

INFUSING SCIENCE INTO NATIVE AMERICAN STUDIES:
A PROJECT-BASED UNIT FOR FOURTH GRADE

by

Rachel Christina Tinkler

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2014

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.

Rachel Christina Tinkler

May 2014

TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND	1
CONCEPTUAL FRAMEWORK.....	2
METHODOLOGY	8
DATA AND ANALYSIS.....	13
INTERPRETATION AND CONCLUSION.....	25
VALUE	27
REFERENCES CITED	30
APPENDICES.....	31
APPENDIX A: Student Interview Questions	32
APPENDIX B: Parent Survey Questions.....	34
APPENDIX C: Student Survey Questions.....	36
APPENDIX D: Project-Based Learning Planner.....	38

LIST OF TABLES

1. Triangulation Matrix	13
2. Student Learning Outcomes	14
3. Parent Survey Responses.....	22

LIST OF FIGURES

1. Example of Final Projects and Artifacts	18
--	----

ABSTRACT

In this study a project-based learning unit was implemented in a fourth grade classroom in order to determine how student learning and engagement would be affected. The unit required individual or group research, creation of a project artifact, and a public presentation component. Compared to a traditionally designed unit on the same topic, participants in the project-based learning group showed modest gains in student learning and periods of increased engagement.

INTRODUCTION AND BACKGROUND

For the last four years I have taught at Lake Bluff School in a suburb of Milwaukee, Wisconsin. Students in this K-6 school come from a wide variety of socioeconomic backgrounds. Approximately half of my fourth graders are from minority populations and roughly 20% qualify for free or reduced rate lunch. While the school's neighborhood encompasses some of the most expensive housing on the west side off Lake Michigan, there are numerous lower-income apartment complexes in our district as well. Lake Bluff prides itself on being a National School of Character and focuses on educating the "whole child." To this aim we teach basic character traits such as cooperation and persistence throughout our curriculum. Furthermore, we identify student interests and preferred learning styles and tailor our curricula accordingly. Our district has a well-known and widely supported visual and performing arts program and students begin learning musical instruments and foreign languages in fourth grade. They begin vocal and visual art classes in kindergarten.

Last year teachers at our school embarked on a mission to make the material we teach more meaningful to students. Several of us formed a project-based learning (PBL) professional learning group to investigate ways to help students connect to their learning. Specifically, we noticed that our students generally come to us excited, happy and motivated to be in school. As we delve into our units of study, students generally remain interested in reading and science but quickly lose enthusiasm for other content areas. Our district utilizes the Reader's Workshop method of instruction which allows students great amounts of choice and independent reading time. Children are responsible for choosing their own books and setting reading goals. They also participate in book clubs which

utilize cooperative learning activities and are peer-led. Science units are largely made up of hands-on, inquiry-based lessons that also incorporate cooperative learning. It is our belief that the great amount of choice and collaborative qualities of these subjects increases student motivation and keeps students actively engaged. Unfortunately, children often lose enthusiasm or become off-task in other subject areas despite showing interest at the beginning of a unit.

Focus Question

Desire to see my students take an active role in their education and become more engaged in daily activities led me to believe that I needed to investigate new ways of teaching. My primary question for this study became, how does implementing a project-based learning unit affect students in my fourth grade classes? The secondary questions were more specific and focused on changes the students and teacher would experience. First, I wanted to know if student learning would change when PBL was used. Next, I also wanted to see if students' level of engagement was affected by PBL. Finally, I looked at how incorporating PBL affected me as a teacher.

CONCEPTUAL FRAMEWORK

Project-based learning, or PBL, is a student-centered form of instruction that involves long term individual and group activities leading up to a final student-created product which demonstrates the learning that has taken place. Teachers who use PBL are attempting to replicate real world experiences for their students by creating a problem or question to drive student research and investigation. Students are then guided through the processes of investigating, debating, designing, experimenting, uncovering data, creating conclusions and sharing their discoveries with an audience (Blumenfeld, Soloway, Marx,

Krajcik, Guzdial, & Palincsar 1991; Thomas & Mergendoller, 2000). While a unit's overarching questions may be formulated by teachers, students carry the responsibility of designing, carrying out and presenting their own projects in PBL. This section of the paper will discuss the origins of project-based learning and include distinctions between PBL and other student-centered instruction. There will then be a review of research that has been conducted on the link between PBL, motivation and engagement. Finally, best practices in PBL will be briefly listed and explained.

Although some elementary school teachers may not have heard of PBL until recently and consider it to be a new fad in education, medical and engineering schools have been successfully utilizing project-centered curricula for many years (Strobel & van Barneveld, 2009). Indeed, different forms of PBL have been around for decades and many attribute its original conception to Dewey who felt that students should be engaged in practical experiences (Lam, Cheng, & Ma, 2009; Thomas & Mergendoller, 2000).

PBL is one of many student-centered models of learning. Other instructional styles that share similar features include problem-based learning, intentional learning, experiential learning, and cooperative learning. According to Thomas (2000), there are five aspects of PBL that make it unique from other methods. The first part of a PBL approach requires that the project is the primary means of achieving student learning. Lessons and activities relate to the driving question/problem and are posed by the instructor and are always part of the primary project. Second, Blumenfeld et al. (1991) state that PBL curricula focus on a question that is central to the project and which students are trying to answer through research and experimentation. Third, Thomas (2000) says that in order for a project to truly be considered PBL, students must be

required to learn and synthesize new information. Projects cannot simply be a repetition of something already known by the children or an activity that requires no new learning to take place. Fourth, PBL lessons may be designed by teachers, but the projects themselves are created and implemented by students (Thomas, 2000). This means that goals can be laid out at the beginning of a unit but students' creations will be unique and work time is pupil-led to the greatest degree possible. Finally, projects must be authentic and created for a specific audience, not solely to determine a letter grade (Thomas, 2000). When students work to create a book, instruction manual, report, video or other artifact of learning, they are doing so to teach others about a topic, not simply to show that they can follow predetermined steps in an activity.

The Buck Institute for Education (BIE) extensively promotes PBL through its website and print resources. The BIE describes project-based learning as a means for mastering 21st century skills and content standards at the same time. This organization also lists the various aspects it considers to be vital to PBL. Students begin with a driving question and an idea for what their final product will be (presentation, booklet, informational website, etc.). Knowing that they will be presenting their end product to an audience, students, in groups or independently, make choices about how their learning will proceed. Children research, refine their questions and thinking, experiment and work toward completing their final product. Before presenting their learning artifacts, peers critique each other's work giving and receiving critical feedback to refine their learning and presentation skills (Buck Institute for Learning, 2013).

Schools utilizing PBL have been shown to have standardized test scores that match or exceed others in their districts (Thomas, 2000; Geier, Blumenfeld, Marx,

Krajcik, Fishman, Soloway, & Clay-Chambers, 2008). This is important because many administrators are increasingly looking at standardized test scores as affirmation that students in their school are learning. While the value of this line of thinking can be debated, teaching methods that promote deep learning will likely prepare students for assessments that measure general knowledge at the elementary level. Therefore if schools utilizing PBL did not score decently on standardized tests, educators would be less likely to want to try PBL in their own classrooms.

For the purpose of this study, the relationship between implementing project-based learning units and student motivation and engagement is the most pertinent area of research to explore. One study by Bartscher, Gould and Nutter (as described by Thomas, 2000) found that 82% of students in third, fifth and tenth grades who participated in PBL felt that the projects motivated them. Also described by Thomas (2000), two elementary schools that implemented Expeditionary Learning (a school wide form of PBL) were able to move from the “well below average” score on the Iowa Test of Basic Skills to the district average. A third school launched itself forward and scored in the “well above the district average” category demonstrating significant student learning improvements.

Research done in Hong Kong demonstrated that secondary students in PBL classes showed greater intrinsic motivation when their teachers demonstrated their own intrinsic motivation for the project (Lam, Cheng, & Ma, 2009). While these results cannot be generalized to elementary students as well, it is interesting to note the relationship between instructor motivation and student motivation when a curriculum involving choice is implemented. In PBL students are given choices as to what and how they will learn (Blumenfeld, et al, 1991). They might not control all of the activities they

undertake but the large project they work on throughout a unit of study is greatly shaped by student interest and preference. Furthermore, a study involving elementary students demonstrated that a math unit with contextualized and personalized content that provided students with choice greatly enhanced students' intrinsic motivation, tendency to use higher order mathematical processes and engagement in learning (Cordova & Lepper, 1996). This study was also able to show significant gains in student learning, by analyzing test scores for students who had been given choice in their learning and had received instruction that was presented in a personally appealing manner. This provides further evidence that project-based learning can be implemented as a method of contextualizing learning and offers students a great amount of choice, thereby positively affecting children's learning and engagement.

Grant (2009) contributes an interesting discussion about motivation and its influences on middle school students as they complete a project-based learning unit. After interviewing students he came to the conclusion that children can be motivated by varying the lengths of projects and not stretching units out too long in order to prevent burnout. Grant also found that students should have as much input as possible into the creation of the unit and its grading scheme. Overall, he felt that when students had more experience with PBL, they would be able to participate more fully in learning opportunities and have increased satisfaction in this type of learning method.

Research points out many best practices in project-based learning that help make projects run more smoothly. Blumenfeld et al. (1991) describe efficient methods of acquiring information about student learning. Formative assessment models mentioned in the article include journal entries, interviews and observation of student group work.

Ching and Kafai (2008) contribute an interesting look at how students in multiage classrooms can scaffold learning for their peers during PBL units of study. They identified one of the major obstacles of open-ended learning as being the teacher's inability to help each group of students transition into a new method of learning as much as is necessary to optimize student learning. In their study they observed how fifth graders were able to scaffold learning for their younger counterparts thereby decreasing students' reliance on the teacher to answer technical questions about the computer program they were using for their projects. The authors of this research maintain that students are often an untapped resource and those with greater experience in PBL are a valuable resource for their less-experienced peers. Through student interviews the researchers were also able to demonstrate continued gains in knowledge for the fifth graders as they were "teaching" their younger peers. This study was of particular interest to me because my school has three multiage classrooms. This confirms my feeling that older students could be utilized to assist the younger children who are participating in PBL for the first time and still be making advances in their own learning.

Thomas and Mergendoller (2000) completed a rigorous study outlining the most important aspects to consider when implementing PBL. Their extensive list of issues include coordinating the timing of projects with other courses; being flexible in regard to the amount of time a project will take and the material to be introduced when problems with scheduling occur; helping students prepare for a project; creating a rubric of expectations for the project; utilizing checkpoints along the way; involving students in the design of their learning; explicitly teaching students time management and organizational skills; emphasizing and modeling high quality work; holding individuals

accountable for their work; checking in with groups to show evidence of quality progress; and communicating with teachers, parents, and involved community members. Each of these considerations is discussed in detail with advice from veteran teachers and organized by topic.

In conclusion, project-based learning is a student-centered method of teaching and learning that is becoming increasingly well studied across the grade levels. Because it involves student choice and active participation I plan to create and implement a PBL unit of study to see how it affects student engagement and learning in an attempt to determine how it compares to traditional instructional methods. From the research reviewed above, students appear to benefit from deep learning and increased participation while working in PBL classrooms. There are also many best practices to take into consideration when designing and carrying out a project. These factors will all play a part in determining if PBL is a viable option for my classroom.

METHODOLOGY

This project examined how project-based learning affected my fourth grade students. In particular, I chose to see how a PBL mini-unit affected student learning and engagement. I also analyzed the ways that implementing a PBL mini-unit affected me as a teacher.

Participants

Participation in the study was voluntary and open to all students who were not required to receive reading or math support during our Guided Study portion of the school day (the time of day that the extension project took place). While conducting this project I taught two groups of fourth graders. Each group had 11-12 students (no

students were English language learners). The comparison group contained five girls and six boys. Of these children, one student from the comparison group had been accelerated one year in math. The second cluster was the intervention group. Three students in the intervention group had been accelerated one year in math. The intervention group consisted of seven girls and five boys. Students were placed in either the comparison or intervention group according to their homeroom. Both groups were designed to be relatively equivalent in regard to academic ability, however neither group contained students who needed academic support in reading or math. While other students took part in the units of instruction, only the work of the participants mentioned above was analyzed for the purposes of this project.

In their previous social studies/language arts unit, students learned about several of the different groups of Native Americans that originally settled in Wisconsin, what life was like for pre-Columbian Woodland Indian tribes, and ways Native Americans used and conserved Wisconsin's land and resources. During the unit that served as the focus of this study, students explored the ways that Native Americans used their knowledge of science (patterns in nature, cause and effect) to improve their living conditions. The instruction and activities for both the comparison and intervention groups covered the same topics but were presented in different manners. The comparison group received traditional instruction that included nonfiction reading strategies, video clips, partner discussions, whole-group discussion and demonstration, journaling activities and individual multiple-choice and short-answer assessments. The intervention group studied the same topic but instruction was modified to revolve around a driving question and a group project. The driving question was, "How can we teach our school that local Native

American tribes used scientific methods to improve their lives?” This driving question was formed after a school poll showed that only 30% of students in grades 4-6 recognized that different civilizations in early America used scientific methods to survive and thrive in their surroundings. Students in the intervention group used the same resources as the control group but focused their efforts on designing a project or model that would show how pre-Columbian Native Americans in Wisconsin used their knowledge of scientific principles or patterns in nature to their benefit. Students worked together in groups of 1-3 pupils to research, design and present their findings to the school. The projects and models were designed in a way that fit in with our unit on the scientific process. Final project artifacts were presented and displayed at the school science fair in March. Both groups completed the same journaling and written assessments to evaluate their knowledge and understanding of the content presented.

Intervention

My project’s intervention consisted of one project-based unit for fourth graders that focused on Native American science. The unit lasted four weeks and took place from February to April 2014. During that time, I compared data I obtained from teaching the PBL unit with data I compiled from teaching the parallel traditionally presented unit and analyzed perceived differences in student learning and engagement.

Throughout this unit, students in the intervention group worked in teams to answer a driving question about Native American use of science. Because this was designed as a project-based learning unit, there was an emphasis on cooperative learning, investigation, group research, questioning and the production of one project “artifact” (student creation that displayed learning). Reading and writing instruction regarding

nonfiction text was also woven into both the comparison and intervention units so the material was presented in a cross-curricular fashion and not strictly classified as reading or science lessons. I met with each group four days per week. Because this served as a voluntary extension activity for students in both groups, it took place during the Guided Study portion of our school day. Class sessions were 30 minutes each and some reading/writing activities were completed at home. The district teaching standards that were addressed in this mini-unit included the following:

- Social Studies (B.4.8) Comparing past and present technologies related to energy, transportation, and communications and describing the effects of technological change, either beneficial or harmful, on people and the environment.
- Social Studies (A.4.4) Describe and give examples of ways in which people interact with the physical environment, including use of land, location of communities, methods of construction, and design of shelters.
- Reading and Responding to Informational Text—describe the sequence of events in a historical or scientific account including what happened and why, based on specific information in a text.
- Reading and Responding to Informational Text—Learn and determine the meanings of general academic language and domain-specific words or phrases encountered in an informational fourth grade text.
- Reading and Responding to Informational Text—Use text features and search tools to locate and process information relevant to a given topic.
- Speaking and Listening—Report on a topic or text...in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

See the Project Planner in Appendix D for more information on the intervention group.

Data Collection

The primary focus of this project was to determine how implementing Project-based learning would affect my fourth grade students. I chose to study this question by collecting parent and student surveys after the unit was complete, recording observations in a journal, and conducting student interviews both during and after the unit was

completed. The surveys (Appendices B and C) asked parents and students to independently rate perceived engagement, student learning and interest in the content students were taught during the PBL unit in comparison with other social studies units we completed during the year. Student interviews were also completed individually and focused on the same topics (see Appendix A for the script). Participation in student interviews was voluntary. I chose to interview two boys and two girls from each group. Selections were made randomly by pulling student names from a bag.

Next, I looked at how student learning changed as a result of the PBL unit of study. Specifically, I used information from pre and post assessments to determine if students showed evidence of mastering the reading, writing and social science standards listed above. One project artifact was also analyzed and scored according to a rubric created by the intervention group. Students were all aware of the rubric expectations and participated in self and peer assessment as well as receiving a score from the teacher.

In addition, I tried to determine how the PBL unit affected student engagement. As mentioned earlier in the paper, students in social studies and writing often start out with enthusiasm for a topic and quickly revert to a more passive level of participation in traditional units. I assessed engagement levels by reviewing my observations and journal entries, analyzing the responses related to participation and engagement given during the student interviews, and by looking at student and parent survey data.

Finally, I wanted to determine how project-based learning affected me as a teacher. I chose to examine my own observations and journal to look for recurring themes that might emerge. Additionally, I compared the lesson plans that I created for this unit with those I have used for traditionally taught units.

The triangulation matrix in Table 1 summarizes my data collection approach.

Table 1
Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i> How does implementing a project-based learning unit affect students in a fourth grade classroom?	The primary question will be answered by analyzing data from the secondary questions		
<i>Secondary Questions:</i> Does student learning change when PBL is used?	Pre assessment and post assessment and project journals	Project artifacts (final products)	Student survey
How is student engagement affected by PBL?	Instructor observation and journaling	Student interviews	Parent and student surveys
How is the instructor affected by using PBL in the classroom?	Instructor journaling	Lesson Plans	

DATA AND ANALYSIS

The data collected from parent and student surveys, interviews, assessments, instructor journaling, and lesson plans was used to examine student learning, engagement, and the affect project-based learning has on the instructor. Each question that was posed is answered according to data collection instrument below.

Impact of PBL on Student Learning

In order to determine how learning changed when project-based learning is implemented, I examined student learning in both the comparison and treatment groups based on a pre and post assessment, final project and artifact for the PBL group, and student self-assessment. The grading descriptors used in my school district are:

Beginning, Developing, Secure and Exceeds Expectations. Students who show proficiency in an area receive the mark of Secure.

Overall, the number of students showing increased knowledge relating to each of the topics assessed was similar between the two groups (see figure 1). The percentage of students to attain proficiency or higher in most of the topics was significantly greater for the students who participated in the project-based learning unit. The percentage of students who achieved a score of Secure for the first topic was 91% in the comparison group and 92% in the intervention group. For the second topic, almost 30% more of the students attained proficiency in the intervention group as opposed to the comparison group. The third topic had a larger leap of over 50% more of the participants achieving a proficient score. The final topic showed a modest increase of roughly 20% more students in the intervention class arriving at a score of Secure.

Table 2
Student Learning Outcomes

	Percentage of students who demonstrated an increase in knowledge or understanding- Comparison Group, n=11	Percentage of students who demonstrated an increase in knowledge or understanding- Intervention Group, n=12	Percentage of students who achieved a score of Secure or higher- Comparison Group, n=11	Percentage of students who achieved a score of Secure or higher- Intervention Group, n=12
Topic 1- Student will be able to differentiate between scientific and nonscientific activities	27%	58%	91%	92%
Topic 2- Student will name and describe four or more Native American practices that are	73%	67%	55%	83%

scientifically based on observation and/or experimentation				
Topic 3- Student will be able to describe one Native American practice in detail and explain the underlying science	82%	100%	27%	83%
Topic 4- Student will be able to create a detailed illustration (with captions) or model of the science underlying one Native American practice	73%	92%	36%	58%

All of the 11 students involved in the traditionally taught unit showed growth in at least 1 of the 4 areas I looked at between the pre and post assessments, but only 2 students showed proficiency in all 4 areas when the unit ended. Two other students were extremely close to achieving a Secure in all of the areas, but were missing some background science information in one of their answers. At the closing stages of the unit, 3 of the students were better able to differentiate between scientific and nonscientific activities and 10 of the 11 students obtained a score of Secure in this area. On the post assessment, eight of the students named more Native American practices based on scientific ideas and 6 of the 11 achieved secure in this area. After our work together, nine students were better able to describe the science behind one specific Native American practice and three students made it to the secure mark. One of these students did not demonstrate her mastery on the post assessment, but I found that she explained her understanding of the topic in her unit journal. Another four students were approaching

the mark of Secure according to their responses on the post assessment. Finally, eight students showed modest growth in their ability to draw an illustration or model of the science behind one Native American practice, and four students scored in the Secure range. Two of the students did not demonstrate this on the final assessment, but successfully showed this in their project journals on more than one occasion. Three other students were approaching a proficient score, but missed supporting information that prevented them from achieving Secure.

In comparison, every student in the intervention group also showed evidence of increased learning, however 3 of the 12 students showed proficiency in all 4 of the areas. Eleven of the twelve participants in the intervention group earned a score of Secure on the section of the post assessment that asked students to differentiate between scientific and nonscientific activities. This showed increase in understanding for seven of the students. Eight participants improved their ability to name and describe Native American practices that were based on science, and 10 of the 12 students scored a mark of Secure in this area. When asked to describe in detail the science behind one particular Native American practice, all students demonstrated an increase in knowledge, however only ten of the students showed this through the post assessment. The other two students were able to express their understanding of the topic more thoroughly in their final project. (This was not an option for the comparison group since they had not created a final project.) Ten of the 12 students achieved a Secure score in this area and the other two were missing minor information that prevented them from receiving a full Secure mark. All but 1 student increased the ability to show their understanding of the science behind one Native American practice by creating an illustration or model of the science, and 7 of

the 12 students were Secure in this area. Three of these students showed an increase in understanding to the level of Secure through their final projects, but not on their written assessments.

In addition to the four basic areas I assessed in both groups, the intervention group was also graded on their final project/artifact and their oral presentations. This represented the “communication” aspect of the 21st century skills that students work to develop in PBL. Ten of the 12 students in the PBL group successfully created artifacts (physical models) that demonstrated the scientific background of a Native American practice (see figure 1). All students completed and presented tri-fold projects to their peers and the school. With regard to the oral presentations, nine students scored a Secure mark for their ability to teach others about their topic and two other students were approaching a score of secure. Only one participant in the group was still developing in this area.

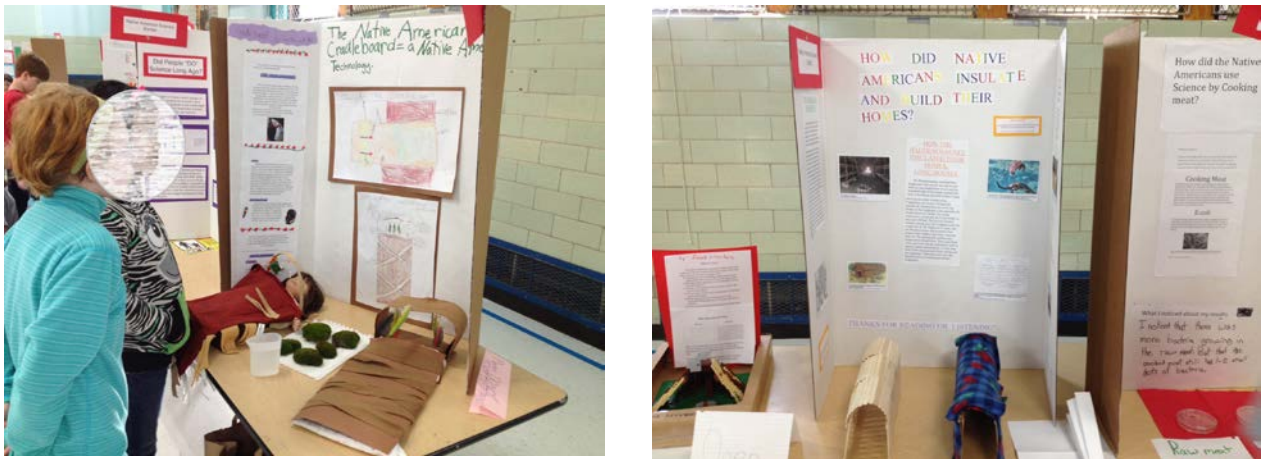


Figure 1. Examples of final projects and artifacts.

Following the unit of study, students were asked to rate how much they had been taught in school about how Native Americans used science to survive in their

environment. Forty-five percent of the participants in the comparison group responded that they had learned “a few facts,” while the remaining 55% felt that they “knew a lot and could teach others” about the topic. Although the students in the intervention group actually did all teach others about how American Indians used science to survive in their environment, 45% of the participants said that they had learned “a few facts” and 55% of the students, said that they “knew a lot and could teach others.” The two groups expressed the exact same level of confidence in this area. Interestingly, all of the students in both groups gave positive and descriptive answers when asked, “What did you learn in this unit?” Nine of the eleven participants in the intervention class also stated that they felt they taught other students about how Native Americans used science to successfully live in their environment. One student answered that she “probably” taught others, and another said that she did not think she actually taught anyone anything because her partner did not give her a chance to present enough at the science fair. All of the students interviewed from the intervention group stated that they learned the most from listening to each others’ presentations.

Impact on Student Engagement

One of my project’s secondary questions involved examining how student engagement was affected by project-based learning. In order to determine how student engagement was affected, I examined my instructor journal and student and parent surveys, and analyzed responses from student interviews.

In order to find evidence of student engagement, I scanned my project observations and journal for class sessions where the words *motivated*, *excited*, and/or *engaged* occurred. In the traditionally taught comparison unit, I counted three instances

that described student behavior using those words. These were days when students were doing a hands-on activity or watching a class demonstration or a video clip. There were also two other days that students complained about having to come to class, or asked if they could work on a different project instead.

In the intervention notes I came across the words *motivated*, *excited*, and/or *engaged* describing nine different class sessions. These entries depicted days when students participated in hands-on activities, chose groups and research topics, and prepared for final presentations. It is notable that two days of journal records indicate information about impromptu classes that the students in the intervention group held during lunchtimes. They skipped their recess to come to class and research or work on putting together their final presentations. I recorded, “Although I didn’t ask them to, almost all of [the students] came in to class at lunchtime to get their information pasted onto their trifolds. Students were very excited and there was plenty of energy in the air! None of them complained about missing recess, and they were so hard at work, they didn’t even hear the bell ring” (3/17/2014). A separate day describes the classroom before school, “The room was buzzing with students at 7:45 this morning! (30 minutes before school starts.) There was pasting, sewing, and last minute set up...They are all very proud and looking forward to presenting to the school” (3/18/2014). These periods of intense motivation and engagement were not seen during the comparison unit.

Next, I used student and parent surveys to measure how engaged students were individually. Students were asked a variety of questions about preferred classroom activities and their participation during the unit on Native Americans and science (see Appendix C). When asked how much students had participated in class during the unit,

45% of students in the comparison group said that they had raised their hand to participate and worked on their assignment “most of the time.” The remaining 55% of the students in that group stated that they had raised their hand and participated “all of the time.” The numbers are reversed for the intervention group with 55% percent of students responding that they raised their hands to participate and worked on their assignment “some of the time” and 45% saying that they did so “all of the time.” This smaller percentage in the intervention group might be attributed to the fact that many of the days were spent on group research and there were fewer class discussions in which students could participate in the PBL unit.

Survey and interview comments from both groups were largely positive. Although positive comments do not necessarily mean active student engagement, they indicate interest in a topic and possibly greater motivation. In the comparison group, all 11 students were able to name parts of the unit that they enjoyed and with which they were actively engaged. A student in the comparison group stated, “I really enjoyed this unit about Native American science. I’ve been wondering if there will be another unit soon.” Three other students made similar comments either in their surveys or during their interviews, leading me to believe that they would be motivated to do another similar unit taught traditionally. Participants in the comparison group specifically mentioned liking the opening group experiment, class demonstrations, and the video clips most. During their interviews, two of the four students in the comparison group said that they participated more during the class demonstrations and the video. Two students mentioned that they were less likely to be engaged during the writing and sketching activities (journaling). Also during the interviews, two of the students responded

neutrally to the question, “How did you feel about the unit we just completed on Native Americans and science” and two students gave positive responses. Finally, when asked if students would rather have completed small group projects similar to the intervention group, 5 of the 11 students stated that they preferred the style of teaching that they received. Several of these students felt that it would have been more work and they would have had to choose only one topic to study. Four of the students stated that they would have preferred to participate in the PBL projects because they “like working in groups” and “could have learned even more” about one chosen subject.

Participants in the intervention group were also largely positive in their feedback. All 12 of the students named activities with which they were highly engaged. On surveys and in interviews, students mentioned that their favorite parts of the unit were researching on computers, working in groups, having the freedom to choose their groups and topics, and sharing what they learned with a real audience (science fair). One student stated, “I learned a lot, we got to choose our own topics, and we didn’t have to work in a group if we didn’t want to.” Having students present their projects at the science fair was a motivating factor for nine of the children. One person declared, “I liked presenting my project at the science fair because I like presenting it to the little kids and explaining what my topic was and also because I felt older.” To other people it served as a hard deadline and source of stress, “I wanted more time to do our project” was repeated four times among this group. This shows to me that students were actually engaged in the project and would have benefited from greater preparation time before their big culminating activity. All four of the students who were interviewed gave positive responses to the

question “How did you feel about the unit we just completed on Native Americans and science.”

Table 3
Parent Survey Responses

	“Disagree” or “Disagree Somewhat” Parent Responses from Comparison Group n=6	“Disagree” or “Disagree Somewhat” Parent Responses from Intervention Group n=9	“Agree” or “Agree Somewhat” Parent Responses from Comparison Group n=6	“Agree” or “Agree Somewhat” Parent Responses from Intervention Group n=9
My child has shown enthusiasm when talking about what s/he is learning during the Native American science extension unit.	33%	22%	67%	78%
My child has asked questions at home about the topics we are covering in the unit during the last four weeks.	33%	25%	67%	75%
My child has been doing extra voluntary research on topics relating to Native American science during the last four weeks.	60%	37.5%	40%	62.5%
In the past two weeks, my child has told me about what s/he is learning regarding Native Americans without prompting.	33%	11%	67%	89%
My child has used what s/he is learning about to explain something at home about Native American science or resource use.	50%	11%	50%	89%

Parent surveys were sent home at the end of the week that each unit was completed. Overall, the surveys were largely positive and more than half of the parents

in both groups noticed that the participants were discussing their learning at home. A parent from the comparison group stated, “[My daughter] makes and applies real world connections. For example, when hiking in the woods, she commented that something looked like a wigwam. Her little brother asked, ‘What's that?’ and she offered a very detailed explanation.” Similarly, a parent in the intervention group commented, “I don't know whether some or any of the research at home that [my child's] done has been voluntary. I just know that she's engaged with the material and that she's communicated her enthusiasm to [my wife] and me.” Interestingly, one parent in each group apologized for their responses. They wrote in the comments section that their children are boys and do not talk about school at home, even when prompted.

Ultimately, I feel that both groups of students enjoyed the unit and felt engaged at times. Due to the public presentation aspect embedded in the intervention unit, I feel that there was greater motivation to complete a final product and project artifact of the students' choosing. This increased student engagement, especially toward the end of the unit. It might also explain why more parents in the intervention group heard about topics relating to Native Americans and science at home during the unit. In addition, my instructor journal identifies a much greater number of times that I felt students were actively motivated and engaged with the intervention group. Participant interviews and surveys from both groups made it clear that the children preferred being able to choose whether they participated in activities alone or in groups, actively participating in research and exploration activities, and class demonstrations.

Effect on Instructor

As the final part of this study, I wanted to see how implementing a PBL unit would affect me as the instructor. My first source of data on this topic was the journal I kept. When reading through my writing, I found it most notable that I was excited by the participants' enthusiasm during the project-based learning unit. Students would come in and ask, "Are we working on our projects today?" and there seemed to be extra energy in the room. This was very motivating as a teacher. The comparison group did not usually outright complain about having class sessions, but they did not show nearly the same level of enthusiasm, and therefore I found myself constantly trying to get them more excited while they participated in traditional activities. In total, I would say that exceptional student enthusiasm, as well as a public presentation during the science fair, kept me personally motivated during the PBL unit.

Next, I compared the two sets of lesson plans to see how they differed and what I had to adjust as I taught. When writing the intervention unit plans, it helped to use the Project Overview and Project Calendar documents that I downloaded from BIE. These made me think about what my guiding question would be, how I would get help from outside resources, and what my students would need to learn in order to be successful both on their assessments and on their final projects. I found that simply trying to translate traditionally planned lessons into a project-based learning unit was not a good idea. Instead, I had to plan ahead for outside speakers and resources and set some firm deadlines for the intervention unit. This unit also ended up lasting longer than the comparison unit because students needed extra time to research. Lessons in the comparison unit were fairly easy to follow or adjust as needed. Lessons in the

intervention unit were more open-ended and I often had to change my plans according to what I realized students still needed. Overall, I did not notice a major difference in time for planning the two units, however, I did feel more confident when planning the traditional unit.

INTERPRETATION AND CONCLUSION

The primary aim of this study was to determine how fourth grade students would be affected by implementing a project-based learning unit. I can answer this question by looking at the general trends that were found in student learning and engagement. Overall, students who took part in the PBL unit showed greater mastery of the material covered. Because they had the freedom to choose their own focus, students did not all learn the same material, but all of them were able to apply their learning to our general topic of Native Americans and science. Most students in the PBL unit stated that they learned as much, or more about Native American practices by listening to their peers' presentations as they did by doing research themselves. They did, therefore, have a common body of knowledge by the end of the unit. In fact, on their final assessment, four students chose to write in-detail about the science behind Native American practices that they did not research themselves, but used the information they had learned from their classmates' projects. There were no areas of the final assessment on which the participants in the intervention group scored lower than those in the comparison group, but on several sections they scored higher. Although these results are not comparing data from standardized test scores, they are similar to the outcomes mentioned in previous professional studies (Thomas, 2000; Geier et al., 2008). Participants in the PBL class

also had the added bonus of being assessed on their presentations and final project artifacts. These served as additional ways of measuring student learning.

The area of student engagement was a little more difficult to gauge. According to their own responses, students in the comparison group felt that they actively participated as much, or more, than their counterparts in the intervention group. My own personal observations were different. From where I stood, pupils in the intervention group were more focused on, and sometimes stressed out about, their learning. Their final projects and presentations served as a motivating factor that kept them engaged in the material. They were proud of their work and very supportive of each other throughout the unit. Students in both groups pointed out how important personal choice can be. Similar to the study by Cordova and Lepper (1996), participants mentioned how happy they were to be able to choose their project topics. Or, in the case of four of the students in the comparison unit who stated this idea in their surveys, increased student choice is a reason to choose PBL over traditional instruction.

In conclusion, I feel that project-based learning helped motivate students to deeply learn and successfully present information. The PBL group showed gains in all of the academic areas that I assessed, and student engagement proved to be high. One definite drawback in this particular study was the small group of participants. Although I taught the units to the greater part of two fourth grade classes, fewer than half of the students in each group became usable participants, and no students needing extra support were included. The results of a study like this could very easily change if students needing extra support staff were present in the participant pool.

VALUE

After completing and examining my work in this study, I have changed my teaching in two ways. Although I did not focus on formative assessment in any of the sections above, I found that set daily assessment helped me understand my students and their learning better. In addition, I discovered that engagement and motivation contribute more to student learning than I previously thought. Because of these two discoveries, my actions as a teacher have changed.

Over the years I have taken several courses on assessment. While I have always understood that it is important to assess students informally in order to determine what still needs to be taught, I did not really appreciate the value of daily formative assessment until I was carrying out this project. As I moved through both science units, I used exit slips and student journal entries to judge which students understood main concepts from my teaching, had completed a certain amount of work on their projects, and determine what questions still needed to be addressed. Taking ten minutes at the end of the day to skim through exit slips or journals gave me invaluable information that allowed me to concentrate on student misconceptions and gaps in information the very next day. I used exit slips in the past, but never on a consistent basis throughout a unit. In this study, students initially had a difficult time expressing what they had learned on their slips, but after showing them several examples and talking through the process, their responses became more focused. The drawings and captions in their journals also clued me in to major problems that needed to be addressed and understandings that were being grasped. After seeing how I was able to respond more quickly to student problems when fixed daily formative assessment was used, I now see that I had previously been doing my

students a disservice by not implementing exit slips and journaling on a regular basis. Since completing this project, I have been using daily journaling in reading class and exit slips in social studies. I hope to also include a form of virtual exit slips for my classes next year in writing.

As I taught the intervention unit in this study, the importance of student motivation and engagement really made itself known. My students were extremely excited about the amount of choice they had in their projects. They became obsessed with their artifacts and with presenting them at the science fair. I originally thought that participant engagement would be higher with project-based learning, but that student learning would not be as high as with traditional teaching. I figured that the children experiencing the PBL unit would know one topic very well, but not really grasp how this applied to the unit as a whole. I now see that I underestimated the power of motivation and engagement. I strongly believe that the intervention group performed so well on their written assessments because they were highly motivated and excited by their projects. They worked incredibly hard to perfect their artifacts and presentation boards and this carried over into their learning and oral presentations. I was impressed with the number of students who shared what they were learning with each other throughout the unit and that there were so many interesting questions that followed the presentations. I believe that participants' enthusiasm and genuine interest in each others' topics increased the amount they learned overall.

This new realization has not drastically changed my style of teaching, but it will affect how I plan units in the future. First, I feel that project-based learning and the style of teaching associated with it are valuable to my learners. They liked having choices and

being able to express their learning in different ways. Because of this, I plan to incorporate two more PBL units in my curriculum next year. Next, even when I do not use PBL, I plan to use as many of the activities that students found engaging as possible in a unit. Finally, I will offer multiple ways for students to express their learning on final assessments. It is my hope that increased engagement due to choice and motivating projects will continue to translate into deep and meaningful learning experiences for my students.

While it is true that I have always used some form of formative assessment techniques and engaging class activities in my teaching, I feel that this study helped emphasize their importance. My students and I will benefit from the insights I have gleaned while completing this capstone paper.

REFERENCES CITED

- Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*, 26(3/4), 369.
- Buck Institute for Learning (2013). What is PBL? Retrieved from http://www.bie.org/about/what_is_pbl/ on 9/22/13.
- Ching, C. & Kafai, Y. B. (2008). Peer Pedagogy: Student Collaboration and Reflection in a Learning-Through-Design Project. *Teachers College Record*, 110(12), 2601-2632.
- Cordova, D. & Lepper, M. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology*, 88(4), 715-730.
- Geier, R., Blumenfeld, P. C., Marx, R. W., Krajcik, J. S., Fishman, B., Soloway, E. Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research and Science Teaching*, 45, 922-939.
- Grant, M. (2009). Understanding projects in project-based learning: A student's perspective. Paper presented at Annual Meetings of the American Educational Research Association. San Diego, CA. April, 2009.
- Lam, S., Cheng, R.W., & Ma, W.Y.K. (2009). Teacher and Student Intrinsic Motivation in Project-Based Learning. *Instructional Science: An International Journal of the Learning Sciences*, 37(6), 565-578.
- Strobel, J. , & van Barneveld, A. (2009). When is PBL More Effective? A Meta-synthesis of Meta-analyses Comparing PBL to Conventional Classrooms. *Interdisciplinary Journal of Problem-Based Learning*, 3(1).
- Thomas, J. W. (2000). A Review of Research on Project-Based Learning. In *Research on PBL* from the Buck Institute for Education. Retrieved from http://www.bie.org/index.php/site/RE/pbl_research/29
- Thomas, J. W. & Mergendoller, J. R. (2000). Managing Project-Based Learning: Principles from the Field. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA. 2000.

APPENDICES

APPENDIX A
STUDENT INTERVIEW QUESTIONS

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time. Your participation or non-participation will not affect your grade or class standing.

Student Name: _____

Date:_____

1. How did you feel about our recent unit of study on Native American science? (Which parts did you enjoy or not enjoy?)
2. Did you feel that you participated during some activities more than others? If so, which activities made you want to participate most and which activities did you want to participate in least? (prompt if necessary and note: research, creating model or demonstration, sharing/presenting, group work, etc.)
3. Which activities do you think you learned the most from during this unit?
4. Do you prefer to work alone or in a group?
5. Did the fact that you like to work alone or in a group affect whether or not you wanted to participate in any of the activities? If so, please say more about that.

APPENDIX B
PARENT SURVEY QUESTIONS

Parent Survey Questions

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time. Your participation or non-participation will not affect your child's grade or class standing.

Question	Disagree	Disagree Somewhat	Agree Somewhat	Agree
My child has shown enthusiasm when talking about what s/he is learning during the Native American science extension unit.				
My child has asked questions at home about the topics we are covering in the unit during the last four weeks.				
My child has been doing extra voluntary research on topics relating to Native American science during the last four weeks.				

Question	Yes	No	Other (Please explain)
In the past two weeks, my child has told me about what s/he is learning regarding Native Americans without prompting.			
My child has used what s/he is learning about to explain something at home about Native American science or resource use.			

APPENDIX C
STUDENT SURVEY QUESTIONS

Participation is voluntary, and you can choose to not answer any question that you do not want to answer, and you can stop at any time. Your participation or non-participation will not affect your grade or class standing.

Rate how much you have been taught in school about Native Americans science?

1	2	3
Nothing	I have learned a few facts	I know a lot and could teach others

Rate how much you have been taught in school about the relationship between Native Americans and the Wisconsin environment?

1	2	3
Nothing	I have learned a few facts	I know a lot and could teach others

Rate how much you enjoy working in groups to complete a project.

1	2	3
I don't enjoy working in groups	I sometimes enjoy working in groups for projects	I really enjoy working in group for projects

Rate how much you enjoy group discussions when learning.

1	2	3
I don't enjoy group discussions	I sometimes enjoy group discussions	I really enjoy group discussions

Rate how much you enjoy learning by reading and answering questions.

1	2	3
I don't enjoy learning this way	I sometimes enjoy learning this way	I really enjoy learning this way

How much have you participated in class during the last four weeks?

1	2	3
I sometimes raised my hand, worked with my group or worked on my project (1 day/week)	I usually raised my hand, worked with my group or worked on my project (2-3 days/week)	Every day I raised my hand, worked with my group and worked on completing my project

APPENDIX D
PROJECT-BASED LEARNING PLANNER

Project Overview				
Name of Project:	Native American Science		Duration:	4 weeks
Subject/Course:	Extension Project	Teacher(s): Tinkler	Grade Level:	4
Other Subject Areas to Be Included, if any:	Science, Social Studies, Language Arts			
Project Idea Summary of the issue, challenge, investigation, scenario, or problem:	Students will work individually or in small groups (2-3 children per group) to research ways that pre-Columbian Native American tribes used their knowledge of science and patterns in nature to survive in their environment. Each group will choose one example of a practice or tradition based on science and create an artifact that demonstrates why the practice worked and how it helped Native Americans successfully live in their surroundings.			
Driving Question	How can we demonstrate that local Native American tribes used science to improve their lives?			
CCSS to be taught and assessed:	See Shorewood School District standards below			

Additional Standards to be taught and assessed:	Social Studies (B.4.1) Identifying various sources of information that are used for constructing and understanding of the past. Artifacts, maps, textbooks, photos, and charts. Social Studies (B.4.8) Comparing past and present technologies related to energy, transportation, and communications and describing the effects of technological change, either beneficial or harmful, on people and the environment. Social Studies (A.4.4) Describe and give examples of ways in which people interact with the physical environment, including use of land, location of communities, methods of construction, and design of shelters. Reading and Responding to Informational Text—describe the sequence of events in a historical or scientific account including what happened and why, based on specific information in a text. Reading and Responding to Informational Text—Learn and determine the meanings of general academic language and domain-specific words or phrases encountered in an informational fourth grade text. Reading and Responding to Informational Text—Use text features and search tools to locate and process information relevant to a given topic. Speaking and Listening-- Report on a topic or text...in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.			
21st Century Competencies to be taught and assessed:	Collaboration	X	Creativity & Innovation	X
	Communication (Oral Presentation)	X	Other:	
	Critical Thinking			
Major Products & Performances	Group : Small group	Each group will choose an example of how pre-Columbian Native Americans in Wisconsin used science to improve their living conditions. They will research the science behind Native American practices such as companion crop planting, smoke vents in dwellings, spring tapping of maple trees, food preservation and medicinal herb use. Each group will then choose a way to demonstrate what they learned about one particular practice and how it	☐Presentation Audience ☐Presentation Audience: ☐ ☐ ☐Class ☐ School	
			☒Class	

		benefited Native Americans and helped them survive in their surroundings. Groups will create an artifact that details the process used and the science behind the practice. They will choose to give an oral presentation to an audience of fourth graders or create a demonstration that can be presented at the science fair.	?	School	
				Community	
	Individual:		`	Experts	
				Web	
			Other:		
Project Overview					
Entry Event to launch inquiry and engage students:	“What is science?” activity. Students work together in small groups to discover that observation of natural patterns and trial and error are used by people to make their life situations easier. This is the basic form of science that humans have been using to improve their lives for centuries.				
Assessments	Formative Assessments (During Project)	Quizzes/Tests		Practice Presentations	
		Journal/Learning Log: completed 2x per week	X	Notes: research notes weekly	X
		Preliminary Plans/Outlines/Prototypes: end of week 2	X	Checklists	
		Rough Drafts		Concept Maps	
		Online Tests/Exams		Other: pre-assessment before mini-unit	X
	Summative Assessments	Written Product(s), with rubric: _____ _____		Other Product(s) or Performance(s), with rubric:	

	(End of Project)	Oral Presentation/demonstration, with rubric and written explanation	X	Peer Evaluation	
		Multiple Choice/Short Answer Test: end of unit	X	Self-Evaluation: rubric	X
		Essay Test		Other:	
Resource s Needed	On-site people, facilities:	Classroom			
	Equipment:	Computers with internet access			
	Materials:	Books, depending on project-possibly items from home			
	Community resources:				
Reflection Methods	(Individual, Group, and/or Whole Class)	Journal/Learning Log: completed 2x week	X	Focus Group	
		Whole-Class Discussion	X	Fishbowl Discussion	
		Survey	X	Other: Interviews	X