The Effectiveness of Project-Based Learning in Science Instruction

A graduate project submitted in partial fulfillment of the requirements

For the degree of Master of Arts in Education

Elementary Education

By

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Dedication

This graduate project is dedicated to my family and friends for all of their love, support, and help through this educational endeavor. Victor Arriola, thank you for being so understanding and supporting my education.

A special thank you Dr. Kretschmer for guiding me in the direction to produce quality work. I appreciate all your time and commitment to ensure my success.
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Abstract

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The purpose of this project is to develop instruction in Project-Based Learning (PBL) for students and teachers in a way that will help students understand content knowledge in third grade. The instruction will include a lesson series designed using the Next Generation Science Standards (NGSS) and STEM (Science, Technology, Engineering, and Math) while incorporating many aspects from PBL. The class will participate in Project-Based science learning for a seven-day period learning the engineering and science behind building a bridge. When the project is complete, the students will present their bridges to the class.
Chapter 1: Introduction

The Project Based Learning (PBL) unit that I have designed has been developed using research from a wide range of studies in PBL instruction. PBL has many different components for helping develop student knowledge. I have chosen to focus on problem solving, collaboration, self-regulated learning, and real-world application. The students will be designing a bridge to solve a problem that their school is facing. They will need to work together to construct a bridge. Additionally, they will learn different aspects of science content so they are able to take the new knowledge learned from this unit and apply it to other real-world situations.

This project focuses on how third-grade students will benefit from PBL instruction in science. It will focus on engineering a design to help solve a hypothetical school problem that they are facing at school. They will be following the NGSS standard of engineering design and have to understand the following key elements:

1) Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

2) Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

The students will use the many strategies of PBL to work collaboratively to come up with a project that they are able to present to their fellow schoolmates. The students will do both independent projects and group work to help them achieve their project goal.
PBL has been used for decades to promote reform across the country from traditional instruction (Lee, Blackwell, Drake, & Moran, 2014). Since the start of PBL in the 1960’s, many elementary school teachers haven’t had the proper training or materials to implement instruction geared towards hands-on learning and problem solving real-world issues, two of the aspects that are very important in science instruction. The PBL approach will benefit the students by giving the teachers a useful lesson to guide their instruction.

All students need to have a usable knowledge of science so they can make informed decisions throughout their lives on issues of individual scientific and community importance (Krajcik, 2015). However, teaching science in elementary schools is a challenge, according to NCES (2012). The number of students in K-12 classrooms continues to rise, and in juxtaposition, the students’ science achievement scores have been on the decline. Case in point, in 2012, only 18.8 % of our nation's’ 15-year-old students were performing at or above proficient in science. What is more, the 2009-2011 National Assessment of Educational Progress (NAEP) report clearly evidenced that students’ science scores have only improved 2 points in all areas except advanced which stayed the same. Additionally, over a third of eighth-graders scored below basic on the 2011 NAEP Science assessment. "The nation’s capacity to innovate for economic growth and the ability of American workers to thrive in the modern workforce depend on a broad foundation of math and science learning, as do our hopes for preserving a vibrant democracy and the promise of social mobility that lie at the heart of the American dream" (Carnegie Corporation, 2007).
The deficit in the nation’s science performance is further exacerbated as we bring the focus closer to home in California. California’s Standardized Testing and Reporting (STAR, 2012) reported no significant change in science scores for grades five, eight, and ten. In 2013, California adopted the Next Generation Science Standards (NGSS), which has been developed to help close the achievement gap across American students. Each standard in NGSS has the following: content, scientific practices, engineering practices, and crosscutting concepts. The integration of rigorous content and application reflects how science is practiced in the real world (www.nextgeneration.org).

According to the Institute of Education Sciences, in 2012 a Program for International Student Assessment (PISA) ranked the United States twenty-third in science out of sixty-five other educational systems. Further disheartening, in 2012 only one in three high school students met the readiness benchmark in science according to the ACT’s college readiness benchmark levels. In a news release from the California Department of Education on the results of the California Assessment of Student Performance and Progress (CAASPP) for the 2014-2015 school year, showed no significant academic gain in the testing areas of English and math. Thirty-eight percent of students did not meet the standards in math, while thirty-one percent of students did not meet the standards in the area of English.

Although some changes have been made in schools across our country, not enough has been done in California. The NAEP (2011) report states that 16% of eighth grade students in California are exploring science concepts using hands-on activities every day or about every day. Additionally, two-thirds of students work on science projects at least weekly. Along with the new adopted NGSS standards, students will have
clear expectations that incorporate Project Based Science which encompasses: driving questions, investigations, and collaboration (Krajcik, 2015). With the small change that has been made thus far in science instruction, it is clear that students need more hands-on learning experiences in the classroom.

Additionally, throughout California teachers are not receiving the training they need to teach effective science instruction. In a study done in 2014 by Ertmer on teacher learning, he concluding that teachers need to have more professional training in science instruction, specifically Science, Technology, Engineering, and Math (STEM) and PBL instruction. Teachers need to have adequate science training to be successful in proper teaching techniques that will benefit their students. “Teachers with stronger content knowledge are more likely to teach in ways that help students construct knowledge, pose appropriate questions, suggest alternative explanations, and propose additional inquiries” (as cited in Ertmer, 2014).

More importantly, having worked as an educator in both urban and suburban school settings for the last four years in Los Angeles, CA, I can attest to the deficit in students’ science performance. It is imperative that science achievement be re-examined and for PBL instruction to be implemented properly in order for students to achieve success. If we, as educators can hone in on what seems to not be working, we will be able to reform education and help all students’ learning improve.
Chapter 2: Literature Review

Definition of Project-Based Learning

Project-based learning (PBL) is defined in the literature as an instructional method which uses authentic, complex, real-life projects to motivate learning and provide learning experiences (Shu-jing & Li-hua, 2010). Project learning allows students to work on complex, open-ended, real world projects. Additionally many researchers use project-based synonymously with problem-based learning. The commonalities between these two include authentic, problem solving, active learning projects, and its approach where the teacher acts as a facilitator throughout the learning process. However the difference in these two approaches is that problem-based learning creates an active learning environment where all students participate, share responsibility of contributing to the team, and students’ learning is directed to studying. Whereas in project-based learning students’ learning is directed at making the final product (Helle, at al. 2006), (p.295).

In PBL, students take a more active part in their learning compared to traditional instruction by challenging students’ critical thinking, problem solving abilities, content knowledge, promoting team interaction, and promoting active learning (Carone & Burker, 2007). PBL integrates knowing and doing because students are learning knowledge and elements of the curriculum, but are also learning how to apply what they have learned to solve authentic problems and produce results that are meaningful. It allows students to work on complex, open-ended, real-world projects and acts as a stimulus and focus for student activity and learning (Bond & Feletti, 1991). Furthermore, another benefit of PBL is that it offers learning in a way that is purposeful and self-sustaining because students are learning to work for solutions to problems that they have
formulated themselves. They are actively involved and learn in the context in which knowledge is to be used (Mettas & Constantinou 2006).

**PBL Increases on Motivation, Engagement, and Effectiveness**

Li (2010) states that motivation and engagement are keys to improving learning outcomes, and when introducing a new project idea, motivation is key to getting students to explore the ideas themselves (Li, 2010). Carone & Burker (2007) surveyed students regarding their engagement, judgments, and effectiveness of problem-based learning (aka project-based learning) in a ten-week rehabilitation counseling practicum, using a 51-item Likert scale instrument (1-4, with 1 noting “strongly disagree” and 4 noting “strongly agree”), they found that PBL is an effective method for promoting student learning in the counseling practicum (3.3-3.7 mean scores). They also found that PBL is a useful strategy that challenges students’ critical thinking, problem-solving abilities, and content knowledge of various required domains, encourages team interactions, and promotes active learning.

In order to be successful in PBL, students must take responsibility for the learning process by setting goals, monitoring progress, reflecting, and sustaining their motivation from the beginning of the project to the end (English & Kitsantas, 2013). In an article on supporting self-regulated learning (SRL) in PBL, English and Kitsantas (2013) studied the relationship between the two and although the findings were limited, found some theoretical similarities. Firstly, they broke up PBL and SRL into three phases and found that they are both cyclical. Phase one of PBL (Project/Problem Launch) and phase one of SRL (Forethought) both require task analysis such as goal setting and planning. Phase
two of PBL (Guided Inquiry and Product/Solution Creation) is where students gather meaning and reflect through evidence and experimentation. In SRL phase two, includes self-control and self-observation processes. This is also where students engage in complex learning tasks, reflect on what they have learned, incorporate feedback, and revise ideas. This study suggests that in last phase of PBL (Project/Problem Conclusion) the students share their learning and reflect to come up with conclusions. Students are able to share their final project with their peers: which engages them in self-judgment and is tied in with SRL. In conclusion, PBL and SRL illustrate a dynamic reciprocal relationship. SRL is a critical skill for student success in PBL (English & Kitsantas, 2013).

In another study focusing on PBL impact on effectiveness in learning and motivation, Özdener & Özçoban (2004) found that thinking, problem solving, and creativity played a critical role when related to having students use computers for help and PBL instruction in personal and group applications. Their findings show many positive comparisons. Specifically, their study included 75 sixth grade primary school students who were learning Microsoft PowerPoint. They conducted a pretest to determine the student's' intelligence profiles. Once intelligence profile is determined, they were divided into two groups randomly. One group was taught using a traditional teaching method, but the second group was taught using the PBL method.

The PBL group was divided into two subgroups based on their pretest intelligence profile. Each subgroup contained 16 people. They worked together to each produce a project for themselves. Additionally a 70-question observation protocol was developed by researchers to determine the student success, motivation, and learning levels. It is
important to note the different multiple intelligences fields (Linguistic Intelligence, Logical-Mathematical Intelligence, Spatial Intelligence, Interpersonal Intelligence) were the factors that helped determine the two groups. The pre-test results showed that all groups had no significant difference once the \( t \)-test results were examined. Each groups had an average score of 48 points. The \( t \)-test difference was \( t = .97, p > .05 \). During the first stage of the research the first group of students’ (which did not have project method applied) had achievement grades increase approximately 7 points, as a group, their average increased from 48.38 to 55.41. However, the second group’s achievement increased 18 points and the group average increased from 48.52 to 66.48. Once the \( t \)-test was performed on the post-test results, there showed a significant difference \( (t = 6.32, p < .05) \) (Özdener & Özçoban, 2004).

The study of these two groups confirmed that PBL is more effective than explanation method when teaching students how to use Microsoft PowerPoint. In PBL, students’ had the opportunity to use abilities such as thinking, problem solving, and creativity both in personal and group work applications (Özdener & Özçoban, 2004). This study points out that students who use project method in exploring computer courses have a better understanding than students who are taught using the explanation method.

Additionally, in an article written by Taylor and Iroha (2015) on Social Studies Education and Public Art, the students had to design a billboard that they thought would be an effective way to promote community growth. PBL elements were used during this study to help the students collaborate and work effectively to solve the problem. They found that during their study the students were more engaged to work on their project knowing that there was an expected outcome that they needed to achieve.
Lastly, a study of teachers implementing PBL in 2013 showed that teachers feel their students’ motivation and engagement increased. A teacher explained, “It gives them more buy-in and they feel like it is something that they want to do, they are motivated to do this rather than it being imposed on them” (Tamim & Grant, 2013). Tamin and Grant (2013) concluded that PBL has a better impact on the learning process, but also because it motivated their students, kept them engaged, and gave them a sense of ownership (Tamin & Grant, 2013).

**PBL Increased Learning**

Cognitive engagement is defined as drawing on ideas of investment and willingness to exert the effort to investigate an issue. It has different dimensions: and it can range from simple memorization to using self-regulated learning (Fredricks, Blumenfeld, & Paris, 2004). In 2012, Cook, Gayle, & Rogers (2012) investigated the cognitive engagement of seventy ninth-graders in a Biology class learning about evolution through PBL. When structuring the cognitively complex tasks, they were able to have the teachers provide opportunities for their students to solve authentic problems. Their methodology was influenced by their belief to create and implement a successful teacher development program by first understanding the issues that science teachers face. An additional aim for their study was to provide baseline knowledge of the changes teachers and students experience in implementing project-based curriculum. For the unit on evolution the students were organized into groups of three. The students needed to research evidence for and against varying aspects of evolution and present their thoughts on how it should be taught in a high school biology classroom. Through interviews and
qualitative methods, Cook, Gayle, & Rogers were able to evaluate the students’ cognitive achievement.

Results showed that during the interview process with each student, the students were able to elaborate on their thinking. Ten questions were coded and given percentages based on cognitive understanding. Interview answers varied, but suggested that PBL had a positive effect. The PBL model gives teachers important structure and is embedded with important components such as collaboration, multiple perspectives taking which in turn can increase cognitive engagement (Fredricks et al., 2004). It should be noted that the results were all done by interviews and observations.

Aral, Kandir, Ayhan, & Yaşar, (2010)’s study of PBL effects on 6-year-old preschool children resulted in all students’ scores improved from the pretest and posttest. What is more, the children in the PBL group showed a larger increase in their posttest results. They randomly assigned two classes of fourteen preschoolers into experimental and control groups. During a twelve-week period, the experimental group took part in PBL education, while the control group had regular instruction. At the beginning of the research the conceptual knowledge of both classes was tested and showed that they were at similar levels. After the procedure and data collection was analyzed. The results showed a more positive impact on the experimental group. These results showed that the conceptual development changed positively over time. What is more, the mean total concept scores for the experimental group were 6.93 points higher than the control group, which shows that the PBL program improved conceptual development in the group of preschoolers observed (Aral, et al. 2010).
PBL Increased Learning in Science and Engineering

Additionally, Kılınc (2010) studied the effects of PBL on the environmental behavior patterns of humans and found that the PBL environment caused a positive change on the way students in their third year of an Elementary Science Teacher Training Program. The students focused on observing the environment by collecting articles on the environment from newspapers’, interviewing local government authorities in Kırşehir, Turkey, reviewing the data and presenting a PowerPoint slideshow on their findings of the environment. Throughout the course, the facilitator would give lectures pertaining to environmental issues such as population, ecosystems, food chains, biodiversity, environmental pollution, local and global environmental problems, sustainable development, and environmental education. These lectures were to help the students focus on a certain area of interest. At the end of the course a questionnaire was administered and qualitative and quantitative data was collected. From that information, the facilitators and Kılınc (2010) broke the qualitative data into segments. Segment questions were broken down and coded by pro-environmental behaviors; segments that overlapped were determined to be cooperative and were better defined in a table. There were 8 segment questions total. Each participant agreed on the segment questions 74% of the time. With the information gathered from this study, Kılınc (2010) concluded that though the participants’ behavior did change over the time of the course, decision-making can still influence many factors. Further education can play a role in a change (Kılınc, 2010). Although the number of participants in this study was low, when you look at the mean gain scores of 4 for the samples shown, Kılınc can say that science-based projects such as ‘literature search’ and ‘questionnaire study’ produced beneficial conclusions...
(Kılınç, 2010). These conclusions make a good argument as to why project-based learning should take place in classrooms. It provided an authentic experience to the subject matter being taught. It allowed the students to observe the environment on their own and construct their own decisions.

McCright (2012) conducted a study with undergraduate students in a STEM (science, technology, engineering, and math) class to see if an inquiry-based learning project would enhance scientific and quantitative literacies. His research was conducted over a twelve-week period. Students in the experimental group had higher scores on the science and statistical knowledge than did students in the control group (McCright, 2012). When compared, McCright’s Knowledge pre-test scores with Knowledge post-test scores, the students improved by 2.41 mean average. This shows a significant difference in how they responded to inquiry project-based instruction.

In another study on effects of PBL in the field of Engineering and Medicine, Bédard, Lison, Dalle, Côté, & Boutin, (2012) wanted to observe the impact that PBL had on 480 undergraduate students during their time in the course. They used a 95-item survey using a Likert Scale. The survey results show some striking relations between two factors, stress and engagement. As mentioned in the article, stress is not always a word that is used negatively. Bédard, et al., (2012) pointed out that stress can occur from having to work within the environment and within themselves. The data suggests, that in all three curriculums, when students are in their PBL learning environment it diminishes their stress. The students are much more likely to engage in the learning activities (Bédard, et al., 2012).
To develop skills in science and engineering, schools have been using STEM, which is science, technology, engineering, and math. STEM PBL is an instructional approach embedded in classrooms for STEM education, it is grounded in theoretical background where students are engaged in the diverse components of problem solving, open-ended questions, hands-on activities, and group work (Capraro & Slough, 2008). In 2012, Han, R. Capraro, and M. Capraro studied the effects of STEM PBL on high, middle, and low achievers in high school and to what effect it played on their overall learning outcomes. Three high schools participated in this study and were required to teach STEM PBL once a week every six weeks for three years (2008-2010). The teachers attended a sustained STEM PBL professional development on how to properly implement PBL instruction. The participants were diverse in numbers. In 2008 there were 836, in 2009 there were 533, and in 2010 there were 485. All three schools were small, urban, low socioeconomic high schools. Data for this study were collected from the students’ mathematic scores from the state's accountability assessment as a baseline. Additionally, two methods were utilized to investigate the impact of STEM PBL on students who varied in math achievement, a descriptive statistics and longitudinal Hierarchical Linear Model (HLM) (Han, R. Capraro, & M. Capraro, 2012). The researchers used Hierarchical linear modeling to analyze state test scores, in which determined which groups the students should be placed.

In all three groups students showed positive growth, but this study indicated that the learning environment might have influenced different impacts on each of the learning groups. Moreover, this study found that students with low socioeconomic status"
Influenced the performance and engagement in a negative way over the three years because of factors outside of their control.

In conclusion, although positive growth was shown, the improvement overall was not what they expected. It should be noted that the results of low achievers and Hispanic students’ growth rates were statistically significantly higher through after instruction in STEM PBL.

**PBL Increased Learning Language Acquisition**

Shu-jing & Li-hua (2010) conducted a study on the effects of project-based procedures on the students’ constructing, analyzing, and summarizing skills, using a mixed methodology. The project was broken into 6 steps: 1) choose the project; 2) plan the project; 3) implement the plan; 4) project assessment; 5) work on the product; and 6) product presentation. During this study, the teacher acted as a facilitator and an organizer.

They wanted to determine if PBL helped to promote Chinese students’ intercultural communication competence and found that PBL not only enabled students to construct their own knowledge, but also see different perspectives by sharing with other students, which fosters rich learning experiences. Students clearly showed a positive attitude toward their competence. Furthermore it contributed to their motivation to learn English and enhanced their learning overall.
PBL Increased Learning in Technology

In technology education, problem-solving activities provide students with opportunities to create and evaluate designs and to experience knowledge seeking, processing, and applications (Mettas & Constantinou, 2006).

Özdener & Özçoban, (2004) found that PBL also positively impacted student-learning outcome in computer courses. Not much information is given on what specifically was taught during the course, but the post-test results showed that the group using PBL had a significantly higher score (18 point jump) than the group who was using explanation method (7 point jump).

In conclusion the studies have shown indisputable evidence that PBL learning strengthens students’ overall learning abilities and increases performance in science, technology, cognitive development, language acquisition, and most importantly effectiveness knowledge. Moreover, PBL increases motivation and engagement, which positively impacts learning outcomes in core subject areas. Thus, PBL, implemented in various ways to accommodate diverse learning styles, certainly will help boost motivation, engagement, and critical thinking skills, which in turn will increase student learning outcomes (Shin-jing & Li-hua, 2010).

In 2014, Hooper (2014) conducted a study in Texas on Bringing the World to the Classroom through Videoconferencing and Project-Based Learning. This study was unique because Hooper looked at K-4th grade students’ PBL curriculum as they implemented video conferencing to achieve their project goal. Videoconferencing can bridge the gap between formal textbook learning and real-world science (McCombs,
Ufnar, & Shepherd, 2007). Videoconferencing has many attributes of engaged learning, it offers students relevant student live experiences, pertinent curriculum content, involvement in critical thinking and problem solving, stimulation of creative thinking, support of collaboration decision making by the group (Dewey, 1938). The Texas school that Hooper (2014) chose had already used PBL in their classrooms and had virtually visited locations. Additionally, they had guest speakers via the internet. The international partner collaborated with the projects through videoconferencing, wikis, Skype, and other websites. Teaming with the school, Hooper (2014) was able to expand on interactivity through student engagement by providing twenty-first century skills (Hooper, 2014). The projects consisted of all subjects, had to include a topic of study, student research, comparison of their research with the partner school, and a presentation. Each grade had to follow a specific rubric, which included a learning objective, student interaction, cultural diversity, communication tools, effectiveness of technology, and global project notes. When examining the effects of technology on the third grade PBL project on a NASA moon project: *If we see a full moon in Texas is there a full moon in Wales?* The third grade classes had the opportunity to 3-way videoconference NASA while discussing the moon and the Earth. Their global project score was the highest of all the other grades, which was 14 because the curriculum goals were met, students interacted on science content through the use of videoconferencing which facilitated learning and student engagement (Hooper, 2014).

Other grade levels did not fare as well on their global project. The first grade class received a score of 8 for not having any student interaction, while kindergarten received a 4 for not having student interaction, communication tools were not met, and they did not
use technology effectively. In conclusion PBL and videoconferencing together played an effective role in the understanding of curriculum, critical thinking, and problem solving skills. Technology provides new ways to communicate and collaborate to cross-global boundaries, which allows students to develop real-world skills to enhance their learning.

In a team PBL project on peer evaluation Lee and Lim (2012) address some important aspects on cognitive learning in a social learning context using a blended e-based learning environment. Lee and Lim (2012) find that peer evaluation is an effective way of allowing every student to participate in team-based learning and monitor the process, as well as the product of team learning. They studied a group of thirty-two undergraduate students enrolled in an Instructional Methods and Educational Technology course at Seoul National University. The students were organized into eight teams of four students each. They were assigned two project tasks and worked using online discussions boards several times a week.

In order to track evaluations, they used seven categories: intellectual, informative, social, diplomatic, managerial, procedural, and technical. They coded each message sent from one classmate to another. Each member in the team evaluated each other privately using five different questions; 1) Participated in group project or meeting, 2) Helped keep the group focused on the task, 3) Contributed useful ideas, 4) Quantity of work performed, and 5) Quality of work performed (Lee & Lim, 2012). Students could receive a total of 25 points (5 points maximum for each area). The rankings were weighted, meaning the first person ranked would receive 4 points, the second-ranked person would receive 3 points, the third-ranked person would receive two points, and the lowest ranked person would receive one point. Results were reviewed and 773 postings were analyzed
based off a message board and categorized using content-analysis framework. The results indicate that the students received the social role of harmonious collaboration and steady progress to be more important than cognitive contributions. The students seemed to perceive collaborative competency as more necessary for successful team learning (Lee & Lim, 2012). Overall, this study showed that students value each other’s opinions.

Some limitations to this study indicate that if one “smart” student in the team handles the high quality end of the team project, they are missing the idea of working as a team. Also, although groups were chosen at random, students can still be biased off of what they comment and contribute to their team project.

Another PBL study in technology on the effects of historical thinking with eighth-grade students conducted in 2013 showed positive effects on students learning and academic growth is a diverse population of students. De La Paz and Ramos’s (2013) study was a six-week unit of American history from the early 1800s. With the help of the classroom teacher, they chose twenty students to be analyzed, but eighty-seven students participated overall: ten students who were identified with learning disabilities and ten students without disabilities who were matched according to gender, ethnicity, and first language spoken at home. This study showed that students who had been identified with learning disabilities were included. All the students varied in academic level ranging from the 1st and 52nd percentile for the students with learning disabilities to the 27th and 93rd percentile for the students without disabilities. After the six-week unit on the westward expansion was determined, the students were broken up into six heterogeneous groups within each of the four classes. Two days of the unit was set aside to help the students understand the software that they would be using and the inquiry process was
explained to them. Along with the group work, the researchers led whole class
discussions on historical secondary and primary sources to make sure all the students
were clear when examining new data. Many scaffolding techniques were provided to all
students including worksheets, mini lessons, and help in the computer lab. Additional
instruction was given as homework to ensure that the students were looking at multiple
perspectives of history.

A mixed methods approach was used because the goal of this study was to
compare the benefits of technology-enhanced PBL with respect to mastery of historical
content and students’ thinking across different types of learners (De La Paz & Ramos,
2013). A fifty item multiple-choice test was given to all the students at the end of the
study and a twenty-minute individual interview was conducted. During the interview,
students were shown documents and asked what they thought about those documents.
They were also asked what they thought life would have been like for (insert historical
name). After coding the interview questions, 88% agreement among the students was
determined (De La Paz & Ramos, 2013).

In conclusion, students with disabilities fared well against their normally
achieving peers. An ANOVA analysis did not show differences in content learning
between the two groups of students. Even more surprising, posttest scores on the 50 item
multiple-choice test averaged 42.2 for the general education students and 40.9 for the
students with disabilities, which is not significantly very different. In addition, 70% of the
students with disabilities and 60% of the students without disabilities demonstrated
understanding of historical content to explain why people acted the way they did. This
study shows that when integrating PBL, technology, and group work all students can be
held to the same expectations with all students having the opportunity to practice advanced skills with an authentic task (De La Paz & Ramos, 2013).

**PBL Increased Learning in Cross Curricular**

In 2009, Ioannou, Brown, Hannafin, and Boyer conducted a study on one hundred ninety middle school students to investigate whether or not multimedia can make kids care more about social studies. Multimedia extends the amount and type of information available to learners. (Ioannou, et al. 2009). They paired with GlobalEd, a company that focuses on problem-based learning environments to simulate international negotiations. Their program is a five-week simulation embedded in the social studies curriculum that several schools across the country have adopted. Before the program begins, each participating class is assigned to represent one of fifteen countries. The number of participating classes is limited due to the number of countries being represented. Some students would have access to the multimedia version, which included pictures, diagrams, charts, and animated graphics, along with text. While the other students had only a text version that included a few pictures.

Within each class, students are placed into groups to research one of five issues: (a) conflict and cooperation, (b) international economics, (c) global environment, (d) human rights, and (e) world security (Ioannou, et al. 2009). During the 5-week simulation, each class must negotiate a treaty with all five issues being addressed with at least one other country. Many research questions were asked throughout the study, for example: Do students assigned to a multimedia instructional program in social studies achieve higher than subjects learning from Web-based, text-based instructional program?
Pre-posttests were administered and data was collected from one hundred and ninety students who had permission from their parents. Although there were $N=359$ in fifteen classes in ten middle schools in five states (California, Connecticut, Nebraska, New Hampshire, and Pennsylvania) only one hundred and ninety students provided pre and post assessments for the study. The studies participants were 51% boys and 49% girls, a majority of the students were White (72.5%), 96% responded that they have access to a computer at home. Over half of the participants (64%) planned to finish some graduate school, and 63% specified that they receive A’s on their report cards (Ioannou, et al. 2009). The following measures were used to direct the study: 1) Social Studies Quiz (pre and posttest), 2) Social Studies Interest Subscale (pre and posttest), and 3) Instructional Effectiveness Attitudes Subscale (posttest only).

In conclusion Ioannou et al. (2009) found significant learning gains in knowledge across all areas. When comparing students who used GlobalEd Multimedia (GEMG) to students who used GlobalEd Text (GETG), pre and posttest scores show a 23.1 point gain on knowledge for GEMG and a 12.9 gain for GETG. In regards to attitude about the effectiveness, GEMG had a gain of 0.13 and GETG had a gain of 0.20, which shows no attitude difference among the students. Due to factors outside of the researchers’ control, it was noted that students who participated in the text group still could have accessed the information outside of class or through different websites.

**PBL Increased Confidence in Teachers**

In an article on helping teachers’ learn/teach cutting edge science using a PBL approach, Ertmer, Scholosser, Clase & Adedokun (2014) discuss the importance of
having effective training for teachers in order for them to feel confident in teaching STEM instruction in their classrooms. Ertmer et al. (2014) designed a mixed-methods research study to examine teachers’ knowledge and confidence in STEM instruction in 6-12 grade science and math classrooms. Twenty-one teachers (7 in-service and 13 pre-service) participated in a 2-week summer workshop where they worked on developing PBL instruction related to sustainable energy (Ertmer et al. 2014). Throughout the 2-week training course, the teachers were challenged to design curriculum units in self-selected groups while learning best practices from speakers and workshops. When looking at the results of the study, pre and post knowledge tests showed a moderate gain. On a pretest, scores ranged from 10-27 out of 30 while post-test scores ranged from 21-30 out of 30. By looking at the post test scores, a slight increase is shown, which can indicate the two-week summer workshop helped teachers better prepare themselves to teach PBL instruction in math and science classrooms.

**PBL Increased Teacher Effectiveness**

*The Grand Challenge,* an article written to address the need for helping teachers learn/teach cutting-edge science. Ertmer et al. (2014) urges the idea that teacher confidence grew when the participants were able to use the technology-embedded approach that was utilized in the workshops to help prepare their lessons.

**Benefits of Project-Based Learning**

Numerous studies have delineated the positive impact of project and problem based learning (PBL) on students. Studies show that PBL enhances students’ self-directed learning, self-regulated learning, and self-reflective learning; all three are linked
to a positive student learning outcomes (Li, 2010). Moreover, additional studies have shown that students involved in PBL tend to acquire knowledge by being more active in their learning. They become more proficient in problem solving and team participation (Hoffman & Ritchie, 1997). PBL capitalizes on open challenges to one another’s thinking and promotes the application of knowledge through real-world application. Additionally, PBL offers an outlet for all students to learn. Students develop tendencies to act in a more constructive and creative way as well as letting the students be able to develop feelings such as self-esteem and confidence (Katz & Chard, 1992). PBL heightens learning gains, which allows students to feel more confident in what they are learning. Students should be able to show their creativity in all PBL learning.
Chapter 3: Methodology

I am a third-grade teacher at a private school, located in the San Fernando Valley. My school is a small non-affiliate private school serving approximately one hundred twenty students from pre-school to fifth grade. About 10% of the students are on some type of financial scholarship. The school is ethnically diverse: 24% White, 36% Asian, 5% African American/Black, 10% Hispanic/Latino, and 26% two or more races. The school has a traditional calendar with one hundred eighty school days. There is one teacher for each grade level starting in kindergarten. All K-5 classes have less than twenty students. My third-grade class currently has nine students, five girls and four boys. Having a small class allows for one-on-one instruction and gives the students opportunities that they might not have in a larger class setting. Their mission is to develop well-rounded individuals with strong moral character, physical fitness, and intellectual curiosity who are capable of achieving high standards of excellence and who will be productive contributors to the future.

When incorporating Project Based Learning (PBL) with STEM (Science, Technology, Engineering, and Math) and NGSS (Next Generation Science Standards) instruction into my schools’ mission, I feel that it can help to develop well-rounded individuals, bridge achievement gaps between my students, strengthen intellectual curiosity, and allows for them to become more independent thinkers, problem solvers, and productive contributors to the future.

PBL is important because it allows students to look at the project and work out the most effective way to solve the problem. They are able to develop problem-solving
skills while working collaboratively. I have chosen to use STEM and NGSS along with PBL because each has guidelines that merge with the practices of PBL instruction. This is beneficial to my students because they learn well from self-directed learning and this will help them develop self-confidence. Additionally, even though my current class is small, PBL offers an outlet for all learners to be successful.

The unit is organized in lessons and is designed in a way that will help any teacher effectively teach PBL through science instruction. I have chosen to use resources from a program called Engineering is Elementary (EiE), which was designed by the Museum of Science in Boston, Massachusetts in 2012. EiE is a great resource because it brings an engineering idea, like building a bridge and transforms it into an entire project geared around solving a specific problem. It provides a research-based curriculum approach for elementary grade levels. It additionally helps the students understand what elements are behind engineering in order for them to be successful in the project and gain critical thinking skills, which is fundamental in PBL instruction.

A key component to effective PBL instruction is to provide an instructional model which uses authentic, complex, real-life projects to motivate learning and provide learning experiences that the students are able to use in the real-world (Shu-jing & Li-hua, 2010). Furthermore, PBL allows for students to think critically about a real-world problem and apply skills to help them solve that problem. In a PBL focused learning environment, students take a more active part in their learning, they are challenged to use critical thinking skills, apply problem solving, learn content knowledge, have productive team interactions, and promote active learning (Carone &Burker, 2007).
In order to gain the students’ interest, I will begin the unit with a question that will guide students in their investigation of the problem: Your school has a big problem; Mrs. Arriola accidentally was digging around the office and discovered a huge hole. Now there is a hole in the middle of the classrooms, which lead to the office. Besides fill in the whole with dirt, what is the 3rd grade class going to do?

The following NGSS Physical Science standard from the section on motion and stability: forces and interactions will be used, 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. The students will go through the process of what it takes to design a bridge, they will learn about force and motion, push and pull acting on an object, and be able to construct a bridge that will work to solve the problem posed.
Chapter 4: Implementing PBL

Implementing PBL learning in Science for 3rd Grade

About PBL-Integrated Learning

PBL learning has been shown across many different studies to be beneficial to students’ academic performance in multiple areas of learning. It allows for each student to understand academic content in a way that is attainable for him or her to learn. By participating in this unit, the students will be able to understand how to apply real-world application and critical thinking in order to help them solve a problem.

Addressing NGSS

To illustrate how PBL instruction can adequately be utilized in elementary science, a teaching approach has been developed using the Next Generation Science Standards (NGSS). The following 3rd grade standard was chosen, Motion and Stability: Forces and Interactions, which state: plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. The second standard I will be addressing is to have the students make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion (NGSS). Additionally, literature will be integrated throughout the unit to help the students to better visualize their projected outcome. This will help build their vocabulary to better understand how to construct their final project, which is to design a bridge to get from the school office to their classrooms. A seven-day PBL unit was developed to address this standard. It will consist of six instructional lessons with two days of building during the fifth lesson. The primary goals of this unit are to have the
students understand push and pull on objects, how bridges help people with everyday life, how to construct a bridge that will carry students from one side to another, and they will be able to see designs of bridges for different functions.

Some of the guiding questions throughout the unit will be: 1) What is the job of a civil engineer? 2) How are Newton’s 1st and 3rd law related to constructing a bridge? 3) What role does balance play when constructing a bridge? 4) Does your bridge work for the function it was designed for?

The expected learning outcomes for the unit are that the students will be able to understand what components of science go into making a bridge. They will be able to work together to implement their bridge design. They will develop critical thinking skills and problem-solving techniques.

This PBL unit is designed to meet all the needs of the 3rd grade class. First, it supports diverse learning styles. The lessons’ will address all the modalities of learning. Research has shown that by addressing all modalities in your teaching practices students will retain more content knowledge. Since PBL is designed around hands-on learning and group work, each student will be able to take on a role that suits their specific needs and interests. Secondly, this PBL instruction provides an authentic experience to the lesson being taught. Students will be able to relate and use their understanding of balanced and unbalanced forces to design a bridge that addresses a real problem. Lastly, this PBL unit guides students to explore, and motivates them to collaborate and critically think problems through to come up with the best solution. Overall, the students are able to procure a better understanding of science when PBL is taught effectively.
Lesson 1 – What is a Civil Engineer? (approximately 30 minutes)

Objective: The objective of this lesson is to have the class understand the different types of jobs that a civil engineer can do for a living. The students will explore with a hands-on activity to open the lesson. They will then move into a discussion and watch a four-minute video on civil engineers from the past to present. The lesson will conclude with a worksheet to check their understanding.

Vocabulary/Academic Language: civil engineer

Introduction: To kick off the unit, the teacher will start by handing out a bag with 12 toothpicks and 8 regular sized marshmallows. The teacher will then proceed to tell the students that they need to design an object that stands by using all the supplies in the bag. The students will have 5-7 minutes to complete the task.

Middle: After the time concludes, the students will share their designs with one another. The teacher will then introduce the concept of civil engineering, which is; a person who designs public works, as roads, bridges, canals, dams, and harbors, or supervises their construction or maintenance. (Dictionary.com). This will lead into a video on a Civil Engineering Motivational Video: (https://www.youtube.com/watch?v=7rQLZgEYtJg). The video shows images with labels of all different types of past and present civil engineered projects. It is intended to leave the students inspired about wanting to know more about engineering and to motivate them to continue through the project. After the video, the teacher will make a KWL
(Know, Want to know, and Learned) chart to see what the students’ ideas of a civil engineer.

*Conclusion and Assessment:* The teacher will make a KWL chart to assess understanding. The students will conclude the lesson by completing a worksheet designed with the help of EiE. They will have to circle what a civil engineer does and then draw a picture of something else that they do. This will count as their independent wrap up for lesson one.
Lesson 1 Assessment – Civil Engineers

Name: ___________________________ Date: ___________________________

1. Look at the pictures below and circle **ALL** the things that a civil engineer would work on.

![City Skyline](image1.png)

![Computer and Keyboard](image2.png)

![Cell Phone](image3.png)

![Bridge](image4.png)

![Bicycle](image5.png)

![Can Stock Photo](image6.png)

2. In the box below, **DRAW 1** other thing a civil engineer would work on. Please label your picture.

![Box for Drawing](image7.png)

Worksheet adapted by EiE: Designing Bridges, Museum of Boston.
Lesson 2 – Newton’s 3rd Law – The relationship between - push and pull forces.

(approximately 45 minutes)

Objective: The students will be able to recognize the relationship between push and pull forces by observing interactions that they will make between various objects in a paper bag.

Vocabulary/Academic Language: force, interacting, relationship

Introduction: The teacher will start the lesson by reading *Push and Pull* (Patricia J. Murphy, 2002). This book is by Rookie Read-About Science and introduces kids the science concept of pushing and pulling. It has colorful photos and gives good examples about forces that are being pushed or pulled and how it affects different objects. After the reading, the teacher will have a poster with the words PUSH and PULL on the board. The students will each receive two post-its and post their own drawing of one push and one pull to the poster. Some examples are a wheel barrel, wagon, stroller, etc. After this quick check for understanding, the students will learn the definition for Newton’s 3rd Law, which states for every action, there is an equal and opposite reaction. In more simple terms, for every interaction there is a pair of forces acting on the two interacting objects. The size of the force on the first object equals the size of the force on the second object. The teacher will explain some push and pull forces in the classroom (pencil push down on desk and the desk pushing up on the pencil, the students pushing down on the floor and the floor pushing up on the bench).

Middle: The students will be split into groups of 2-3 and get the following four items in a brown paper bag: a tennis ball, clothespin, paper and pencil, and a four-foot rope. They
will have to work together and figure out which items can be used by pushing, which items can be used by pulling, or both. They will need to demonstrate each example to their teacher.

*Conclusion and Assessment:* Following the group activity, the students will have to complete a cut and paste handout assessment individually. This will show their understanding of Newton’s 3rd Law and will help the teacher to know which students are still having a difficult time grasping the concept of force using push and pull.
Lesson 3 – How does balance play a role in building a bridge? (approximately 45 minutes)

Understanding Newton’s 1st Law

Objective: After a lesson on Newton’s 1st Law, the students will be able to understand the importance of balanced forces on an object after completing an activity on balancing beans.

Vocabulary/Academic Language: balanced forces, investigate, unbalanced forces, weight, engineer, prediction

Introduction: To start the lesson, the teacher will pose the unit question to the students: Your school has a big problem; they recently had a sinkhole in the middle of their campus. The students have not been able to get to their classes. The 3rd grade class had an idea; they want to build a bridge to help get all the students and teachers across. They didn’t know where to start so they contacted Joey, a civil engineer who makes bridges for a living. He is going to help them fix their problem. After the problem has been told, the students will read the non-fiction book Brides Are to Cross (Philemon Sturges, 1998). They will discuss the different types of bridges that they saw and they will be able to discuss which bridge might work best for their problem.

Middle: The students will then be given a coat hanger with two cups attached to string hanging from it and a cup of dried beans. The teacher will instruct them that they need to balance the beans in the two cups so that the coat hanger is balanced. The teacher will ask each student to make a prediction as to how many beans each cup will need to be balanced, they will chart the predictions on the board. The teacher may choose to model
what it may look like when the coat hanger is unbalanced. It is important to note that weight is a force and it is the weight of the beans on each side of the hanger that determines just how balanced the hanger is. The students will be given the Balancing Beans handout before they begin their investigation. The teacher will facilitate during this time, and assist the students when needed. They will be given 20 minutes to complete Balancing Beans.

*Conclusion/Assessment:* Following the investigation, the teacher will call the students back together and discuss their findings. The teacher should ask the following questions: how many tries did it take for you to balance the beans?, how many beans did you need to put in each cup?, by observing your Balanced Bean project, how do you think balancing beans relates to a balanced bridge? The teacher will add their discussion ideas to the chart made earlier in the lesson on bridges. The teacher will close the lesson by having the students watch a video on Extreme Engineering Under Construction. This video will show a snip of what it is like to make a balanced bridge.

**Link to website:**

http://science.howstuffworks.com/bridge-building-videos-playlist.htm

**Picture of Balancing Beans Investigation:**
Lesson 3 Assessment - Balancing Beans

Name: ________________________________ Date: _____________________

Answer the following questions.

1. Before you begin, what do you think will happen if the beans are not balanced correctly in the cup?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. By looking at the amount of beans you were given, make a prediction as to how many beans each cup will need for the coat hanger to be balanced?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. Was your prediction correct? Why or why not?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

4. How do you think this relates to having a balanced bridge?
________________________________________________________________________
________________________________________________________________________
5. Draw a picture of your Balanced Bean project. Be sure to label each part and draw the beans used for each cup.
Lesson 4 – Making a blueprint of your bridge.

(approximately 45 minutes)

Objective: After reading a book on bridges, the students will work together to design a blueprint using graph paper for a bridge that they are planning on constructing.

Vocabulary/Academic Language: blueprint, construct

Introduction: The teacher will start the lesson by reading the book *Kids Discover: Bridges* (Kids Discover, 2014). This book describes and shows pictures of the many types of bridges. It gives the students an idea of which bridges would go best in which settings (Kids Discover, 2014). The teacher will chart the different types of bridges (beam, arch, suspension, cable-stayed, truss, and cantilever) and then the students will proceed to discuss which type of bridge would work best with the problem at their school. After charting ideas down about the different bridges types and tallying the students’ thoughts on which bridge would work best, the teacher will explain to the students that they will be designing a blueprint on graph paper for their bridge design.

Middle: The students will proceed to get into their project groups. The will be handed a bin full of all the supplies (popsicle sticks, string, white glue, cardboard, index cards, and a toy car) that they will be getting to construct their bridge. By looking at the supplies in the bin, they will formulate a blueprint using information learned in previous lessons and a handout with the six different bridge types. The teacher will walk around to the different groups giving guidance and providing feedback as needed.
Conclusion/Assessment: After the students have decided on their design and have drawn out their bridge, they will answer a few short questions to make sure that understand why they chose the bridge design and what materials they will use to complete their design.
Lesson 4 Assessment – Making a Blueprint of Your Bridge

Using the graph paper, draw and measure out how you are going to design your bridge.
Lesson 4 Assessment – Making a Blueprint of Your Bridge

Answer each question in a complete sentence.

1. Which type of bridge did your group decide to design?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. Which bridge type did your group decide to work on, and why?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. How is your bridge design going to solve the problem your school is facing?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Lesson 5 – Construction of the Bridge

(approximately two, 45 minute sessions)

Objective: The students will be able to construct their bridge using the materials supplied and their blueprint design to help guide them. They will test their bridge and determine if it meets the guidelines in the rubric.

Vocabulary/Academic Language: balanced forces, unbalanced forces, modifications, stable

Introduction: The teacher will start the lesson by handing out all the bins to the groups. The teacher will pose the question and chart the problem again on chart paper. Each group will work together to construct their bridge. The teacher will remind the students that their bridge needs to be sturdy enough to hold 4 toy cars all the way across.

Middle: During construction of the bridge, the teacher will facilitate all the groups. The teacher will ask the students questions about what they are observing in the building process and the students should be able to give clear answers using force, balance, unbalanced, etc. The students will be working together to complete the assignment. The building process will take approximately two 45-minute sessions to complete.

Conclusion/Assessment: Each group will need to show their teacher that their bridge is capable of holding a toy car from the beginning of the bridge to the end. After each group completes their bridge, they will answer a worksheet to assess the engineering design process.
Lesson 5 – Wrap Up to Bridge Construction

Answer the following questions in a complete sentence.

1. Did you have to make any modifications to your bridge? If so, explain.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

2. Is your bridge stable enough to hold 4 toy cars? Explain.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

3. If you had to make your bridge again, would you choose a different design?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
4. Draw your final bridge design.
Lesson 6 - Unit Closing Lesson – Demonstration and Presentations

(approximately 45 minutes)

Objective: The students will be able to demonstrate their bridge and be able to explain the type of bridge they chose and why they chose that design.

Vocabulary/Academic Language: modifications

Introduction: The teacher will explain to the students that they will be presenting their bridge to the class. They will need to demonstrate how their bridge works and explain why they chose to make the bridge that they did. They will also have to talk about any modifications that they made during their construction process.

Middle: Each group will present their bridges. The other groups will be able to ask questions after each presentation. Once each group has gone, the bridges will be displayed in the back of the classroom.

Conclusion/Assessment: The wrap up the unit, the teacher will have each of the students share the challenges they faced during the construction phase of lesson 5. The students will also share all the positive aspects that they had while working together. The teacher will end the unit by charting what the students have learned and what any students might want to look further into.
### Rubric to Assess Bridge Design, Assessments, and Group Work

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bridge Design</strong></td>
<td>Our bridge was able to have 4 toy cars run across it. The bridge was stable and balanced.</td>
<td>Our bridge was able to have 4 toy cars run across it, but had some issues with stability and balance.</td>
<td>Our bridge was only able to hold 3-4 toy cars for half of the bridge and/or had some issues with stability and balance.</td>
<td>Our bridge was not able to hold any toy cars.</td>
</tr>
<tr>
<td><strong>Followed Blueprint</strong></td>
<td>We followed our blueprint accurately and had to make 0-3 changes to make our bridge work.</td>
<td>We followed our blueprint accurately and had to make 3-6 changes to make our bridge work.</td>
<td>We followed our blueprint accurately and had to make 7-10 changes to make our bridge work.</td>
<td>Our blueprint was wrong and did not help us.</td>
</tr>
<tr>
<td><strong>Overall Assessment Knowledge</strong></td>
<td>I completed all 5 assessments with 0-2 mistakes.</td>
<td>I completed all 5 assessment with 2-3 mistakes.</td>
<td>I completed all 5 assessments with 4-5 mistakes.</td>
<td>I completed all 5 assessments with 6 or more mistakes.</td>
</tr>
<tr>
<td><strong>Final Presentation and Scientific Knowledge</strong></td>
<td>We used 4-5 scientific terms when explaining our bridge to the class.</td>
<td>We used 3 scientific terms when explaining our bridge to the class.</td>
<td>We used 2-1 scientific terms when explaining our bridge to the class.</td>
<td>We used no scientific terms when explaining our bridge to the class.</td>
</tr>
<tr>
<td><strong>Team Work</strong></td>
<td>We worked well together and were able to resolve our own conflicts.</td>
<td>We worked well together and needed help resolving some of our conflict.</td>
<td>We worked ok together and needed help more than once to solve our conflicts.</td>
<td>We did not work well together and had to get help to solve our conflicts.</td>
</tr>
</tbody>
</table>
Material List for Unit

**Technology:** Through out all lessons, the teacher will need access to the internet.

**Lesson 1**
- 1 box of toothpicks
- 2 bags of regular sized marshmallows
- 1 box clear plastic sandwich bags
- Push and Pull by: Patricia J. Murphy

**Lesson 2**
- Post-Its
- 10 brown paper lunch bags
- 6 tennis balls
- 6 clothespins
- 20 feet of rowing rope
- paper
- pencil

**Lesson 3**
- 6 plastic coat hangers
- spool of yarn (any color)
- 2 bags of lima beans
- 12 small plastic cups

**Lesson 4**
- graph paper
- 4 plastic bins
- 1000 popsicle sticks
- white glue
- cardboard strips for each bin
- index cards
- 4 toy cars
- Kids Discover: Bridges by: Kids Discover

**Lesson 5**
- use supplies from lesson 4
Chapter 5: Discussion

This unit lesson guide has been developed to introduce elementary school teachers to a way that they can implement PBL instruction in science to their students. It has been designed to motivate and engage all students in science instruction by bringing science content to life with relatable situations. The end project goal is to have the students design a bridge for a problem that they are facing at school. The lessons leading up to the final project will allow the students to understand the science components behind what it takes to make a bridge. It gives each student a hands-on opportunity to explore the science behind balanced and unbalanced forces. Not only will this help each student’s knowledge in science content, but it is geared towards teaching them cognitive skills that cannot be taught from a book alone.

PBL instruction has been and can be taught using many different approaches, but the end goal is always designed to engage the students by using real-world application, problem-solving, and collaboration. Many researchers have discussed their findings on the PBL approach and although the basic idea is to have the students produce a project, many different avenues can be used to get the students to that point. I chose to combine EiE, NGSS, and a combination of both project-based learning and problem-based learning when designing my lessons.

I would advise other teachers to use this unit as a guide to their own teaching style and instruction type in PBL. It provides clear examples with a project for each lesson and will give teachers an outline of what should be addressed to reach the designated goal. In PBL instruction, students become their own “teachers”, and as a teacher, the role is to
facilitate instruction and guide the students in the right direction. With that being said, some students may require more help than others. At my current teaching position, I do not have any ELD students, so I was able to gear my lessons around knowing their vocabulary background. When you know your students academic ability, you are able to involve or change certain aspects of your lessons.

This unit project is consistent with the following statement from the NGSS when referring to having the students explore applications of what they have learned. “Students need to be able to make sense of the world and approach problems not previously encountered—new situations, new phenomena, and new information.” (NGSS, 2013) The unit project designed addresses the NGSS standard related to Motion and Stability in many ways. It allows the students to explore different avenues through PBL science instruction. It teaches the students to plan and conduct an investigation based on information acquired through learning the effects of balanced and unbalanced forces. It also allows the students to explore an object’s stability during construction of the project. In all the lessons, the students will be able to have self-regulate their learning (Li, 2012), problem solve, and collaborate with each other to get the best outcome.

As elementary school educators, we are responsible for making sure our students have the tools and knowledge that they need to succeed in the real-world. By providing students with PBL instruction, we are giving them a valuable asset that they can use when faced with critical thinking tasks outside of the classroom environment. I believe that PBL instruction in all subjects is a valuable tool for teachers to use when developing lessons because it not only challenges students, but it encourages collaboration and promotes problem-solving skills.
References


Li, Y. (2012). The negotiated project-based learning: understanding the views and practice of kindergarten teachers about the implementation of project learning in Hong Kong. *Education 3-13,40*(5), 473-486.


