CALIFORNIA STATE UNIVERSITY, NORTHridge

PROJECT-BASED AND COMMUNITY SERVICE LEARNING: A
RESEARCH BASED PROFESSIONAL RESOURCE GUIDE FOR
ELEMENTARY IMPLEMENTATION

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ABSTRACT

Project-Based and Community Service Learning: A Research Based Professional Resource Guide for Elementary Implementation

by Corina Bowens

Master of Arts in Education, Elementary Education

As an educator in an age of an incredibly stimulating, fast paced world, it has become evident that many students experience disengagement with school curricula as standardized tests, and a textbook based curriculum are implemented. The focus of this project seeks to examine Project-Based Learning (PBL) in conjunction with community service learning as a means of igniting an interest in learning, fostering meaningful connections, and ultimately preparing elementary students for a 21st century world and workplace. To demonstrate how PBL and community service learning can together be implemented successfully, a website is created to guide educators in understanding benefits and connecting with resources.
Chapter 1: Introduction

French writer, Louis Mercier once said, "What we learn with pleasure, we never forget" (Howe, 2006, p. 112). Reflecting thoughtfully on one's own school experiences, many might recall a select series of moments that shine colorfully through the gray blur of their elementary school days. Maybe it was in kindergarten when your Styrofoam contraption successfully protected your egg as it plummeted thirty feet to the ground; or fourth grade when you became Benjamin Franklin for 'open house'. Whatever the moment may be, somewhere, at some time, a teacher engaged a learner in such a way that content was not only fun, but authentic, stimulating, and ultimately memorable. While you may still warmly refer to these experiences and artifacts as 'projects', it is evident that projects are so much more than the model on the shelf. Through our exploration of project-based learning (PBL) in conjunction with community involvement within the science, technology, engineering, mathematics (STEM) framework, it becomes increasingly clear we as teachers have the opportunity to significantly engage our students emotionally, behaviorally, and cognitively--all the while preparing them for life in the 21st century.

Today, with the ever-present climate of the No Child Left Behind Act (NCLB) that drives the rigorous application of state standardized testing, the task of creating authentic, meaningful learning experiences has proven particularly challenging, especially when it comes to the integration of science. In 2008, the Center on Education Policy reported that since the 2001 implementation of NCLB, there has been a gradual yet momentous shift in allocation of instructional time in 58 percent of elementary school districts: The amount of time spent on mathematics and the English language arts (ELA)
have increased by approximately 89 and 141 minutes respectively, while instruction in science has continued to decline with an average decrease of 75 minutes per week. (Center on Education Policy, 2008). While the significance of a mere hour and 16 minutes a week decline in science instruction may not seem to exert damage to the prospect of producing scientifically literate students, its costs are real as educators, parents, and policy makers have seemingly begun to place less value on the importance of science within elementary school curriculum.

As federal and state funding for school programs disintegrates and expectations for student learning increase, we are faced with the challenge of educating our students in creative and meaningful ways with limited time, fewer resources or access to opportunities. While high stakes testing continues to drive our educational goals and purposes, our students’ educational opportunities suffer and their overall talents are invariably overlooked and neglected. Furthermore, as a result of increased standardized testing and minimization of instructional time and teacher motivation in science, many students have uniformly begun to view the subject as frustrating, inapplicable to their own life, and reduced to a 'grade game' in which spoils go to those who can memorize the most information with as little effort as possible (Burstein & Knotts, 2011; Fredricks, Blumenfeld, & Paris, 2004; Larmer & Mergendoller, 2012). Pope (2001) describes this trend as 'doing school'. As one high school student puts it, "People don't go to school to learn. They go to get good grades which brings them to college, which brings them the high-paying job, which brings them to happiness, so they think. But basically, grades are where it's at" (p.4). In order to prepare our youth to be informed citizens and enter the 21st century workplace, it is evident something must be done to promote and value deep
and meaningful learning over test scores. If the 'doing school' trend continues, science learners are neither develop a deep or prolonged interest in the subject nor the critical thinking and innovation skills necessary to contribute to the production of new knowledge, development of technologies that promote solutions to pressing problems of our global community. We are no longer living in the 1900s when 95 percent of jobs required only that employees follow simple procedures and 'bubbling' in the right answer on multiple choice tests could get the job done (Barron & Darling-Hammond, 2008). In today's global community, the need for elementary students to acquire a more holistic science learning experience is ever present (Hurd, 1998). Researchers recognize a shift in what it means to truly do science: less emphasis is being placed on developing new theories and laws and more attention is focused on science as it relates to human welfare, economic development, social progress, and the quality of life (1998). In order to gain the scientific skills necessary to develop knowledge in this way, it is essential for educators to begin reconsidering the way critical thinking in science can be scaffolded into a restructured curriculum. As expressed by Hurd,

Science literacy characteristics are not taught directly but are embedded in a lived curriculum where students are engaged in resolving problems, making investigations, or developing projects. Supporting laboratory and field experiences are viewed as exercises in citizenship. As teachers we need to recognize constantly that public understanding of science is conceptually different from the traditional forms embedded in the structure of science disciplines (1998, p.414).

Today, technology and global connectedness are advancing and expanding at such an astounding rate that the need for creative, innovative, original, and problem-solving thinkers is an unquestionable necessity. If we fail to develop such essential KSD in science for our students, we face a future citizenship comprised of individuals with
limited abilities to think in complex, creative ways or to solve essential problems experienced by an increasingly competitive global society. Such innovative skills are fundamental in maintaining and improving our global relationships and ability to survive in the ever-changing world in which we live. For instance, when examining the rapid disappearance of clean and usable water globally, our future scientists must be ready and able to tackle the challenge with innovative solutions. Anderson and Dripps (2009) highlight a grave future for all if solutions for salvaging our dwindling water supplies are not achieved:

Since the overall supply of freshwater is finite, as the population grows there will be less water per capita. Already around the world there are now numerous signs that human water use exceeds sustainable levels. Consequently, the overall prognosis is not good; in fact by midcentury as many as three quarters of the world population could face water scarcity (Rogers, 2008), and more than 76 million people are projected to die over the next 20 years because they can’t access enough fresh water (Jaffe, 2004).

Therefore, the need for instilling an interest in and providing access to an engaging science curriculum is absolutely imperative to the advancement of our future leaders in scientific discovery. Yet the challenge remains: how do we as science educators begin to deeply engage our students in a way that will instill a sense of wonder in the natural world, acquisition of ability in practical application and recognition of the connectedness between science and their real world?

A synthesis of the current research shows that a likely remedy to the widespread disengagement and dislike of science may lie within the integration of project-based and community-engaged learning through STEM in the elementary school grade levels. As advocated by researchers in the diverse fields of STEM, as well as Workforce Development advocates, such as the Society of Manufactures Education Foundation, a
significant way to ensure sustained student engagement and interest in the sciences is to welcome the scientific and career technical community into the classroom learning experience. Similarly, it is important to bring students out of the classroom and into the real-world places in the local community where STEM knowledge and creativity is being applied in local problem solving. Society of Manufacturing Engineers (SME) is one such company dedicated to providing funding and opportunities for students to engage in engineering, technology, science and math through a manufacturing outreach program. Through working with such qualified experts in the fields of science, technology, engineering and mathematics, students will gain greater access to and engagement in the subjects they are examining.

With such ongoing classroom experiences and community interactions, that are fostered through student engagement and lifelong learning in STEM project-based learning, our future generations will acquire, further develop and maintain essential skills in problem solving and critical and creative thinking. Scientists Betteley, Harr and Lee, integrated Antarctic sea life studies into elementary age classrooms by using actual hands on experiments coupled with technology and simulations to authenticate the overall experience.

This collaborative partnership between scientists and schools added value for learners by enriching the curriculum and improved student performance by modeling scientific processes and careers, motivating students to inquire about the word around them and solve real-world problems, and using best practice instruction (2013, p.16).

The ability to fine-tune knowledge, skills and dispositions as young science scholars will result in our future generations becoming the innovative and risk-taking individuals needed for the development of our great nation. By integrating science with
open-ended authentic PBL projects and connecting learners to their community, student 'voice and choice' will become part of an inquiry process that bridges the connection to students' real worlds and the 21st century workplace and community. Making the connection between science and the community through projects can therefore be viewed as an essential in creating and adapting a lived curriculum within students’ school experience (Hurd, 1998). Students who are enabled to actively engage firsthand within their surrounding community to solve, a variety of problems will be learning through 'doing'. 'Doing' science with community members and experts in the STEM field will allow students a greater opportunity to see the connections between their classroom-based instruction, as they acquire the multiple skills necessary to successfully interact with diverse groups of people in the processes of inquiry, discovery, problem solving and innovation.

The coupling of project-based inquiry and community engagement learning will provide opportunities to enhance and intrigue our current and future generations in the fields of science and other STEM related professions. The immense need for hands-on, real-world learning in the sciences will be examined in the literature review to follow. Furthermore, the handbook developed in a website format will provide the needed utilities for educators, parents, students and the community to contribute to and develop a science literate community ready to tackle the challenges of an ever growing interconnected global society.
Chapter 2: Literature Review

STEM Science through PBL

To gain a rich understanding of how and why PBL has an important place in the elementary science curriculum, it is first necessary to explore what science has meant to teachers and students in the past and where the future of science education is heading. Merriam-Webster defines science as "knowledge about or study of the natural world based on facts learned through experiments and observation" (Merriam-Webster, 2013). On a frequent basis, K-5 children watch science experiments on television, do assigned textbook readings, and follow provided lab procedures. Many times the aforementioned activities are designed to do just what the noted definition of science calls for: teach the truths inherent within scientific content knowledge.

While science was, once believed to be acquired through individual research based inquiry, current analysis determines the need for collaborative and hands-on approaches to inquiry. Hurd (1998) explains the historical attitudes toward science in the classroom citing the British philosopher, Herbert Spencer throughout his article entitled *Scientific Literacy: New Minds for a Changing World*. In the study, Hurd (1998) quotes Spencer as stating, “science courses make the pupil a passive recipient of others’ ideas and not in the least teaching the student to be an active inquirer or self-instructor” (p.408). While Spencer articulated his feelings in regard to the teaching of science in the 1800s, his notions still hold true in today's American classrooms. Teachers continue to primarily teach science in a textbook fashion, if at all, whereby students lack any real connection to the content being taught, nor contribute any meaningful solutions to the development of scientific research. The inability of students to connect with the science
curriculum to fully understand its importance and necessity in world matters ultimately prevents them from engaging and participating in the scientific, cultural, civic and social growth of our nation as children are left believing that the vast majority of what constitutes science is essentially unchanging facts and formulas; that scientists know all and there is always a right answer (Hanuscin & Lee, 2013). While students may acquire science knowledge, they are not often given the opportunity to acquire scientific thinking (2013; Krauss & Boss, 2013). In today's advancing global climate there is an increasing call to place more of an emphasis on this concept of thinking like scientists. In fact, according to Next Generation Science Standards (NGSS) it is recommended students more frequently engage in inquiry, observe patterns, propose explanations, develop models, design investigations, gather and analyze data, and construct individual, innovative explanations using evidential arguments (Krauss & Boss, 2013). It is crucial for educators and students to begin defining and seeing science as open-ended malleable methods by which we make sense of the world around us; a creative process where each voice counts and all can participate in constructing truths (2013; Hanuscin & Lee, 2013).

Hurd (1998) emphasized the need for such a lived curriculum, whereby:

Students have a feeling that they are involved in their own development and recognize that they can use what they learn…. The development of a lived curriculum in science/technology will require cooperative endeavors with specialists in the social sciences and the humanities, as well as in such fields as ethics, the judiciary, and political science (Hurd p.412).

Developing and encouraging engaging opportunities for students to embrace and experience science in cooperative and social settings is essential to improving and expanding our nation's ability to compete in and improve the world in which we live. The necessity to create a lived experience in the sciences is imperative, as our
relationships with people around the world grow and become increasingly intertwined. With the rapid expansion and interconnectedness gained from the growth of technology, we as a society must successfully learn to communicate and interact effectually to develop solutions to worldwide problems. Having a lived experience in the scientific realm, whereby students work with science experts in and out of the classroom would allow for improvement of communication and social skills as well as awareness of the nature science (NOS) that is necessary to further expand our overall ability to work civilly and productively with others. Students who have the opportunity to experience science in the community or within the community will be better able to cope with real-world interactions and provide real-world solutions to obstacles (Hurd, 1998). Therefore, students in the elementary classroom would greatly benefit from the expertise and involvement of various community members either in the classroom or community at large.

As we will evidence and explore more deeply in the forthcoming synthesis of literature, project-based science coupled with community-involved teaching and learning requires teachers’ innovation, critical evaluation, individual insights and inquiry. Each of these dispositions are necessary for developing this progressive undertaking of engaging K-5 students in the study of science process, nature of science and scientific literacy. Not only do PBL and community service opportunities inherently incorporate and reflect 21st century teaching goals in science but these models accomplish this while motivating and engaging students to an exponential degree.
Engagement: Defined

In order to grasp how project-based learning in conjunction with community involvement influences student engagement in elementary science, it is important to obtain working definitions and descriptors of student engagement as a whole. In today's classrooms teachers seeking to engage students may often glance around the room, notice working bodies, smiling faces and contentedly move along with the day. Being an arguably abstract concept, engagement is often thought of generally as a student's involvement, interest, and investment in school. As research shows, however, it is not always that simple to identify an absolutely engaged child (Christenson, Reschly, & Wylie, 2012; Fredricks, Blumenfeld, & Paris, 2004). To lay the foundation for the measurement of engagement within PBL, it is necessary to look more closely this concept and examine the working parts.

To aid in recognizing the indicators, Fredricks, Blumenfeld, and Paris (2004) breakdown the dimensional concept of engagement into three key components: Behavioral engagement, cognitive engagement, and emotional engagement. Behavioral engagement, researchers assert, is essentially the 'what you do' facet of engagement. For instance, following directions, participating in discussions, arriving on time, refraining from disruptions, and actively contributing to school-related activities may be self-reported or observed predictors. Emotional engagement, on the other hand, refers to the affective reactions students have in response to school, or in this case, the science curriculum. Self-reported feelings of boredom, happiness, sadness, interest, anxiety, excitement measure engagement in this area and essentially provide the incentive for behavioral engagement as well. The third component, cognitive engagement, is the
measured level of investment in academia characterized by going 'above and beyond'.

When students are cognitively engaged, intellectual behaviors such as critical thinking, deep-strategy use, and extracurricular-inquiry effort are frequent indicators (2004; Christensen, Reschly, and Wylie, 2012).

The Importance of Engagement

Perhaps the most powerful motive to strive for cognitive, emotional, and behavioral engagement in schools lies in what occurs when we lose sight of that goal. Studies reported by Christenson, Reschly, and Wylie (2012) assert that students who are not engaged often lack drive to participate, challenge themselves cognitively, or develop a 'sense of belonging' in school. Such factors associated with disengagement may in turn reduce the likelihood of school success as thoughts, feelings and behaviors continue to be perpetuated as negative relationships with faculty, parents, or ties to other disengaged students are strengthened (2012; Marks, 2000). In order to stifle this trend, it is important we as teachers ask ourselves what factors encourage students to become engaged in the behavioral and cognitive, and report a sense of belonging and comfort in the emotional areas.

Fredricks, Blumenfeld, and Paris (2004) advocate three main opportunities to be regularly presented to students, First, the opportunity for autonomy. This is described as doing things for one's self and personal desires, and is promoted by giving students the chance to work independently or collaboratively on a subject on which they are passionate. Autonomy is frequently noted as enhancing both behavioral and emotional engagement in school. A second positive influence on behavior and emotional engagement is meeting students' need for competence. This feeling of confidence in one’s
ability is something often inherent in most of us as we begin school but dwindles with negative school experiences that may result in low or failing grades. When teachers, peers and others recognize and reinforce student ability, it in turn reduces anxiety, raises self-efficacy beliefs, and allows the learner to feel in-charge of his/her own learning. When many adults reflect on their elementary science experiences they recall scribbling notes and nervously following step-by-step lab directions to avoid the 'wrong' reaction and peer embarrassment if something goes wrong, all the while avoiding eye contact with the instructor. The third reason why true engagement is necessary for learning demonstrates that educators need to seek the opposite of this common science experience. Taking care to develop pro-social relatedness between student peers as well as the teacher enhances emotional engagement, as the student is able to obtain supportive connections during science and therein experience the joy of learning with those same peers and/or adults (Christensen, Reschly, & Wylie 2012; Marks 2000).

Renowned seminal constructivist theorists John Dewy and Lev Vygotsky echo these indicators of engagement, as they have asserted that children learn more effectively and are more engaged when they are able to have individual experiences and make personal, meaningful, connections with their content (Brooks & Brooks, 1999; Skoning, 2010). Blakemore's research provides evidence of this as he found that for students to be successful and engaged in content they need to be actively involved in decision making, be supported in exploring creative solutions to problems, and provided with sufficient time to reach conclusions (2004). These kinds of authentic, personal, and real experiences "doing" the content as opposed to passively following directions are, as many students will matter-of-factly tell, more fun and interesting. Teachers find that students more
readily transfer these experiences to life outside of school and show evidence of their developing scientific thinking. It is therefore necessary to have a clearly laid out lesson plan to aid in the absolute goal of attaining engagement of all students.

**Engagement and the NASA 5E Lesson Format**

Educators can achieve engagement in a project-based learning experience by aligning their goals and objectives with those of the NASA 5E learning cycle model. NASA outlines the 5E lesson plan to include, Engagement, Exploration, Explanation, Elaboration, and Evaluation. In the first stage of 'engagement', learners are intrigued by a problem that needs further exploration to conquer. Following a discovered area of interest the learner then approaches the second step in the 5E lesson plan of, 'exploration'. Exploration allows for hands on manipulation of materials necessary for understanding the problem posed. It is here where the learner will gather, organize, interpret, analyze, and evaluate data to search for answers or develop additional questions to be considered. Following the exploration and investigation of the question of interest, learners will have an opportunity to use the information gathered to explain their new understandings. In the 'explanation' stage of the project-based learning experience the learner will clarify understandings discovered, reach conclusions or generalizations and communicate such discoveries using various modes and forms. Students will then 'expand' their learning. As students construct new meanings for learned content, they must apply the newly acquired knowledge toward impacting and improving real life situations and problems. In the final stage of the 5E lesson plan, students will evaluate their learning and understanding of the project examined. Learners accomplish this through self- reflection by assessing their knowledge, skills and abilities (Mwsu.edu). Learning through doing, as is achieved in a project-based learning experience must be accomplished through thorough and planned
out lessons. As project-based learning is examined, one must keep in mind its success to be highly impacted by its implementation.

**Project-Based Learning: Defined**

So, what is PBL? Was it that model of the atom you built? The wax-resist solar system painting you did when studying astronomy? The photosynthesis poster on which you carefully labeled and described the parts of a plant? When many teachers and students think of projects, these images immediately jump to mind with process as a secondary consideration. While seeking to engage students through multimedia and various realia it becomes important to make large strides in best practices that engage and motivate students. Research in the growing field of PBL and the constructivist practices that support it, demonstrates that there is simply more to it. Scholars, investigators, and proponents of the PBL approach define it as largely a process in which students collaborate, communicate, make choices, inquire, investigate, bridge global connections, and self assess as they demonstrate learning through the construction of authentic products or presentations (Barron & Darling-Hammond, 2008; Bell, 2010; Blumenfeld, 1991; Larmer & Mergendoller, 2010; Ravitz, Hixon, English, & Mergendoller, 2012). While products like a painting, poster, or model may result, the PBL approach ensures that the process of creation incorporates aforementioned critical engagement-boosters such student voice, real-world application, and individual goal setting. Simply, following instructions to create a project and reviewing predetermined facts is not an element of PBL. In contrast PBL requires students to use higher order thinking strategies to determine a problem or need and calculate the best solution to resolve that self encountered issue.
**Pieces of Project-based Science**

In *Thinking Through Project-Based Learning: Guiding Deeper Inquiry*, Krauss and Boss (2004) highlight the benefits of PBL, particularly within the elementary science curriculum. Since the exploration of the world around us is inherent in all, immersive inquiry investigations that lead to discovery are not only a natural way to construct meaning but get at the true nature of science (NOS). But how do we as teachers implement such an approach successfully? In an article published through the Buck Institute for Education (BIE), Larmer and Mergendoller (2010), describe eight components of successful project approach to learning. As we explore each of these elements in synthesis with pertinent research, it becomes increasingly clear that PBL serves as a catalyst for student engagement in elementary science.

**Significant content and the need to know.** While much of the learning in PBL is student centered, it is still important to meet current state science standards. However, it is also important that content have relevance and importance within the minds of teachers as well as students. When students begin to see content as relevant within their own lives or in exploration of their real-world, the second indicator of PBL, the need to know, emerges (2010). This part of PBL might be thought of as 'the spark that lights the fire'. Here, the teacher employs real-world primary sources, stories, guest presentations, or leading questions that ignite curiosity and cognitive connections within learners. Studies analyzing the long-term effects of engagement with science signal that when students are supported in their pursuit of knowledge students are more likely to pursue interests in science and choose careers in the field (Farenga & Joyce, 1999; Krauss & Boss, 2013). This finding clearly demonstrates how simply supporting children in their quest for
scientific understanding fosters long-term interest in the sciences. As a result, students will experience heightened self-efficacy through autonomous investigation, and engage behaviorally, while freely utilizing cognitive strategies in science.

A driving question. "A project without a driving question is like an essay without a thesis" (Larmer & Mergendoller, 2010, p.2). As researchers eloquently assert, in PBL the driving question serves as the heart of student inquiry. Most often facilitated by the teacher with a specific learning goal and/or challenge in mind, the driving question is open-ended, relates to student-inquiry interests, and invariably leads learners down a path of discovery, hypothesis making and further questioning (2010; Barron & Darling-Hammond, 2008; Blumenfeld, 1991, Thomas, 2000). Looking at driving questions from the perspective of elementary science, a driving question should address key science theories or concepts yet provide the necessity for students to develop smaller, more intimate investigative queries meaningful to their interests and world (Brown & Abell, 2013). For instance, while the teacher may propose an initial driving question of Why should we recycle? students zoom in on a more specific, individually-motivating driving question such as How does recycling help protect the lives of Dolphins? or How does recycling help families in my community save money? As one might infer, the autonomous and individually-relatable nature of the driving question is what makes this element of PBL a successful engagement hook or “anticipatory set” when it comes to science.

Voice and choice. As touched upon previously, student voice and choice is perhaps one of the most essential elements of the PBL approach. This is the element that makes learning memorable, meaningful, and individual to students. Within the outline of
a larger driving question, students micromanage their own learning as they make decisions about what pieces of content to investigate, how to structure time, allocate responsibilities, and choose which materials or methods they will use to pursue their leaning and present evidence. (Barron & Darling-Hammond, 2008; Bell, 2010; Blumenfeld, 1991; Chu, Tse, Low, & Chow, 2011; Larmer & Mergendoller, 2010; Schwalm, & Tylek, 2009). In the article Collaborative Inquiry Project-Based Learning: Effects on Reading Ability and Interests (2011), researchers Chu, Tse, Loh, and Chow closely examined how Hong Kong fourth-grade primary students were affected when teachers cooperated and implemented project-based learning (PBL). In order to determine how students' reading and engagement is affected by PBL, researchers designed a learning activity that consisted of two PBL phases in which students completed individually-selected research projects. The first phase lasted ten weeks and called on students to engage in inquiry and design of an individual project under the open-ended theme of "the Earth". The second nine-week phase, asked students to choose a topic, search for information, and produce a presentation under the theme of History of Hong Kong and Mainland China. Upon analysis, results of the survey calculating the perceived effects of PBL demonstrated that all participant groups (including teachers, students, and parents) noticed how children in PBL borrowed library books more frequently and self-initiated the exploration of magazines and newspapers to seek information. It was concluded that because of the students’ PBL experiences a heightened interest in reading positively affected their reading abilities (Chu, Tse, Loh, & Chow, 2011). Implications of this study signal that when it comes to classroom applications of PBL, student choice positively influences engagement outcomes.
**21st century skills.** Another way PBL continually destroys the wall separating the classroom from the real-world is by incorporating and facilitating the use of technology, communication, collaboration, and critical thinking that develops deep understanding and promotes problem-solving abilities. As noted previously, we as a global community have moved into the 21st century, an era that already shows promise of constant innovation and technology growth. In order to fully engage our students in knowledge acquisition it is essential to bring awareness of the global problems, challenges, advances, so they understand the need for corollary knowledge and skills required of them in the real-world. Hence the need for the dimensional pedagogical practices and learning promoted in PBL (Barron & Darling-Hammond, 2008; Bell, 2010; Blumenfeld, 1991; Brown & Abell, 2013; Chu, Tse, Low, & Chow, 2011; Larmer & Mergendoller, 2010). Krauss and Boss echo the need to bridge the classroom with real-world connections as they pose, "How have we reached the ridiculous point where one may be considered illiterate if she does not know how many legs a grasshopper has, yet it is considered perfectly fine in not understanding how the water comes out of a faucet?" (2013, p. 105). Facts about bugs and steps of the water cycle are important but without the connection to real-life and daily out-of-the-classroom experiences content remains abstract and therefore not engaging and frequently unmemorable.

In a German study, Zumbach, Kumpf, and Koch (2004) compared two fourth-grade classrooms: a project-based science class and a traditional, teacher-directed class. Students were challenged to identify a small animal and decide what to do when encountering it in the woods. In the traditional, lecture-based approach a movie and verbal explanations, questions and answers were used to communicate content. In the
project approach class, children used technology and collaborated in groups to develop learning outcomes and processes. Results of student motivation surveys showed that when compared to their counterparts, students in the PBL science class had higher motivation and spent significantly more time out of class working on projects that involved the web and computers. In addition, through knowledge acquisition measures it is noted that PBL students had better long-term retention of content as opposed to those in the traditional classroom (2004). These results suggest that PBL in science is effective in behaviorally, cognitively, and emotionally engaging children as it provides the opportunity to use skills and develop skills that are actually relevant in the world today.

**Inquiry and innovation.** PBL simply would not be PBL without inquiry and innovation. Think back for a moment to the styrofoam egg contraption and dramatic interpretation of Benjamin Franklin offered in the introduction. One reason why these culminating activities or others like it are often so vividly recalled is because of the process used to create them. Research suggests that content is more meaningful and engaging when students have the ability to take part in real and authentic inquiry and discovery (Barron & Darling-Hammond, 2008; Blumenfeld, 1991; Larmer & Mergendoller, 2012). National Science Education Standards (NSES) define inquiry as "a multifaceted activity that involves making observations; posing questions; examining books and other sources...planning investigations; using tools to gather, analyze and interpret data; proposing answers, explanations and predictions; and communicating the results" (as cited in Ohana, 2013, p. 15). In essence, what real scientists do. Would we have remembered creating the egg-drop box if we had simply followed step-by-step directions or recalled walking in the shoes of Benjamin Franklin if we had
merely memorized a script in unison with the rest of the class? Researchers in the field of inquiry suggest it is unlikely.

In a synthesis of literature and action research examining the impact of science inquiry on elementary, middle, and high school student outcomes, the role of inquiry on student engagement is supported. In five of six studies, students showed heightened conceptual learning in inquiry based science practices. A later assessment further demonstrated that retention of content was higher for students who were able to take part in discovery learning (Minner, Levy, & Century, 2009). Similar studies cited in Hanuscin and Lee (2013) looked at the science attitudes and beliefs of first and fifth graders. Before taking part in project-based science, first graders reflected on the idea that scientists do not change their ideas and that once a conclusion is drawn science is over and fifth-graders believed the most important part of science is finding the 'right' answer (2013). Engaging students through inquiry ultimately allows the opportunity to break this often perpetuated stereotype and see the creativity in science. Students who look for multiple solutions, see multiple perspectives, and take charge of their own discovery not only better understand the nature of science but gain confidence, efficacy, interest, and therefore engagement in learning.

**Collaboration and revision.** Collaboration and revision among students are two more elements of PBL that foster student engagement within the science content learning arena. Research in the field of PBL suggests that while student voice, inquiry, and significant content are important to engagement and the process of the PBL approach, students must have the opportunity for discussion, reasoning, and collaborative designing in order for deep meaningful learning and engagement to occur (Bryson, 1994; Minner,
Levy, & Century, 2009). In a PBL program referred to as FIRST (For inspiration and Recognition of Science and Technology) educators strive to motivate students to take interest and engage in math, science, engineering and technology. Upon rising to inquiry challenges throughout the program students are placed in teams according to self-reported interests and talents. Students are then placed into teams of diverse abilities to cooperate, communicate, and collaborate to design projects. While the inclusion of student interest is engaging in itself, the fact that students learn to work with others' of varied backgrounds and skill levels allows for raised behavioral, emotional, and cognitive engagement as all parts of the team are necessary and important to the understanding of science concepts and culminating artifact (Furger, 2001, as cited in Barron & Darling-Hammond, 2008). Reflecting on one's own school experiences, we often can recall the joy we felt when we had the opportunity to collaborate with friends and peers. We likely also recall the disappointment and frustration we felt in being told to switch seats because 'there is too much talking'. Since many have experienced this scenario, it comes as no surprise that students are more engaged when they have the opportunity to reflect and discuss. As Bronfenbrenner advocates, "Children learn by paying attention to other people, events, and aspects of their surroundings that they find meaningful and enjoyable (1979 as cited in Marks, 2000, p. 155). The key, it seems is directing chatter toward academic conversation. PBL serves as an effective approach as it allows for open-ended collaboration yet is still centered on learning.

A publicly presented product. A publicly presented product or artifact represents the culmination of a successful projects unit. With the process of learning being authentic and meaningful, it too is necessary to give the created artifact a real-
world authentic context to exist in. In PBL it is highlighted that when work is presented to a real audience, as opposed to the teacher alone students invariably are more invested in creating work of high quality. (Larmer, & Mergendoller, 2010). One project undertaken by the Philadelphia Out-of School Time (OST) program sheds light on the benefits of presenting authentic project discoveries to a real-world audience. When elementary school students in Centro Nueva Creacion found themselves frustrated with litter and trash in the community, they began a project to discover ways in which to help the community. As a result, a clean-up project was proposed to members of the community and students performed a play to further educate members about environmental issues (Schwalm & Tylek, 2009). Through this process and community involvement, students not only enhance their academic knowledge and understanding of science as well as engagement, but students learn how they too can make a difference in the world and become scientists themselves.

Now that it has been established that the project approach lays a solid foundation for student behavioral, emotional, and cognitive engagement, we turn our magnifying glass on this piece of PBL that might often be underestimated: engaging with science through community involvement.

**Community Service Learning**

Community service learning is an opportunity for students to interact with community members and content experts in a real-world, hands-on environment. Students not only grasp a solid understanding of the content being taught but also establish relationships with the many diverse populations around them. As described by Service Learning (California State University, Northridge, 2013):
Service Learning is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities.... Through service learning, students—from kindergartners to college students—use what they learn in the classroom to solve real-life problems. They not only learn the practical applications of their studies, they become actively contributing citizens and community members through the service they perform.

Community service learning offers an enormous benefit to students involved because it gets them out into society to learn and experience in an environment that will be essential for them to thrive in. Students involved with service learning successfully develop and learn through active participation in a thoughtfully organized service experience (Ohn & Wade, 2009). Students typically spend much of their day in the confines of a classroom and the remainder of the day in front of the television or consumed by video games and computer activities. While classroom learning is necessary, working in the community gives greater meaning to the purpose their education will serve. Furthermore, students’ lack of social interaction as a result of television and computers hinders their ability to socialize and work effectively and cooperatively among their peers. So while students are becoming experts and contributing to solve many social and scientific problems in the community service realm, they too are strengthening their ability to work with a variety of people.

According to Jenkins (2010), service learning has a positive impact on student personal outcomes. As a result students participating in service learning projects are more emotionally, behaviorally, and cognitively engaged as they are able to demonstrate elevated efficacy, positive moral judgment, and a higher ability to work well with others. Furthermore, students generate greater social outcomes in facilitating racial and cultural understanding, citizenship skills and continued community involvement. The
ability to work with diverse groups of people to solve problems and develop solutions is the most necessary skill in expanding and strengthening our countries growth in the global society in which we operate.

**Types of community service learning.** Whether students are embarking on scientific and social adventures in the community or interacting with experts in the classroom, all opportunities of community engagement impact students in a most positive way. All experiences that encourage students to believe they are capable and well able to achieve science related goals are necessary in building a stronger scientific community. Students’ confidence and self perceptions must be nurtured in a way that lead them to believe they can do and achieve success in the sciences. Integrating the community and classrooms is one way to achieve scientific breakthroughs and growth by children in grades k-12. Utilizing the resources and philosophy of STEM are helpful in leading the teaching needed in science, technology, engineering and mathematics content areas. Evaluating STEM when strategizing ways to strengthen students’ academic experiences is essential. Combining areas of STEM, particularly the sciences with community outreach programs are necessary to expanding student engagement.

STEM is an acronym standing for science, technology, engineering, and mathematics. It is a method of integrating many disciplines in a way that prepares and strengthens our students’ ability to compete in a global society. As the need for students to compete globally increases, it has become essential to prepare them in ways that more closely “parallel the work of a real –life scientist or engineer” (Breiner, Harkness, Johnson & Koehler, 2012, p.3). Incorporating STEM lessons into a k-12 curriculum aims to produce students who are capable, competent and prepared for professions in the
sciences, mathematics, engineering, and technology fields. Successful STEM strategies are accomplished through integrating meaningful hands-on experiences that aim to engage and prepare students to be productive and contributing members of our growing economy.

One use of STEM and community involvement was articulated in an article entitled *Sharing Antarctic Research in the Classroom: Authentic Outreach as a Means of Improving Student Performance*. In the article researchers of the Antarctic sought to incorporate their actual research into the lessons of elementary school age children. While some scientists worked in the classroom with students and teachers to enact simulations of actual Antarctic research, scientists in the Antarctic also used technology to bring the Antarctic directly to students in the classroom. Therefore, students were able to witness life and projects researched in the Antarctic firsthand. Additionally, teachers were sent to the Antarctic to work hand in hand with the research team to better understand the work being done there. This unprecedented opportunity for professional development is necessary in properly training teachers to be better able to educate children in the subject matter being taught. Teachers became better equipped to offer current insight into the Antarctic experience. Students in turn benefited from the expertise of teachers and researchers to explore and study “current and meaningful research questions, issues, or real-time phenomenon” through technology and hands-on research (Betteley, Harr, & Lee, 2013). As a result students were far more engaged and well prepared for future experiences in the science and social studies realm. Teachers and researchers were able to generate greater interest in students’ desire to further study and explore various scientific fields of study and or professions.
Allowing students opportunities to explore subject matter firsthand is essential in their gaining a clear, more in depth understanding of and connection to the material being presented. Baker, DeCoito, Pedretti & Shanahan (2011) established students exposed to science through community outreach programs such as Scientist in School or SIS would experience a deeper interest and disposition toward a future in science and technology professions. SiS’s goal was to encourage and ignite an interest in the sciences through offering elementary schools access to actual scientists and engineers. SiS provided expertise and support to teachers and students through hands-on learning experiences. The SiS program specifically aimed to “inspire greater understanding and interest in all young minds” and to “expose students to the excitement and enjoyment of scientific discovery” (Scientists in School, 2004). The success of the SIS program as well as other service learning curriculums demonstrate the great need for additional opportunities that offer real-life experiences to foster students’ scientific and social democratic growth. Bridging students and the community is essential in attempting to direct students in the field of science while at the same time strengthening their ability to work with others to solve a variety of scientific and societal problems.

Effects of PBL with community involvement on science engagement

Bryson's 1994 examination of project-based learning within a first grade classroom adds to the growing support of implementing this approach as means of heightening student engagement. In this study, students took part in two separate thematic learning experiences with their teacher recording qualitative observations. First, students took part in a dinosaur unit in which the teacher supplied a series of questions to be answered about a given dinosaur. With inquiry questions developed by the teacher rather
than students, in their search for answers reported qualitative findings showed that most often students searched for answers they were looking for as opposed to the ones related to the given question. Further, during free reading time, students frequently chose to read about dinosaurs. The second learning experience had students engage in critical inquiry around the topic of frogs. During this unit, students developed driving questions and spent time searching for information about the questions they had. "They turned immediately turned to the indexes as a way to find their information and tackled resource books with great vigor, even those written above their reading level" (Bryson, 1994, p.10). The dinosaur unit may by many educators be considered successful. Students enjoyed the topic were learning about and were eventually able to regurgitate the correct answers to supplied questions. However, in comparing the two, it is clear the frog project simply took students to the next level of engagement. Students driving their own learning were motivated to go above and beyond, make stronger personal connections, and take joy the process of scaffolding their own knowledge.

Dresden and Lee (2007) added to the evidence that PBL heightens engagement in science through a similar first grade study comparing traditional (teacher-led) and project approaches to science. In this study, learning and performance outcomes of a traditionally taught unit on animals was compared with student learning and performance outcomes of a following PBL unit on chicks. Data collected through student work samples, photos, and videotape ultimately indicated a dramatic rise in response rate in PBL when it came to answering questions and discussing individual projects. This finding signals deeper more meaningful and engaged learning on behalf of the learner as students were able to
raise competence beliefs through autonomous and peer collaboration as related learning to the world around them.
Chapter 3: Methodology

About Our Project

To aid in preparing current and future elementary educators to develop science learning in children of the 21st century, our pedagogical resource website, Teach Science For Tomorrow (www.teachsciencefortomorrow.weebly.com) was established. Each section and page of this website has been carefully crafted in consideration of what current research dictates as fostering meaningful and life-long learning experiences in science. Upon visiting Teach Science for Tomorrow, teachers are given the opportunity to learn about our project goals, explore the benefits of project-based and community learning, and utilize a helpful how-to guide for implementing successful projects and integrating the community within their own classroom. Strategically chosen sample projects are provided to act as models for implementation, and selected resources are linked giving educators a plethora of options for integrating projects and the community. Finally, an 'in the news' section linking real-world successes of PBL and community learning, serves as an energizer for teachers as it illuminates the connection between authentic teaching and meaningful, real life application of learning.

About us About us, a short biography of Laura and Corina welcomes teachers to learning about our cause by making a supportive teacher-to-teacher connection. Being a teacher today, it is often easy to get lost in the academic conversation, empirical research, teacher manuals, and district mandates that are ever-present and often overwhelming. In development of our website, we as teachers ourselves wanted to let others know that we are, in essence, just like them. We feel the struggles of standardized bubble-in answers and we know the frustration of losing children's interest when teaching to the textbook.
We want other teachers to know we lend an empathetic ear, know where they are coming from, and believe they too can evoke positive change in their learners. By sharing our stories and explaining why and how we believe in project learning, we hope to inspire others to take risks, test a new way of teaching, and reach out to the supportive community around them.

**About PBL and Community-Based Learning.** To introduce viewers to our site and establish fundamentals of PBL and community involvement, an 'About' section is incorporated. Here, we discuss what projects and community contributions are and detail the benefits of each in a succinct and teacher-friendly manner. With research from the previous review of literature alluded to, this section provides a strong foundation for building conceptual understanding for professionals. For instance, we detail projects as being authentic, central to the curriculum, student-driven, focused on inquiry, investigation, and performance based and community learning as being central to gaining a real-world insight while making connections to one’s personal school experience. For example, students participate in projects that heavily relate to their interests and incorporate the community and industry experts to authenticate the overall task. Therefore, students are making real connections to the world in which they live, while developing solutions to worldwide issues early on in their educational careers. We then go on to explain how PBL and community learning are beneficial to leaning science as they are engaging and prepare young learners for the rapidly developing world they will emerge into.

**Bring PBL to Your Classroom and Community**
As teachers, we felt after providing research-based information about why project and community learning is beneficial it is necessary to provide educators with useful tools to take directly into the classroom and community with them. A 'How-To' drop down guide is included on Teach Science for Tomorrow, linking teachers to pages that detail how to establish the learning environment, connect progressive Common Core and Next Generation Science Standards, and how to implement engaging projects, complete with checklists. Furthermore, sample projects, PBL and community connection resources are included and easily accessible for teachers to explore and employ.

**A How-To Guide.**

*Create the environment.* Before going about the task of implementing projects and community learning in one's classroom, this page explains the necessary considerations that should be made to establish an environment of success and meaningful learning. First, we note the importance of collaboration. Mindful flexible grouping in which the teacher facilitates groups or partnerships of students is highlighted as an important part of PBL and community learning. Flexible grouping is a way of taking into account individual learning styles, abilities, and personalities to create teams that work together to enhance learning in other members. For instance, in a project about the water cycle, one student might have a parent that works for the water department and have tons of background information or resources for research, another student might have come from another country that obtains drinking water differently than in Los Angeles, another student might not have a lot of background knowledge but be a computer whiz. In flexible grouping, the teacher takes differences into account and rather than numbering off students to group them or allowing all the high achieving and low
achieving students to work together, teams are formed with experts in different areas to
develop a well-rounded project and a variety of social, and self-efficacy skills as well as
academic gains.

Most teachers can relate to walking into a classroom, seeing many students on
their feet, hearing chattering voices and feeling their blood-pressure rise. Our
environment page suggests that this is not necessarily an unsuccessful environment.
Allowing students the freedom to choose workspaces, and independently utilize
classroom resources acts to develop self-efficacious behaviors that therein yield more
satisfying, focused work and greater engagement in investigations. With the expectation
that students take control of their own learning in this way, it is also essential to set up
guidelines and goals for safety as well. For an open-ended inquiry environment to also
be safe, we advocate opening the floor for continuous discussion and application of
respect. Students work together to develop working, relatable definitions of what respect
means to students. They ponder together why it is important to use positive language, be
open-minded and supportive of each other's varied knowledge..

The above act of integrating one's self into a discussion rather than being the
leader or authority of right or wrong is also an important element of developing a
successful learning environment for project learning. We want teachers to know that
implementing a new way of learning does not necessarily mean hours and hours of
preparation time and micromanaging. Simply going through the process with students
and asking questions, listening, and modeling alongside them not only reduces anxiety on
behalf of the teacher but the students as well. Empowering students by letting them know
they are as much an authority as the teacher has the potential to significantly engage
learners. This course of igniting individual inquiry with students is another highlighted aspect of our 'Establish the Environment' webpage. As supported by research, we feel it is important for teachers to set and hold high expectations. It is not enough, for instance to say, "Okay kids, go learn about the water cycle!" It is appropriate however to expect clear plans, goals, and developed procedures for individualized inquiry from students. As noted on our site, students should always be prepared to respond to a 'tell me what you are working on' prompt.

Furthermore, authentic assessment of learning aids in the creation of a positive project-based learning environment, as students are made aware that their learning will be assessed on criteria they know best demonstrates their learning. To assess authentically, teachers may assess social and behavioral goals as well as academic performance, looking at the learning process holistically and considering growth made in all areas. This was an important aspect to note on our website as it again helps provide a more holistic visual of how to set up an environment that is supportive of open-ended learning.

*Integrate common core and next generation science standards.* The next section in our educator 'How-To' guide makes the connection between the Common Core and Next Generation Science Standards and PBL community learning. With the Common Core being implemented in California this year, there is a fresh call to teachers to look for ways to make learning more meaningful, deeper, and authentically-stimulating for learners. Students will more frequently find themselves being asked to explain their work and describe their thinking processes as opposed to memorizing facts and bubbling-in answers. Project-based and community learning proves useful in smoothing this
transition, as projects and community inquiry require learners to dive into research and resources to develop and uncover meaning. On this particular page of our website we link an Edutopia article, *The Role of PBL in Making the Shift to Common Core* as a resource for teachers to explore and further develop their understanding of how PBL can serve as a supplement to progressive standards. For teachers, parents, or community members still questioning goals of Common Core, we also link a short video by the District of Columbia, Washington Public Schools explaining the transition.

While we felt it was important to touch upon the Common Core standards because they are at the forefront of education in the upcoming years, we also felt it necessary to touch on a lesser-known movement to promote more meaningful learning in science specifically. The *Next Generation Science Standards* (NGSS), (as our linked video describes) effectively integrates core scientific content with an equal emphasis on scientific practices and inquiry. Engineering plays a newly important role as students are no longer required to memorize facts and procedures but to put theories and understandings of scientific concepts to the test in a realistic environment. Because NGSS is not yet recognized or mandated nationally, including information about these standards helps position teachers on the forefront of where teaching and learning is going in the upcoming years. Not only do NGSS seamlessly correspond to many goals of Common Core state standards, projects provided and detailed in upcoming sections of our website give teachers a clear view of how to promote learning that not only heightens academic knowledge but provides authentic, engaging learning experiences as well.

At the bottom of our ‘Integrate Common Core and NGSS’ page we provide some useful tools that are directly aligned with progressive standards. A 'rate your mates'
collaborative rubric is embedded to aid teachers in assessing authentic outcomes and culminating project ideas are included to provide teachers with a guide to meeting the standards through outcomes that can be developed through meaningful projects.

**Implement engaging projects.** To give teachers a clear idea of the process required to develop successful projects with community integration, we include a page teachers can easily refer to. On our 'Implement Engaging Projects' page, we describe the steps research tell us are crucial pieces of project development: Set the scene with significant content, develop a driving question, give students voice and choice, facilitate inquiry and innovation, and publicly present a product. We present these steps in a clear and succinct way, which gives interested educators a loose outline of what is required to integrate PBL. To the right of this information we embedded Edutopia video *Anatomy of a Project*. This helpful video includes the perspectives of teachers as they describe the process of developing projects 'behind the scenes' in collaboration with other teachers and preparing to scaffold learning. This tool is helpful in giving a working relatable example of how the community may be successfully integrated as projects develop and through culminating experiences in real world classrooms.

After giving teachers an outline and idea of how projects are developed, we included a useful checklist tool created by Dr. Susan Belgrad of CSUN (California State University Northridge) for teachers to consider and utilize. With this lesson template tool, teachers are guided through group formation, setting tasks, time limits, and assessment goals. In addition, this tool helps teachers remember to make connections to progressive standards all the while being mindful of student engagement and valuable academic, social, and behavioral goals. To further support teacher development of PBL,
BIE’s rubric for project design is embedded for teachers to reflect on and consider their own designs and project endeavors. Though teaching a new way and letting go of constraints of closed-ended problems can be challenging, we hope teachers come away from this page with a can-do attitude and tools to reach for when it comes to implementing engaging projects.

**Sample Projects**

**PBL in a day.** The next section of Teach Science for Tomorrow provides sample projects for teachers to explore and utilize. To demonstrate the wide range of possibilities for integrating project and community learning, we included day-long, week-long, and sample unit learning opportunities. Looking at PBL in a day, two projects are presented that ignite engagement, meaningful learning and integrate the community. The first lesson, *Investigating Solar Energy* uses NASA’s 5E lesson plan format and guides teachers through engaging, exploring, explaining, expanding, and evaluating the concept of solar energy. Throughout this lesson, students take control of their own learning as they experiment and engineer their own solar oven. In the process of exploring, students make choices, work collaboratively to share background knowledge, and develop significant academic content to determine what materials are most likely to absorb solar radiation. Following the initial inquiry portion of the project, students expand on their learning by connecting new knowledge to the real world by going out into the community to locate and examine how solar energy is used.

The second project showcased in our 'PBL in a Day' section is *The Amazing Egg Drop* inspired by Dr. Susan Belgrad (2014). In this project, students engage in engineering and exploration as they work in teams to determine which provided materials
to use to protect an egg as it plummets from several feet in the air. Again, we chose to put this lesson into NASA’s 5E lesson plan format as it allows for aspects including significant content, voice, choice, inquiry, innovation, and a publicly presented project to shine through, which clearly illuminates essential parts of PBL. We additionally chose this lesson due to the extension opportunity to have students connect with their community. For instance, after students make choices, inquire, and test their predictions, the teacher may facilitate the development of a driving question such as ‘what materials do astronauts use to build space shuttles?’ or ‘what materials are used to manufacture the fastest cars or planes?’ From here, teachers could visit museums, invite in guest-speakers, or even video chat with astronauts (see our community connections page). Ultimately, it is our hope that these projects provide teachers with a realistic guide for implementation, are open-ended enough to allow for student and facilitator creativity, and take the engagement of learners to new heights.

**Week-long projects.** To provide educators with a useful tool and image of week-long PBL experiences, we chose to embed a NASA’s B.E.S.T activity guide that serves to advance learning of engineering design processes through project and community learning. Through these series of lessons that incorporate tasks that build upon each other to extend learning, students work in teams to ask questions, plan model designs, build, and improve structures utilizing academic knowledge they gain along the way. With tasks that may include building satellites, launching satellites, preparing for a space mission, designing a lunar buggy, designing a landing pod, and launching crew exploration vehicles, students have the opportunity to dive into numerous aspects of space
exploration, all the while authentically creating a product and learning from actual astronauts.

*In-depth PBL units.* To give examples of how PBL can be supplemented with community involvement to create authentic outcomes, we chose to include in-depth units for teachers to reference when given the opportunity to extend learning and make even bigger contributions within the community. First, we embedded PBLU’s School-Yard Habitat project. This project, designed for grades 5-6 clearly details Common Core State Standards and each essential element of project-based learning as students are presented with the task of improving local wildlife habitats within their community. With the teacher as the facilitator, students research local wildlife, investigate climate, conditions, and ways to make a real-world change. For instance, students may interview others, write position stations, create petitions, engineer ways to save or improve habitats, to name a few. We chose to include this lesson because of its transferability and applicability to nearly any school and age of learner. To create successful projects and make an impact on one's community, one needs not spend loads of money or time but simply take a walk outside.

A second unit of study we chose to include in our exploration of in-depth PBL is demonstrated through the Herbert Schenk Elementary Courtyard Re-Design Project uploaded by the Buck Institute for Education. This embedded video takes educators on the project and community based learning journey to an abandoned courtyard of an elementary school and learning how students creatively transform it into a usable space. Through exploring this account of PBL, teachers are able to view brainstorming and planning sessions of the educators involved as they ponder ways to connect with
community members such as architects and scaffold student development of the project. The documentary continues to chronicle student progress as they present designs and models to community members and explain how and why their choices positively impact the community and impact local life. Ultimately the plan is put into action and a new courtyard is revealed. This unit too, highlights the importance of looking for opportunities to integrate community learning and projects. Many people might look at an empty courtyard, deem the project as one for the 'experts' and continue about their day. From examining current research, we feel PBL with community involvement is important as it teaches our youth the importance of taking-risks, persistence, and resource utilization, as well as collaboration. These 21st century skills not only make learning more enjoyable, their accomplishment in turn, aids in creating learners to be better prepared for the jobs, advances, and challenges of tomorrow.

**PBL resources.** In addition to sample lessons, we chose to develop pages that link teachers directly to the PBL resources worthy of exploration and consideration when developing their own projects. This page is divided into two sections: ‘Teaching and Planning’ and ‘Recommended Reading’. When it comes to ‘Teaching and Planning’, we linked *Trash for Teaching, Bricks for Kidz,* and *Buck Institute for Education*, to name a few. We chose these specific sites as they proved most useful in providing sample projects, rationales, and opportunities for further professional development in the field of project-based learning. Exploration of these sites can not only inspire instructors to implement innovative learning tasks, but also provides opportunities for experts to visit one's school and/or provide specialized workshops. The suggested reading material link serves as a useful resource for teachers to further their undertaking of 21st century
learning through PBL as well. We chose to include books and guides including the PBL 
*Starter Kit: To-the-Point Advice, Tools and Tips for Your First Project* by John Larmer, 
David Ross, and John R. Mergendoller, *Reinventing Project-Based learning: Your Field 
Guide to Real-World Projects in the Digital Age* by Suzie Boss, Jane Krauss, and Leslie 
Conery, and *Teaching Science in Elementary and Middle School Classrooms: A Project- 
Based Approach* by Joseph Krajcik and Charlene Czerniak. We specifically included 
these reference materials along with those linked on our site due to their ability to clearly 
and effectively appeal to teachers with little time to explore academic language heavy 
materials or develop their own. We feel readings included on our site will provide 
guidance, examples, and aid in creating a clear vision for PBL integration within today's 
classrooms.

**Connect with the Community.** In efforts to support deep and meaningful 
learning through authentic experiences, Teach Science for Tomorrow includes a page 
dedicated to making the connection between learning and the community. Here, teachers 
will find a plethora of opportunities to bring the community into the classroom and the 
classroom to the community. Numerous sites are linked including NASA and JPL which 
host opportunities for reading journals of astronauts in space and video conferencing with 
astronauts and space specialists to inquire about a variety of scientific concepts. Project 
host site, *ePals* connects students with learning communities around the globe as teachers 
can browse a variety of projects posted by other educators, select appropriate topics and 
set up communication and correspondence as they best fit the inquiry and academic needs 
of both groups of students. With a similar concept, *Flat Stanley*, invites students to create 
a flat companion and send him or her around the globe to different schools, experts, and
locations to experience scientific ideas and report back. Ultimately, our goal in creating this space is to demonstrate the accessibility of community resources and show that real-world learning is not only realistically implemented but happening all over the world. We seek to assist educators as they jumpstart students' learning about what is going on in the world today, and in doing so, prepare them for the world of tomorrow.

**In The News**

Finally, to inspire and energize teachers to take a risk and effect positive change, we incorporated an 'In the News' page. Here, we embedded several videos chronicling the successes and triumphs of junior science engineers and project-based learning outcomes with community involvement. From a sixth grader developing an awesome iPhone application to middle school students taking action to stop the spread of West Nile Virus in their community, and Ellen DeGeneres' 'Brilliant Kid Inventors', educators and viewers are able to see the proverbial light at the end of the 21st century learning tunnel. We link the new FOX television show *Cosmos* which is currently engaging and enthralling young viewers as it explores the universe and we conclude the page with Google's inspiring advertisement encouraging those of all ages to enter their science fair and inevitably make a difference in the world.
Chapter 4: Project/Website

In developing a project and community based science learning resource guide for teachers, we chose to employ the free website host Weebly (www.Weebly.com). Weebly provided an accessible open-source platform to display our objectives of developing student conceptual understandings of science and engagement in learning through project-based-learning and community involvement. Weebly allowed us to deliver valuable resources to educators, community members and any other persons dedicated toward improving student learning outcomes in STEM related projects. It was our primary goal to include resources that would allow educators to lead students toward developing a greater engagement in and ability to do science, mathematics, engineering and technology inevitably leading to greater preparedness to enter a 21st century global learning environment and workplace.

We specifically chose a website as a medium to pass along our knowledge and resources in a large part to essentially 'practice what we preach'. That is, utilizing up-to-date technology and current 21st century opportunities for developmentally-appropriate learning in a real-world setting. We wanted to reach our audience in an authentic setting that viewers find relatable, accessible, and enjoyable to explore. Utilizing Weebly allowed us to easily create a comprehensive display of information related to our project including projects and community based engagement opportunities in the areas of STEM learning. During the development of our project we realized the ease in which Weebly provides a fantastic opportunity for students and teachers alike to create and develop a functional personal, educational, or informational website of one's choice. Options to have multiple contributors and continual editing privileges makes website collaboration and updating a
breeze. A multitude of templates and an easy-to-use built-in site editor allows for a wide variety of design capabilities welcoming to users of all ages to build and alter content. In addition to a landing page, one can also incorporate and link a number of subsequent pages that are accessible through customized menus.

*Weebly's* drag-and-drop interface makes website creation fun and simple as one can embed saved images, video, audio, slideshows, maps, contact forms, surveys, documents, and customized text with few clicks of the mouse. Initial site layout can be edited to liking with columns, boxes (text, image, document, or video), and dividers dropped in a location of choice. Interactive choices such as forums or blogs are also easily embedded and maintained through *Weebly*. Furthermore, available *YouTube*, *Scribd*, and *Flash* widgets allow videos and documents to be embedded and viewable directly from the website without the need to follow external links. Should the need for external site connection arise, linking pictures and text is accomplished effortlessly by clicking the desired object or phrase, choosing the link option, and inputting the external site's Uniform Resource Locator (URL). When it is time to publish one's site, simply clicking the publish icon activates a worldwide web connection as well as a user friendly mobile site layout (pictured left).

Our site, aptly titled *Teach Science For Tomorrow* (TeachScienceForTomorrow.Weebly.com), takes full advantage of the features *Weebly* offers. After creating a simple yet colorful landing page to greet viewers and invite discovery of project and community learning, we continued to build upon our site by
adding and linking navigation pages such as 'Home' 'Bring PBL to your classroom and community' and 'In the news'. *Weebly*’s horizontal navigation bar makes exploring the site an enjoyable and simple experience while routing users to a PBL how-to guide, sample PBL lessons, PBL and community resources, and an exciting up-to-date 'in the news' page. We then chose to incorporate teacher-friendly photographs, text, embedded documents, and videos that allow for an aesthetically-pleasing, engaging learning experience while accommodating multiple learning styles and backgrounds of viewers.

To accomplish the task of laying out the different sections of our site, text, linking, *YouTube*, image, and divider tools were particularly useful along with the option to strategically insert columns. It is our hope as website creators and educators that teachers around the world might look to Teach Science for Tomorrow as an appropriately structured, informational resource worthy of time, exploration and consideration.

To measure the success of Teach Science for Tomorrow, we plan to utilize and monitor activity via the 'Stats' tool provided to *Weebly* website administrators. As pictured (right), this useful tracking device provides a traffic report detailing the number of website views for the current month. Upgrading one's account for nominal fee further provides administrators with the option of viewing reports on which pages attract the most traffic, and from where viewers come into contact with Teach Science for Tomorrow.
In efforts to further improve the ongoing development of our website and to maintain useful and current information, we created and embedded a forum accessed via the 'Share' link on our navigation bar to allow for feedback from our readers. In this section, we plan to post topics to ignite discussion, prompt feedback, and support collaboration among educators and the community. It is our hope to inspire educators and community members to input their ideas, experiences, and or other resources related to project-based learning and community engagement. We aim to illicit responses to include additional lessons conducted, photographs, resources, opinions and suggestions.
Chapter 5: Discussion and Implications

Our development project explored ways to best offer educators a useful resource guide to improve STEM related instruction while providing project-based learning and community service engagement opportunities. We addressed the need for an accessible, teacher-developed and open-resource that inspires teachers to adopt a hands-on approach to K-5 student learning while also seeking out and working with local experts in the community. We determined that the development of a website was necessary in order to encourage and ignite student interest in the sciences and other key, STEM-related areas of study. The community resource integration unique to our PBL website encourages elementary school educators to access actual scientists, engineers, mathematicians and technology experts while designing and engaging their students in related project-based assignments develop a deeper interest and disposition toward a future in STEM related professions. Bringing representatives of the local community, not usually accessed by K-5 students is essential in broadening their awareness of STEM as well as their sustained knowledge and achievement, which will enable them to compete in the greater global society. Community outreach and involvement in the elementary classroom is viewed as essential to offering children continuous, well informed, hands-on learning experiences that are enhanced by experts in a particular field of study who demonstrate the real-world applications of science, technology, engineering and mathematics. Interacting with the community provides K-5 children with opportunities to explore and learn from professionals while also developing a vision of how they will one day be prepared to contribute to the world around them.
In recognizing the need to promote student engagement and success by bridging the gap between school and community, project-based assignment guidelines and resources were developed in an open-source website. We identified and integrated project-based learning principles that promote creative, hands-on, real-world projects for elementary school teachers. We also addressed the need to actively incorporate the engagement of local experts who are most familiar with the STEM disciplines to be an effective and important form of community outreach resulting in a seamless integration of science, engineering, mathematics, and technology. Both community engagement and project-based learning are advanced in our project as being integral to developing the minds and professional aptitudes of our future generations. In order to best improve and develop engagement in the areas of STEM, the focus on community-based partnerships is necessary and essential. When students are given opportunities to learn civically, and to become engaged in curriculum and instruction that models real-life problem solving in the STEM disciplines, they will be better prepared to connect their lived experiences to the world around them. As recognized by Diezmann and Watters (2013), education needs to engage in partnerships with the community and industry to better confront the knowledge demands of the 21st century. Furthermore, with a majority of findings highlighting the benefits of project-based learning, it is clear that we as teachers must advocate for more information and professional development on how to incorporate the often, underestimated approach. In addition to advocating for more information regarding project-based learning, community outreach and STEM-related subjects, we must take it upon ourselves to lead investigation, discovery, design and dissemination of useful tools and information to our fellow colleagues.
In order to better facilitate the connection between students and the community through participation in STEM-related projects, it has become apparent to us that by providing such a resource guide we will assist and lead educators toward accomplishing this goal. Therefore, the development of our website entitled, www.TeachScienceForTomorrow.weebly.com was initiated.

Our website, “Teach Science for Tomorrow” is an easy and accessible tool for educators, parents and community members to retrieve the information necessary to provide students with a rich project-based learning program while utilizing STEM experts from the community. It is our goal to offer elementary educators a broad and comprehensive range of uncomplicated and attainable information to help them individually implement project-based learning, while simultaneously connecting to their local as well as global-STEM community. In so doing, all students will develop a greater interest in and ability to do science, mathematics, engineering and technology while in school, and progress to careers in which they may contribute to the greater success of our society at large. From the review of literature related to the promise of project-based learning and the demands of the 21st century global workforce, it is our recommendation that educators and community members collaborate to assure that all students are offered the most effective and enriching learning experiences in STEM. Our research and design efforts have resulted in a website that bridges the connection between teachers and the community. To explore our website visit Teach Science for Tomorrow at www.TeachScienceForTomorrow.weebly.com.
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