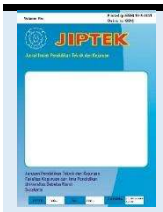

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Implementation of Project-Based Learning in Vocational Education: Success Factors, Challenges, and Its Impact on Students' Competencies: A Systematic Literature Review

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ABSTRACT

Vocational education has increasingly adopted Project-Based Learning (PjBL) as an instructional approach to strengthen students' technical capabilities while simultaneously fostering a wide range of professional competencies. Existing evidence, however, remains scattered across different vocational disciplines and educational contexts, limiting a comprehensive understanding of how PjBL has been implemented. This study presents a Systematic Literature Review (SLR) to examine the key success factors, implementation challenges, and educational impacts of Project-Based Learning within vocational education. The review was conducted in accordance with the PRISMA 2020 framework, with Scopus serving as the primary database for identifying relevant publications. Following the screening and eligibility process, 40 studies satisfied the inclusion criteria and were incorporated into the final qualitative synthesis. The synthesis identified project design, student collaboration, and technology integration as the principal factors associated with the successful implementation of PjBL. The most frequently reported challenges were student readiness, teacher readiness, and time constraints. In addition, the reviewed studies consistently demonstrated that PjBL enhances students' technical skills, soft skills, critical thinking, problem-solving abilities, and employability. Overall, the findings suggest that PjBL represents an effective pedagogical approach for advancing vocational education while equipping graduates to respond to evolving industrial requirements and technological change.

Keywords: *Project-Based Learning (PjBL), Vocational Education, TVET, Student Competence, Systematic Literature Review*

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INTRODUCTION

Rapid developments in digital technologies, industrial automation, and workplace transformation have substantially changed the competencies expected from vocational education graduates. In addition to technical expertise, employers increasingly expect graduates to possess critical thinking, problem-solving, collaboration, communication, creativity, and adaptability to continuous technological advances. Consequently, vocational education institutions are encouraged

to adopt instructional approaches that simultaneously cultivate technical competencies and transferable skills in order to strengthen graduates' readiness for employment. (Mutiaraningrum et al., 2024; Habibi et al., 2025).

Vocational education is characterized by practice-oriented learning and the development of occupational competencies aligned with the needs of business and industry. However, conventional teacher-centered instructional approaches often fall short in fostering the twenty-first-century skills required in today's dynamic workplace. These challenges highlight the need for instructional approaches that are more active, contextual, and student-centered. Among the instructional approaches commonly implemented in vocational education, PjBL has attracted considerable interest because it actively engages students in authentic project work that mirrors real workplace situations (Hamdani & Suherman, 2021; Syahril et al., 2022).

During the past few years, PjBL has been implemented across an increasingly diverse range of vocational education disciplines, reflecting its growing acceptance as an instructional approach. An increasing number of studies have shown that PjBL strengthens students' technical competencies by involving them in authentic project experiences designed to resemble actual workplace practices. Its application in disciplines such as manufacturing, information technology, automotive engineering, welding, and hospitality has been shown to improve both practical competencies and students' conceptual understanding (Rahim et al., 2024; Ali et al., 2025). Beyond technical achievement, many studies describe PjBL as an approach that encourages students to develop critical thinking, collaborative abilities, creativity, and problem-solving skills that are increasingly valued in contemporary workplaces (Habibi et al., 2025; Tokoš et al., 2025).

Despite the positive outcomes reported across many studies, implementing PjBL in vocational education remains far from straightforward and continues to present several practical challenges. Earlier research has highlighted several factors that influence the effectiveness of PjBL implementation, including teacher preparedness, student readiness, limited learning resources, restricted project time, and the integration of digital technologies (Ealangov & Jamaludin, 2024; Kholifah et al., 2025). At the same time, the literature consistently points to several elements that contribute to successful implementation, particularly authentic project design, teachers' professional competence, collaborative learning, technology integration, and the incorporation of STEM or STEAM approaches (Ghafara et al., 2025; Rahim et al., 2024).

The expanding body of literature on PjBL in vocational education demonstrates a growing academic interest in examining the effectiveness of this instructional approach. Nevertheless, the existing evidence remains fragmented across different vocational disciplines, educational levels, and implementation contexts. While some studies primarily focus on improving

technical competencies, others emphasize the development of soft skills, employability skills, critical thinking, or student engagement in the learning process. This variation makes it difficult to obtain a coherent understanding of how PjBL has been implemented and what outcomes have been reported across vocational education settings. A systematic synthesis is therefore needed to consolidate the available evidence.

To bridge this research gap, the present study employs a Systematic Literature Review (SLR) to consolidate existing evidence regarding the implementation of PjBL in vocational education. More specifically, this review aims to identify the factors associated with successful PjBL implementation, explore the challenges encountered during its application, and examine its influence on students' competencies within vocational education. To achieve these objectives, the study is guided by the following research questions:

RQ1: *What factors contribute to the successful implementation of PjBL in vocational education?*

RQ2: *What challenges are encountered in the implementation of PjBL in vocational education?*

RQ3: *How does the implementation of PjBL influence the competencies of students in vocational education?*

The review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure a transparent and systematic process of literature identification, screening, and synthesis.

RESEARCH METHOD

This study employed a Systematic Literature Review (SLR) to synthesize published evidence concerning the implementation of PjBL in vocational education. All stages of study identification, screening, eligibility assessment, and final selection followed the PRISMA 2020 guidelines to maintain methodological transparency and consistency throughout the review process.

Relevant studies were retrieved from the Scopus database through a literature search conducted on June 13, 2026, using the following search strategy: TITLE-ABS-KEY ("project-based learning" OR PjBL) AND TITLE-ABS-KEY ("vocational education" OR "technical and vocational education and training" OR TVET OR VET OR "technical education"). The inclusion criteria comprised empirical studies that investigated PjBL as the primary instructional approach, were conducted in vocational education or TVET contexts, were available in full text, and were published in English. The exclusion criteria included bibliometric studies, systematic reviews, literature reviews, and meta-analyses, as well as studies that did not focus on the implementation of PjBL, were not conducted within vocational education settings, did not report implementation outcomes, or were duplicate publications.

The initial database search yielded 189 records. Following the application of document type, language, and accessibility criteria, 69 open-access articles remained eligible for the subsequent screening stage. Screening of titles and abstracts reduced the dataset to 67 potentially relevant studies, which were subsequently examined through a full-text eligibility assessment. Full-text evaluation led to the exclusion of 27 studies because they did not satisfy the predefined eligibility requirements. As a result, 40 studies were retained for the final qualitative synthesis.

The complete article selection process is illustrated in the PRISMA flow diagram presented in Figure 1.

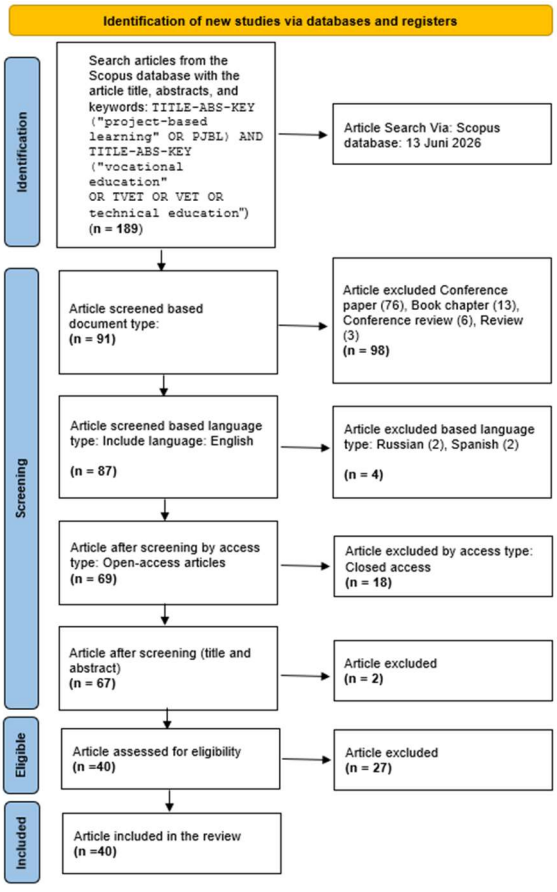

Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process

Each selected study subsequently underwent a quality appraisal using a five-criterion assessment framework that examined its relevance to PjBL implementation, suitability of the vocational education context, methodological clarity, adequacy of implementation reporting, and completeness of the reported findings. Subsequently, relevant information was extracted using a standardized data extraction form that documented the authors, publication year, country of origin, research methodology, sample characteristics, and principal findings of each study. The extracted information was analyzed through a thematic synthesis approach to identify recurring themes concerning the success factors, implementation challenges, and educational impacts of PjBL on students' competencies in vocational education.

The PRISMA 2020 selection procedure resulted in 40 studies that satisfied all predefined inclusion criteria and were retained for the final qualitative synthesis. The reviewed literature spans publications issued between 2009 and 2026, although most studies appeared during the 2021–2026 period. This concentration of recent publications suggests that interest in examining PjBL within vocational education has increased considerably over the last few years. Based on the country of origin, Indonesia contributed the largest number of studies, followed by Malaysia, China, India, Slovakia, Türkiye, South Africa, and several other countries. The large number of studies originating from Indonesia demonstrates the country's strong research interest in PjBL,

particularly its contribution to improving students' competencies and graduates' employability.

Quasi-experimental and experimental designs were the research approaches most frequently adopted to evaluate the educational outcomes associated with PjBL implementation. Other methodological approaches included mixed-methods research, research and development (R&D), structural equation modeling (SEM), survey-based investigations, and case studies. Collectively, these methodological variations provide a broad perspective on the ways PjBL has been implemented and examined across different vocational education settings.

The reviewed studies showed that PjBL has been applied in diverse vocational fields, including information technology, manufacturing, automotive engineering, welding, hospitality, healthcare, entrepreneurship, and engineering education. Across the reviewed literature, PjBL was consistently associated with improvements in students' competencies and with learning experiences that were more authentic, contextual, and closely connected to workplace practice.

Table 1. List of the Included Studies

No.	Author(s)	Year	Key Findings
1	Syahril et al.	2022	Region-based PjBL was more effective in improving vocational students' 4Cs skills than projects based on unrestricted themes.
2	Asnur et al.	2025	Vlog-integrated PjBL improved culinary learning outcomes, enhanced practical efficiency, and reduced procedural errors.
3	Habibi et al.	2025	PBL enhanced vocational high school students' computational thinking, teamwork, project management, and problem-solving skills.
4	Rahim et al.	2024	STEAM-integrated PjBL improved students' cognitive, affective, and psychomotor learning outcomes in welding technology.
5	Haq et al.	2024	Project-based learning improved vocational students' cognitive performance and product quality.
6	Vani et al.	2021	Sustainable Project-Based Learning enhanced students' problem-solving skills, presentation abilities, and conceptual understanding.
7	Li & Rohayati	2024	PjBL and assessment strategies contributed to the achievement of vocational graduates' competencies.
8	Hamdani & Suherman	2021	Self-Design PBL improved students' planning and product manufacturing competencies aligned with industry needs.
9	Kholifah et al.	2025	Project-based learning supported the strengthening of the Pancasila Student Profile and the development of vocational students' soft skills.

No.	Author(s)	Year	Key Findings
10	Ealangov & Jamaludin	2024	Lecturers' knowledge and attitudes significantly influenced their readiness to implement PjBL.
11	Green & C	2023	PjBL enhanced learner autonomy and employability skills in hospitality TVET education.
12	Lyu & Kit	2024	PjBL in film and television production increased students' motivation, practical skills, critical thinking, and teamwork.
13	Dzulkurnain et al.	2024	PjBL supported the development of practical skills and twenty-first-century competencies among vocational students.
14	Xiong et al.	2025	Interdisciplinary PBL improved cognitive flexibility, innovation, and the quality of peer feedback.
15	Yusuf et al.	2023	STEM-integrated PjBL contributed to improving vocational students' 4Cs skills.
16	Mutiaraningrum et al.	2024	Vocational students demonstrated positive perceptions of implementing PjBL in English language learning.
17	Sukatiman et al.	2026	Flipped PjBL supported by Augmented Reality enhanced vocational high school students' critical thinking skills.
18	Tokoš et al.	2025	PjBL implementation in scripting courses improved programming skills and learner autonomy.
19	Prabhu et al.	2025	Project-based IDEA Lab training enhanced diploma students' manufacturing skills and engineering competencies.
20	Rahim et al.	2025	STEAM-integrated PjBL improved technical competencies, teamwork, and industry readiness among manufacturing students.
21	Samsir et al.	2025	Blended PjBL improved learning outcomes and computer networking skills.
22	Hufnagl & Annen	2026	PjBL contributed to improving students' competencies and employability in vocational education.
23	Vergara et al.	2025	Project-based active learning enhanced student engagement and learning interest in vocational education and training (VET).
24	Fontana-Bria et al.	2025	Inquiry-based and Project-Based Learning improved scientific literacy among vocational healthcare students.
25	Ghafara et al.	2025	Android-assisted STEAM-integrated PjBL enhanced students' cognitive, affective, psychomotor, and soft skills.

No.	Author(s)	Year	Key Findings
26	Setyawan et al.	2024	A project-based mobile robot training kit improved practical skills and promoted authentic learning experiences.
27	Dogara et al.	2019	PjBL effectively developed vocational students' soft skills in TVET institutions.
28	Prasetya et al.	2024	The project-based PePA model improved soft skills relevant to industry needs.
29	Ambiyar et al.	2024	Integrated STEM-PjBL enhanced vocational students' technical competencies and employability.
30	Díaz-Lauzurica & Moreno-Salinas	2025	Gamified PjBL improved learning motivation and academic achievement in vocational computer education.
31	Sa'adah et al.	2025	Agile Project-Based Learning helped bridge the competency gap between education and the software industry.
32	Muslim et al.	2024	An Augmented Reality-based PjBL framework enhanced learning experiences in engineering education.
33	Hasan et al.	2026	AR-based simulation in PjBL-T improved students' automotive troubleshooting skills.
34	Nofriansyah & Ganefri	2020	A project-based software learning model improved vocational students' software engineering competencies.
35	Sardi et al.	2025	The integration of Mobile Learning and PjBL enhanced student engagement in TVET.
36	Huda et al.	2024	Community-integrated PBL strengthened interdisciplinary collaboration and promoted authentic learning experiences.
37	Tuncer	2009	PjBL implemented in a virtual learning environment improved learning outcomes in engineering education.
38	Ikhwanuddin et al.	2025	The Design-Build-Test Project enhanced vocational education students' academic motivation and learning outcomes.
39	Triyono et al.	2025	TPACK-based PjBL improved the digital competencies of pre-service vocational teachers.
40	Isa et al.	2021	PjBL implemented in the TVET context improved secondary school students' academic achievement.

Table 1 shows that most of the reviewed studies linked PjBL implementation with improvements in technical competencies, soft skills, twenty-first-century skills, and graduates'

employability. Many studies also integrated complementary instructional approaches, such as STEAM, Mobile Learning, Augmented Reality, gamification, blended learning, and virtual learning environments, to strengthen PjBL implementation in different vocational education contexts. Collectively, these studies illustrate that PjBL is no longer viewed merely as a project-based instructional technique but has developed into a broader pedagogical strategy that responds to industry competency requirements and ongoing technological change.

Success Factors for the Implementation of PjBL in Vocational Education

Table 2. Success Factors for the Implementation of PjBL in Vocational Education

Success Factor	Frequency (n)
Project Design	24
Student Collaboration	17
Technology Integration	14
Teacher Competence	5
STEM/STEAM Integration	4
Learning Resources	3
Mobile Learning Integration	2
Industry Collaboration	2
Assessment Strategy	1

Across the reviewed studies, project design emerged as the most frequently reported factor contributing to successful PjBL implementation in vocational education, being identified in 24 studies. This pattern highlights the importance of well-planned project design as a key element influencing the effectiveness of PjBL. Projects designed around authentic workplace contexts and aligned with industry expectations help students connect theoretical knowledge with practical application, creating learning experiences that are more meaningful and relevant.

This finding is consistent with the studies by Syahril et al. (2022) and Rahim et al. (2024), which demonstrated that projects designed around authentic industry contexts significantly enhanced students' technical competencies, 4Cs skills, and employability. Ghafara et al. (2025) and Asnur et al. (2025) also showed that incorporating STEAM principles together with digital technologies into project activities enriched students' learning experiences and contributed to better learning outcomes. Taken together, the available evidence demonstrates that carefully planned projects grounded in industry practice help students bridge classroom knowledge with authentic workplace application.

Besides project design, the review also identified student collaboration and technology integration as important elements supporting effective PjBL implementation. Studies by Habibi et al., (2025), Green & C, (2023), and Youyou & Kit, (2024) demonstrated that collaborative project activities enhanced students' communication, teamwork, and problem solving skills. Likewise, the integration of digital technologies, such as Mobile Learning, AR, virtual learning environments, and blended learning, was found to improve student engagement, learning experiences, and

instructional effectiveness (Sardi et al., 2025; Muslim et al., 2024; Sukatiman et al., 2026). From a theoretical perspective, these findings align with constructivist learning theory, which views knowledge as being developed through authentic, collaborative, and context-rich learning experiences.

Challenges in the Implementation of PjBl in Vocational Education

Table 3. Challenges in the Implementation of PjBL in Vocational Education

Challenge	Frequency (n)
Student Readiness	8
Teacher Readiness	7
Time Constraints	7
Limited Learning Facilities	6
Technology Adoption	4
Internet Connectivity	2
Assessment Difficulties	1
Financial Resources	1

Student readiness emerged as the challenge most frequently identified across the reviewed literature, appearing in eight studies that examined the implementation of PjBL. Several studies reported that students often struggled to manage projects independently, work effectively in teams, and sustain their performance throughout long-term project activities. This finding is consistent with the studies by Ealangov & Jamaludin, (2024), Mutiaraningrum et al., (2024) which reported that self-directed learning abilities, learning motivation, and collaborative skills significantly influenced students' success in PjBL. In addition, time constraints associated with project implementation and the complexity of project tasks were frequently identified as barriers to the effective implementation of PjBL in vocational education.

Other frequently reported challenges included teacher readiness, limited learning facilities, and technology adoption. Studies by Ealangov & Jamaludin, (2024), Samsir et al., (2025), and Sardi et al., (2025) indicated that teachers require specialized competencies to design authentic projects, facilitate collaborative learning, and conduct project-based assessment effectively. Furthermore, inadequate learning facilities, limited access to technological devices, and unreliable internet connectivity continue to hinder the implementation of PjBL in various vocational education settings. From the perspective of experiential learning theory, these findings suggest that the successful implementation of PjBL depends not only on the instructional approach itself but also on the availability of supportive learning environments that enable students to engage in authentic, experience-based learning activities.

Impact of PjBL Implementation on Students' Competencies in Vocational Education

Table 4. Impact of PjBL Implementation on Students' Competencies in Vocational Education

Impact	Frequency (n)
Technical Skills	18
Soft Skills	11
Critical Thinking	11
Problem-Solving Skills	10

Impact	Frequency (n)
Collaboration Skills	7
Student Engagement	6
Employability Skills	6
Communication Skills	3
Entrepreneurial Skills	1

The synthesis results indicate that the enhancement of technical skills was the most frequently reported impact of PjBL implementation, appearing in 18 of the reviewed studies. This finding suggests that PjBL is well aligned with the characteristics of vocational education, which emphasizes the development of practical competencies through authentic workplace-oriented learning experiences. Studies by Rahim et al., (2024), Setyawan & Anwar, (2026), Hasan et al., (2026), and Nofriansyah et al., (2020) consistently demonstrated that PjBL improved students' practical skills, technical competencies, and the quality of project outcomes. In addition to technical competencies, the reviewed literature frequently associated PjBL with improvements in soft skills, problem-solving, and critical thinking abilities, indicating that its educational benefits extend beyond technical performance alone (Dogara et al., 2019; Yusuf et al., 2023; Xiong et al., 2025).

These findings are further supported by the studies of Green & C, (2023), Hufnagl & Annen, (2026), and Kholifah et al., 2025) which demonstrated that PjBL contributes to development of employability skills, digital competencies, and graduates' work readiness. Project activities encourage students to identify authentic workplace problems, develop and implement solutions, investigate possible alternatives, and critically evaluate the outcomes of their work. These learning processes foster higher-order thinking, communication, collaboration, and adaptability, all of which are essential competencies for the contemporary workplace. Taken as a whole, the reviewed evidence portrays PjBL as an effective pedagogical approach for strengthening vocational competencies while preparing graduates to respond to continuously evolving industry expectations.

Collectively, the reviewed studies demonstrate that implementing PjBL contributes substantially to the development of both technical and non-technical student competencies. The overall body of evidence reinforces the value of PjBL in vocational education by supporting the development of industry-relevant competencies, strengthening twenty-first-century skills, and helping vocational education adapt to technological advances and changing workforce needs.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This review synthesized evidence from 40 published studies that investigated the implementation of PjBL in vocational education. Analysis of the selected studies identified three factors that consistently supported successful PjBL implementation: well-designed projects,

effective student collaboration, and appropriate technology integratio. Together, these elements help create learning environments that reflect authentic workplace situations, encourage contextual learning, and maintain students' active engagement during project activities.

At the same time, the reviewed studies revealed that implementing PjBL remains associated with several practical challenges. Student preparedness, teacher capability, and the limited time available for project activities were the barriers most frequently reported across the reviewed literature. The review also identified inadequate learning facilities and the continuous need to adapt to emerging technologies as persistent issues that require attention if PjBL is to be implemented effectively in different vocational education settings.

Evidence synthesized in this review consistently shows that PjBL contributes positively to students' competency development. Improvements in technical skills were the outcome reported most often, followed by gains in soft skills, critical thinking, and problem-solving abilities.

Overall, the available evidence suggests that PjBL strengthens discipline-specific competencies while simultaneously fostering twenty-first-century skills and improving graduates' readiness for employment. These findings reinforce the value of PjBL as a pedagogical approach that helps vocational education respond more effectively to technological change and evolving industry expectations.

Recommendations

Drawing on the findings of this review, vocational education institutions are encouraged to further strengthen PjBL implementation by designing projects that more closely reflect authentic industrial practice. Teachers are likewise encouraged to strengthen their capacity to design, facilitate, and evaluate PjBL while making effective use of appropriate digital technologies.

Future reviews could broaden the evidence base by incorporating additional international databases such as Web of Science, ERIC, and Dimensions alongside Scopus. Expanding the search sources would provide a broader perspective on PjBL implementation and strengthen the overall evidence available in this field.

Declaration of AI-Assisted Writing

In preparing this manuscript, the authors used ChatGPT and Scispace to support translation, language refinement, and the identification of relevant literature. All scientific judgments, interpretation of findings, data analysis, and the final revision of the manuscript were carried out independently by the authors, who assume full responsibility for the accuracy and integrity of the published work.

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