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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