of what wind

energy was than algae biofuel. The students may have had a more difficult time staying

focused while learning about algae, which is an organism that is invisible to them and

they had little or no experience with, compared to the more familiar and tangible wind

energy. Wind was initially easier to think about and understand in the contexts of their

own lives. The behavior problems in this class also increased throughout the entire

school year. There may have been factors in the classroom or at home that I was not

made aware of that led to these problems increasing throughout the school year.

<u>3. Effective interventions in science/technology integration</u>

There were several things that came into play when analyzing the results of this

question. Data from the study shows that students were interested in the wind energy

unit, which contained more hands-on and computer-related tasks, to a higher degree than

the algae biofuel unit. Although the latter was technology-oriented, it still contained

portions of lessons that did not utilize technology (i.e. monitoring the algae growth).

More students discussed activities from the wind energy unit during the post-interviews

and were better able to articulate what they had learned on the "What Did You Learn?"

journal entries. In my own observation journals, I also noted that students were more

interested in the wind energy activities and started to lose interest more quickly during a

couple of the algae biofuel activities.

Scaffolding the lessons and activities so that they led from teacher-assisted to

open-ended inquiry provided students the best opportunity to learn. The students were

much more prepared for the open-ended turbine blade activity after going through the

lessons that gradually led them to a more student-centered learning model than they

would have been starting with that type of activity. While students were still closely

monitored in the open-ended inquiry setting, they were able to explore their own ideas

and thus have a bigger sense of accomplishment in the end.

The different types of technology used within this study helped the students gain a

better understanding of the science content presented. By utilizing websites that could be

manipulated by the students, Internet-based visual aids, such as YouTube videos, and

sites that allowed the students to create their own computer-based projects, students were

much more engaged in the learning process. As previous research had shown (Dunbar,

1999), utilizing technology and inquiry together provided the students with a richer, more

realistic learning environment. This, in turn, was shown in the students' content test

score increases.

In the past, science at Lame Deer Elementary was typically taught only in the

regular classroom with inadequate science equipment and little or no technology

integration. If teachers wanted to use the internet with students, it was often only a couple of students at a time or large groups of students crowded around a couple of computers. This was not very optimal when it came to classroom management or student learning. One major goal of my research was to bring science into another setting and implement science lessons that utilized technologies that would enhance the lessons. I was able to better integrate science and technology, by utilizing the computer lab and other available internet resources, while still allowing students to work independently or in small groups when needed. The internet-based lessons and activities worked well to provide students instant feedback in some cases when I was engaged with other students.

Much like the lack of technology at Lame Deer Elementary School, inquiry-based science was also limited or nonexistent for the students. The school building is very old and did not have proper lab settings or other things that might be needed to complete a science lab, such as a sink in every room. Although there are certainly ways to implement inquiry-based science without a laboratory setting, many teachers were also limited in their knowledge of inquiry-based science by their adherence to old teaching methods. This attitude about how to teach science had been maintained much longer than it should, partly because of massive amounts of scripted curricula required from the teachers, as well as a few of the teachers' unwillingness to make the changes needed to work on inquiry activities with their science classes.

There are many families that are at or below the poverty line on the Northern Cheyenne Reservation. Despite sitting on a vast reserve of coal, the Northern Cheyenne people have been unwilling to capitalize on this energy supply for fear of losing control of their land and other resources. These units on renewable energy gave the students a

chance to learn about alternative energy resources that may be available now or in the future to help their families. The lessons also hopefully got them to begin thinking about how the world's, or at least their own local energy supply problems, can be solved. If the students start to consider alternative energy resources now, it will be easier later in their lives when they become the decision makers for their families and can chose renewable energy products that are more beneficial to their families and their environment in the long run.

Another way to get students thinking about energy conservation would be to involve community members or organizations. There are people available through either the tribe or Chief Dull Knife Community College (also located in Lame Deer) who have lived in the area their whole lives and may be able to come in and share or discuss their knowledge of other resources on the reservation. There is also an organization called Red Feather Development Group, similar to Habitat for Humanity, that works with Northern Cheyenne tribal members to build energy efficient homes utilizing more conservative techniques, such as straw bale insulation and solar-powered, water heated floors to minimize energy consumption. These resources can be used to show students how energy conservation is already in effect in their surrounding community.

<u>Possible Changes to the Study</u>

Some students would benefit from a larger range of technologies than I was able to provide. Some lessons involved more technology integration than others and those lessons were sometimes the ones that required more effort to maintain student participation and cooperation. Some students would get off-task or distracted by the

technology, whereas others would focus more on the task at hand because the technology held their interest better. With that in mind, a possible improvement might include the use of laptops or I-pads instead of desktop computers or even having more science equipment on-hand for student use. The key to whether or not this added technology would be successful lies in the teacher's familiarity with the technology and their classroom management techniques. If the teacher was able to quickly adapt to events or problems that might arise while still maintaining control of the classroom, the added technology could be beneficial for the students. On the other hand, if the teacher was not as well prepared or did not have a good handle on the classroom management, the addition of even more technology resources would quickly overwhelm the teacher (Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007).

It would also be beneficial for students if the lessons were not as spread out. Students had their computer class with me only once a week. However, in a couple of occasions I was able to find time to work with them on additional days. In a regular classroom setting, where a teacher sees their students every day, there would be a better chance to keep the students on track and focused throughout the units.

Increasing the sample size of students that participated in the study would lend itself to more conclusive data on the effectiveness of the integration process as well. Only working with a single classroom of fourth graders does not necessarily convey how a larger group of students, in the same grade level or at different levels, would view the same level of science/technology integration.

VALUE

In a world where everything is becoming more technology-oriented, the integration of science and technology seems only logical. Throughout this study, I tried to determine to what level that integration would play a role in the students' ability to understand new science concepts and whether they would view this integration as positively or negatively affecting their science experiences.

In several of my previous teaching experiences, I was able to utilize either science education or technology enhancement; however, I rarely had the opportunity to integrate the two. Because of curriculum restrictions and teaching assignments, the technology that I had access to was typically used only for the purpose of enhancing reading and mathematics instruction. When science lessons were taught, they were usually from a textbook or impromptu "labs" with inadequate equipment or simply a walk around the school yard for the purpose of allowing students to make observations. Each situation would leave the students unsatisfied with their educational experience and I wondered what could improve their outlook.

For the 2011-2012 school year I was assigned to teach in the computer lab where there was no established curriculum. This gave me the opportunity to integrate technology and computer use with any subject area and in any way that I felt would give students a better educational experience. I quickly chose to focus in on science education, not only because that was the focus of the degree I was working towards, but because science education was severely lacking within our school district.

Throughout this study I also noticed that my teaching style was changing. As I saw the students begin to accept the integration and inquiry process more and more, I noticed that I began to use similar methods in my other classes more often. This led students to show a greater interest in science education than I initially assumed. As I progress through my teaching career, I will make a concerted effort to continue to implement more technology-based, open-ended inquiry into my classroom. Utilizing technologies such as SmartBoards, online modules and simulations, portable computing devices like I-Pads or laptops, and other science inquiry activities at the same time will offer the students the best opportunity to learn. Even when a subject does not lend itself to technology- or inquiry-based instruction, creative thinking can be used to develop new activities that will better utilize those two important approaches to education.

This study can provide a rationale for others when it comes to decision-making about technology integration. If the factors and results mentioned in this study are taken into consideration, the technology implementation process can be more thoroughly completed. The results of this study would also be beneficial to any teacher seeking to improve student attitudes towards science through developing a more integrated style of teaching. The integration of science content with technology caused students' content knowledge to dramatically increase from the beginning to the end of the study and, thus, was a positive intervention technique to employ with this group of students. As the units progressed, the students performed better on the assigned tasks and activities and also increased their overall scores on the unit assessments.

For the majority of students, this study's integration of science and technology was also a positive experience in terms of student attitudes. There were a few students

who said that their attitudes towards science education were lower at the end of the study than the beginning, but even those students showed that they understood the concepts presented, and this increase could have only happened through active engagement in the lessons. From the post-interviews, it was apparent that the lessons that lent themselves to more open-ended inquiry were by far the students' favorite. Inquiry and the ability for the students to explore on their own within the science lessons turned out to be an important factor in how the students viewed that particular lesson.

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APPENDICES

APPENDIX A

STUDENT INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

1. Do you enjoy learning about science? When the teacher says it is time for science, are you happy?

2. In your science classes, have the teachers used more class lectures, computer models or lessons, or group work when teaching you about a science concept?

3. Which one do you enjoy more when learning about science: (a) using a computer lesson or model, (b) listening about it in a class lecture, or (c) learning in a collaborative group?

4. Why was exploring a topic through (the one they enjoyed) a better way for you to learn?

5 & 6. What could be changed to make (the other two), _____ more effective for you?

7. What is the most memorable lecture you can remember in science?

8. What is the most memorable group activity you can remember in science?

9. What is the most memorable computer activity/lesson you can remember in science?

10. What subjects in science do you find interesting?

11. What subjects in science do you find boring?

12. Is there anything else you would like to share about this topic?

APPENDIX B

TEST OF SCIENCE RELATED ATTITUDES 2 – PRETEST AND POSTTEST

What do YOU think about science?

This survey is completely confidential and your participation is voluntary.

Gender: Male _____ Female _____   Student Number: _____

Please choose how you feel about each statement by circling the best response.

1. Money spent on science is well worth spending. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

2. Scientists usually like to go to their laboratories when they have a day off. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

3. I would rather find out why something happens by doing an experiment than by being told how it works. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

4. I find it boring to hear about new ideas. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

5. Science lessons are fun. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

6. I would like to belong to a science club. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

7. I would dislike being a scientist. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

8. Science is man's worst enemy. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

9. Scientists are about as fit and healthy as other people. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

10. Doing experiments does not help me learn as much as finding out information from teachers. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

11. In science experiments, I like to use methods which I have not tried before. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

12. I dislike science lessons. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

13. I get bored watching science programs on TV. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

14. I would like to work with people who make discoveries in science. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

15. Public money spent on science in the last few years has been used wisely. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

16. Scientists do not have enough time to spend with their families. Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

17. I would rather do experiments than read about them.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

18. I am unwilling to change my ideas even when evidence shows that my ideas are faulty.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

19. School should have more science lessons each week.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

20. I would like to be given a science book or a piece of scientific equipment as a present.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

21. I would dislike a job in a science laboratory.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

22. Scientific discoveries are doing more harm than good.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

23. Scientists like sports as much as other people do.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

24. I would rather agree with other people than do an experiment to find out the information for myself.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

25. In science experiments, I report unexpected results as well as expected ones.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

26. Science lessons bore me.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

27. I dislike reading books about science in my leisure time.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

28. Working in a science laboratory would be an interesting way to earn a living.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

29. The government should spend more money on scientific research.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

30. Scientists are less friendly than other people.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

31. I would rather do my own experiments than find out information from teachers.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

32. I dislike listening to other people's opinions.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

33. Science is one of the most interesting school subjects.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

34. I would like to do science experiments at home.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

35. A career in science would be dull and boring.   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

What do YOU think about science?

This survey is completely confidential and your participation is voluntary.

Gender: Male _____ Female _____   Student Number: _____

Please choose how you feel about each statement by circling the best response.

1. Too many laboratories are being built at the expense of the rest of education.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

2. A scientist can have a normal family life.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

3. I would rather find out about things by asking an expert than by doing an experiment.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

4. I enjoy reading about things which disagree with my previous ideas.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

5. Science lessons are a waste of time.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

6. Talking to friends about science outside of school would be boring.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

7. I would like a career teaching science.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

8. Science helps make life better.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

9. Scientists do not care about their working conditions.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

10. I would rather solve problems by doing an experiment than be told the answer.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

11. I dislike repeating experiments to check that I got the same results.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

12. I enjoy doing science lessons.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

13. I would enjoy having a job in science during my school break.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

14. A job as a scientist would be boring.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

15. This country is spending too much money on science.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

16. Scientists are just as interested in art and music as other people.

   Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

17. It is better to ask teachers the answer than to find it out by doing experiments.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

18. I am curious about the world in which we live.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

19. The material covered in lessons is uninteresting.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

20. Listening to science reports on the radio is boring.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

21. A job as a scientist would be interesting.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

22. Science can help to make the world a better place in the future.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

23. Few scientists are happily married.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

24. I would rather do an experiment on a topic than read about it in science magazines.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

25. Finding out about new things is unimportant.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

26. I look forward to science lessons.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

27. I enjoy visiting science museums during my leisure time.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

28. I would dislike being a scientist because it requires too much education.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

29. Money used on scientific projects is wasted.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

30. If you met a scientist, he/she would look like anyone else you might meet.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

31. It is better to be told scientific facts than to find them out from experiments.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

32. I like to listen to people whose opinions are different from mine.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

33. I would enjoy school more if there were no science lessons.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

34. I dislike reading newspaper articles about science.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

35. I would like a career as a scientist.

Strongly Agree   Agree   Not Sure   Disagree   Strongly Disagree

Pretest

Scale Allocation and Scoring for Each Item

S Social Implications of Science	**N** Normality of Scientists	**I** Attitude of Scientific Inquiry	**A** Adoption of Scientific Attitudes	**E** Enjoyment of Science Lessons	**L** Leisure Interest in Science	**C** Career Interest in Science
01 (+)	02 (-)	03 (+)	04 (-)	05 (+)	06 (+)	07 (-)
08 (-)	09 (+)	10 (-)	11 (+)	12 (-)	13 (-)	14 (+)
15 (+)	16 (-)	17 (+)	18 (-)	19 (+)	20 (+)	21 (-)
22 (-)	23 (+)	24 (-)	25 (+)	26 (-)	27 (-)	28 (+)
29 (+)	30 (-)	31 (+)	32 (-)	33 (+)	34 (+)	35 (-)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively.

For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively.

Omitted or invalid responses are scored 3.

Posttest

Scale Allocation and Scoring for Each Item

S Social Implications of Science	**N** Normality of Scientists	**I** Attitude of Scientific Inquiry	**A** Adoption of Scientific Attitudes	**E** Enjoyment of Science Lessons	**L** Leisure Interest in Science	**C** Career Interest in Science
01 (-)	02 (+)	03 (-)	04 (+)	05 (-)	06 (-)	07 (+)
08 (+)	09 (-)	10 (+)	11 (-)	12 (+)	13 (+)	14 (-)
15 (-)	16 (+)	17 (-)	18 (+)	19 (-)	20 (-)	21 (+)
22 (+)	23 (-)	24 (+)	25 (-)	26 (+)	27 (+)	28 (-)
29 (-)	30 (+)	31 (-)	32 (+)	33 (-)	34 (-)	35 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively.
For negative items (-), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively.
Omitted or invalid responses are scored 3.

<u>APPENDIX C</u>

UNIT PRETESTS AND POSTTESTS

WIND ENERGY TEST

Student Number: _____   Circle One: Pretest   Posttest

1. (1 point) Wind turbines are used to produce which of the following:
A. Electricity   B. Oxygen
C. Gasoline   D. Hydrogen

2. (1 point) What produces more carbon emissions, wind power or fossil fuels?

_____

3. (1 point) Will nonrenewable energy resources run out someday?   Yes   No

4. (2 points) What type of area would be the best place to put a wind turbine? Check all that apply.

Flat ___   Hilly ___   Windy ___   Calm ___
Near the ocean ___   Near the slopes of a mountain range ___

5. (1 point) Which of these is a problem with using wind as an energy source?

A. Increased carbon emissions.   B. The turbines need to be in a city.
C. Noise from the generators.   D. It is a nonrenewable energy resource.

6. (1 point) Thousands of birds die each year when they fly into wind turbines.

        True   or   False

7. (1 point) How does a wind turbine create electricity?

A. The spinning blades turn a shaft that is connected to a generator.
B. They raise water that then flows downhill and turns a turbine connected to a generator.
C. There are people inside the turbine that turn the generator.

8. (1 point) Which wind turbine would work better?

A. A heavy wind turbine   B. A light wind turbine

9. (2 points) Would downtown Lame Deer be a good place for a wind turbine? Why or why not?

_____

_____

_____

10. (2 points) What is an ideal number of blades for a wind turbine and why?

_____

_____

11. (4 points) Please draw a picture of a wind turbine in the space below and label its parts.

ALGAE BIOFUEL TEST

Student Number: _____   Circle One: Pretest   Posttest

1. (2 points) What are some ways the buffalo was used as a source of energy by many

tribes? _____

_____

2. (1 point) What is one of the benefits of using algae as a fuel source instead of corn?

_____

_____

3. (2 points) What are two of the benefits of using algae as a fuel source instead of oil or

coal? _____

_____

4. (2 points) Is a microscope needed to view algae? Why? _____

_____

5. (1 point) Bases are from 0-7 and acids are from 7-14 on the pH scale.

       True   or   False

6. (2 points) Why is pH level important to algae growth? _____

_____

7. (1 point) Can algae biofuel be used to power cars?

       Yes   or   No

8. (2 points) Why can some microbes grow well in Yellowstone's thermal vents?

_____

_____

9. (4 points) In the space below, draw a picture of a cell and label its parts. Make sure to label where the oil is stored in the algae.

APPENDIX D

WIND ENERGY UNIT LESSON PLANS

<u>Activity 1 – Introduction to Renewable vs. Nonrenewable Resources</u>

<u>Materials Needed</u>
-200 unifix cubes
-piece of coal or charcoal briquette
-Google pictures of coal, coal miners, and a coal mine
-Youtube video showing effects of wind
-3 oz. plastic cups
-pencils
-paper
-website: http://nces.ed.gov/nceskids/createagraph/default.aspx
-computer/projector
-student computers with internet

<u>Procedure</u>
1. Before class hide 200 unifix cubes around the classroom.
   Engage
2. Begin class by showing students a piece of coal or charcoal and ask volunteers to tell what it is used for, record answers on a Word document on the projector.
3. After discussing, explain to students that coal is a source of energy that must be mined and burned in order to release energy.
4. Show pictures of coal, coal miners, and a coal mine.
5. Watch Youtube video showing the effects of wind.
6. Discuss vocabulary: nonrenewable energy and renewable energy.
   Explore
7. On a Word document, label the two energy sources (coal and wind). Have the class compare and contrast the two types of energy. Record answers on the document.
8. Arrange students in pairs and hand out the paper, pencils, and plastic cups.
9. Explain to students that they will be searching for a nonrenewable source of energy (coal) that will be symbolized by unifix cubes hidden throughout the room.
10. Give students four 30-second opportunities to find the hidden unifix cubes.
11. After each search, have them count, record, and deposit the unifix cubes back in the tub.
12. After the last search, students will be asked to make bar graphs using the website provided above. Go over how to create the graphs with the entire class before letting them work on their own.
    Explain
13. After the students have completed their graphs, discuss the following questions:
    -In which search did you find the most unifix cubes?
    -What is the difference in numbers of unifix cubes found in the searches?

-Why do you think it became harder to find unifix cubes?

-If you were really searching for coal, what do the results from the graph tell you?

14. By comparing data, students should be able to figure out that the search yielded smaller numbers each time due to the limited supply.

Evaluate/Explain

15. Have the students complete a "What Did You Learn?" Journal Entry form before they leave.

Activity 2 – Introduction to Renewable vs. Nonrenewable Resources (continued)

Materials Needed

-clothing appropriate for walking outdoors

-paper and pencils for students to take notes

-computer with projector

Procedure

Elaborate

1. Review what the students learned about renewable and nonrenewable resources in the previous lesson.
2. Take the students to the playground or other areas on school grounds to look for examples of renewable and nonrenewable energy resources.
3. After the students have found several examples of renewable and nonrenewable energy resources, return to the classroom.
4. Discuss with the class what they observed and how they are important in relation to renewable vs. nonrenewable energy resources.
5. Record student observations on a Word document.

Evaluate/Explain

6. Have the students complete a "What Did You Learn?" Journal Entry form before they leave.

Activity 3 – How a Wind Turbine Works

Materials Needed

-computer/projector

-student computers with internet

-website: http://images.nationalgeographic.com/wpf/media-live/0/3/ng_wind-cb1262812836.swf

-Youtube video: http://www.youtube.com/watch?NR=1&v=a09vHnVrBi0

Procedure

Engage

1. Begin class with a group discussion of what they have learned about energy so far.

2. Show Youtube video of the construction of a wind turbine
3. Explain that the students are going to explore the parts of a wind turbine and how they work.
   Explore
4. Have students go to the website listed above and read though the descriptions of how wind turbines operate. Make sure they get a chance to work with the interactive section of the site and explore what factors go into energy production (wind speed, altitude, height, and blade radius).
5. Have students take notes on what factors are important for wind energy production.
   Explain
6. Come back together as a class and discuss what the students had learned from the interactive website. Record observations in a Word document.
7. Generate student questions for the MSU scientist to answer.
   Evaluate/Explain
8. Have the students complete a "What Did You Learn?" Journal Entry form before they leave.

Activity 4 – Montana Wind Data Online

Materials Needed
-computer/projector
-student computers with internet
-website 1: http://www.windpoweringamerica.gov/wind_maps.asp#us
-website 2: http://www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=mt
-website 3: http://weather.noaa.gov/weather/MT_cc_us.html

Procedure
1. Begin class by showing the students the U.S. map of annual average wind speed at 80 meters (a typical wind turbine height). Use website 1, listed above.
2. Ask students what patterns they observe. In which regions is the wind speed greatest? Least? Most variable over short distances? How can we explain some differences?
3. Given that areas with annual average wind speeds around 6.5 m/s (15 mph) and greater at 80-m height are generally considered to have suitable wind resource for wind development, in what regions would the students build a wind farm? Remember 1 m/s is about 2.237 miles per hour.
4. Now show students the Montana wind speed map at 80 meters. Use website 2, listed above.
5. Have students work in pairs to write down the patterns they observe. Share with the class. What factors might someone consider in choosing where to locate a

wind farm in Montana? Based on these factors, where would the students locate a wind farm in our state?

Explore

6. Students will now work in teams, using online weather data to monitor how wind changes during a 2-week period at sites they select across Montana.

7. Divide the students into groups of two. Let each class choose a Montana city whose wind data they will study. Encourage the student to choose sites from all across Montana so that they will be able to form a picture of how wind changes across the state.

8. Working with students, develop data collection tables on Microsoft Word or Excel that they will use throughout the process.

9. As the students choose locations, discuss different features of the areas that might help them decide whether or not the location is ideal for a wind farm, such as elevation, land features, or other geographic information.

10. Using website 3, listed above, have the students monitor hourly wind speeds and record their observations in the tables they created. Important things to look at are speed, direction of the wind, and times of day. Discuss with the class any other possible important observations they might want to keep track of.

11. During the data collection period, ask the students to record observations of any patterns they notice in their data, as well as any questions that arise. Ask students to share their observations and questions in class discussion.

Evaluate/Explain

12. When the collection period has ended, students should share their findings with their peers. With the class, discuss the differences in wind speed, direction, and variability across the sites they studied. What did students notice that might affect wind turbine performance, and which sites would work best for electricity generation?

13. Have the students complete a "What Did You Learn?" Journal Entry form before they leave.

Activity 5 – Exploring Wind Turbines

Materials Needed
-wind apparatus (stand, hub, dowels)
-straws and strips of paper
-duct tape
-materials for constructing blades (http://www.kidwind.org)
-fan with at least 3 speeds

Review
-Go over responses to the student generated questions that were submitted to a wind scientist.

Procedure

1. Students will have the opportunity to explore wind energy starting with a guided inquiry, followed by an open inquiry.

   Engage – Guided Inquiry

2. Using a simple blade pattern constructed by the teacher, demonstrate how to attach the blades to the spokes with duct tape, then insert and secure the spokes in the hub.

3. Ask the students to observe what happens when the wind apparatus is placed in front of a moving stream of air from a household fan.

   Explain

4. As students share what they observed, some questions to guide discussion include:

   -What happens when the fan speed is at the lowest setting?
   -What happens when you change the fan to higher speeds?
   -What happens when you move the apparatus different distances from the fan?
   -How can you compare this to what happens with an actual wind turbine?
   -What is causing the blades to move?

5. Explain to students that the energy in the moving air is spinning the blades. Explain that real world windmills work on the same principle. The blades convert wind into a spinning motion that spins a turbine.

   Explore – Open Inquiry

6. Engage the class in brainstorming investigable questions about how to make the wind apparatus work better, posting students' questions on paper strips, then inviting student teams to join a "question walk," each team selecting one of the posted questions for investigation. Hypothetical examples of questions your students may pose are:

   -Would a different size (larger or smaller) make a difference?
   -Would different materials make a difference?
   -Would a different number of blades make a difference?
   -Would a different shape make a difference?

7. Give the students ample opportunity to explore their questions and try to come up with an answer using the provided materials and the wind apparatus. Monitor student progress and assist with ideas or suggestions of how the students can further their understanding of their question.

8. Have the students complete a "What Did You Learn?" Journal Entry form before they leave.

APPENDIX E

ALGAE BIOFUEL UNIT LESSON PLANS

Activity 1 – Culturally Relevant Uses of Buffalo/Intro to Algae Biofuel

Materials Needed
-Projector or Smart Board
-website: http://www.texasbeyondhistory.net/kids/buffalo.html
-website: http://lewisandclarktrail.com/buffalo.htm#A
-Information Sheet (http;/www.nebraskastudies.org/0300/frameset_reset.html?http://www.nebraskastudiesorg/0300/stories/0301_0109.html, also attached below)
-The Buffalo Story (http://www.buffalofieldcampaign.org/aboutbuffalo/bisonnativeamericans.html, also attached below)
-YouTube Video: http://www.youtube.com/watch?v=SU6q-N0XvEc
-algae sample and test tube to your grow own sample
-camera for monitoring algae growth

Engage & Explore
1. Students will use the Smart Board or projector to view the different parts of the buffalo and see what parts were used in the past and what they were used for. Go through the two websites listed above and discuss with the class the various uses for the buffalo.

Elaborate
2. Read and discuss the Buffalo Story and information sheet (attached) with the students, emphasizing how the Native Americans used every part of the buffalo and did not waste any part. Talk about how the non-natives wasted the buffalo meat and other parts by just taking the hide and the tongue, leaving the rest of the buffalo to rot out on the plains. This relates to conserving our natural resources and how the Native Americans practiced conservation by respecting the Earth as their mother.
3. Make connections between how Native Americans used all available energy resources and how wind energy and algae biofuel help us utilize all available resources.
4. Discuss how multiple types of fuel resources need to be used to help reduce dependence on nonrenewable energy resources.
5. Introduce algae farms and how oil can be extracted from algae to produce a useable fuel resource.
6. Watch the 2010 Sapphire Energy Corporate Video on YouTube. Discuss what interested the students in the video and answer any questions may that arise.
7. Begin growing your own algae sample with the class; take pictures to monitor the color of the tube each day to look for algae growth.

Evaluate
8. Have students complete a "What Did You Learn?" journal form at the end of the lesson.

Information Sheet

Plains Indians relied on the Bison (Buffalo) for their very lives. Their hides were used for shelter and blankets. The meat was cut into thin strips and dried which made transporting them easier and could be stored easier in a sack fashioned out of the heart. Buffalo bull weighed an average of 2000 pounds providing 800 pounds of meat while a cow weighed 700 to 1200 pounds allowing for 400 pounds meat. The horns were used as spoons and scoops. The extra thick hide at the top of the head was used a bowl. Wild onions, herbs, and meat put in the stomach filled with water and hot rocks to boil provided stew. Even after the repeating rifles were brought the Plains Indians preferred their bows and arrows in the hunts. They were able to tell which buffalo belonged to their family by the markings on the arrows. After a successful hunt there were days of feasting and hard work. Women had to dress the hide using tools fashioned by the bones, antlers and even the cooked brain of the buffalo. The tribe only killed the buffalo they needed. European trade became important. Only the hide and tongue were exchanged for goods. The demand of the hides for trade exceeded what the Indians used for themselves. In the 1839 American Fur Company bought 45,000 buffalo robes and 67, 000 the next year.

The plains' inhabitants the Indian and the buffalo had to be removed so Europeans could own the land and raise cattle. This would help civilize the Indians putting them on reservations. The buffalo ranged from the eastern seacoast to Oregon and California, From Great Slave Lake in northern Alberta to northern Mexico. It was thought that there were about twenty-five to seventy million buffalo. The Indians ultimate resource waste the buffalo, it provided food, clothing, and shelter but nearly every material needed.

The Buffalo Story

Yellowstone Valley and the Great Flood

" I have heard it told on the Cheyenne Reservation in Montana and the Seminole camps in the Florida Everglades, I have heard it from the Eskimos north of the Arctic Circle and the Indians south of the equator. The legend of the flood is the most universal of all legends. It is told in Asia, Africa, and Europe, in North America and the South Pacific."

Professor Hap Gilliland of Eastern Montana College was the first to record this legend of the great flood. This is one of the fifteen legends of the flood that he himself recorded in various parts of the world:

He was an old Indian. His face was weather beaten, but his eyes were still bright. I never knew what tribe he was from, though I could guess. Yet others from the tribe

whom I talked to later had never heard his story.

We had been talking of the visions of the young men. He sat for a long time looking across the Yellowstone Valley through the pouring rain, before he spoke. "They are beginning to come back," he said.

"Who is coming back?" I asked.

"The animals," he said. "It has happened before."

"Tell me about it."

He thought for a long while before he lifted his hands and eyes. "The Great Spirit smiled on this land when he made it. There were mountains and plains, forests and grasslands. There were animals of my many kinds—and men."

The old man's hands moved smoothly, telling the story more clearly than his voice.

The Great Spirit told the people, "These animals are you brothers. Share the land with them. They will give you food and clothing. Live with them and protect them."

"Protect especially the buffalo, for the buffalo will give you food and shelter. The hide of the buffalo will keep you from the cold, from the heat, and from the rain. As long as you have the buffalo, you will never need to suffer."

For many winters the people lived at peace with the animals and with the land. When they killed a buffalo, they thanked the Great Spirit, and they used every part of the buffalo. It took care of every need.

Then other people came. They did not think of the animals as brothers. They killed, even when they did not need food. They burned and cut the forests, and the animals died. They shot the buffalo and called it sport. They killed the fish in the streams.

When the Great Spirit sent rains to put out the fires and to destroy the people.

The rains fell, and the waters rose. The people moved from the flooded valleys to the

higher land. Spotted Bear, the medicine man, gathered together his people. He said to them, "The Great Spirit has told us that as long as we have the buffalo we will safe from the heat and cold and rain. But there are no longer any buffalo. Unless we can find buffalo and live at peace with nature, we will all die."

Still the rains fell, and the waters rose. The people moved from the flooded plains to the hills. The young men went out and hunted for the buffalo. As they went they put out the fires. They made friends with the animals once more. They cleaned the streams.

Still the rains fell and the waters rose. The people moved from the flooded hills to the mountains. Two young men came to Spotted Bear. "We found the buffalo," they said. There was a cow, a calf, and a great white bull. The cow and the calf climber up to the safety the mountains. They should be back when the rains stops. But the bank gave way, and the bull was swept away by the floodwaters. We followed and got him to shore, but he had drowned. We have brought you his hide."

They unfolded a huge white buffalo skin.

Spotted Bear took the white buffalo hide. "Many people have been drowned," he said. "Our food has been carried away. But our young people are no longer destroying the world that was created for them. They have found the white buffalo. It will save those who are left."

Still the rains fell, and the waters rose. The people moved from the flooded mountains to the highest peaks.

Spotted Bear spread the white buffalo skin on the ground. He ad the other medicine men scraped it and stretched it and scraped it and stretched it.

Stills the rains fell. Like al rawhide, the buffalo skin stretched when it was wet, Spotted Bear stretched it farther.

Then Spotted Bear tied one corner to the top of the Big Horn Mountains. That side, he fastened to the Pryors. The next corner he tied to the Bear Tooth Mountains. Crossing the Yellowstone Valley, he tied one corner to the Crazy Mountains, and the other to Signal Butte in the Bull Mountains.

The whole Yellowstone Valley was covered by the white buffalo skin. Though the rains still fell above, it did not fall in the Yellowstone Valley.

The waters sank away. Animals from the outside moved into the valley, under the white buffalo skin. The people shared the valley with them.

Still the rains fell above the buffalo skin. The skin stretched and began to sag.

Spotted Bear stood on the Bridger Mountains and raised the west end of the buffalo skin to catch the West Wind, The West Wind rushed in and caught under the buffalo skin. The wind lifted the skin until it formed a great dome over the valley.

The Great Spirit saw that the people were living at peace with the earth. The rains stopped, and the sun shone. As the sun shone on the white buffalo skin, it gleamed with colours of red and yellow and blue.

As the sun shone on the rawhide, it began to shrink. The ends of the dome shrank

away until all that was left was one great arch across the valley.

The old man's voice faded away; but his hands said "Look," and his arms moved toward the valley.
The rain had stopped and a rainbow arched across the Yellowstone Valley. A buffalo calf and its mother gazed beneath it.

Activity 2 (2 days) – pH/Acids and Bases

Materials Needed
-meter stick
-cash register tape
-student computers with internet access
-website: pH Info- http://en.wikipedia.org/wiki/PH
-website: pH Info- http://web.jjay.cuny.edu/~acarpi/NSC/7-ph.htm
-website: Interactive Simulation- http://phet.colorado.edu/en/simulation/ph-scale
-website: Glogster- http://www.glogster.com
-website: Screenr- http://www.screenr.com

Engage & Explore
-Check on algae growth (at this time we began growing a second sample because the first was not growing) and review previous lesson.
-Discuss with the students what an acid is (pH below 7), what a base is (pH above 7), and what is considered neutral on the pH scale (pH of 7). Using cash register tape, show the students that each number up or down is 10x stronger the further you get away from 7 (water). A useable scale is listed below. When you get to the larger distances, you will have to describe them and give examples found in real life instead of using the cash register tape. As you show them this model, talk about examples of substances found (some examples are listed below as well) at each pH level and address safety issues when discussing strong acids and bases.

pH Scale Distance Activity	Examples	Examples
7 to 8 & 7 to 6: 1 mm	8: sea water	7: distilled water
8 to 9 & 6 to 5: 1 cm	9: baking soda	6: milk
9 to 10 & 5 to 4: 10 cm	10: hand soap	5: rain water
10 to 11 & 4 to 3: 1 m	11: ammonia	4: soda
11 to 12 & 3 to 2: 10 m	12: Drano	3: vinegar
12 to 13 & 2 to 1: 100 m	13: bleach	2: lemon juice
13 to 14 & 1 to 0: 1000 m	14: sodium hydroxide (lye)	1: stomach acid
	0: battery acid	

Explain & Elaborate
Have students go to the Interactive simulation (http://phet.colorado.edu/en/simulation/ph-scale) and experiment with the different acid and base levels. Once they have explored, have the students create their own substance with a specific pH level. They need to create a common use for this substance and give it a name. They will need to explain

why it does what it does based on its pH level. The students can use Glogster (computer created posters, can add graphics, text, and videos) or Screenr (screen cast tool, records what is on your computer screen, as well as records voice if you have a microphone) to show off and explain their substance. In their presentations, students also need to discuss whether or not their substance would support the growth of algae and why or why not.

Evaluate
-Have the students review their project with the teacher before presenting.
-Allow time for student presentations
-Have students complete a "What Did You Learn?" journal form at the end of the lesson.

Activity 3 – Invisible Yellowstone

Materials Needed
-DVD: Invisible Yellowstone (provided by Montana State University-Thermal Biology Institute)
-Whiteboard/Smart Board
-Computer & Word document for recording questions.

Engage
-Discuss with the students what they have learned about algae biofuel up to this point in the unit.
-Show students the video Invisible Yellowstone that is provided by Montana State University Thermal Biology Institute.
-If students have questions during the video, pause and discuss.

Explain & Elaborate
-When the video is completed, discuss the students' thoughts and reactions to the video. Keep track of important questions or notes on the board throughout the rest of the lesson.
-Discuss how some bacteria and microscopic life is able to live in extreme environments like the thermal vents of Yellowstone. Discuss how the different areas that microorganisms can live will play a major role in the ability to generate algae biofuel for mass energy consumption.
-Have students generate questions they would like to ask a scientist who works in the field of algae biofuel. Record these questions on a word document and, after the lesson, submit them.

Evaluate
-Have students complete a "What Did You Learn?" journal form at the end of the lesson.

Activity 4 –Parts of a Cell & Algae Biofuel Wrap Up

Materials Needed
-microscope(s)

-slides with algae
-white board or Smart Board

Engage
-Discuss with the students what they have learned about algae biofuel up to this point in the unit.
-Have a microscope or two prepared with slides containing algae samples. Allow students to explore the samples using the microscopes and make notes on what they see.

Elaborate & Explain
-After all students have had a chance to view the algae, use a whiteboard or Smart Board to draw and discuss the different parts of the algae cell. Make sure to discuss the vacuole where the oil would be held and tie it back in with the idea of algae as a renewable energy resource.
-Review what the students have done and learned about throughout the algae biofuel unit. Discuss any new understandings and things the students found interesting. Remind students that algae biofuel will need to be utilized along with several other renewable energy resources (such as wind energy and solar power) to help us reduce our dependence on nonrenewable energy resources such as oil, natural gas, and coal.
-Go over responses to the student generated questions that were submitted to an algae biofuel scientist. (This part actually happened the next time I had the class because the answers were not immediately available.)

Evaluate
-Have students complete a "What Did You Learn?" journal form at the end of the lesson.

APPENDIX F

"WHAT DID YOU LEARN?" JOURNAL ENTRY FORM

Name: _____   Date: _____

Mr. Asbury's Computer Class

What big ideas did you learn about today?

Why are they important?

Did you have a positive science learning experience today?

                YES   NO

Why or why not?

APPENDIX G

TEACHER OBSERVATION JOURNAL FORM

TEACHER OBSERVATION JOURNAL

Date: _____

Lesson: _____

Did anything unusual happen today?

Did students seem to understand the ideas presented?

Did students have a positive attitude towards the lesson?

Were there any ideas for modifying lessons in the future?

Other notes: