2013

An Examination of Project Based Learning at the Secondary Level: A Review of Literature

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Review of Literature

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Background

Virginia Commonwealth University and the school divisions of Chesterfield, Colonial Heights, Goochland, Hanover, Henrico, Hopewell, Powhatan, and Richmond established the Metropolitan Educational Research Consortium (MERC) on August 29, 1991. The founding members created MERC to provide timely information to help resolve education problems identified by practicing professional educators. MERC currently provides services to over 12,000 teachers in eight school divisions. MERC has based funding from its membership. Its study teams are composed of university investigators and practitioners from the membership.

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- To enhance the dissemination of effective school practices.

In addition to conducting research as described above, MERC conducts technical and educational seminars, program evaluations, an annual conference and publishes reports and research briefs.

A Literature Review of
An Examination of Project Based Learning
at the Secondary Level

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Introduction

Project based learning (PBL) is a pedagogical approach designed to capture student interest by integrating a contemporary and relevant problem or issue with content standards. The expectation is that students who have not been successful under traditional teacher-centered/ lecture-oriented instruction will be taken in by the opportunity to investigate a topic of personal interest using PBL. Moreover, some say that when constructivist learning (upon which PBL is based) is designed to reflect contemporary research methods and design protocols, students will be better prepared for the 21st century workplace (Apedoe, Reynolds, Ellefson & Schunn, 2008; Bell, 2010; Technology Assistance Program, 1998).

Parameters of the Literature Review

Aside from student interest in a relevant problem or issue, project based learning is defined by collaboration among students towards a final product or presentation. (Grant, 2011; Hernandez-Ramos & De La Paz, 2009). The examples of PBL described in this review are primarily based in the social studies and science content areas where products and presentations ranged from museum exhibits to research papers to classroom debates to film documentaries. Although skills in the language arts and mathematics are prerequisite to these end results, I found few examples in the literature which specifically address content areas outside of social studies and science.

Sources for this review were obtained by using the EBSCOHost search engine through Virginia Commonwealth University's Library System. The most helpful database was Education Research Complete. I used the keywords —Project Based Learning and —Secondary, but I learned that Project Based Learning is sometimes used interchangeably with Problem Based Learning, Design Based Learning, and Inquiry Based Learning. I used primarily peer-reviewed articles published after 2007. Reference lists for initial journal articles provided additional leads to some otherwise unknown sources.

In this review, I provided detailed descriptions of four authentic examples of PBL at the secondary level. I highlighted the positive outcomes of each as well as the pitfalls from which other educators can learn. I focused on the demographics and learning environment for each of the examples, the level of preparation among PBL among teachers, student reactions to PBL, and the impact of the PBL initiatives on content skills and standardized test scores.

Origins in Constructivism

PBL is rooted in the constructivist theory which is characterized by collaboration among learners who bring their own beliefs and prior knowledge to new learning environments. With constructivism, learning is a reflective process which is —internally controlled and mediated by the learner (Technology Assistance Program, 1998). Hernandez-Ramos and De La Paz (2009) explain that "A core assumption of constructivist theory is that learners actively construct knowledge through activity, and the goal of the learning experiences designed by teachers is to promote a deep understanding rather than superficial (and short-lived) memorization" (p. 150).

PBL is beneficial when students become engaged with a "problem to be solved" while the teacher acts as a coach or facilitator (Harada, Kirio, & Yamamoto, 2008). Moylan (2008) describes the role of the teacher as the "guide on the side" rather than the traditional "sage on the stage." He states that the teacher "is an *enabler* of learning, utilizing a hands-on approach to engage the

student learning, which are the hallmarks of the Project -Based Learning criteria" (p. 288).

The Influence of Content Experts Outside of the Classroom

Project based learning can involve content experts outside of school. Often these experts are affiliated with local universities or businesses. For example, in their study of the Intertidal Regions of Hawaii, Baumgartner and Zabin incorporated student-scientist partnerships (SSPs) among ninth graders enrolled in marine science and local university and museum researchers. Zabin was interested in learning more about marine biodiversity off the island of Oahu but needed help in collecting samples:

> *Students filled a much-needed research role by gathering data on intertidal organisms on the island of Oahu, Hawaii. A significant portion of our instruction involved training approximately 50 student field assistants each year to help with the labor-intensive job of surveying the intertidal zone for species richness and composition. This training encompassed the processes to be used in the research and the specific content knowledge needed for the students to put the project in perspective. Additional ecological content knowledge and learning related to the nature of science was gained authentically during the course of the project through direct discovery in the field and laboratory (2008, p. 99).*

In another example, researchers Apedoe et al. conducted several phases of their PBL project, "The Heating/Cooling Unit" which integrated high school chemistry content with the engineering design process (2008). They explained that PBL, more commonly referred to as Design Based Learning (DBL) in the engineering realm, is a plausible way to focus on engineering content and bring attention to all science, technology, engineering, and mathematics (STEM) fields in the era of high stakes testing and standardized curriculum:

> *The DBL units are designed to inspire a broad cross -section of high school students to want to become engineers, as well as transform their science classrooms so that they will graduate from high school with a foundation of knowledge that will allow them to do well as undergraduate engineers (p. 454).*

Use of Technology

Most of the PBL examples in this review incorporated computers as a research tool for student exploration. In fact, the distribution of individual laptop computers to students prompted PBL initiatives in some localities (Grant, 2011). In order to streamline students' efforts among middles schoolers new to Internet research, Grant and his teaching partner developed their own website to launch a PBL unit on geography human rights:

> *Throughout the ten-week unit, the students referred to the WebQuest site cocreated by the teacher and researcher. Resources, such as CIA World Fact Book Web site and Internet links to newspapers produced in the countries under study, were provided to the students to reduce searches and information seeking. Scaffolds, such as a physical and human geographies spreadsheet, electronic note card template, guiding questions, brainstorm sheets, peer evaluation forms and Internet bibliographic links, were developed to support the students in their project-based learning approach (p. 41).*

Aside from student exploration, computers have been used as a means of communication for the final product in some PBL units. For example, Grant's students were required to write their research papers on their computers; and the materials for their museum exhibits, such as photos and other graphics, were generated via their laptops (2011).

In another study, eighth grade history students used computers to take notes from primary and secondary

sources before creating documentaries to interpret the historical significance of the westward expansion of our country (Hernandez-Ramos & De La Paz, 2009). PBL requires teachers to address not only content skills but process skills as well. Some examples of process skills specific to technology include notetaking via the Internet, vetting and citing sources found online, and using specialized software to create a product.

Four Examples of Project Based Learning

PBL 1: Interpretation of the Westward Expansion Through Student Documentaries

Hernandez-Ramos and De La Paz (2009) based their study of eighth grade history students on the constructivist theory. They relied on the fact that students bring their own beliefs and strengths to the classroom and cited the work of Drake and McBride (1997) who contend that student use of technology to recreate history digitally has proven to be more meaningful than memorization of facts out of textbooks. Hernandez-Ramos and De La Paz asked students to collaborate in creating a documentary to interpret the significance of the westward expansion in our country. They were particularly interested in determining if students who participated in their PBL intervention group experienced higher gains in content skills than the contrasting group, so they required close adherence to state history standards in both conditions.

> *The fact that all states have established subject-specific content standards, and that high stakes accountability measures (standardized tests) are linked to those standards, may lead teachers to believe that technology-supported PBL is incompatible with current schooling priorities. Therefore, we chose to address this question in the hope that positive outcomes would mitigate concerns that students who engage in technology-supported PBL do not acquire as much content knowledge compared to students in traditional settings (p. 154).*

Hernandez-Ramos and De La Paz (2009) chose a school division of 4,000 students in Northern California. There were two middle schools in the division, and one served as the alternative to PBL intervention in this quasi-experimental study. A true control group was not feasible given that random assignment was not possible. One hundred students under the guidance of a veteran teacher (33 years) participated in the PBL intervention, and 70 students at the second site were divided between two veteran teachers who taught the 19th century history content in their traditional manner. To determine gains in content skills, students in both groups were pre-tested and post-tested using a 50-item multiple choice test on the westward expansion designed by the three teachers. A comparison of standardized test results for the two conditions was conducted two months after the completion of this six-week unit.

Classes in both settings were described as heterogeneous with regard to prior academic achievement. The majority of students were White in both schools (63%, intervention and 75%, contrasting). Only 15.5% (intervention) and 5% (contrasting) were classified as free and reduced lunch recipients. With regard to parent educational attainment, 32% of the parents of students in the intervention group had completed college, and 37% of the parents of students in the contrasting group had done so.

According to the California State Board of Education, students in eighth grade history should learn about the differing experiences of Americans who populated the South, Northeast, and West during the period from 1800 to 1850 (Hernandez-Ramos & De La Paz, 2009). Each student in the intervention group was assigned one of these regions with the understanding that everyone would learn about them all from classmates' presentations. During the first four weeks of the intervention, Hernandez-Ramos and De La Paz taught

students how to take notes from and distinguish between primary and secondary sources. They also introduced and modeled mPower, the software program that students would eventually use in their final products. The intervention moved to the computer lab during the final two weeks for documentary creation. The unit concluded with an open house for parents and other students. Meanwhile, students in the contrasting condition completed the traditional curriculum via thematic units on civil rights and suffrage, the westward expansion, and the Civil War.

On the 50-item pre-test, the mean scores for students in the intervention and contrasting groups scored 9.6 and 11.0, respectively. There were notable gains among students in the intervention group where the mean score rose to 41.8 on the post-test. The mean score for the contrasting group was 27.4 on the post-test.

Hernandez-Ramos and De La Paz examined the overall scores for the California standardized test in social studies as well as the sub-test (the Early Republic score) which aligned with this particular unit of instruction. On the Early Republic section, the mean scores for students in the intervention group were significantly higher (*M = 15.85, SD = 5.4)* than those of students in the contrasting group *(M = 13.63, SD = 7.2).* Similarly, there was a statistically significant difference between scores for the intervention group (*M = 376.53, SD = 57.06*) and those of the contrasting group *(M = 348.56, SD = 59.17)* for the overall scores.

In addition to the impact of technology-based PBL on content skills, Hernandez-Ramos and De La Paz investigated students' feelings about social studies before and after the units. Students in both the conditions completed a pre- and post-survey where they rated themselves (out of five points) on five constructs: perceived knowledge, test self-efficacy, social learning, active social learning, and attitude toward social studies (2009, p. 161). Two of the five constructs, "social Learning" and "attitude toward social studies," were positively influenced by the PBL experience.

PBL 2: Integration of Chemistry and Engineering Via Design of a Heating/Cooling Unit

This second example describes a PBL unit where high school students designed their own personal heating or cooling unit using their knowledge of chemistry and engineering processes (Apedoe et al., 2008). According to classroom chemistry teachers, field trials of this unit have been successful with a range of students in both urban and suburban settings with students in general to "Honors" chemistry courses:

> *Teacher 1: …Some of the kids actually want a final product perfect and working at the end.*
>
> *Teacher 2: That's what I'm saying. Some of them really, really want to have something. They think they're earning patents!*
>
> *Teacher 3: They actually think that people at [the university] are going to steal their ideas (p. 460).*

Additionally, teachers noted that attendance improved during the PBL unit.

The unit required students to plan, design, and test a prototype of a product which would satisfy a personal heating or cooling need. Final products (p. 456) included the Stay Cool Water Bed (chills the water using NaHCO3 and HCl in metal pipes under the mattress), the Coola Coasta (for cold beverages using a combination of LiCl, KBr, and HCl), and Warmtastic (handwarmers using plastic packets of LiCl and water). Although these examples seem universally appealing, the underlying "student interest or problem to be solved" feature of PBL prompted other creative ideas:

> *….during the unit, students set goals to create systems that would: (1) help keep them cool in the*

summer when they are playing sports outside, (2) prevent them from having to sit on a cold toilet seat, and (3) keep them cool when on a date and things start to 'heat up.' Once the team reaches consensus for a need they would like to meet, then they brainstorm ideas for heating or cooling systems that they could create to meet their need (p. 456).

At the conclusion of the unit, students presented their products via a gallery walk" as introduced by Kolodner (2003) wherein they responded to "why" and "how" questions about their designs. This process simulated a poster session at a true scientific conference, and the learning was further authenticated by student completion of the documentation to apply for a patent.

Apedoe et al. reported content gains from sample of 271 high school students in their first year of general chemistry. These students learned under the guidance of five classroom teachers, three of whom had previously taught this design based unit. Students were pre- and post-tested using a 24-item assessment comprised of multiple choice questions from the Chemical Concept Inventory (CCI, designed by Mulford, 1996) and the American Chemical Society's (ACS) Test Item Bank (Eubanks & Eubanks, 1993).

The researchers expected the CCI questions to be challenging as they were designed to assess "non-mathematical conceptual questions that tap into student's understanding of chemical ideas" of college freshman after one semester of chemistry (p. 461). However, the ACS questions were specifically written to assess high school students. They were more factual in nature and aligned to this particular unit of study. The results of the posttest show that the mean score of the sample increased 13% over the pre-test. After the PBL unit, when questions were categorized, there was a gain of 21% for questions related to "atomic interactions," 12% for "reactions" questions, and 14% for questions related to "energy gains."

Additionally, the researchers investigated the level of student interest in engineering after participating in the "Heating/Cooling Unit." Seventy-nine students who had completed the PBL took a survey to rate their agreement with the following statements (p. 462):

- I know what an engineer is
- I want to be an engineer
- I want to take classes to design products
- I want to take extra-curricular engineering experiences

The results were compared with those of 58 students who had not participated in PBL. Students who had participated in the PBL tended to agree more with each of the four questions than those who did not participate. For the statement "I want to be an engineer," the difference was statically significant $t\ (135) = 2.82,\ p = 0.01;\ d = .49$. In this case, the effect size of 0.49 was large enough to conclude that higher ratings among the 79 participants were attributable to the PBL experience.

PBL3: Fostering Student Engagement Through a Classroom Debate on Evolution

The third example is a case study of a single high school biology teacher and his efforts to engage students in a classroom debate on the controversial topic of evolution. Cook, Buck, and Rogers (2012) conducted this qualitative study in a large Midwestern high school with a strict pedagogical focus on project based learning. Specifically, the researchers were interested in learning what Mr. Shepherd (pseudonym) did or did not do to increase student engagement in topic of evolution.

Mr. Shepherd's 70 ninth graders were divided among two block classes. Students in the school were predominantly White (83%), and 43% qualified for free and reduced lunches. Mr. Shepherd's two classes reflect the demographics of the school overall. Mr. Shepherd was a first year teacher with master's degree in

education with concentrations in biology and chemistry. At the time of the study he had conducted several PBL units. Cook et al. describe Mr. Shepherd in this way:

> *He understood it was necessary to teach the science content standards, uphold the ideals of the project-based reform initiatives at his school, and encourage students to think beyond the scientific explanations of biological change. At the time, he expressed apprehension and concern about not offending his students who he perceived as being mostly skeptical about evolution. Nonetheless, he understood the need to teach evolution and often referred to the state standards as a justification for why he was teaching it to his sometimes-resistant students. (p. 20).*

This three-week PBL unit culminated in a classroom debate as its final product. In preparation for the debate, students were divided into teams of three. The teams completed online research to answer specific questions related to evolution in order to explain how evolution should be taught in the public school. Students also responded via journal entry to an incendiary article regarding the discussion of Creationism in school and participated in a "Chalk Talk" activity where they anonymously responded to controversial questions central to the debate such as "Are faith and science incompatible?" (p. 20).

Cook et al. collected data from classroom observations, student journal entries, daily discussions with Mr. Shepherd, student interviews, and audio/video tapes. To document the level of student engagement, they looked for examples of students who stuck with the work even when it was challenging, who related their learning to pervious knowledge, who communicated their thoughts through use of analogies that classmates could easily understand, and who asked meaningful questions. They contrasted these behaviors from other task-oriented behaviors such as goal setting and organizing which were important but did not reflect engagement.

Once their data was coded, the researchers summarized their findings in four conclusions. First, students were able to share their opinions and have a voice. Notably, Mr. Shepherd remained neutral in his stance while he asked leading questions to motivate students to further their arguments.

Second, in his attempt to remain neutral, Mr. Shepherd did not require students to provide *scientific* evidence for their arguments and there was little discussion of bias in online sources. It seemed that he focused on the controversy rather than the scientific theory:

> *The teacher's emphasis on the controversy did not allow for exploration of evolutionary theory itself. In fact, as a result of students' lack of cognitive engagement of evolutionary theory, the code of 'students' realizing where their knowledge was lacking was iteratively to our list of indicators for cognitive engagement (p. 23).*

Third, Mr. Shepherd's focus on the controversy caused students to merely take sides rather than engage in scientific inquiry. Cook et al. comment, "Students seemed to perceive the theory of evolution as a belief system with which they needed to either agree or disagree. There was no discussion about what a scientific theory is or how it develops in science…" (p. 24).

Finally, Cook et al. found that an inordinate amount of the coded behaviors were related to managing the group members and following procedures (46%) rather than engagement in discussion about the topic. Although classmates were familiar with classroom routines, some groups still had to rush to finish their preparation.

In summary, the researchers concluded that Mr. Shepherd's students were not ready to consider how evolution should be taught in school. Instead, his students needed more time to learn the evolution theory itself. They suggested that teachers carefully design PBL units at the appropriate level for students:

> *Construction of the driving question in a PBL is critical to students' motivation and engagement; the question should not be so constraining as to*

> *predetermine the project's outcomes, nor should it be so broad that it would overwhelm and de-motivate students' attempts to learn and engage in problem-solving (p. 25).*

Also, Cook et al. determined that the summative assessment rubric for the individual student's debate performance, although based on content standards, was too rigorous. The assessments reflected a low level of understanding of the content skills. This may have been in part due to the lack of attention to the formative assessments (daily journals). Cook et al. recommended that teachers use a variety of formative assessments to guide their PBL instruction:

> *It is recommended that we prepare teachers to read and use these daily assessments to guide their instruction and provide proper scaffolds for student cognitive engagement, as well as to embed formative assessment prompts, such as journal questions or written reflections, throughout the entirety of a PBL unit. These can include student-teacher interactions, practice worksheets, peer counseling, guiding questions, job aides, project templates, relevant in-class discussions, or follow up questions about what students have learned. This will allow teachers to stay connected to what the students are processing as they independently explore on-line resources in the context of PBL (p. 26).*

PBL 4: Influences on Student-Decision Making in Creation of a Museum Exhibit

Grant offered further advice to aspiring PBL teachers after his qualitative study of eighth grade geography students (2011). His goal was to examine the influences on student decision-making in the creation of a research paper and museum exhibit on the topic of human rights. Based on data collected from student interviews and classroom observations, Grant described the internal and external influences on students engaged in PBL.

The study was conducted in a private school with four classes of about 15 students each under the guidance of one teacher. As noted earlier, Grant and the classroom teacher developed a website for this PBL unit which included links and other scaffolds such as guiding questions, electronic notecards, and spreadsheets. The project was divided into four stages. During the first two stages, students learned about the geography of five countries which were experiencing human rights violations and defined human rights in their own vocabulary. Students were then assigned one of countries to explore further. They completed online research in order to write a paper on their assigned country's history of human rights violations. The paper was one of the products of the unit followed by a museum exhibit which incorporated use of the computer for word processing and collection of graphics.

Grant selected five students for interviews and observations. There were three females and two males; four of the five students were White, and one was Asian. The five students were interviewed 4 times throughout the ten-week unit and observed 3 times for 50 minutes each:

> *…the participants were asked to chronicle and reflect on their project as it developed. On a number of occasions, the students were asked to reason what was impacting their projects and their learning, as well as their choices and uses of technology tools. For example, the participants discussed which scaffolds had been most helpful in the construction of their projects (p. 43).*

Grant summarized his data with four internal influences on student decision-making. First, students lost interest in the unit before it was over. They seemed to have gotten the learning "takeaways" before finishing their products. Second, students chose strategies that had been successful in the past. He stated that "Participants' evaluations of their abilities were invisible processes" (p. 47), and that these processes are difficult to assess. Third, although the unit's website was intended to streamline online research, students were overwhelmed by the amount of information available to them. Fourth, students did not connect learning from this unit to

disciplines outside of geography.

Grant noted that the teacher was a strong external influence in that students often sought confirmation from her:

> *Allison: Well, it was pretty much outlined by [our geography teacher] ... [Our geography teacher] has helped a lot writing it ... Like I'll ask her questions about "is this — are these kinds of facts okay? Is this what you want the paper to be like? Is this sentence a good sentence?" And whether she thinks it's a good thesis statement. And in general answering questions about my topic. Like I'll ask her which side do you think has done more things to the Kashmiri people or which side is the worst side? I thought the website was fairly helpful.… However, I rarely used it unless told to in class (p. 51).*

Students indicated that the teacher control of the final grade was another external influence. They understood that certain types of efforts would result in higher grades but were not necessarily satisfied with the teacher's judgment:

> *Bob: With the project for a grade, it's, you know, you have a set thing you have to do. It's like you have to do a paper and a poster and present it to the class or something. Like we had the freedom of how we wanted to do it, the big thing and the PowerPoint. The paper, we had the freedom of how we wanted to do it, but when she actually started grading, it looked like she graded the way she wanted to grade on, like if you did a poster board— just a poster board—I don't think she would have graded you as well unless it was good as like if you had done a PowerPoint and a poster board and all that information… (p. 51).*

Finally, Grant noted that time management was both an internal external influence on student decision-making because they had to juggle extra-curricular activities and project completion simultaneously.

In conclusion, Grant's findings prompt the following suggestions for teachers:

- Adjust the length of the unit to fit the needs of the learner
- Avoid natural didactic tendencies and allow students to be risk-takers. As students gain experience in PBL, allow them to chart the direction of the learning.
- Remember that students have predispositions about project work from past experience. They may think that projects are supposed to be "easier" than tests.
- Include both student product and process in the assessment. Some learning is intangible. Consider using student journal reflections to monitor the otherwise invisible processes.
- Communicate the interdisciplinary connections inherent to PBL, and encourage transfer of knowledge among subject areas.

Synthesis of the Literature

In this review, I outlined the features of authentic project based learning which include student interest in a problem or issue to be investigated, social and collaborative interaction among students, teacher as facilitator in a student-centered learning environment, integration of technology, and creation of a final product or presentation. PBL is a constructivist pedagogical approach which calls for the student to create his or her own learning while scaffolded by the classroom teacher and other content experts.

Of concern to teachers as they embark upon PBL is the impact of this type of learning on standardized test scores. Two of the four examples described here showed significant increases in content gains on teacher-made and other widely known measures (Apedoe et al., 2011; Hernandez-Ramos & De La Paz, 2009). Although not described in detail here, other researchers have found significant gains in standardized test scores through inquiry-based learning in middle school science classes, particularly with African American males (Geier,

Blumenfeld, Marx, Krajcik, Fishman, Soloway, & Clay-Chambers, 2007).

From my research, I concluded that content gains were traceable to well-planned and field tested PBL units with veteran teachers. Much can be learned from student responses, and there was some evidence in these examples that students gained interest in the subject area through their PBL experiences (Apedoe et. al, 2011; Grant, 2011). Importantly, PBL called on students and teachers to learn how to do new things (most often with technology) as they engaged in content learning. These process skills need to be included with content skills for more meaningful assessment of student learning (Grant. 2011; Vega & Brown, 2012).

Suggestions for Policy and Practice

Finally, in a study of middle school teachers and administrators, Vega and Brown learned that teachers needed to allow time to teach process skills that accompany its student-centered nature (2012). The participants worked in three middle schools and had completed only a 5-day summer training prior to implementing PBL in their classrooms during the 2010-11 school year. According to Vega and Brown,

> *….the participants reported that it was evident most students were not prepared for the type of leaming prompted by PBL. Teachers and administrators indicated students lacked skills in collaboration, organization, speaking, and time management. "Our students need the ability to work together, to work in teams, the ability to do research, and the ability to work with different types of media technology," offered one administrator (p. 17).*

The participants were also concerned that some students were not mature enough for PBL, and one teacher explained that students need to become non-linear thinkers. ". . . I'm struggling to find the right amount of scaffolding without spoon feeding them, but at the same time giving them enough support because they are very linear thinkers" (p. 18). One teacher indicated that PBL might be more successful at the high school level than at the middle school level.

My research has shown that teachers are resistant to PBL out of a concern that it takes away from the content focus which is critical in the era of high stakes testing, and this issue was echoed in the comments from participants in Vega and Brown's study (2012). The participants talked of the "the struggle between implementing PBL fully and the need to meet the curricular and benchmark demands of the district" (p. 14), but they indicated that being assured that evaluating principals and central office staff were fully trained and knowledgeable of PBL would relieve some of that stress.

Overall, the teachers and administrators (Vega & Brown, 2012) had positive feelings about PBL. According to one teacher, "The existing curriculum gives me what I need to teach, and PBL gives me the how to do it" (p. 17). But participants noted that PBL would take on a different look from classroom to classroom, and that it would "be received differently by different people…. this meant that some of the faculty from all three middle schools initially embraced PBL, whereas some did not" (p. 20).

The teachers and administrators admitted that PBL required more preparation time up front. They cautioned that PBL would work best when a building operated on a block scheduled to allow more time for meaningful coverage of a topic in one day. The participants indicated that it would be beneficial to have only one administrator in charge of the PBL initiative, and Vega and Brown found that support for PBL across the three middle schools had been inconsistent. Lastly, the teachers in this study asked for additional training as well as opportunities to watch veterans model PBL.

References

Apedoe, X., Reynolds, B., Ellefson, M. & Schunn, C. (2008). Bringing engineering design into high school science classrooms: The heating/cooling unit. *Journal of Science Education & Technology, 17*(5), p.454-465.

Baumgartner, E. & Zabin, C. (2008). A case study of project-based instruction in the ninth grade: A semester-long study of intertidal biodiversity. *Environmental Education Research, 14*(2), p.97-114.

Bell, S. (2010). Project-based learning for the 21st Century: Skills for the future. *The Clearing House, 83*, p.39-43.

Cook, K., Buck, G. & Rogers, M. (2012). Preparing biology teachers to teach evolution in a project-based approach. *Science Educator, 21*(2), p.18-30.

Geier, R., Blumenfeld, P., Marx, R., Krajcik, J., Fishman, B., Soloway, E., & Clay-Chambers, J. (2008). Standardized test outcomes for students engaged in inquiry-based science curricula in the context of urban reform. *Journal of Research in Science Teaching, 45*(8), p.922-939.

Grant, M. (2011). Learning, beliefs, and products: Students' perspectives with project-based learning. *The Interdisciplinary Journal of Problem-Based Learning, 5*(2), p.37-69.

Harada, V., Kirio, C., & Yamamoto, S. (2008). Project-based learning: rigor and relevance in high schools. *Library Media Connection, 26*(6), p.14-19.

Hernandez-Ramos, P. & De La Paz, S. (2009). Learning history in middle school by designing multimedia in a project-based learning experience, *Journal of Research on Technology in Education, 42*(2), 151–173.

Moylan, W. (2008). Learning by project: Developing essential 21st century skills using student team projects. *The International Journal of Learning, 15* (9), p.287-292.

Technology Assistance Program. (1998). *TAP into Learning (Newsletter), 1*(1), 1–8. http:// www.sedl.org/pubs/catalog/items/tec99.html

Vega, A. & Brown, C. (2012). The implementation of project-based learning. *National Forum of Educational Administration and Supervision Journal, 30*(1), p.4-29.