Supplemental Attachment 1

Project Based Learning Research Data

BUCK INSTITUTE FOR EDUCATION

Top 10 Reasons Why Teaching Key Competencies* with Project Based Learning is a Good Idea

1. Our graduates will be better prepared for college, careers, and citizenship.
2. Students will still learn academic content (and remember it better).
3. Our test scores will be fine, and our students will be better able to meet today's more demanding standards.
4. Students will get better at managing their time and staying organized.
5. Students will learn how to work together to get things done, just as they will need to do on the job.
6. Students' public presentations will be fun to watch, and give them a chance to develop communication skills.
7. Students will be more engaged and take more responsibility for their own learning.
8. Students' creativity might lead to improvements in our community.
9. Parents and community members can share what they know as a content expert, guest speaker, or project consultant.
10. Students will have interesting things to say when asked, "What did you do in school today?"

*e.g., Critical Thinking, Collaboration, Communication, Creativity

Research Summary: PBL and 21st Century Competencies

Project Based Learning has been shown to yield a number of benefits for students, ranging from deeper learning of academic content to stronger motivation to learn. Looking specifically at how PBL supports 21st century learning goals, we can find several promising areas, including:

Academic achievement:

Goals for 21st century learning emphasize mastery of significant academic content, which also is the foundation of any well-designed project. Comparisons of learning outcomes in PBL versus more traditional, textbook-and-lecture driven instruction show that:

- Students learning through PBL retain content longer and have a deeper understanding of what they are learning.
  (Penuel & Means, 2000; Stepien, Gallagher & Workman, 1993)
- In specific content areas, PBL has been shown to be more effective than traditional methods for teaching math, economics, language, science, and other disciplines.
  (Beckett & Miller, 2006; Boaler, 2002; Finkelstein et al., 2010; Greier et al., 2008; Mergendoller, Maxwell, & Bellisimo, 2006)
- On high-stakes tests, PBL students perform as well or better than traditionally taught students.
  (Parker et al., 2011)

21st century competencies:

PBL helps students master the key competencies identified as essential for college and career readiness. Research has shown:

- Students demonstrate better problem-solving skills in PBL than in more traditional classes and are able to apply what they learn to real-life situations.
  (Finkelstein et al., 2010)
- When teachers are trained in PBL methods, they devote more class time to teaching 21st century skills; their students perform at least as well on standardized tests as students engaged in traditional instruction.
  (Hixson, Ravitz, & Whisman, 2012)
- PBL students also show improved critical thinking.
  (Beckett & Miller, 2006; Horan, Lavaroni, & Beldon, 1996; Mergendoller, Maxwell, & Bellisimo, 2006; Tretten & Zachariou, 1995)

- Through PBL experiences, students improve their ability to work collaboratively and resolve conflicts.
  (Beckett & Miller; ChanLin, 2008)
- Opportunities for collaborative learning provide benefits to students across grade levels, academic subjects, and achievement levels.
  (Johnson & Johnson, 2009; Slavin, 1996)

Equity:

- PBL shows promise as a strategy for closing the achievement gap by engaging lower-achieving students.
  (Boaler, 2002; Penuel & Means, 2000)
- PBL can work in different types of schools, serving diverse learners.
  (Hixson, Ravitz, & Whisman, 2012)
- PBL also can provide an effective model for whole-school reform.
  (National Clearinghouse for Comprehensive School Reform, 2004; Newmann & Wehlage, 1995; Ravitz, 2008)

Motivation:

- In PBL classrooms, students demonstrate improved attitudes toward learning. They exhibit more engagement, are more self-reliant, and have better attendance than in more traditional settings.
  (Thomas, 2000; Walker & Leary, 2009)

Teacher satisfaction:

- Teachers may need time and professional development to become familiar with PBL methods, but those who make this shift in classroom practice report increased job satisfaction.
  (Hixson, Ravitz, & Whisman, 2012; Strobel & van Barneveld, 2009)

For links to full text of studies as well as updates on research about Project Based Learning, visit the Buck Institute for Education at **bie.org.**

English Learner Scaffolds for PBL

The chart below provides scaffolding strategies and recommendations to support English Learners during each phase of the project process. The recommendations here align with the planned scaffolding strategies from the *Theoretical Foundations and Research Base for California's English Language Development Standards*, provided at the end of this document.

	Scaffolding the Project Process *How can you reduce linguistic or cultural barriers to project completion and success?*	**Scaffolding Content Learning** *How can you reduce linguistic or cultural barriers to content or skill mastery?*	**Scaffolding Language Development** *How can you support students' acquisition of English language skills within the context of a project?*
Launching the Project: Entry Event + Driving Question	• Have students develop and use a BIE Project Team Work Plan to structure and organize their project work.[2, 5] • Post due dates and tasks to be completed to a project wall (virtual or in the classroom).[2] • Use the Question Formulation Technique to help students understand how to create effective questions.[6] • Provide closed and open sentence frames to support question generation.[8] • Brainstorm and sort the questions generated by students. Sort questions into categories that are easy for students to identify (e.g., Content Questions, Process Questions, Presentation Questions).[8]	• Use a KWL chart[7], question frames, and explicit modeling[8] for the need to know list to help capture what students already know about the topic and to support students in asking new questions.[1, 6] • During an entry event, use visual aids (e.g., photos, videos, physical objects) to help build context for learners at all levels of language proficiency.[7] • If the entry event is an "experience" (e.g., field trip, hands-on activity), have students use graphic organizers to keep their thoughts organized, or to write key words that can serve as memory triggers. A scavenger hunt is an useful strategy for a field trip.[7] • Use a camera, if possible, for students to capture experiences during the entry event or allow students to create visuals that they can later use to recall information and develop connections.[7]	• Explicitly teach and define content-related vocabulary during the discussion of the entry event.[2] • Create and maintain a vocabulary wall for academic language associated with the project.[8] • Use entry events as an opportunity to introduce students to different types of texts, and to discuss the conventions and purposes of text types.[4, 8] • To provide more opportunities for low-stakes speaking and listening practice, have students discuss the entry event and need to knows in pairs or small groups before engaging in a whole-class discussion.[5] • Avoid (or explicitly teach) colloquialisms and idioms in project-related resources (e.g., entry events, driving questions, rubrics).[4]
Build Knowledge, Understanding,	• Post daily objectives, in student friendly language ("I Can....") for content, skills, and language learning.	• Deliver instruction in a variety of formats (e.g., hands-on learning experiences, small group lessons, direct	• Use observations and written tasks such as reflective journals to formatively assess student progress on language

and Skills to Answer Driving Question	Refer to these often. Note when objectives are differentiated for specific students.[2] • Use a variety of grouping strategies (heterogeneous, language level, pairs, self-selected, etc.) strategically throughout the course of a project.[5]	instruction, etc.)[7] • Provide leveled texts for students during work time.[4] • Structure workshops in a logical sequence, providing clear modeling and explanation as well as opportunities for guided practice.[2] • Have students work in linguistically diverse pairs or small groups to engage in reciprocal teaching of project content.[5] • Plan frequent opportunities for informal formative assessments (e.g., exit tickets, journals, whip-arounds, conferences), and adjust instruction based on these assessments.[3]	development targets.[3] • Have students develop personalized illustrated dictionaries to keep track of key vocabulary.[8] • Provide varied opportunities for speaking and listening (e.g., inner-outer circles, think-pair-share, Jigsaw, role-plays).[5]
Develop and Critique Products and Answers to the Driving Question	• Model and practice the use of structured protocols for critiquing work.[8] • Provide Thinking Maps to help students organize ideas and information.[7] • Co-create rubrics for final products and success skills with students. Both teachers and students should use the rubrics for assessment and reflection, and the same rubrics should be used for formative and summative assessment.[3]	• Use the Question Formulation Technique to guide students in developing new questions to refine their understanding of content.[6]	• Provide sentence frames to help students give and receive feedback.[8] • When appropriate, provide students with exemplary writing samples and/or text frames to teach them about text and language conventions.[8]
Present Products and Answers to Driving Question	• Have students work in groups to complete a BIE Presentation Plan[7] • Provide multiple opportunities for students to practice their presentations and receive feedback.[2, 3]	• Provide graphic organizers to help students organize their learning when observing one another's presentations.[7] • Encourage students to use visual aids and multimedia to enhance and clarify the content in their presentations.[7]	• Work with students to identify the tone, level of formality, and linguistic style that are most appropriate for the presentation audience and context. Provide models to help students understand the appropriate "register."[8]

	• Record students as they practice presentations. Allow them to review the video and compare their performance to the presentation rubric, reflecting on opportunities for improvements.[3]	• Have students use structured protocols to reflect on how this project built on their existing knowledge and skills.[1]	• Provide language models for different aspects of presentations (e.g., giving instructions, describing processes, comparing and contrasting ideas.)[8] • Provide question frames to support audience members in asking effective questions.[6]

Planned Scaffolding Strategies from California Department of Education. (2012). ***Appendix C: Theoretical Foundations and Research Base for California's English Language Development Standards.*** **Retrieved from http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf.**

[1]Taking into account what students already know, including primary language and culture, and relating it to what they are to learn.

[2]Selecting and sequencing tasks, such as modeling and explaining, and providing guided practice, in a logical order.

[3]Frequently checking for understanding during instruction, as well as gauging progress at appropriate intervals throughout the year.

[4]Choosing texts carefully for specific purposes (e.g., motivational, linguistic, content).

[5]Providing a variety of collaborative grouping processes.

[6]Constructing good questions that promote critical thinking and extended discourse.

[7]Using a range of information systems, such as graphic organizers, diagrams, photographs, videos, or other multimedia to enhance access to content.

[8]Providing students with language models, such as sentence frames/starters, academic vocabulary walls, language frame charts, exemplary writing samples, or teacher language modeling (e.g., using academic vocabulary or phrasing).

PBL and Common Core — and Next Generation Science Standards

(Excerpted from the book *PBL for 21st Century Success: Teaching Critical Thinking, Collaboration, Communication, and Creativity*, published by the Buck Institute for Education, 2013)

With the Common Core State Standards adopted by all but a handful of states, efforts are underway across the country to help students meet the higher bar that the new standards set. The overarching goal of the new standards is to better prepare students for college and careers. PBL, with its emphasis on both significant content and 21st century competencies, addresses these new standards in several important ways.

David Ross, director of professional development for BIE, offers this pithy analysis about the alignment of PBL and the Common Core:

> *Everyone knows that content is king and Common Core wears the crown. Significant content is one of our eight Essential Elements of PBL. Make an easy connection: Significant Content = Common Core. Now let's use a shorter word. When designing a rigorous, relevant, and engaging project, Common Core is the "what." But what about the "how?" In our minds the answer is obvious: PBL is the solution for Common Core implementation. PBL is the "how."*

Of course, we realize that PBL is not the only way to help students master these new standards. As states move toward implementation of the Common Core, however, more and more schools and districts are focusing on PBL as their go-to instructional strategy to prepare students for deeper thinking. Next-generation assessments aligned to the new standards (still in development at this writing) are expected to emphasize application of knowledge rather than recall of facts. Here, too, we find common ground with PBL, in which students demonstrate and share what they know or can do through performance assessments. For PBL veterans, student demonstrations of learning are not new at all. They're an essential element of every project.

Common Core Standards for English Language Arts include tasks that are very familiar to people who know PBL:

> *"Conduct short as well as more sustained research projects based on focused questions"*
>
> *"Prepare for and participate effectively in a range of conversations and collaborations with diverse partners"*
>
> *"Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others"*
>
> *"Conduct short research projects to answer a question (including a self-generated question)"*

Common Core Standards of Mathematical Practice also echo PBL best practices. The math standards set expectations for students to do real-world problem solving, use mathematical modeling, apply statistical analysis, and communicate their understanding. "Mathematically proficient students can apply the mathematics they know

PBL addresses the new Common Core State Standards in several important ways.

to solve problems arising in everyday life, society, and the workplace," according to the Standards of Mathematical Practice. Such applications naturally have a place within high-quality projects that ask students to use mathematics concepts and procedures in authentic contexts.

Next Generation Science Standards

The new national standards proposed for K-12 science shift the focus of instruction from simply acquiring content knowledge to the practice of science skills. Many of the draft Next Generation Science Standards (NGSS) align with practices common to 21st century Project Based Learning. For example, look at what students are supposed to learn how to do in the "Science and Engineering Practices" section:

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Many of the Next Generation Science Standards align with practices common to 21st century Project Based Learning.

Some of the standards could actually be used as a stand-alone project idea, such as, "Design, evaluate, and refine a solution for reducing negative impact of human activities on the environment and ways to sustain biodiversity and maintain the planet's natural capital" (HS-LS2-j). And as blogger and BIE National Faculty member Andrew Miller points out:

> *"With the new engineering focus of NGSS, consider design challenge PBL projects, a key component of science, technology, engineering, and mathematics (STEM) education."*

Even when the standards do not have an explicit project-based tone, there is a focus on the key competencies needed for PBL: inquiry, communication, and critical thinking. Consider what students are asked to demonstrate in order to meet the "College and Career Readiness" standards: "applying a blend of science and engineering practices... to approach problems not previously encountered by the student" and "self-directed planning, monitoring, and evaluation." Sounds like what happens in PBL!

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Summary of Research on Project-based Learning

Overall, the research on Project-based Learning (PBL) reports positive outcomes related to student learning in the areas of content knowledge, collaborative skills, engagement and motivation, and critical thinking and problem-solving skills. This summary utilizes Thomas's (2000) five criteria to define PBL: (a) "Projects are central, not peripheral to the curriculum"; (b) "projects are focused on questions or problems that 'drive' students to encounter (and struggle with) the central concepts and principals of the discipline"; (c) "projects involve students in a constructive investigation"; (d) "projects are student-driven to some significant degree"; and (e) "projects are realistic, not school-like" (p. 3-4). Collaboration is also included as a sixth criterion of PBL.

PBL has several positive effects on student content knowledge. Compared to traditional classes, students in PBL classes performed better on assessments of content knowledge (Boaler, 1997; Penuel & Means, 2000; Stepien, et al., 1993). Research also reported that PBL had a positive effect on specific groups of students. For example, students with average to low verbal ability and students with little previous content knowledge learned more in PBL classes than in traditional classes (Mergendoller, et al., 2006; Mioduser & Betzer, 2003). In addition, students were able to demonstrate specific content area skills after taking part in PBL (Mioduser & Betzer, 2003; Peck, et al., 1998). For instance, students working on a geometry project linked to architecture and design utilized measurement skills as they developed their blueprints, of which 84% met architectural building standards (Barron, et al., 1998). In sum, students taught in PBL classes emerged with useful, real-world content knowledge that they could apply to a variety of tasks (Boaler, 1997).

PBL also has resulted in high levels of student engagement (Belland, et al., 2006; Brush & Saye, 2008). For instance, in one study within an economics classroom, a PBL unit engaged the lowest and highest level students as well as those students who were least interested in economics at the start of the unit (Ravitz & Mergendoller, 2005). Another study reported that PBL had a positive effect on student motivation to learn (Bartscher, et al., 1995). According to elementary teachers, who reported using 37% of their overall instruction time on PBL, students' work ethic improved as well as their confidence and attitudes towards learning as a result of PBL (Tretten & Zachariou, 1995). Conversely, one study found that high school student engagement and/or participation were difficult to maintain (Edelson, et al., 1999).

Students who participated in PBL also benefitted from improved critical thinking and problem-solving skills (Mergendoller, et al., 2006; Shepherd, 1998; Tretten & Zachariou, 1995). In particular, one study of PBL showed a positive effect on low-ability students, who increased their use of critical-thinking skills including synthesizing, evaluating, predicting, and reflecting by 446% while high-ability students improved by 76% (Horan, et al., 1996). Furthermore, during PBL, students showed initiative by utilizing resources and revising work, behaviors that were uncharacteristic of them before they engaged in PBL (Barron, et al., 1998).

In addition, PBL has been shown to benefit a variety of students in developing collaborative skills. For example, through PBL, elementary students learned to understand multiple perspectives (ChanLin, 2008) and conflict resolution skills (ChanLin, 2008); special education students developed social skills such as patience and empathy (Belland, et al., 2006); and low-ability students demonstrated initiative, management, teamwork, and conscientiousness as they worked in groups (Horan, et al., 1996). Students also enjoyed PBL because it gave them opportunities to interact with their friends and make new friends through cooperative projects (Belland, et al., 2006; Lightner, et al., 2007). However, group- and self-

efficacy were found to depend largely on the quality of the group process (Weng-yi Cheng, et al., 2008) while high school students struggled to work positively in small groups (Achilles & Hoover, 1996).

Several studies found that PBL is challenging for teachers to enact despite its positive benefits. For example, one study found the following barriers to successful implementation of PBL: (a) projects were time-consuming, (b) classrooms felt disorderly, (c) teachers could not control the flow of information, (d) it was difficult to balance giving students independence and providing them supports, (e) it was difficult to incorporate technology as a cognitive tool, and (f) authentic assessments were hard to design (Marx, et al., 1997). In addition, the authors found that teachers generally focused on addressing one or two of these challenges at a time and moved back and forth between old habits and new ideas, incorporating the new information gradually and with varied success (Marx, et al., 1994; Marx, et al., 1997). Teachers also may struggle with entrenched beliefs when attempting to implement PBL. For example, it may be challenging to negotiate between giving students opportunities to explore their interests or covering the state standards, allowing students to develop individual answers or providing students with one correct answer, and empowering students to direct their learning or controlling the distribution of expert knowledge (Ladewski, et al., 1991).

In summary, research indicates that PBL: (a) has a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, and problem solving; (b) benefits students by increasing their motivation and engagement; and (c) is challenging for teachers to implement, leading to the conclusion that teachers need support in order to plan and enact PBL effectively while students need support including help setting up and directing initial inquiry, organizing their time to complete tasks, and integrating technology into projects in meaningful ways (Brush & Saye, 2008; Krajcik, et al., 1998).

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