

THE IMPLEMENTATION OF PROJECT-BASED LEARNING IN K-12 EDUCATION: TEACHER QUALITIES AND STUDENTS ACHIEVEMENTS

BINGJIE QI

Brock University



Abstract

Project-based learning (PBL) is a constructivist teaching strategy that encourages students to explore real problems and acquire knowledge and skills by adhering to teachers' guidelines. This study aims to examine the effects of project-based learning on students, and qualities required of K-12 teachers who engage in PBL. This study will use a narrative literature review to synthesize previous findings on the implementation of PBL in primary and secondary levels, and to interpret teachers' and students' perceptions regarding project-based learning. This review argues that PBL is beneficial for students in terms of attitudes towards learning and academic performance, as well as the development of practical skills. The review also examines the challenges that teachers may face and the features of highly successful PBL teachers. Based on the results, implications and recommendations are presented.

Keywords: project-based learning, student-centered teaching strategies, academic achievement, authentic skills, teaching qualities

The Implementation of Project-Based Learning in K-12 Education: Teacher Qualities and Students Achievements

Project-based learning (PBL) is a constructive instructional strategy that originated in progressive education in the late nineteenth and early twentieth centuries, which called for a student-driven and teacher-facilitated approach to teaching and learning (MacMath et al., 2017). According to Wurdinger et al. (2007), in a PBL classroom, students are guided by teachers through a step-by-step and interdisciplinary learning process: identify a problem; plan; solve the problem; reflect and evaluate the experience (as cited in Mahasneh & Alwan, 2018). Teachers act as the coordinator in classrooms, connecting the subjects taught with the world outside the classroom in PBL curriculum design so that students can learn knowledge and solve authentic challenges. An inspiration for a project can be hearing news or a story, reading an article, or experiencing an event to get students' creative juices flowing (Dayna, 2020). For instance, Ms. McIntyre, a science teacher in a high school, launched a PBL class in the environmental field. She showed a video in class about the closure of a beautiful beach, and let students think about why the beach had been closed and how to solve ocean pollution as a project plan (Larmer, & Mergendoller, 2010).

Many research studies illustrate that PBL is an effective tool for engaging students in the real world of the twenty-first century (see, e.g., Bell, 2010; Doppelt, 2003; Kaldi et al., 2011; Tamim & Grant, 2013). Bell (2010) states that skills such as practical thinking, research, collaboration, and communication, are not measurable through standardized tests. Compared with the teacher-centered instructional approach and traditional assessment, PBL creates flexible learning environments for students to improve their thinking and problem-solving abilities (Doppelt, 2003). For example, Ms. Laur, a social studies teacher, often buys things through Amazon, which led her and a math teacher to discuss whether 'shipping' could be used as an entry point to design for a sixth-grade class. For instance, students could design new systems for courier companies and online stores to ship items so that fewer and smaller boxes are used. The purpose of the class is to teach students mathematics and inspire their awareness of environmental protection (Laur, 2020). However, to achieve maximum benefit from PBL, teachers might face challenges and they need to be motivated to shift their teaching methods and philosophy (Tamim & Grant, 2013). This literature review argues that PBL is beneficial for students' attitudes towards learning, academic performance, as well as practical skills, but there are challenges in the implementation of PBL, which should not be neglected. Hence, the features of highly successful PBL teachers are also examined in this review, including role transition, collaboration, and motivation.

Research Questions

The research questions that guided this literature review are:

- 1) What are the advantages and disadvantages of PBL for K-12 students' learning?
- 2) What are the teacher qualities that lead to successful implementation?

Literature Review

Current Trends of PBL

According to Lunenburg (2011), in an inductive curriculum design, teachers first identify the students' circumstances, such as age, grade, and cultural background. After that, "content vehicles" (Weinstein and Fantini describe content vehicles as "life experiences of the learner, attitudes and feelings of the learners, and the social context in which they live" (as cited in Lunenburg, 2011, p.5)) and learning skills can be explored by teachers to design curriculums, meeting students' learning concerns and interests. The last step is outcome evaluation, according to learners' performance (Lunenburg, 2011). PBL is one type of inductive instructional strategy as compared to the traditional paradigm of teaching, and the ethos of PBL is to facilitate students' self-motivation, logical criticism, and responsibility for learning (Mahasneh & Alwan, 2018). PBL is not a new educational theory. It originated in the constructivist approach by John Dewey. PBL strategy promotes autonomy in learning to cultivate independent and critical thinking in learners (Speckels, 2011), and requires students to find problems, develop solutions, and integrate life experiences and cognition to create a project (Thomas, 2000; Webb, 2003); at the same time, the teachers act as facilitators to provide resources and guidance (Thomas, 2000).

Some scholars and researchers have analyzed the principles of PBL and investigated the effectiveness of PBL. According to Doppelt (2003), PBL integrates knowledge of different disciplines and explores new areas and scientific issues. Scarbrough et al. (2004) agree that PBL can overcome knowledge boundaries to generate a high level of learning. It is worth mentioning that most features of PBL conform to problem-based learning (Grant, 2011; Kokotsaki et al., 2016). However, PBL focuses on results. Learners in PBL classes need to select problems and develop solutions, and create a project in the end, such as a report, model, or presentation, while the strategy of problem-based learning emphasizes the new knowledge that students can acquire in problem-solving (Blumenfeld et al., 1991). Kaldi et al. (2011) believe that PBL is an inclusive teaching-learning method that supports all learners to develop their abilities and put them into practice, but it is not "a panacea for ills" (p. 37) in education. Since PBL requires active engagement of students for an extended time, it cannot be widely adopted without adequate attention for supporting students in the classroom (Blumenfeld et al., 1991; Prince & Felder, 2006).

Research Methodology

This study aims to examine the effects of the PBL approach on students and the qualities required for teachers of PBL in K-12 education. Consequently, the method used in this study is a narrative overview that is a useful type of educational literature review (Green, Johnson, Adams, 2001). It summarizes the author's findings and information into a readable format, which helps present broad perspectives and describe the development in a topic area (Green et al., 2001). The method chosen is one of the most feasible ways to acquire a variety of standpoints of students and teachers for the PBL approach in varying grades and subjects. The author used electronic search engines to find educational-related publications, peer-reviewed journal articles, and social

media posts, objectively evaluating PBL by combining different contents. Key word phrases were used, including ‘the definition of project-based learning,’ ‘the effect of project-based learning for students,’ ‘the implementation of project-based learning in K-12 education,’ ‘cases of project-based learning,’ and ‘teachers’ perception and motivation of project-based learning’ to narrow down the search results. Most of the data and journal articles used in this study are from within the last 15 years.

Table 1
The Studies on the Effect of PBL on K-12 Students

Study Reference	Study Design	Population Studied (n)	Outcome Positive (Yes/No)	Findings
Kizkapan, O., & Bektas, O. (2017)	Quantitative, Quasi-experimental design	Seventh-grade students (n=38)	No	There is no significant difference between PBL and traditional teaching groups’ scores. The authors suggest that pre-activities should be performed for the adaption of teachers and students before PBL units.
Kaldi, S., Filippatou, D., & Govaris, C. (2011)	Qualitative Quasi-experimental design	Primary school students (n=94)	Yes	PBL is beneficial for students to gain content knowledge and group skills and develop a positive attitude toward peers from different backgrounds.
Hernández-Ramos, P., & De La Paz, S. (2009)	Qualitative Quasi-experimental design	Eighth-grade students	Yes	Students improved their historical thinking skills and many students grasp a fundamental understanding of history knowledge in PBL groups.
Doppelt, Y. (2003)	Qualitative Quasi-experimental design	Tenth to twelfth- grade students	Yes	Scientific-technological PBL boosted students’ motivation and achieved effective learning. Most of the low-achieving students succeeded with high scores in the matriculation exams.
Bell, S. (2010)	Qualitative method Literature Review	Literature	Yes	Students can enhance viable technology, communication, collaboration, problem-solving skills, and creativity from the PBL approach.
Study Reference	Study Design	Population Studied (n)	Outcome Positive (Yes/No)	Findings
Ergül, N. R., & Kargin, E. K. (2014)	Qualitative Experimental design	Elementary school students (n=92)	Yes	Teaching with the PBL method contributed to students’ science success more compared to teaching according to the current program.

Based on the analysis of previous research on the exploration of PBL in K-12 education, this paper used a narrative literature overview method to collect data, including interpretation of students’ and teachers’ attitudes and perceptions towards PBL (shown in Table 1 and Table 2). A total of twelve journal articles were included. This review uses previous research findings and several PBL program cases to explore the effects of and requirements for PBL in K-12 education.

Table 2
The Perception of Teachers for PBL

Study Reference	Study Design	Population Studied (n)	Outcome Positive (Yes/No)	Findings
MacMath, S., Sivia, A., & Britton, V. (2017).	Qualitative procedure, Interview	Secondary school teachers	Yes	Investigation results provide the requirements for successful implementation of PBL, benefits and challenges of PBL for both teachers and students.
Lam, S. F., Cheng, R. W. Y., & Choy, H. C. (2010)	Qualitative procedure, Questionnaire	Hong Kong secondary school teachers (n=182)	Yes	Results indicated that teachers received stronger school supports for teacher competence and autonomy; they could have higher motivation in PBL and stronger willingness to persist in educational innovation.
Mahasneh, A. M., & Alwan, A. F. (2018)	Qualitative Quasi-experimental design	Student teachers (n=79)	Yes	Results showed differences between PBL and the control group in student teachers’ self-efficacy and achievement scores. Researchers recommended applying PBL in teaching-learning situations.
Study Reference	Study Design	Population Studied (n)	Outcome Positive (Yes/No)	Findings
Tamim, S. R., & Grant, M. M. (2013)	Qualitative, Interview and document collection	Teachers from grade four through twelve	Yes	Teachers in the PBL approach “emphasized scaffolding, through clarification, facilitation, and guidance” (p. 93). Collaboration with other teachers is an essential aspect for teachers in the PBL approach.
Baysura, O. D., Altun, S., & Yucel-Toy, B. (2016)	Qualitative phenomenological study, interview	Teacher candidates (n=58)	No	Results show that teacher candidates are familiar with the PBL method, but they lack professional skills and knowledge, which could cause difficulties in practice.
(Chang & Lee, 2010)	Qualitative Quasi-experimental design	Computer teachers and subject teachers	Yes	Team-teaching approach is a win-win situation for all teachers and students in PBL classroom.

This study also reviewed social media articles to retrieve real PBL classroom cases in K-12 schools, and to access voices from schools and social media for PBL strategies. Altogether, there are five representative articles identified from senior education consultants, pedagogy bloggers, webinars, and public schools websites within the last 5 years (shown in Table 3).

Table 3
The Perspectives of Social Media Posts for PBL

Title	Author	Education Level	Opinions
9 Reasons to Use the Project Approach in Your Inclusive Early Childhood Classroom (2018)	Brookes Publishing Webinar Focusing on Inclusive Education	Early Childhood Classroom	PBL strategy satisfies the curiosity of young children by allowing them to delve into interesting topics in-depth. Project methods can provide opportunities for children to research and investigate, acquiring firsthand experiences.
Project-Based Learning in the Early Years (2018)	Diana Wehrell-Grabowski, Ph.D. Science and STEM education consultant	Early Childhood Classroom	PBL approach encourages students to actively seek knowledge and interact with the community and environment. It also is beneficial for teachers to explore the right direction for different children and freeing teachers to provide diversified instruction. However, students' different projects and opinions are challenging for teacher workloads.
Project-Based Learning in the K12 Classroom (2018)	Lacey Lyons Freelance writer and editor	K-12 Classroom	PBL promotes student engagement. It can help to narrow down the achievement gap among students in different social-economic backgrounds or with different learning abilities.
Power of One Change Makers Project (2016)	Melissa Cochran On a public charter school website	Eleventh Grade	The author provides a case of eleventh graders working with nonprofit organizations. This project encourages students to care about the local community and develop students' authentic skills.
Project-Bases Learning and Problems Analysis (2018)	Penny (screen name) Blogger	K-12 Classroom	The author provides some PBL class cases in USA and China to demonstrate that PBL curriculum design includes selecting problems, project planning, solving problems, and evaluation.

Table 1 and Table 2 reviewed pieces of research in qualitative design, which used experiments and data to prove arguments, while social media posts in Table 3 allows readers to view and experience PBL from the perspective of working on the front line of K-12 education. Moreover, the relevant content of the social media posts mentioned in this review merely served as the reference, and more importantly, it provided real and effective PBL cases in recent schools and communities. Therefore, social media posts would not affect the authority of the research findings.

Results

Advantages of PBL for Students

Academic achievement. Project-based learning is effective in advancing students' academic achievement. Many students believe schoolwork is meaningless because they do not perceive a need for what they are learning and why they would need it (Larmer & Mergendoller, 2010). In education sectors where large-scale standardized testing is the norm, the shortcoming of traditional teaching and learning approaches is the decontextualized nature of learning.

Students passively receive the knowledge by traditional and didactic approaches (Bell, 2010). Indeed, students' academic performance can be improved by attending lectures, but it fails to recognize the constraints of traditional teaching and learning, which make it difficult for students to practice the knowledge and skills they learn to solve authentic problems. However, in PBL classes, students engage in projects meticulously designed by teachers to explore problems, hypothesize, generalize knowledge, solve problems, and experience success.

Some studies compare students' learning outcomes in the conventional education approach and PBL, confirming that PBL plays a positive role in improving students' learning achievements. Ergül and Kargın (2014) investigated the effect of PBL on sixth-grade students' learning in science subjects. They found teaching with the PBL method contributed to students' success more than teaching with a teacher-centered method. Moreover, Hernández-Ramos and De La Paz (2009) state that eighth-grade students' work in the PBL class revealed greater growth in history study than students in the more conventional instruction setting. Doppelt's (2013) research results over three years show that most of the low-achieving students across tenth to twelfth grades "succeed with distinction in the same matriculation exams" (p. 255) by participating in PBL activities.

Students participate in learning activities in real scenarios through teamwork and coordination to achieve precise goals. For example, in a mathematics class in Beijing Shun Yi International School for 12 to 13-year-old students, teachers supported students in learning the function $y=kx+b$ through a project of designing barrier-free access for students with physical disabilities on campus, instead of drawing on the axes with a ruler in the formal classes (Jenny, 2017). In this project, some students chose to build models for experiments, and others used Ping-Pong balls to calculate the speed. They collected data for analysis and completed reports. Finally, students presented to introduce their projects to teachers and staff and received feedback (Jenny, 2017). Students learn in classes with greater passion and interest, which is an active and effective learning process.

Thirty years ago, few students acquired post-secondary credentials in China, yet they can expertly apply scientific principles to deal with life's problems. Today, almost all young people receive higher education, but they generally have a poorer ability to live independently and often lack compassion and social responsibility (Yang, 2007). Fewer people can use knowledge for practical purposes like household maintenance, such as maintaining water pipes and electric circuits in the home. One of the reasons is that the teacher-centered and student-followed methods do not provide opportunities for students to know why they need knowledge and how to apply knowledge (Xuan, 2006). Hence, today many children believe that doing schoolwork is to prepare them for their next courses or test-taking, rather than something they will use later in their life (Larmer, & Mergendoller, 2010). The advantage of PBL is that students can grasp the depth and intent of learning, choose the learning style, and initiate application by themselves. In PBL programs, students can immerse themselves in their learning projects and are willing to spend extra time gathering information and thinking (Doppelt, 2013). When working on the same theme, PBL allows different groups to present different projects according to discussion

and cooperation between team members. According to Doppelt (2003), students enjoy learning autonomously in the PBL class so that they have higher engagement and learning motivation. Hence, the flexible learning environment is beneficial for elevating students' learning capacity, motivation, and authentic skills.

21-century skills. Students can cultivate practical skills in project-based learning processes. Today, the internet provides people with massive amounts of information, so the traditional teaching-learning method that aims at mastering knowledge cannot fulfill the developing needs of current students. They need to grasp basic skills, such as literacy, language, research, science, and authentic skills, including collaboration, communication, thinking, solving-problem skills, and technology use. Researchers support PBL as a useful tool to engage students in real life. Kibett and Kathuri (2005) examined the effect of PBL on secondary students' cognitive skills. Results demonstrate that students in PBL classrooms gain high cognitive skills that outperform students in regular classes. Bell (2010) states that students benefit from the PBL approach by practicing technical skills, and become proficient communicators and advanced problem solvers. The practical ability and soft skills of individuals are valued by the labor market and employers. Lyons (2018) states that the PBL strategy helps to close the achievement gap between students from different socio-economic backgrounds or with different learning abilities, in terms of the transition from K-12 education to higher education and eventual employment. Some government offices have encouraged the implementation of PBL into schools and have organized projects with schools to provide opportunities for students to understand their future workplace environment and business world. For instance, the American Government Office of Disability Employment Policy has suggested teachers of special education should encourage students' soft skills for future employment, and NASA has cooperated with high schools and middle schools to create engineering projects and select students for engagement every year (Lyons, 2018).

An old saying in China describes the contemporary learning condition in schools is: "*liang er bu wen chuang wai shi, yi xin zhi du sheng xian shu.*" It means that students pay no attention to what is going on beyond one's studies and buries oneself in textbook knowledge. A lot of parents and teachers encourage children to focus on their studies through textbook learning. However, when students finish school and engage in society, many are unable to accept and fulfill the social roles and responsibilities expected of them. It can be difficult for them to deal with complicated interpersonal relationships (Xuan, 2006). The Chinese Ministry of Education is aware of this problem and encourages schools to implement the PBL approach in the *Chinese STEAM Education White Paper* (Ministry of Education of the People's Republic of China, 2017). Some schools in Jiang Su, Shen Zhen, and Cheng Du have established pilot PBL programs and provided professional training for teachers (Ministry of Education of the People's Republic of China, 2017).

An example in an American school exhibits how PBL develops students' 21-century skills (Cochran, 2016). In the humanities class for eleventh grade, students partnered with nonprofit organizations to make a positive impact on the development of the local community.

Students researched and explored issues in the community and provided projects for the needs of partner organizations to deal with community issues. In this PBL case, eleventh-grade students investigated local community issues that they cared about, gathering and negotiating opinions and ideas with other classmates and organization staff to solve problems. They took action to make a positive impact in their local community while improving their research, communication, collaboration skills, and creativity in teamwork. Bell (2010) states that “PBL promotes social learning as children practice and become proficient with the 21st -century skills of communication, negotiation, and collaboration” (p. 40). During the project, students could assess their achievement and performance in the project. They considered whether the information they searched for was relevant, whether the allocation of work was reasonable, and if they expressed their opinions clearly. 21st -century skills are important to future success for the global economy (Bell, 2010). Consistent self-evaluation and employment of these skills can enhance students’ abilities to become proficient. Although the research suggests PBL is a beneficial and valuable learning approach for students, there still are disadvantages that cannot be ignored.

Disadvantages of PBL for Students

Classroom management issues. It is difficult to supervise the engagement of all students in classes and activities. All the teacher candidates in the interviews conducted by Baysura et al. (2016) believed classroom management to be one of the most outstanding difficulties in implementing PBL. Students work collaboratively to discuss and use technology to explore knowledge in projects. Nevertheless, teachers have limited time and energy to monitor each student’s behavior in activities. Students cooperatively work and discuss in groups, which does not guarantee that every student can participate in classes actively. Certain students might chat with others or search for information that is irrelevant to projects, disrupting the classroom. MacMath et al. (2017) argue that students’ misbehavior and/or disengagement could be an issue in collaborative work. Although students have larger spaces to manage their learning style and to express their opinions and creativity in PBL programs, it is difficult for teachers to supervise student engagement and control classrooms, especially for those with large class sizes. Therefore, the PBL approach might reduce student learning efficiency to some extent, if there is no reasonable distribution and monitoring among team members.

Project-based learning is time-consuming. Many of the advantages and disadvantages of PBL are intertwined. Teachers require time to transition from a teacher-centered to a student-centered approach. Likewise, children, especially those newly introduced to the PBL classroom, need to spend significant time adapting to a new role that requires working collaboratively, cultivating skills, and being self-efficient. On the one hand, according to Mihardi et al. (2013), PBL “takes a very long time and teacher professionalism as a facilitator” (p. 102). For example, some students are unable to properly consider and arrange their workload and time in each stage, and they fail to develop clear learning objectives. As a result, they might spend too much time brainstorming and organizing their projects. Thus, teachers, as the facilitators of learning, have to work hard to track different learning processes of students and provide counselling and guidance

constantly. Other students who have lower comprehensive capacity might be slower than students with a strong comprehensive capacity to collect resources, solve problems, use technology, and understand others and/or express their opinions accurately. Therefore, some teachers reflected that teaching students skills before embarking on the project is necessary (Tamim & Grant, 2013).

Additionally, PBL is costly because students might think off-topic when the project boundary is not clear (Baysura et al., 2016). There are diverse and open-ended project topics for students to choose independently, so PBL classrooms need more students' time than the teacher-centered approach. As usual, students need to make several attempts to determine their projects and amend the solution before reaching a satisfactory result (Mahasneh & Alwan, 2018).

Project-based learning does not fit every student. Although PBL is beneficial for the learner to integrate better into education and modern society, it leads to frustration and anxiety for some students. Teachers participating in the MacMath et al. (2017) study stated that some higher-achieving students appreciated and preferred structured learning environments. The efficiency of PBL instruction for students depends on multiple factors. Low achievement groups of students showed outstanding growth rates in the PBL approach and displayed their strength in terms of creativity, cognitive strategy, and self-adjusting (Doppelt, 2003; Han et al., 2015). By contrast, the study results of Han et al. (2015) show that students with high-level academic performances demonstrated only slight differences in terms of the growth rate of mathematics grades over 3 years. Students with high achievement may have disappointing performance using projects. They may be reluctant to cooperate with others to learn, and while they may be good at structured learning environments, they may have difficulty coping with open-ended and complex situations. For instance, when dealing with math problems, some high achievers might not be able to present their thoughts clearly through simple language or other forms for an audience to understand, which could impact the evaluation of their learning projects and causing a sense of frustration (Han et al., 2015). Therefore, the successful PBL program cannot be implemented successfully without teacher quality and school support.

The Requirements for Implementation of PBL

Teachers' role transition. Teachers need to change roles from a controller in the class and build skills that will help them be successful in PBL implementation. Students search for knowledge and actively explore solutions, which are the main feature of PBL. Doppelt (2003) states that teachers change their role to mentors who boost students' capacity, rather than guarding pupils' growth. Brookes Publishing Webinar (2018) describes a bakery project in the early childhood education classroom. The bakery project aimed to provide students an understanding of the operations side of the business. Teachers first considered what children might be interested in, such as the process of making bread, the uniforms and work of bakers, and how bread is transported to grocery stores. In this case, students had to share what they learned with other children after visiting a bakery. Subsequently, children needed to construct their bakery with various resources and materials independently with the teachers' supports in

the classroom. At the end of the project, students presented their bakery. This example illustrates the importance of preparing prior to starting a PBL unit; the teacher must design the project processes and develop questions to meet fitting the course requirements and students' learning capacity (Kizkapan & Bektas, 2017; MacMath et al., 2017). Instructors need to consider the learning goals and what knowledge and 21st -century skills they expect students to acquire in completing the project. Teachers are to present the topic, objectives, and process clearly to students and guide them to work through PBL (Tamim, & Grant, 2013). Teachers also function as facilitators and guides during a project to provide learning resources and suggestions for students' exploration and reflection. In PBL classes, the role of the teacher is to facilitate learning and guide children to ask questions and explore solutions, instead of answering questions.

Furthermore, teachers are recorders who need to observe students' engagement and performance, and patiently support students to solve problems. Teachers should notice and record students' ideas. When students make mistakes, teachers should restrain from correcting them directly and guide students to find their problems and solutions by themselves. Teachers could record the changes and progress of students' thinking and capacity, which helps teachers to create or adjust learning spaces, promoting children's growth and development. It is worth mentioning that teachers need to help pupils demonstrate their learning outcomes publicly and provide opportunities for them to practice their communication and presentation skills. For example, Ms. McIntyre invited parents, peers, community, government organizations, and businesses as audiences to view the 'Beach Closed: Contaminated Water' project (Larmer & Mergendoller, 2010). After the project, teachers should evaluate whether students have mastered the knowledge and improved their abilities. At the same time, teachers are expected to consider shortcomings and highlight what can be improved or valued in future PBL programs (Tamim & Grant, 2013).

Teaching collaboration. PBL is an interdisciplinary learning approach, which requires the cooperation of other teachers. Teachers work closely with teaching partners to discuss student learning needs, which is a significant element in the implementation of PBL (MacMath et al., 2017). In the preparation and design stage of a PBL unit, the cooperation of teachers from different subjects could put forward the idea of open-ended courses and give play to the characteristics of an interdisciplinary approach. Tamim and Grant (2013) agree that collaboration with other teachers could facilitate the planning of the PBL program and the integration of different subjects.

In Taiwan, teachers for the National Subject-Competency Test (NSCT) must teach content following rigid rules and plans, but computer teachers can freely introduce concepts and practical software tools (Chang & Lee, 2010). Therefore, Chang and Lee (2010) formed a novel team-teaching model where the subject teachers and computer teachers worked collaboratively to facilitate the PBL classroom to examine the availability of teacher collaboration in the PBL approach. In their study, the computer teachers conducted computer-related PBL activities to prepare students for the necessary internet skills, such as facts finding, data analysis, and the use

of software. In the next stage, subject teachers conducted subject-specific project work, focusing on specific learning goals. The results show that the teacher-collaboration model improves the efficiency of both teachers and students and minimizes wasted class time in the PBL program (Chang & Lee, 2010). Therefore, a teacher-collaboration model in a PBL classroom could positively impact students' readiness for working and their learning outcomes in projects, and can help teachers and students make the transition to the PBL. Some teachers can achieve high teaching efficacy in the PBL approach, but school support is an important motivator where teachers are hesitant to transition.

Teacher motivation and school support. The motivation of teachers in PBL implementation comes from personal factors, such as the congruence between the innovation and personal teaching philosophy and teachers' perceived efficiency of PBL, and school factors, including principals' management styles and school culture (Lam et al., 2010). According to Jesus and Lens (2005), if teachers have a higher expectancy of efficacy, they have more motivation in teaching and engagement. For the implementation of a new teaching strategy, most teachers need to spend time realizing its function and learn professional skills. PBL is an educational innovation that is different from traditional teaching and learning. Encountering problems during the implementation of PBL is a risk, which may put pressure on teachers and negatively impact their motivation to apply PBL instruction. Thus, in-service professional training and resources for PBL should be provided to teachers. Wehrell-Grabowski (2018), who is a science and STEM education consultant, shares a case of training units for kindergarten teachers to practice project methods. She chose a theme of studying the human skeleton to introduce the PBL approach, and trained teachers to create a connection between different subjects in teaching and learning. After the training, schools required those teachers to reflect on and apply for this training course. Trained teachers successfully integrated the project method into their classrooms and tended to redesign their existing educational structure (Wehrell-Grabowski, 2018). Therefore, the format of the in-service training used PBL is necessary to teach teachers the fundamentals of PBL.

Furthermore, in Baysura's et al. research (2016), some teacher candidates stated they typically learn PBL in theory and do not have a chance to practice it. One of the reasons is that project-based learning has not been a mainstream instructional approach in many regions and schools. Therefore, available PBL classrooms are not only reliant upon the effort of teachers and students, but also the schools where teacher candidates practice teaching. Lam et al. (2010) found that information about how schools support PBL could be instrumental for teachers who advocate instructional innovation but are concerned about being rejected or marginalized. If the school encourages teachers to use the PBL method, the school and administration must provide teachers the support they require. For instance, schools must provide financial and resource supports, allow teaching autonomy, and involve teachers in decision-making.

Conclusion

The purpose of this narrative literature review was to examine the benefits and shortcomings of project-based learning on students and the qualities required for teachers to implement PBL in K-12 education successfully. Based on interpreting previous research experiments and different PBL classroom cases in different countries, this study shows that PBL is effective in advancing students' academic performance and practical skills. However, owing to the shortcoming of PBL, including classroom management issues, time-consuming processes, and the need for flexibility, some teachers and students are frustrated in PBL programs. It is worth acknowledging that the benefits of PBL far outweigh its disadvantages. In order to improve the positive impact of PBL instruction, in addition to the effort of students, an achievable PBL class is also reliant upon more supports in many aspects. Teachers should receive professional training to be proficient in PBL teaching skills to deal with any problems that may occur in classrooms. Meanwhile, they need to adjust teaching routines and work collaboratively with other teachers from different subjects to design PBL curriculums and facilitate students learning independently. Schools should provide professional training and allow teaching autonomy, which can motivate teachers to practice PBL instruction effectively.

The strengths of this study exist in synthesizing research findings and social media posts about non-scientific PBL examples on the implementation of PBL in K-12 school levels. The results reported here are valuable for institutions and teachers that are considering practicing PBL in classes. However, this study analyzed the research results and cases in different countries. When discussing the effect of PBL on students and the qualities required of teachers, the author recognized not all issues are universal. Therefore, future research is recommended to discuss the implementation of PBL, macro educational reform policy, national education resources, and professional teaching development, in a particular country.

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