

Implementation of Project-Based Learning Models in Senior High School Education: A Systematic Review

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Abstract

The rapid development of twenty-first-century education has emphasized the need for innovative pedagogical models that foster both academic achievement and essential twenty-first-century skills, one of which is Project-Based Learning (PBL). Although PBL has been widely implemented and examined in primary and higher education contexts, studies focusing specifically on its implementation at the senior high school level remain limited and report inconsistent findings. This study aims to systematically review the existing literature on the implementation of Project-Based Learning in senior high school education, with particular attention to implementation models, impacts on students' learning outcomes, challenges faced by teachers, strategies to address these challenges, and emerging research trends. A systematic literature review method was employed by searching articles indexed in the Scopus database using the keywords "Project-Based Learning," "Secondary Education," and "Educational Models." The selected studies were screened based on predefined inclusion and exclusion criteria and analyzed using the PRISMA framework. The findings indicate that PBL in senior high schools is commonly implemented through interdisciplinary and contextual approaches and has a positive impact on students' critical thinking, collaboration, creativity, and learning engagement, although its effects on academic achievement remain mixed. Major challenges in implementing PBL include limited teacher training, insufficient resources and infrastructure, time management constraints, and assessment complexities. Furthermore, recent research trends highlight increased integration of advanced technologies, including artificial intelligence, inter-institutional collaboration, and a growing emphasis on process-oriented assessment and the development of twenty-first-century skills. Overall, this review suggests that Project-Based Learning holds substantial potential to enhance the quality of learning in senior high school education; however, its effective implementation requires systematic planning, sustained teacher professional development, and strong institutional support.

Introduction Section

Rapid developments in educational methodologies have become a defining characteristic of the 21st century, with the implementation of innovative pedagogical models playing a crucial role in transforming teaching and learning practices (Zuhri & Afriani, 2025). Among these methodologies, Project-Based Learning (PBL) has emerged as a prominent approach, particularly in secondary education. PBL encourages students to engage in long-term, interdisciplinary projects that require critical thinking, problem-solving, collaboration, and creativity—skills considered essential for success in a rapidly changing modern world. In the context of secondary education, where students are prepared for higher education and the workforce, PBL aligns well with the need to develop not only academic knowledge but also practical, real-world skills (Amran et al., 2025).

Despite its growing global adoption, the implementation of PBL in secondary schools continues to face significant challenges. Educational systems, particularly in developing countries, encounter barriers such as insufficient teacher training, limited resources, and difficulties integrating PBL into rigid and standardized curricula (Sánchez-García & Reyes-de-Cózar, 2025). Although some studies report positive outcomes, including increased student engagement, academic achievement, and enhanced critical thinking, other findings suggest that the effectiveness of PBL is highly context-dependent. Furthermore, the lack of systematic reviews specifically focused on secondary education highlights a gap in understanding how PBL can be effectively implemented at this level.

Inconsistent implementation of Project-Based Learning in secondary schools remains a critical concern. While several studies have demonstrated the positive effects of PBL on critical thinking, collaboration, and problem-solving skills (Bell, 2010; Thomas, 2000), evidence regarding its impact on academic achievement—particularly in traditional subject areas—remains mixed. Additionally, there is no clear consensus on the most effective strategies for integrating PBL into existing secondary school curricula, given the constraints imposed by standardized testing and traditional instructional models.

Teachers also face substantial challenges in implementing PBL, including limited opportunities for professional development, restricted access to technology, and difficulties managing complex projects with diverse student needs. This gap between the theoretical potential of PBL and its actual classroom implementation underscores the urgency of understanding the factors that contribute to its success or failure.

This study aims to systematically review the existing literature on the implementation of Project-Based Learning in secondary education. Specifically, this review seeks to:

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1. Identify various forms of PBL implementation in secondary schools, including models and strategies used by teachers and institutions.
2. Examine the impact of PBL on student learning outcomes, focusing on academic achievement and 21st-century skills.
3. Explore the challenges faced by teachers in implementing PBL and identify potential solutions.
4. Analyze emerging research trends related to PBL and highlight best practices in secondary education.

The research questions addressed in this study are:

RQ1: How is Project-Based Learning implemented in secondary education, and what key strategies are used?

RQ2: What is the impact of PBL on student learning outcomes in secondary education, including academic achievement and 21st-century skills?

RQ3: What major challenges do teachers face when implementing PBL in secondary schools?

RQ4: What strategies have been identified as effective in overcoming challenges in PBL implementation?

RQ5: What emerging research trends are associated with PBL in secondary education, and how have they evolved over time?

Methodology

This study adopts a qualitative research design using a systematic literature review approach. Although Project-Based Learning (PBL) has been extensively examined in primary and higher education contexts, relatively few studies have specifically investigated its implementation at the senior high school level. A review by Thomas (2000) reported positive effects of PBL on student motivation, engagement, and long-term knowledge retention; however, findings focusing on secondary education remain inconsistent. Some studies demonstrate improvements in students' learning outcomes, while others highlight challenges related to implementing PBL within more structured and content-dense curricula.

The literature selection process was conducted using the Scopus database, with searches limited to peer-reviewed journal articles published between 2021 and 2026 and written in English. The keywords used were "Project-Based Learning," "Secondary Education," and "Educational Models," with additional restrictions applied to articles indexed in Scopus, classified as research articles, and available through open access. The Title-Abs-Key search query applied was: ((TITLE-ABS-KEY(Project-Based Learning) AND TITLE-ABS-KEY(Secondary Education) AND TITLE-ABS-KEY(Educational Models)) AND (LIMIT-TO(SUBJAREA, "SOC") OR LIMIT-TO(SUBJAREA, "ARTS"))) AND (LIMIT-TO(DOCTYPE, "ar")) AND (LIMIT-TO(LANGUAGE, "English")) AND (LIMIT-TO(OA, "all"))).

The article selection process began with an initial search that yielded 111 articles relevant to Project-Based Learning in secondary education and its impact on learning outcomes. After applying the inclusion criteria, the number of eligible articles was reduced to 25. These articles were then further screened based on title relevance and alignment with the research focus, resulting in a final selection of 13 articles for in-depth analysis. The screening and selection process was documented using a PRISMA flow diagram to ensure transparency and methodological rigor at each stage of the review.

Data were collected exclusively from the Scopus database to ensure the quality and credibility of the sources. Following article selection, the data were analyzed through thematic coding to identify key themes related to PBL implementation. Previous studies have reported positive effects of PBL on students' critical thinking, collaboration, and problem-solving skills (Bell, 2010; Thomas, 2000); however, evidence regarding its impact on academic achievement, particularly in traditional subject areas, remains mixed. Moreover, there is no clear consensus on the most effective strategies for integrating PBL into existing secondary school curricula, given the constraints imposed by standardized testing and conventional instructional models.

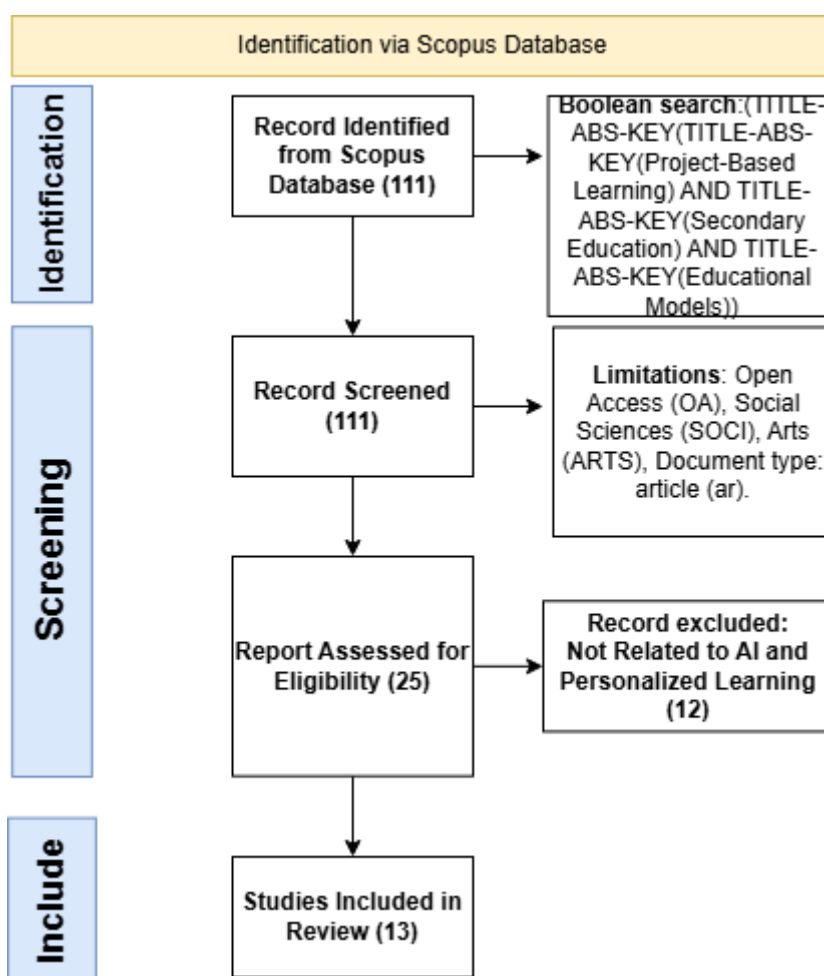
Teachers also face significant challenges in implementing PBL, including limited opportunities for professional development, restricted access to technology, and difficulties in managing complex projects that address diverse student needs. This gap between the theoretical potential of PBL and its practical implementation in senior high school classrooms highlights the urgency of identifying factors that influence its success or failure (Batdı et al., 2024).

The inclusion criteria for selected articles focused on studies examining the implementation of Project-Based Learning in senior high school contexts. Although PBL is widely recognized as an innovative pedagogical approach, its application at the secondary level remains inconsistent and underexplored. While early studies suggest that PBL enhances student engagement, critical thinking, and problem-solving skills, its impact on academic achievement remains unclear. Furthermore, challenges related to resource limitations, curriculum constraints, and insufficient teacher training have not been comprehensively addressed in the literature (Tafakur et al., 2023). These research gaps, combined with the growing

demand for student-centered and effective pedagogical approaches in secondary education, underscore the need for a systematic review to synthesize existing evidence and provide actionable insights into PBL implementation at the senior high school level.

Quality appraisal was conducted using established assessment tools such as the JBI Critical Appraisal Tools or the CASP framework. Each selected article was evaluated based on methodological rigor, clarity of reporting, and relevance to the research objectives. The PRISMA framework was employed to ensure transparency throughout the article selection process, from identification to final inclusion.

The extracted data were organized into a standardized table containing information such as author(s) and year of publication, country of study, educational level (senior high school), types of digital learning tools examined (e.g., learning management systems, gamification, AR/VR, and mobile applications), measured learning outcomes, research methods, sample sizes, and key findings related to the impact of these tools on learning outcomes (Ferrero et al., 2021). The extracted data were analyzed using narrative synthesis and thematic analysis, focusing on the types of digital learning tools employed, their effects on student engagement, and the factors that facilitate or hinder their effectiveness, particularly in high-engagement and online learning environments.



Research Questions

- RQ1: How is Project-Based Learning (PBL) implemented at the senior high school level ?
- RQ2: What is the impact of PBL on senior high school students' learning outcomes?
- RQ3: What challenges do teachers face in implementing PBL?
- RQ4: What strategies are effective in addressing these challenges?
- RQ5: What research trends are emerging in PBL studies at the senior high school level?

Discussion results

Project-Based Learning (PBL) implemented at the senior high school level

The implementation of Project-Based Learning (PBL) at the senior high school level is generally carried out through an interdisciplinary approach that integrates multiple disciplines, such as science, technology, engineering, arts, and mathematics (STEAM). In this context, students are engaged in projects that not only teach theoretical concepts but also encourage them to solve real-world problems using the knowledge they have acquired. For example, in mathematics education, PBL is applied to help students understand complex mathematical concepts in a more practical and applicable manner through projects involving the creation of artifacts or solutions relevant to the topics being studied.

Furthermore, the implementation of PBL in senior high schools also emphasizes the development of sustainability competencies, in which students are involved in projects that connect global issues—such as climate change and the circular economy—with solutions that can be applied locally. Technology plays a crucial role in this process, as students utilize advanced tools such as artificial intelligence (AI) and machine learning to conduct experiments and data-driven projects, including weather forecasting. Through the use of these technologies, students not only learn theoretical concepts but also gain hands-on experience in collecting and analyzing data to produce practical solutions (Zhang & Ma, 2023).

PBL at the senior high school level also highlights the importance of collaboration among students, teachers, and other participants, such as university students and professionals. Through teamwork, students are encouraged to co-design solutions, enabling them to develop collaborative skills that are essential for the workplace. In addition, PBL promotes self-directed learning and reflection by providing students with opportunities to explore their own ideas and reflect on project outcomes, thereby enhancing learner autonomy and responsibility for their own learning. Consequently, the implementation of PBL in senior high schools focuses on the development of twenty-first-century skills, including creativity, problem-solving, and independent learning (S, 2024).

The impact of PBL on senior high school students' learning outcomes

The implementation of Project-Based Learning (PBL) at the senior high school level has a significant impact on students' learning outcomes. One of the primary effects of PBL is the enhancement of students' critical thinking and problem-solving skills. Through authentic projects that are relevant to real-life contexts, students are confronted with challenges that require in-depth analysis and creative solution-finding. This approach deepens their understanding of subject matter, as students do not merely memorize theories but actively apply them in practical situations (Azmi & Festiyed, 2023). In addition, PBL increases students' motivation and engagement in the learning process. By being directly involved in meaningful and engaging projects, students develop a stronger sense of responsibility for their own learning, which fosters curiosity and commitment to the learning material.

Beyond academic understanding, PBL also plays a vital role in developing collaboration skills. Students involved in team-based projects learn to communicate effectively, work cooperatively, and solve problems collectively—skills that are essential in professional and social contexts. Moreover, PBL provides students with opportunities to develop technical skills, particularly through technology- and science-based projects (Naila Rohmaniyah & Siti Wulan Asih, 2024). For instance, projects involving artificial intelligence and machine learning enable students to gain deeper insights into programming and hardware, competencies that are increasingly important in today's workforce.

However, the effectiveness of PBL in improving learning outcomes is also influenced by certain challenges, such as insufficient teacher training and limited resources. Without adequate support, the implementation of PBL may be constrained, and its impact on learning outcomes may not reach its full potential. Therefore, effective PBL implementation requires careful preparation, both in instructional planning and in the provision of supporting infrastructure. Overall, despite existing challenges, PBL has been shown to have a substantial positive impact on enhancing students' academic, social, and technical skills, as well as increasing their motivation to learn (M. & Jamaludin, 2025).

Challenges do teachers face in implementing PBL

Teachers face a wide range of challenges when implementing Project-Based Learning (PBL) at the senior high school level. One of the main challenges is the lack of professional training and support for teachers. Many teachers experience difficulties in adopting the PBL approach because they are unfamiliar with the method and have not received adequate training. Without sufficient understanding of how to design, manage, and assess projects, teachers tend to rely on more familiar traditional teaching methods, such as lectures or direct instruction, making the transition to PBL more difficult (Shamim et al., 2022).

Additionally, limited resources and infrastructure pose significant barriers. PBL often requires adequate technological tools, collaborative classroom spaces, and instructional materials aligned with project activities. However, many schools lack these facilities, making it difficult for teachers to design and implement effective projects. These limitations greatly affect the success of PBL implementation in some schools (M. & Jamaludin, 2025).

Another challenge relates to assessment. In PBL, assessment focuses not only on final products but also on learning processes, collaboration, and students' critical thinking skills. This differs from traditional assessment methods that emphasize written tests or examinations. Many teachers struggle to develop assessment rubrics that can evaluate multiple aspects of learning in a fair and objective manner.

Finally, time management is a major challenge. PBL requires more time than traditional instruction because it involves multiple stages, including planning, implementation, and project evaluation. In many cases, teachers find it difficult to allocate sufficient time for each stage, particularly in schools with dense curricula and tight schedules. These challenges indicate that although PBL holds strong potential to enhance learning, its successful implementation requires greater support in terms of teacher training, adequate resource provision, and the development of assessment systems aligned with the characteristics of PBL.

Strategies are effective in addressing these challenges

To address the challenges faced by teachers in implementing Project-Based Learning (PBL) at the senior high school level, several effective strategies can be applied. First, continuous professional development for teachers is essential, focusing on both the theoretical foundations and practical implementation of PBL. Teachers need to be equipped with the skills required to design and manage projects effectively. Training programs that incorporate case studies or hands-on experiences in PBL implementation can enhance teachers' confidence and ability to address challenges encountered during the learning process. Additionally, teachers should receive training on developing appropriate assessment rubrics to evaluate both project processes and outcomes holistically (Yang, 2021).

Second, to overcome resource and infrastructure limitations, schools should establish partnerships with external institutions or organizations that can support the provision of facilities and technologies required for PBL implementation. These partnerships may include collaborations with industry or higher education institutions that can offer additional equipment or expertise. Furthermore, maximizing the use of existing resources—such as utilizing simple and readily available tools within schools can serve as a temporary solution to infrastructure constraints (Bin Adnan, 2024).

Third, in addressing assessment challenges, it is crucial for teachers to develop clear and comprehensive assessment rubrics. These rubrics should encompass various dimensions of PBL, including collaboration skills, critical thinking abilities, and the quality of final project outputs. Formative assessment that emphasizes ongoing feedback throughout the project process is also highly beneficial in helping students continuously improve their work. With well-defined rubrics, teachers can conduct more objective and equitable assessments (Pérez-Torregrosa et al., 2022).

Finally, to address time management challenges, teachers should plan projects using flexible and realistic approaches. Dividing projects into clearly structured stages with well-defined timelines can help students remain focused and complete tasks on schedule. The use of project management technologies can further assist teachers in monitoring project progress and ensuring that each stage is completed as planned without compromising learning quality. By implementing these strategies, challenges in PBL implementation can be minimized, allowing the learning process to become more effective (Mustamin, 2024).

Research trends are emerging in PBL studies at the senior high school level

Research trends in Project-Based Learning (PBL) at the senior high school level indicate significant developments, particularly in the integration of technology and modern instructional methods (Ruiz Viruel et al., 2025). One major emerging trend is the use of advanced technologies, such as artificial intelligence (AI) and machine learning, in PBL implementation. Studies suggest that AI-based tools can enhance learning personalization by providing real-time feedback that increases student motivation and engagement. Through AI, students can independently regulate the pace

and direction of their learning while receiving tailored recommendations to overcome project-related challenges (Bosarge, n.d.).

Another notable trend is inter-institutional collaboration. Numerous studies emphasize the importance of collaboration between senior high schools and universities in implementing PBL. Such collaboration provides students with opportunities to engage in more complex and interdisciplinary projects, better preparing them for real-world challenges. Through these partnerships, students gain not only academic knowledge but also broader perspectives and practical experiences from professional environments (Fransiska Dwi Yunitasari, 2025).

Research also increasingly emphasizes the development of twenty-first-century skills, such as critical thinking, collaboration, and problem-solving, which are considered central outcomes of PBL (Ayu et al., 2023). By implementing PBL, senior high school students are given opportunities not only to learn theoretical content but also to develop practical skills aligned with workforce demands, thereby preparing them for complex and dynamic global challenges (Andy Agustian & Sanusi, 2024).

Additionally, recent studies highlight a growing focus on process-oriented evaluation in PBL, which emphasizes assessment throughout the project lifecycle rather than solely on final outcomes. Contemporary research underscores the importance of using comprehensive assessment rubrics that include dimensions such as collaboration, reflective skills, and critical thinking. This approach ensures that students receive meaningful feedback for continuous improvement during the learning process, offering deeper insights than traditional assessment methods that focus exclusively on final products (Barbara Green Winslet Bessie, 2025).

Overall, research trends in PBL at the senior high school level indicate a shift toward advanced technology integration, inter-institutional collaboration, and a strong focus on twenty-first-century skill development, all of which contribute to more adaptive and future-oriented learning environments.

Conclusion

Based on the findings of this systematic literature review, it can be concluded that Project-Based Learning (PBL) at the secondary school level has a significant positive impact on students' skill development, both in terms of academic achievement and twenty-first-century competencies. The implementation of PBL in secondary education generally adopts an interdisciplinary approach that integrates multiple disciplines such as science, technology, engineering, arts, and mathematics (STEAM), while providing students with opportunities to engage in projects focused on real-world problem solving. This approach not only enhances students' understanding of theoretical concepts but also strengthens practical skills such as critical thinking, collaboration, and creativity.

However, despite the positive outcomes associated with PBL, substantial challenges remain in its implementation. Teachers frequently encounter difficulties related to insufficient professional training, limited resources, and inadequate supporting infrastructure. These constraints often serve as major barriers that influence the overall effectiveness and sustainability of PBL implementation in secondary school settings.

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