



## A Systematic Review of Reviews on Problem-Based Learning and Its Effectiveness

Portia Amoa-Danquah

Washington State University

Kira J. Carbonneau

Washington State University

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**Abstract:** This systematic review of reviews is an exploratory study that aims to synthesize the myriad of reviews about Problem-Based Learning (PBL) to provide a consensus regarding the definition, components, effectiveness, and most common areas of application of PBL. This will provide educators and policymakers with a robust framework to enhance instructional design and implementation in various educational contexts. The review examined 22 studies, primarily focusing on healthcare education but also including other fields. Findings indicate that PBL is consistently defined as a learner-centered approach, emphasizing collaborative learning and problem-solving. Evidence supports the effectiveness of PBL in enhancing student engagement, critical thinking, and professional competencies, although its impact on theoretical knowledge is mixed. Factors such as instructor expertise, cultural context, and subject matter influence the effectiveness of PBL.

**Keywords:** Problem-based learning, PBL, Systematic review, Student-centered, Problem-solving

**Citation:**

Amoa-Danquah, P., Carbonneau, K.J. (date). A systematic review of reviews on Problem-Based Learning and its effectiveness. *Current Issues in Education*, 26(2).  
<https://doi.org/10.14507/cie.vol26iss2.2293>

**Accepted:** 05/09/2025

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## **A Systematic Review of Reviews on Problem-Based Learning and Its Effectiveness**

Problem-based learning (PBL) is defined as a teaching approach in which students acquire knowledge and skills by addressing and resolving real-world issues (Marra et al., 2024). PBL emerged decades ago at McMaster University in Canada as a response to the limitations of traditional teaching methods (Servant-Miklos, 2019). This innovative instructional strategy was soon recognized as a superior approach for equipping medical students with the skills and knowledge essential for their future careers (Barrows, 1996). Studies have delineated the effectiveness of PBL in the classroom. However, some studies have highlighted the aversion some students and teachers have to the application of this method. Although PBL is implemented in some schools (Hallinger & Bridges, 2017; Gao et al., 2020; Manuaba et al., 2022; Merritt et al., 2017), studies have found that it may not be pedagogically sound for certain teachers and learners (Kong et al., 2014). Not only are there diverse and conflicting definitions of PBL, but there also does not seem to be a consensus about its effectiveness across disciplines.

A systematic review is considered a structured, reliable, and valid method for providing a comprehensive synthesis of available pertinent studies on a specific topic (Aromataris & Pearson, 2014). Nevertheless, the downside of having multiple reviews on the same topic is that the differing results can be confusing for decision-makers, making it challenging for them to draw definitive conclusions. Jadad et al. (1997) proposed a solution to this problem by suggesting systematic reviews of reviews. This approach helps determine the divergence or uniformity of review results. The aim of this systematic review of reviews is to synthesize findings on the effectiveness of PBL and identify factors influencing its success. It also seeks to explore what 21st-century skills are nurtured by PBL, establish a consensus on its core components, explore its common applications across disciplines, and examine teacher and student responses to this instructional method.

Overall, the primary goal of this review of reviews is to provide a comprehensive understanding of PBL's instructional efficacy by synthesizing the existing literature, while also identifying the right questions to ask moving forward. A plethora of systematic reviews have been conducted over the years on the topic of the effectiveness of PBL (e.g., Akl, 2014; Manuaba et al., 2022; Qin et al., 2016; Sayyah et al., 2017). This review encompasses a broad analysis of the literature, aiming to classify existing research based on study designs spanning diverse educational populations from elementary to professional graduate school.

Another reason for conducting a systematic review of reviews on the topic of PBL is the wealth of research in this area and the need for a comprehensive synthesis of findings. PBL has garnered significant attention as an instructional strategy, and numerous reviews have been conducted across diverse academic domains. However, a consolidated review of these reviews is essential to distill overarching patterns, identify consensus, and uncover any disciplinary nuances. Such an inclusive examination is essential for offering educators, researchers, and policymakers a better understanding of the broad applicability and effectiveness, and challenges of PBL. By examining the collective evidence across disciplines, we provide an overview that can inform educational practices and guide our future research in PBL.

### **Research Questions**

1. What is the consensus across the articles included in this review about the definition of PBL?

- (a) What are the components of a PBL classroom?
2. What does the evidence in the reviews present regarding the effectiveness of PBL?
  - (a) What are some factors that could impact the effectiveness of PBL (e.g., anxiety)?
3. In what discipline is PBL most commonly applied in education?

### Method

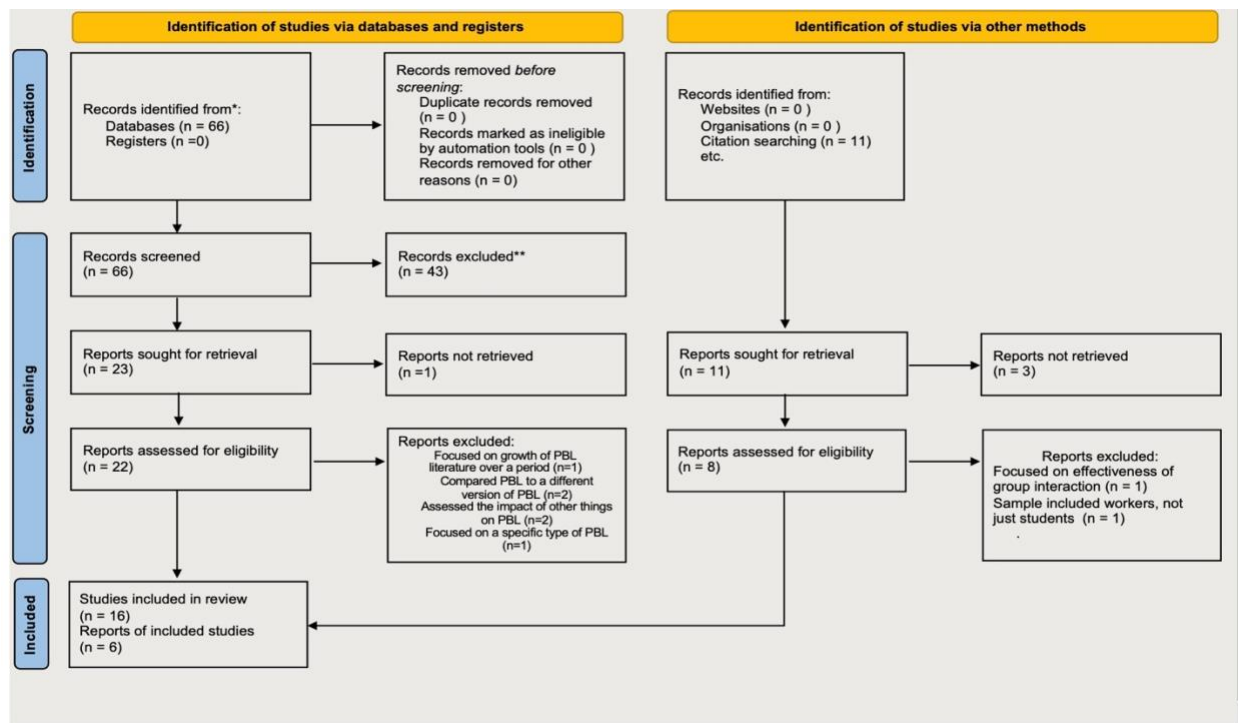
In this study, we gathered information about the consensus on PBL and synthesized findings from the included reviews to answer the research questions. We thoroughly checked to ensure that the data from individual studies in each meta-analysis were not used more than once (Smith et al., 2011).

### Search Parameters

Our inclusion criteria required each review to: (a) have examined the effectiveness of PBL on students’ learning; (b) explicitly mentioned PBL in the title; (c) have been published in English, and employ a review methodology, such as systematic review, scoping review, narrative review, critical review, or meta-analysis; (c) have been published in a peer-reviewed journal; and (5) have been conducted in a formal educational environment with a student population (e.g., healthcare program versus at a museum). Reviews were excluded when the study: (a) did not assess the effectiveness of PBL, (b) compared PBL in its entirety to a different method of PBL, or (c) lacked a clear statement identifying PBL as the primary focus of the study. A flow diagram illustrating the literature search process and the outcomes of the study selection is shown in Figure 1.

**Figure 1**

*Flow Diagram of Study*



### ***Publication Search***

We conducted a search in the ERIC and PsycInfo electronic databases with publication years ranging from 2014 to 2023. It generated 66 reviews across both databases. Our decision to limit our search to these two reputable databases is based on the fact that ERIC is recognized as one of the best databases for peer-reviewed education research. Given that one of our research questions enquires about the factors that impact PBL's effectiveness, such as anxiety, we included PsycInfo as a relevant database for our search. We also searched the references of the chosen studies, and new reviews were included ( $n = 6$ ). Following the removal of duplicates and those that did not meet the inclusion criteria after reviewing the titles and abstracts, we were left with a total of 22 reviews included in our systematic review of reviews.

As illustrated in Figure 1, six studies from this pool of 22 were excluded due to reasons such as focusing on a specific type of PBL, comparing versions of PBL, or examining unrelated outcomes. This brought the total to 16 studies. From the reference search, 11 additional studies were identified, of which five were excluded because they either did not meet the inclusion criteria or could not be retrieved. This resulted in 6 additional reviews included in our synthesis, bringing the total number of studies to 22. Our search term was "*problem-based learning*" AND *systematic review* for both databases. We opted not to include unpublished reviews due to time constraints and to streamline the screening process by focusing on a select number of studies.

### **Results**

Our analysis delves into both the consensus on the definition of PBL and the identified components of PBL, thereby providing an overview of current perspectives and structures in the reviewed literature.

### ***Definition of PBL***

Central to the definitions of PBL in the reviews was the portrayal of PBL as a student-centered educational approach, emphasizing collaborative learning in small groups. According to the reviews, PBL incorporates collaborative learning (Ma & Lu, 2019), where students work together in small groups to construct knowledge (Davidson & Major, 2014). However, PBL differs from collaborative learning in several ways. For instance, although collaborative learning is a central component of PBL, PBL itself extends beyond collaborative learning by integrating a structured problem-solving process into its methodology. In PBL, students not only collaborate to solve a problem and construct knowledge but also engage in solving real-world problems that require critical thinking, the application of theoretical concepts, and interdisciplinary approaches (Wosinski et al., 2018).

Collaborative learning, on the other hand, primarily focuses on students working together to achieve shared learning goals without the necessity of solving real-world problems. It emphasizes teamwork, communication skills, and cooperative knowledge construction, which are valuable in various educational contexts but may not always require the depth of inquiry and application required in PBL (Davidson & Major, 2014). Another example of the way PBL differs from and extends collaborative learning is that it places students in an environment where they are not just working together but are also required to engage in deeper cognitive processes, such as solving real-world problems and engaging in self-directed learning, and the application of critical thinking skills (Abdul Ghani et al., 2022; Tan, 2021). While collaborative learning emphasizes teamwork and shared responsibilities among group members, PBL goes several steps

further by requiring students to take individual accountability for their learning as well as to incorporate knowledge from various sources to solve ambiguous, ill-structured problems (Chang et al., 2022; Hung et al., 2019).

PBL is uniformly highlighted across the reviews as essential for addressing real-world problems effectively. The consensus among these studies emphasizes PBL's focus on active student participation, collaborative teamwork, and the application of theoretical knowledge to practical problems. The definitions provided by Demirel and Dağyar (2016), Zhang et al. (2015), and Wosinski et al. (2018), reinforced this perspective. They similarly depicted PBL as centered on student engagement and practical problem-solving, aligning with the broader consensus on the method's educational philosophy. For instance, Demirel and Dağyar's (2016) explanation that PBL encourages students to accumulate knowledge across different subjects resonates with the broader understanding of PBL as a mostly multidisciplinary approach that facilitates deep learning. These authors also emphasized that the PBL process enables students to learn how to think critically, operationalize research, engage actively in the learning process, and construct their own knowledge of the subject matter. With their description of PBL as a method that enables students to acquire and nurture problem-solving skills by making use of their diverse experiences, they also subtly highlighted the concept that PBL is a pedagogical strategy designed to align with how students naturally learn (Turcotte et al., 2022). In a PBL classroom, the individuality of each learner can be better supported, allowing them to explore, enquire, question, and construct their knowledge in a manner that is meaningful to them.

While variations in terminology and specific emphases exist across the reviews, the foundational elements of PBL, its student-centered nature, collaborative learning, and focus on practical application, remain consistent. These elements collectively affirm that PBL is a tool that aims not only to impart theoretical knowledge but also to equip students with the critical skills needed to navigate real-world problems they may encounter in their professional careers.

In the next section we present our findings for the three key components of PBL, namely: ill-structured problems, collaboration process, and teacher-led facilitation. However, while conducting this review of reviews, we noticed an emerging theme through each of these components: *iteration*. Iteration, as observed in some reviews, is a feature of PBL that influences the stages in the problem-solving process. Rather than following a linear path to arriving at a solution to the ill-structured problem, students engage in cycles of inquiry where they ask themselves and their peers questions, revisit their ideas and approaches, and adjust them based on new information and feedback from peers and the facilitator. This iterative approach is important because it mirrors the complexity of real-world problem-solving, where initial attempts often call for adjustments based on feedback. By acknowledging that iteration is a constant and crucial part of the knowledge acquisition process during PBL, we gain a better understanding of how students evolve in the learning process. As they tackle ambiguous, ill-structured problems, work collaboratively with their peers, and interact with the facilitator, iteration opens them up to consider more information, think critically, deeply reflect on the problem and potential solutions, and refine their thinking.

### ***Components of PBL***

In this section, we identify the key components that define a learning environment as PBL. These components of PBL, namely *Ill-structured Problems*, *Collaboration Process*, and *Teacher-led Facilitation*, are drawn from the studies included in our review. According to the literature, these are the essential features that distinguish PBL from other instructional

approaches. Before doing so, we begin by examining the role of iteration in the problem-solving process.

**Iteration During PBL Problem-Solving.** In problem-solving during PBL, iteration is crucial as real-world problems often demand iterative approaches for effective resolution, deeming important the need to test and refine ideas continuously (Carlson et al., 2018). Iteration in problem-solving has been highlighted as significant in the problem-solving context, where each cycle of testing and revision brings new insights and improvements (Adams et al., 2003; Wynn & Eckert, 2017). Although this was not present in all our included reviews, nine of the 22 studies provided detailed information about the problem-solving aspect of PBL by describing the iterative nature of this process.

According to the review by Wilder (2015), the PBL process begins with students identifying the problem, brainstorming for potential solutions, and recognizing areas in their comprehension where they may need extra help from a peer or a facilitator. This initial phase sets the stage for iterative cycles, where students refine their hypothesis based on new information and feedback from peers. The iterative nature of PBL is further exemplified by the continuous formulation, testing against evidence, and refinement based on new insights and information gathered during self-directed learning (Abdul Ghani et al., 2022; Kong et al., 2014; Merrit et al., 2017). For instance, Kong et al. (2014) emphasized that the PBL process involves students encountering “problem-solving situations in small groups” (p. 2), where they actively search for information and integrate it into their understanding through iterative group discussions and feedback loops. This iterative process supports the development of critical thinking and problem-solving skills, which are essential for effective learning.

Although Hung et al. (2019) did not emphasize iteration in the PBL process, they touched on how PBL shifts paradigms from passive reception to active inquiry and iterative problem-solving. They also observed that PBL encourages students' engagement in problem analysis, information gathering, collaborative discussion, and solution formation. Alrahlah (2016) supported this view, describing in detail how PBL uses problems as the starting point, leading students through cycles of research on the topic, discussion, solution-finding, and reflection. Specifically, a PBL session begins with the presentation of a complex problem to a group of students. To delve deeper into the problem, students gather additional information through research. During the investigation phase, students pause to reflect on and analyze the gathered information, posing questions and making assumptions to grasp the root causes of the problem. Subsequently, they develop new theories based on their own knowledge, observations and discussions. They then break into smaller groups or work alone to delve deeper into specific aspects of the problem. Afterward, they come back together to discuss their findings, reconsider initial ideas, and incorporate new insights. At the end of the session, they reflect on their problem-solving journey, receive feedback, and assess the quality of their work.

According to the reviews, these three essential components also emphasize the integration of both prior and new knowledge in practical contexts, fostering self-directed learning, critical thinking, and problem-solving. The teacher's role in guiding students as they construct their own understanding emerges as a constant theme across definitions, highlighting its importance in cultivating an enriching PBL environment. In examining the reviews of reviews, we noticed that not all reviews included in this study provided detailed description of how ill-structured problems, active peer-collaboration, and teacher-led facilitation are applied within PBL.

The following paragraphs will examine how various reviews have detailed the implementation of these components.

**Ill-structured Problems.** Ill-structured problems, typically characterized by their complexity, ambiguity, and the absence of a single correct solution, serve as the central mechanism for driving student engagement and learning within PBL. The reviews show that the presentation and format of ill-structured problems vary significantly. Alrahlah (2016), for example, described how PBL scenarios, such as patient case simulations, written scenarios, and even video clips, reflect real-life situations, requiring students to integrate knowledge from multiple sources to solve them. Similarly, Hung et al. (2019) mentioned the evolution of ill-structured problem presentation in PBL with the advent of electronic and internet-based tools and environments for delivering content. Authenticity and realism are also crucial in the design of ill-structured problems. Abdul Ghani et al. (2022) emphasized the importance of “high fidelity simulations” in creating authentic learning experiences. In their review, they observed that these simulations involve role playing and using real medical equipment, for example, to replicate clinical settings, making the learning process more relevant and engaging for students. The authenticity of scenarios is paramount, and expert advice is often sought to ensure the cases reflect real-life situations. Furthermore, Akl (2014) cited an example of a scenario where a motivated student’s academic performance declines. This example enables PBL learners in teacher education programs to investigate the relationships among motivation, learning theories, and student behavior. Across different reviews (Abdul Ghani et al., 2022; Alrahlah, 2016; Hallinger & Bridges, 2017; Hung et al., 2019; Merritt et al., 2017), a recurring emphasis emerged on the realism and complexity embedded within ill-structured problems.

The operationalization of ill-structured problems also varied significantly based on the students' educational level and the instructional approach (Merritt et al., 2017). For younger students, problems tend to be more structured with clear guidance. For instance, Merritt et al., (2017) cited Karaçalli & Korur, (2014), who described elementary school students in a PBL class being provided with essential information about how electricity impacts their daily lives, after which they completed projects involving basic electric circuits from the curriculum. Additionally, the degree of student involvement in defining the ill-structured problem and learning objective varies. Some approaches are more instructor-led, providing structured problems and objectives (Hallinger & Bridges, 2017), while others are more student-centered, encouraging learners to take ownership of their learning process by identifying their own problems and solutions. For instance, in a student-led PBL assignment, students identify a genuine issue at their school and create a tool to aid in understanding and resolving the problem, whereas in an instructor-led problem, the instructor presents students with the school problem and a data set to guide their analysis.

**Collaboration Process.** The reviews offered nuanced perspectives about how the collaboration process is operationalized in PBL. A recurring theme showed an emphasis on small-group dynamics. For example, in their review, Alrahlah (2016) stated that students, often organized into groups of five to nine, engage in collaborative activities where they initiate discussions, identify learning objectives, and collectively solve complex problems. Additionally, in healthcare education settings, students work together to analyze patient case studies to propose comprehensive treatment plans. Their review outlined a five-step process where groups are formed, roles are clarified, tasks are assigned, independent research is conducted, and findings

are collaboratively reviewed and synthesized. This structured approach ensures that all group members actively contribute and learn from each other.

Further, Zhou et al. (2016) provided cultural insights into collaborative practices within PBL, particularly in Chinese educational contexts. These authors observed the importance of respectful communication styles that influence group interactions. In Chinese pharmacy education, for example, students participate in structured group discussions to explore clinical scenarios, with an emphasis on consensus-building and collective decision-making to address patient care challenges effectively. In their review, introverted students tend to have difficulty participating in these discussions. Technology in PBL was also discussed. For instance, Merritt et al. (2017) noted the integration of digital tools to enhance the PBL experience. High-fidelity simulations and multimedia tools (Akl, 2014) can create engaging and interactive learning environments, allowing students to collaborate more effectively. For example, in healthcare education, digital platforms enable students to simulate real-world clinical environments, practicing teamwork and communication skills essential for professional practice.

Additionally, Kong et al. (2014) highlighted a structured approach to collaboration within PBL, detailing a five-step process: analysis of problems, establishment of learning objectives, collection of information, summarizing, and reflection. In this model, students work in small groups to tackle problem-solving situations. Each group must determine the necessary information to understand the problem, communicate findings, and re-formulate the problem to address it effectively. In the realm of management education, Hallinger and Bridges (2017) briefly mentioned the importance of student-led learning within small groups. They discussed a “model of problem-based management” (p. 3), which includes characteristics such as learning centered around real-world problems, students taking charge of their own learning, and implementing simulated solutions that they demonstrate to the group and facilitator, if possible. They also emphasized the crucial role of small-group collaboration, where students collectively analyze significant workplace issues, pursue self-directed learning, and receive ongoing formative feedback from peers and facilitators.

The collaboration process was also explored through a detailed description of student roles in PBL. In their review, Abdul Ghani et al. (2022) stated that students are placed in groups of 8 to 10 to discuss problem triggers, identify and clarify terminology, categorize issues, brainstorm hypotheses, develop inquiry plans, and refine their hypotheses based on evidence they gather through their research. This review also underscored several themes that foster collaboration, including establishing guidelines to ensure equal participation among group members, fostering teamwork within groups, and promoting healthy competition between groups to motivate students. The authors also emphasized the use of interactive tools, such as online quizzes and social media, for sharing knowledge. Wosinski et al. (2018) highlighted the role of group learning in developing clinical reasoning skills in nursing education. Students collaborate in small groups to exchange, evaluate, and discuss information to address clinical case studies. The process involves dividing tasks among group members, researching topics, summarizing findings, and organizing the knowledge constructed. This review outlined essential skills students need to master this process, such as managing emotional states, adapting to a seemingly unstructured format common to PBL, time management, and learning from and collaborating with peers. For instance, when presented with a clinical case study, students must actively listen to each participant's contributions, focus on problem-solving, and leverage each member's strengths.

**Teacher-led Facilitation.** Out of the 22 studies included in our review, only seven specifically described the role of teacher-led facilitation in PBL. It is the facilitators' job to orchestrate inclusive discussions where all group members actively participate (Abdul Ghani et al., 2022). According to the authors, the facilitator is also responsible for assigning specific learning roles tailored to each student's strengths and interests, thereby fostering a collaborative environment enriched by diverse perspectives that contribute to comprehensive problem-solving strategies. Additionally, Abdul Ghani et al. (2022) stated that facilitators guide students' learning by implementing specific tasks within PBL to incentivize student engagement and achievement. These rewards, specifically focused on students' learning process and not necessarily the final result, are given at the end of the PBL process. Although they did not state what exactly the rewards should be, they mentioned that they are designed to recognize and reinforce positive learning behaviors during both individual and collaborative problem-solving activities, aiming to sustain students' individual motivation and commitment to the collaborative learning process.

Similarly, Akl (2014) emphasized the importance of the tutor focusing on the learning process rather than just the result. Although he did not delve deep into this component, Wilder (2015) briefly noted the impact of teacher expertise and experience on PBL process and outcomes. He specifically highlighted that for tutors to better facilitate meaningful learning experiences, it is imperative they have extensive PBL experience and robust subject matter knowledge. Only then can they effectively guide students through complex problems, provide timely feedback, and scaffold learning experiences that align with the curriculum's objectives. This makes the issue of tutor expertise somewhat complex, as Alrahlah's (2016) review showed that students taught by peer tutors who facilitate the process but are not necessarily subject-matter experts performed slightly better on final exams compared to those taught by content experts. The reason was that the experts overdo it and may be somewhat rigid due to their expertise in the field, whereas student tutors are able to better relate and understand the challenges and process students go through when constructing knowledge.

Additionally, Merritt et al. (2017) delineated the multifaceted role of tutors as facilitators in PBL, detailing their responsibilities beyond mere information dissemination. The authors stressed that tutors should not only distribute worksheets and lead discussions but also play a crucial role in guiding students through the knowledge construction process. This guidance includes prompting students to explore and analyze information critically, verify hypotheses, and construct reasoned arguments among their peers. According to Alrahlah (2016), it is essential to recognize that one primary goal of PBL is not only to impart knowledge but also to foster a broad range of essential learning outcomes. These include assisting students in constructing a broad and adaptable knowledge foundation, enhancing collaboration skills and the ability to successfully solve problems, fostering intrinsic motivation for learning, and developing self-directed learning skills. The review included an example where tutors guide students by prompting them with questions that encourage deeper understanding and more efficient problem-solving, an approach which empowers students to engage in self-directed inquiry and mutual stimulation within their group.

Hallinger and Bridges (2017) discussed the differences between "problem-stimulated" and "student-centered" projects and the role the tutor plays. In problem-stimulated projects, the tutor provides necessary resources, discussion questions, as well as the learning goals. This structure suggests that the instructor takes the lead in setting the educational agenda and ensuring that students focus on specific learning outcomes predetermined by the instructor. On the other hand, in student-centered projects, students have more say in identifying learning objectives,

sourcing resources, and formulating guiding questions. Finally, Akl (2014) stated that tutors must know how to adapt their instructional strategies to suit the dynamic nature of PBL. This may involve preparing mini-lectures or providing targeted feedback to address specific learning gaps identified during problem-solving sessions.

### ***Effectiveness of PBL***

Several of the studies we reviewed, including Wang et al. (2016) and Qin et al. (2016), affirmed that PBL effectively enhances the overall learning outcome. They emphasized PBL's role in deepening understanding and promoting higher-order thinking skills such as analytical thinking and problem-solving abilities (Hallinger & Bridges, 2017). For example, Qin et al. (2016) observed that students in PBL classes scored significantly higher in various aspects of the medical educational environment compared to those in lecture-based learning (LBL) classes. Specifically, they found substantial differences favoring the PBL group in medical educational environment scores (WMD 9.10,  $p < 0.00001$ ). Additionally, students' perceptions of learning (WMD 2.84,  $p < 0.0001$ ), perceptions of teachers (WMD 1.77,  $p < 0.0001$ ), academic self-perceptions (WMD 1.06,  $p < 0.00001$ ), perceptions of atmosphere (WMD 1.76,  $p < 0.00001$ ), and social self-perceptions (WMD 1.19,  $p < 0.00001$ ) were significantly higher in the PBL group. The authors concluded that PBL is more effective in enhancing students' knowledge and skills, leading to improved performance in clinical exams and faculty evaluations. PBL also promotes critical thinking, creates a supportive and pleasant learning environment, and positively influences students' attitudes and opinions about their educational programs. Wang et al. (2016) corroborated Qin et al.'s (2016) findings by demonstrating that PBL significantly enhances students' knowledge and clinical skills compared to traditional teaching methods. Their analysis showed a significant improvement in knowledge scores for the PBL group (SMD 0.76,  $P = 0.0006$ ). In terms of clinical skills, studies revealed a substantial advantage for the PBL group (SMD 1.46,  $P < 0.001$ ). Their studies found that PBL students consistently achieved better knowledge and skill scores.

Results from another study (Ma & Lu, 2019) indicated that PBL may not improve factual knowledge acquisition. However, the authors also stated that PBL did appear effective in fostering deeper cognitive processing and enhancing student comprehension of complex concepts. For example, the authors stated that there were significant improvements in theoretical knowledge, skills, and case analysis scores with PBL compared to LBL. The analysis reported an increase of 1.16 points in theoretical knowledge ( $P < .00001$ ), a 1.56-point improvement in skills, and a 1.54-point enhancement in case analysis for PBL groups versus LBL groups. These results provide evidence of PBL's capacity to markedly enhance students' skill performance. In fields such as pediatric medical education, where mastering clinical diagnostic skills and problem-solving abilities is crucial, PBL has emerged as a superior instructional approach compared to traditional teaching methods.

In terms of critical thinking, Manuaba et al. (2022) and Kong et al. (2014) presented mixed results. Whereas Kong et al. (2014) found PBL to be useful in improving nursing students' critical thinking skills when compared to the traditional teaching method, Manuaba et al. (2022) suggested that PBL does not consistently actually demonstrate a significant advantage over traditional teaching methods in terms of developing problem-solving skills ( $p=.47$ ), critical thinking ( $p=.29$ ), and self-directed learning. This discrepancy underscores the variability in PBL's impact on critical thinking across different educational contexts.

Conversely, Alrahlah (2016) and Abdul Ghani (2022) stated that during the PBL process, the facilitator ensures that learners are actively engaged in their learning process. Other reviews

highlighted PBL's positive impact on learner engagement and the development of practical competencies essential for professional settings. For example, Demirel and Dağyar, (2016) discovered that, compared to traditional teaching methods, students taught through PBL generally had a more positive attitude towards their courses. Nevertheless, their study, which calculated the effect sizes of PBL on student attitudes, indicated that while PBL positively influenced attitudes, the effect size was relatively small ( $g=.44$ )

In conclusion, while specific outcomes may vary, the collective evidence supports PBL as an effective educational strategy. It enhances learning outcomes, fosters critical thinking in a specific context, boosts learner engagement, develops practical competencies, enhances attitudes, and improves specific skills and knowledge necessary for professional practice across diverse educational settings.

**Challenges to PBL's Effectiveness.** Some reviews emphasized the challenges that could impact the effectiveness of PBL and admitted that PBL may not always be suitable for learning (Kong et al., 2014; Zhou et al., 2016). For example, Zhou et al. (2016) identified several obstacles to implementing PBL, including the need for instructors to undergo professional development training to effectively facilitate this method. They also highlighted the logistical challenge of reducing class sizes because smaller class sizes are better suited for PBL, and this could potentially increase educational costs. Kong et al. (2014), however, argued that PBL may not be universally suitable for all students and instructors, suggesting variability in acceptance and effectiveness of PBL across different educational settings. They went on to emphasize the facilitator's role in PBL programs, specifically stating that effective facilitation significantly enhances learning outcomes. For instance, facilitators who provide clear guidance, foster collaborative environments, and manage group dynamics effectively can mitigate issues such as poor communication, absence of mutual support, and unresolved conflicts among group members. These challenges emphasize the importance of skilled facilitators and supportive educational environments in maximizing the benefits of PBL.

Other challenges mentioned in the reviews were the management of teacher and student anxiety (Hallinger & Bridges, 2017), group dynamics (Jin & Bridges, 2016), and assessment methods (Hung et al., 2019). Hallinger and Bridges (2017) delineated concerns regarding student and faculty anxiety in adapting to PBL. They noted that both students and instructors may experience apprehension about their new roles, including learning collaboration skills and adapting to new teaching, learning, and assessment methods. With regards to assessment methods, the traditional assessments used for traditional pedagogy will not be effective in assessing the higher-order thinking skills in PBL, and as such could lead to some anxiety. A similar finding was presented in Jin and Bridges's (2016) review, which found that students' learning outcomes and the way they learn in PBL classrooms are influenced by the assessment methods used, which can have both positive and negative effects. The adjustment process from traditional instruction to PBL instruction requires sufficient time for PBL lesson preparation, resources that support effective project implementation, and flexible scheduling to accommodate intensive learning sessions.

Cultural differences were also considered as a factor. For instance, Ma and Lu (2019) discussed how the effectiveness of PBL in China could be affected by the country's culture and educational system, which differs from that of the West. This perspective was echoed by Gao et al. (2020), who also pointed out the significance of cultural differences in the success of PBL, specifically pointing out the reluctance of Chinese teachers and learners to engage in learning

this way because of the discomfort with students being in control of their learning. Specifically, Manuaba et al. (2022) noted factors such as how long students have been taught via PBL, the subject matter being studied, and students' prior knowledge. Wilder (2015) and Kong et al. (2014) also briefly noted that lack of communication skills, discord, and stress during the peer collaboration process could impact PBL's effectiveness. Qin et al. (2016) and Hung et al. (2019) underscored the significance of frequent evaluation and adaptable educational methods within PBL.

The review also showed that both Eslami et al. (2014) and Wosinski et al. (2018) mentioned the critical role of instructor proficiency in PBL. Eslami et al. (2014) noted that for PBL to be effective, the facilitator must be well-versed in the use of the instructional tool as well as have a high level of content knowledge, as this may significantly impact students' performance. Similarly, Wosinski et al. (2018) highlighted that a tutor's ability to combine content knowledge with pedagogical skills has a positive impact on learning outcomes. Course type was also found to play a significant role. Zhang et al. (2015) found that PBL is more effective in practical, hands-on courses compared to theory-based courses. Their study suggests that the hands-on practical nature of laboratory settings aligns better with the PBL approach. This finding is supported by Wilder (2015), who emphasized how important it is for students to have adequate prior knowledge about the subject matter in order to successfully participate in the PBL process and be able to be practical and apply it in certain courses.

Lastly, the duration of PBL exposure and the subject matter being taught were identified as influencing factors by Manuaba et al. (2022). They suggested that these factors, along with students' prior knowledge, play a role. This perspective adds another layer of complexity, indicating that the length of time students are engaged in PBL and the specific content area can influence outcomes.

To conclude, while there are commonalities in recognizing the importance of instructor expertise and the influence of cultural and educational context, differences exist in the emphasis on general versus specific factors. For instance, Demirel and Dağyar (2016) suggested that general mediator variables (i.e., class sample size, field of science, education level, and application time) do not significantly impact students' attitude towards PBL classes. Other studies (e.g., Gao et al., 2020; Hallinger & Bridges, 2017; Kong et al., 2014; Manuaba et al., 2022; Wilder, 2015) highlight the importance of specific factors such as instructor expertise, course type, anxiety, group dynamics, communication, assessment methods, duration of exposure, and subject matter. These findings collectively highlight the multifaceted nature of factors influencing PBL's effectiveness, suggesting that its success depends on a combination of contextual, instructor-related, and course-specific factors.

### *Disciplines*

Table 1 is in answer to our final research question, which asks in what discipline PBL is most commonly applied in education.

**Table 1**

*Distribution of Disciplines Utilizing PBL*

Disciplines	Studies
Medical Education	Alrahlah, (2016); Demirel & Dağyar, (2016); Eslami et al., (2014); Gao et. al, (2016); Gao et al., (2020); Hung et. al, (2019); Jin & Bridges, (2016); Kong et al., (2014); Ma & Lu, (2019); Manuaba & Wu, (2022); Merritt et al., (2017); Qin et al, (2016); Sayyah et. al. (2017); Wang et. al, (2016); Wilder, (2015); Wosinski et al., (2018); Zhang et al., (2015); Zhou et. al, (2016);
Educational Leadership	Hallinger & Bridges (2017)
Gamified elements	Abdul Ghani et al. (2022)
Teacher Education	Akl (2014)

**Discussion**

The goal of this study is to synthesize findings from a diverse array of literature to provide a comprehensive understanding of PBL’s definition, components, effectiveness, disciplinary applications, and influencing factors. The findings of this review reinforce that PBL, when implemented thoughtfully, can enrich educational outcomes in multiple ways. Across diverse reviews, PBL has been associated with higher student engagement and the development of key skills, such as communication, teamwork, and domain-specific reasoning. In professional programs like medicine, for example, the collaborative analysis of patient cases in PBL is credited with sharpening students’ clinical reasoning and interpersonal skills. However, the evidence also indicates that the benefits of PBL are contingent on certain conditions. The positive effects tend to emerge most strongly under well-structured implementation, including appropriate problem design, effective facilitation, and supportive learning cultures. Notably, while PBL generally enhances problem-solving capabilities and enthusiasm for learning, its impact on critical thinking remains equivocal, with some reviews finding significant gains (Kong et al., 2014) and others reporting no difference compared to traditional methods (Manuaba et al., 2022). This nuanced picture suggests that educators must carefully consider how to adopt PBL in order to maximize its advantages. In the discussion below, we elaborate on the broader implications of these findings for educational practice, from instructional design and teacher training to cultural adaptation and future applications, and we offer recommendations to navigate the challenges of PBL implementation.

**Implications for Educators and Instructional Design**

For educators and curriculum designers considering a shift toward PBL, this review highlights several key practices that can make the approach more effective. First, it is essential to structure small-group collaboration deliberately. PBL relies on students working in teams, and clear organization within those teams helps ensure that learning is productive. Effective PBL

groups often assign clearly defined roles (Wosinski et al., 2018) and responsibilities to each member, which promotes balanced participation and accountability (Alrahlah, 2016). Establishing such roles and norms guards against common pitfalls of group work. For instance, it helps prevent scenarios where a few students do all the work while others remain passive. Instead, every student is expected to contribute, and the team can tackle the problem through coordinated effort. By attending to group structure and task distribution from the outset, educators can foster a collaborative climate in which students actively learn from one another (Li et al., 2022). This finding resonates with social constructivist principles that knowledge is co-constructed; indeed, PBL's success hinges on productive group processes, which effectively become the backbone of the learning experience (Johnson & Golombek, 2016).

Another crucial design element is the nature of the problems used in PBL. Our review underscores the value of using ill-structured, authentic problems as the driving force for inquiry (Hallinger & Bridges, 2017; Merritt et al., 2017). In contrast to well-defined textbook exercises, ill-structured problems have multiple unknowns, ambiguous parameters, and no single "right" solution (Liu et al., 2020). Such real-world complexity is by design: the aim is to push students to integrate knowledge from various subjects and think deeply about how to apply what they know. When confronted with a messy, authentic problem scenario, learners must draw on different disciplines and connect concepts in a holistic way, rather than simply recalling isolated facts. This process promotes more integrative and deep learning. For example, a medical PBL case on a patient's condition might require understanding anatomy, biochemistry, and ethics simultaneously, mirroring the interdisciplinary problem-solving required in actual practice. Research has found that problems situated in meaningful contexts compel students to engage in analysis and evaluation more rigorously, yielding a deeper grasp of the material (Smith et al., 2022). The authenticity of PBL scenarios is likely to boost intrinsic motivation when learners perceive that the problem has real-world significance. Thus, to leverage PBL's full potential, educators should design problem scenarios that are realistic, complex, and open-ended, providing fertile ground for students to research, discuss, and learn actively.

### **Role of Facilitators and Teacher Development**

Central to the success of PBL is the role of the facilitator. Rather than delivering content through lectures, the facilitator in PBL acts as a guide on the side, a subtle but pivotal shift in teacher function. The review findings repeatedly emphasize that skilled facilitation is critical for steering the inquiry process, prompting reflection, and maintaining an inclusive dialogue among students (Akl, 2014; Merritt et al., 2017). In a typical PBL session, the facilitator is present throughout the discussion to guide the students' tutorial activities and thinking. This guidance does not mean giving students the answers; instead, effective facilitators use techniques such as asking open-ended questions, encouraging students to elaborate on their ideas, and periodically summarizing or clarifying key points. At some institutions with PBL, facilitators receive training on how to perform these roles (Li et al., 2022). They learn how to ask probing questions, stimulate discussion, and prompt students to reflect on their reasoning. Such training is important because traditional instructors may not innately know how to facilitate without lecturing. The facilitator must strike a balance between stepping back to let students direct their own learning and stepping in at the right moments to keep the group on track or to deepen the inquiry with a well-placed question. In sum, the central role of the facilitator means that PBL's effectiveness is closely tied to teacher practices. Educational leaders should thus make facilitator training and

support a priority, as a well-trained facilitator is the linchpin that keeps the student-centered inquiry both rigorous and inclusive.

### **Interdisciplinary and Global Applications of PBL**

One of the exciting implications of these findings is the potential for PBL to foster interdisciplinary learning and to be applied on a global scale. By its very design, problem-based learning breaks down traditional subject silos: real-world problems do not respect disciplinary boundaries, and students in a PBL setting quickly learn that they must draw knowledge from multiple domains to develop a solution. This aligns with modern educational goals of producing graduates who can think holistically and work across disciplines. In doing our review, we found that authentic problems often require a blending of perspectives. For example, a public health problem might involve biological, social, and statistical considerations all at once. Through PBL, students routinely practice this kind of integrative thinking. They learn to see connections between theory and practice because the problem demands it. Educators can leverage this by designing PBL curricula that intentionally span subject areas. The interdisciplinary nature of PBL is thus a strength that can inform future curriculum development. This suggests that PBL could be a core strategy in programs aiming to address complex societal issues where understanding the problem from multiple angles is crucial.

In addition to crossing disciplinary lines, PBL also has a strong resonance with 21st-century skills that are globally relevant. The skills nurtured by PBL, such as problem-solving, collaboration, self-directed learning, adaptability, and critical thinking, are often cited as essential for the modern workforce and for global citizenship (Ahmed, 2024). As our world becomes more interconnected, the challenges we face (e.g., pandemics, environmental crises, social inequalities) are global in scope and require collaborative problem-solving on an international scale. PBL prepares students for this reality by giving them practice in tackling complex problems in teams. It is not surprising, then, that PBL has been adopted in various forms around the world, in both developed and developing countries. This review's findings encourage educators to view PBL as a globally transferable model. With appropriate adaptation, a problem-based approach can be used to teach anything from primary school science to graduate-level business strategy. Indeed, PBL has been successfully implemented in fields as diverse as law, nursing, engineering, economics, and beyond. This versatility speaks to a fundamental aspect of PBL, as it focuses on learning how to learn, a meta-skill that transcends disciplines and national curricula.

Finally, in light of these points, one broad implication is that educational policymakers and institutions might consider PBL as a framework for interdisciplinary programs and global partnerships. PBL's emphasis on student-centered learning makes it a natural platform for interdisciplinary projects, design thinking challenges, and international case competitions. As a recommendation, schools and universities could pilot joint PBL modules across departments or even with partner institutions abroad, assessing outcomes in terms of student learning and engagement. If done carefully, such initiatives could produce graduates who are not only experts in their field but also skilled collaborators and innovators with a global outlook.

### ***Limitations***

A few limitations of this study should be noted. First, the inclusion criteria were restricted to articles published in English, which may have led to the exclusion of relevant studies in other languages. Second, the reliance on accessible reviews and peer-reviewed journals might have

introduced a publication bias, potentially overlooking valuable insights from non-peer-reviewed sources or even gray literature.

Across the reviews, methodological concerns such as lack of randomization, blinding, and allocation concealment were reported, increasing the risk of bias and reducing internal validity (Gao et al., 2020; Zhou et al., 2016). Variability in study design, implementation, and evaluation of PBL, including differences in outcome measures, populations, and intervention types, further complicated comparisons and generalizability (Eslami et al., 2014; Zhang et al., 2015). Geographic concentration was another limitation, as many included studies were conducted in China, restricting the applicability of results to broader educational contexts (Ma & Lu, 2019; Qin et al., 2016). Other reviews have also highlighted the reliance on self-report measures, such as interviews and reflective journals, which may be influenced by social desirability and fail to accurately reflect actual learning outcomes (Eslami et al., 2014; Jin & Bridges, 2016). Lastly, several studies evaluated outcomes over short time spans (e.g., one academic year), leaving the long-term effects of PBL largely unexplored (Manuaba et al., 2022).

### Conclusion

To begin this review of reviews, we first identified and synthesized findings from 22 reviews of PBL to understand its definition, components, and applications across different educational contexts. From this, we found that PBL is consistently described as a student-centered, collaborative approach that emphasizes solving real-world, ill-structured problems through collaborative work. We also analyzed how PBL is implemented across various disciplines, revealing that while it is currently predominantly used in healthcare education, its principles are adaptable to fields such as educational leadership and teacher training. Finally, in our review of reviews, we explored factors that influence the success of PBL, such as instructor expertise, cultural context, group dynamics, and assessment methods. These factors were shown to either enhance or hinder the effectiveness of PBL, depending on how well they are managed in a classroom setting.

The goal of this study was to synthesize the existing reviews to provide a comprehensive understanding of PBL's instructional effectiveness, clarify its core components, and identify the key factors that contribute to its success or challenges. Our findings suggest that while PBL is effective in promoting student engagement, critical thinking, and the development of practical, real-world skills, its impact on theoretical knowledge acquisition is mixed. Factors such as the role of the facilitator, the complexity of the problems, and the cultural readiness for student-centered learning play a significant role in determining how successful PBL is in various educational settings. To conclude, PBL's success is largely dependent on contextual factors, including facilitator expertise, the design of ill-structured problems, group collaboration, and the cultural and institutional environment. While it shows great promise, particularly in healthcare education, its broad applicability across disciplines requires careful consideration of these variables to ensure it meets the learning needs of students. This review of reviews underscores the need for more standardized methods of implementation and long-term evaluations to further understand its impact and refine its application across different fields.

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#### Author Notes

Portia Amoa-Danquah, M.A.  
<https://orcid.org/0009-0004-7502-3933>  
Washington State University  
[portia.amoa-danquah@wsu.edu](mailto:portia.amoa-danquah@wsu.edu)

Kira J. Carbonneau, Ph.D.  
<https://orcid.org/0000-0002-4686-1290>  
Washington State University  
[kira.carbonneau@wsu.edu](mailto:kira.carbonneau@wsu.edu)



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