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Quality Equivalence Across Diverse Learning Contexts: A Comparative Study of Project-Based Learning from a Deep Learning Perspective

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ABSTRACT

This study aimed to analyze the implementation of Project-Based Learning (PjBL) in public and private vocational schools from a deep learning perspective. The study was conducted at Muhammadiyah 2 Vocational School, Pekanbaru, a private school, and Public Vocational School 1, Pucuk Rantau, a state school. This research employed a comparative qualitative approach using observation, interviews, and documentation as data collection techniques. The findings revealed that the implementation of PjBL in both schools demonstrated different characteristics influenced by school environment, student characteristics, learning facilities, and educational orientation. At Muhammadiyah 2 Vocational School, Pekanbaru, PjBL focused more on social projects, character development, empathy, and students' social awareness. Meanwhile, at Public Vocational School 1 Pucuk Rantau, PjBL emphasized production skills, entrepreneurship, and the utilization of local potential through practice-based learning activities. The findings also indicated that PjBL positively influenced students' social attitudes, creativity, learning motivation, 21st-century skills, and critical thinking abilities in both schools. From a deep learning perspective, students were able to connect knowledge with real-life experiences and authentic contexts through meaningful project activities. Although the schools adopted different project orientations, they successfully created active, contextual, and authentic learning experiences through Project-Based Learning.

Keywords*: *project based learning, deep learning, vocational school, learning quality, 21st-century skills

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INTRODUCTION

Project Based Learning (PjBL) has become one of the most widely implemented student-centered learning models in modern education because it emphasizes authentic learning experiences, collaboration, creativity, and problem-solving skills. Through project-oriented activities, students are encouraged to actively construct knowledge through investigation, discussion, product creation, and reflective learning. Compared to conventional learning approaches that tend to focus on teacher-centered instruction and memorization, PjBL enables students to engage in meaningful learning through direct involvement in real-world tasks and contextual problems (Kokotsaki, Menzies, & Wiggins, 2016).

The increasing adoption of PjBL is also closely linked to the growing demand for educational approaches that support deep learning. Deep learning perspectives emphasize students' ability to understand concepts meaningfully, connect knowledge with authentic situations, and apply learning outcomes in practical contexts rather than merely memorizing information. In this context, PjBL is highly relevant because it promotes inquiry, critical reflection, collaborative learning, and authentic assessment, encouraging students to become active participants in learning activities (Guo et al., 2020).

In vocational education contexts, particularly in Sekolah Menengah Kejuruan (SMK), the implementation of PjBL becomes increasingly important because vocational learning naturally emphasizes

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practical activities, project completion, competency-based assessments, and industry-oriented learning experiences. Students in vocational schools are required not only to master theoretical concepts but also to demonstrate practical competencies through projects, simulations, and performance-based examinations. Therefore, PjBL is an appropriate learning model for developing students' technical competencies, problem-solving abilities, and workplace readiness.

However, despite the growing adoption of PjBL, its implementation may vary across different educational contexts, including between public and private vocational schools. Differences in institutional management, learning facilities, teacher readiness, student characteristics, and educational resources potentially influence how PjBL is designed and implemented in classrooms. Previous studies indicate that school environments and institutional support significantly affect the effectiveness of project-based learning practices (Condliffe et al., 2017). Public schools may have advantages in terms of infrastructure and government-supported learning programs, while private schools may demonstrate greater flexibility in instructional innovation and classroom management. These contextual differences may shape distinct patterns in the implementation of PjBL within vocational education settings.

In addition to implementation differences, the quality of learning generated through PjBL may also differ between public and private vocational schools. Learning quality in project-based learning can be observed through students' engagement, collaboration, critical thinking, creativity, communication skills, and the meaningfulness of learning experiences gained during project completion. (Research by Guo et al. 2020) explained that successful implementation of PjBL contributes positively to students' active participation and higher-order thinking skills. Similarly, deep learning-oriented PjBL encourages students to develop reflective understanding and contextual problem-solving abilities through authentic learning experiences (Nurazizah et al., 2025). Nevertheless, differences in school culture, teacher competence, and learning support systems may lead to variations in the quality of students' learning experiences across different school contexts.

Despite the growing implementation of Project-Based Learning (PjBL) in vocational education, previous studies have mostly focused on its effectiveness within single educational settings. Limited studies have comparatively examined how PjBL is implemented in public and private vocational schools, particularly regarding its influence on learning processes and students' learning outcomes from a deep learning perspective. Differences in school environment, facilities, student characteristics, and educational orientation may influence how PjBL is implemented and how meaningful learning experiences are created in each context.

Therefore, this study aims to analyze three major aspects of PjBL implementation in public and private vocational schools: (1) the differences in the implementation of PjBL, (2) the influence of PjBL on the learning process, and (3) the learning outcomes achieved by students after the implementation of PjBL. Through a deep learning perspective, this study seeks to understand how project-based learning creates authentic, contextual, and meaningful learning experiences in different vocational education environments.

LITERATURE REVIEW

Project-Based Learning

Project-based learning (PjBL) is a learning model that attempts to connect technology with everyday life problems familiar to students or school projects. In PjBL, students are encouraged to be more active in learning. The teacher only acts as a facilitator and evaluator.

According to the Big Indonesian Dictionary, "A project is a work plan with specific objectives and a definite completion date." Joel L. Klein et al. in Widyantini (2014) explain that "Project-based learning is a learning strategy that empowers students to acquire new knowledge and understanding based on their experiences through various presentations." According to Thomas et al. (1999), in Wena (2010), project-based learning is a learning model that provides teachers with opportunities to manage classroom learning by involving project work.

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According to Trianto (2011: 51), the project-based learning model has enormous potential to create a more engaging and rewarding learning experience for students (Santyasa, 2006: 12). In project-based learning, students are encouraged to be more active in their learning. The teacher acts solely as a facilitator, evaluating students' work products, which are displayed in the project results, thereby producing tangible products that can encourage students' creativity and enable them to think critically as they analyze various factors and conditions within the learning process.

Project-Based Learning in Contextual Learning

Project-Based Learning (PjBL) is an instructional approach that positions students as active agents in the learning process through engagement in authentic, meaningful projects. It emphasizes integrating knowledge and real-world experience, enabling students to develop critical thinking, collaboration, and problem-solving skills (Kokotsaki et al., 2016).

In contemporary education, PjBL is widely recognized as an effective approach to bridge the gap between theory and practice. Engaging students in real-world problem-based projects not only enhances conceptual understanding but also facilitates the application of knowledge in everyday life. This aligns with the principles of contextual learning, which emphasize connecting academic content with students' social realities.

Despite its effectiveness, PjBL does not produce uniform learning outcomes across different settings. Contextual factors, including the learning environment, student characteristics, and resource availability, strongly influence its implementation. Therefore, it is essential to examine how PjBL adapts across diverse educational contexts.

Advantages and Disadvantages of Project-Based Learning (PjBL) in Learning

The advantages of the Project-Based Learning model are as follows:

a. Increased student motivation. Many written reports about the project indicate that students persist beyond deadlines and strive to complete the project. Teachers also report improvements in attendance and reduced tardiness. Students report that learning in projects is more enjoyable than other curriculum components.
b. Improved problem-solving skills. Research on the development of students' higher-order cognitive skills emphasizes the need for students to engage in problem-solving tasks and receive specific instruction on identifying and solving problems. Many sources describe project-based learning environments as enabling students to become more active and successful in solving complex problems.
c. Enhanced collaboration. The importance of group work in projects requires students to develop and practice communication skills. Cooperative group work, student evaluations, and online information exchange are all collaborative aspects of a project. New cognitive and constructivist theories emphasize that learning is a social phenomenon and that students learn more in collaborative environments.
d. Improved resource management skills. Part of becoming an independent learner is taking responsibility for completing complex tasks. Well-implemented Project-Based Learning provides students with opportunities to learn and practice organizing projects and allocating time and resources, such as equipment, to complete assignments.

The disadvantages of project-based learning include:

a. Many "real-world" problems are inherently disciplinary; therefore, it is recommended to teach by coaching students and facilitating their efforts to address these issues.
b. Requires a significant amount of time to solve problems.
c. Costly.
d. Many instructors are comfortable with traditional classrooms, where the instructor plays the primary role.
e. The large amount of equipment required.

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Deep Learning in Educational Perspectives

In the educational context, deep learning refers to a learning process characterized by meaningful understanding, critical reflection, and the ability to connect knowledge with real-life experiences. Unlike surface learning, which focuses on memorization, deep learning emphasizes meaning-making and knowledge transformation (Guo et al., 2020).

Within the implementation of PjBL, deep learning occurs when students actively engage in exploration, analysis, and reflection throughout the learning process. Activities such as problem-solving, group discussions, and project reflection play a crucial role in fostering deeper learning experiences. Previous studies indicate that PjBL significantly enhances higher-order thinking skills (HOTS), particularly in analysis, evaluation, and creation (Zhang & Ma, 2021).

Thus, there is strong conceptual alignment between PjBL and deep learning, with PjBL serving as a pedagogical vehicle to facilitate meaningful, experience-based learning.

Educational Ecology and Learning Contexts

Educational ecology views learning as the result of interactions between individuals and their surrounding environments, encompassing micro-level (classroom), meso-level (school and community), and macro-level (socio-economic conditions). These contextual factors play a crucial role in shaping learning experiences and determining the relevance of educational practices.

In different contexts, such as urban and rural or remote areas, students encounter varying levels of access, exposure, and learning needs. Urban environments typically provide greater access to technology and information, whereas remote areas tend to rely more on local resources as learning assets. These differences significantly influence how PjBL is implemented and the types of creativity that emerge from the learning process.

Research suggests that contextually and relevantly designed learning approaches enhance student engagement and motivation (Lestari & Ilhami, 2022). Therefore, understanding how PjBL operates within different educational ecologies is essential to evaluating its effectiveness across diverse contexts.

Disciplinary Characteristics in Learning

Each academic discipline possesses distinct characteristics in terms of learning objectives, knowledge structures, and instructional approaches. Subjects such as Civics Education are inherently normative and value-oriented (value-based), focusing on character development and civic awareness. In contrast, Entrepreneurship education is more application-oriented (skill-based), emphasizing practical competencies and productive skills.

These disciplinary differences shape the design and implementation of PjBL. In value-based disciplines, PjBL tends to foster reflective and affective learning experiences, such as empathy and social awareness. Conversely, in skill-based disciplines, PjBL emphasizes practical engagement and production processes, leading to tangible outputs.

Accordingly, variations in learning outcomes within PjBL should be understood as reflections of disciplinary characteristics rather than as inconsistencies in instructional effectiveness.

METHOD

This study employed a qualitative, descriptive-comparative design to analyze the implementation of Project-Based Learning (PjBL) across two educational contexts and to examine the equivalence of learning outcomes. This approach allows for an in-depth, contextual, and holistic understanding of the learning processes. The research was conducted at two schools with contrasting educational ecologies: SMK Muhammadiyah 2 Pekanbaru and SMK Negeri 1 Pucuk Rantau. The participants were students involved in project-based learning activities in Civics Education and Entrepreneurship subjects.

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Data were collected through observations, documentation, and student reflections. Observations focused on the learning process, student engagement, and project implementation dynamics. Documentation included students' project outputs and reports, while reflections captured students' experiences and interpretations of the learning activities. Data analysis was conducted using an interactive qualitative analysis technique, including data reduction, data display, and conclusion drawing. A comparative analysis was also conducted to identify similarities and differences in learning outcomes across educational ecologies, disciplinary characteristics, and deep learning processes.

To ensure data validity, source and method triangulation were employed by cross-checking data from multiple collection techniques. The research procedure consisted of planning, implementation, data collection, analysis, and conclusion drawing conducted systematically.

RESULTS AND DISCUSSION

Results

Table1. Comparison of Project Based Learning (PjBL) Implementation in Public and Private Vocational Schools

No	Aspect	Public Vocational School (SMK Negeri)	Private Vocational School (SMK Swasta)
1	Characteristics of PjBL Implementation	PjBL implementation tends to follow structured institutional regulations and curriculum standards established by the government. Projects are generally integrated with competency standards and formal assessment systems. Teachers commonly use collaborative, systematic project stages.	PjBL implementation tends to be more flexible and adaptive according to school policies and institutional culture. Teachers often adapt projects creatively to meet students' needs, align with industry partnerships, and leverage available learning resources.
2	Learning Environment	Learning activities are usually supported by relatively complete facilities, standardized workshops, laboratories, and government-supported learning infrastructure.	Learning facilities vary depending on school funding and institutional management. Some private schools compensate for limited facilities through innovation, industry collaboration, and flexible project management.
3	Teacher Role in PjBL	Teachers tend to function as facilitators within structured instructional procedures and competency-based assessment frameworks.	Teachers frequently demonstrate greater flexibility in mentoring, classroom management, and project adaptation, depending on student needs and institutional objectives.
4	Project Orientation	Projects are generally designed to align with curriculum achievement indicators and competency examinations.	Projects often emphasize creativity, entrepreneurship, innovation, and context-specific problem-solving aligned with institutional identity and market needs.
5	Student Participation	Student participation is relatively organized through structured project	Student participation tends to be more dynamic because projects often encourage independent

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No	Aspect	Public Vocational School (SMK Negeri)	Private Vocational School (SMK Swasta)
		division and standardized assessment mechanisms.	exploration and flexible collaboration patterns.
6	Learning Quality in PjBL	Learning quality is reflected through systematic project implementation, structured collaboration, and measurable competency achievement. Students experience clear learning guidance and alignment with competencies.	Learning quality is reflected through flexibility, creativity, active participation, and adaptive learning experiences. Students tend to demonstrate higher learning autonomy and contextual engagement.
7	Critical Thinking Development	Critical thinking is developed through structured problem-solving processes and competency-oriented project tasks.	Critical thinking emerges through exploratory learning, innovation-based projects, and flexible problem-solving.
8	Collaboration and Communication	Collaboration is commonly conducted through formalized teamwork and guided project coordination.	Collaboration tends to be more flexible and interactive because students are encouraged to negotiate roles and to solve problems independently.
9	Authentic Learning Experience	Students gain authentic experiences through competency-based projects and practical examinations aligned with vocational standards.	Students gain authentic experiences through contextual projects closely connected with entrepreneurial activities, local needs, or industry partnerships.
10	Learning Outcomes	Students generally demonstrate improvements in technical competencies, academic achievement, project completion skills, and performance on competency examinations.	Students commonly demonstrate improvements in creativity, communication skills, entrepreneurial competencies, adaptability, and contextual problem-solving abilities.
11	Deep Learning Outcomes	Deep learning outcomes are reflected in students' mastery of competencies, reflective understanding, and ability to apply knowledge systematically.	Deep learning outcomes are reflected in students' creativity, independent learning, innovation capacity, and ability to connect learning with real-life contexts.

Table 2. Differences in Characteristics of State Vocational Schools and Private Vocational Schools in Implementation PjBL

No	Aspect	Muhammadiyah 2 Vocational School, Pekanbaru (Private)	Public Vocational School 1 Pucuk Rantau (State)
1	Condition School environment	Located in the center of the city, with a strategic location and easy access to technology and information, making it easy for students and teachers to obtain.	Being in a remote environment, namely in relatively isolated areas with limited facilities.
2	Characteristics Learners	Students at Muhammadiyah 2 Vocational School, Pekanbaru, tend to be active on social media; however, they still do not	

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		show sufficient engagement with useful social media or curiosity about the environment around them.	Students are more used to simple conditions ; however, they are beneficial.
3	Facility Learning	The facility is relatively complete, well-suited to student needs, and supports learning through modern technology. Including this project, students are permitted to edit videos in the lab's editing room.	Existing facilities tend to be simple and limited, making it difficult for teachers and participants to perform activities; as a result, activities are practiced more often in natural settings.
4	Focus Implementation PjBL	Through the eye lesson PPKn, students engage in an activity-based learning project on social and character development.	Through eye lesson In entrepreneurship, students are invited to do a learning project: soap production.
5	Main Challenges	Realize change behavior in students , from the "audience becomes perpetrator action social.	Overcome limitations, practice facility, and utilize results to make local food useful.
6	The Role of Teachers	Teachers play a role as facilitators of reflection, social formation, and character development. Teachers serve as motivators and facilitators, promoting social and character development and helping students become more empathetic and caring.	Teachers play a role as mentors, provide technical support, and produce accompanying activities to ensure students progress in accordance with the learning objectives.

Table 3. The influence of Project Based Learning (PjBL) on learning in public and private vocational schools

No	Aspect Influence PjBL	Muhammadiyah 2 Vocational School, Pekanbaru (Private)	Public Vocational School 1 Pucuk Rantau (State)
1	Influence on Social Attitudes	Increase empathy, caring, social skills, and awareness of citizenship	Increase work, responsibility, and independence
2	Influence on Activity Study	Students become more active in discussing and engaging directly in social issues.	The student is more active in practice, production, and problem-solving.
3	Influence on Creativity	Creativity appears in compilation, action, social, and campaign concerns	Creativity appears in innovative products and marketing strategies
4	Influence on *Deep Learning*	A student capable of connecting Pancasila values with real life.	Students understand the connection between entrepreneurship theory and practical work in real life.
5	Influence on Motivation Study	Learning becomes more meaningful because it relates to life and society	Learning is more interesting because it produces a real product
6	Influence on 21st Century Skills	Develop communication, collaboration, and critical thinking in a critical social environment.	Develop problem-solving, creativity, and vocational skills.

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Table 4. Learning Outcomes in PjBl Learning in State and Private Vocational Schools

No	Learning Outcome Aspects	Muhammadiyah 2 Vocational School, Pekanbaru (Private)	Public Vocational School 1 Pucuk Rantau (State)
1	Affective Domain	Very prominent	Enough develop
2	Cognitive Domain	Increase through reflection and social discussion	Increase through analysis of production and marketing processes
3	Psychomotor Domain	Develop through social activity	Very dominant through practice, manufacturing a product
4	Problem-Solving Ability	Develop a settlement problem in social	Develop a settlement problem production
5	Collaboration and Teamwork	Seen in an active social group	Seen in the distribution task production
6	Quality Learning	Meaningful and contextual	Meaningful and applicable
7	Learning Output Forms	Social action and change attitude	Product entrepreneurship and skills Work

Discussion

Discussion Table 1

The findings indicate that the implementation of Project Based Learning (PjBL) in public and private vocational schools demonstrates both similarities and contextual differences. In both educational settings, PjBL serves as a student-centered learning model that emphasizes authentic learning experiences, collaborative activities, and the completion of projects. However, differences in institutional culture, learning management, teacher flexibility, and educational resources influence how PjBL is implemented and experienced by students.

In public vocational schools, PjBL implementation tends to be more structured and curriculum-oriented. Learning activities are commonly integrated with competency standards, formal project stages, and government-regulated assessment systems. This structured implementation enables students to experience systematic learning processes aligned with competency-based vocational education objectives. Teachers in public schools generally act as facilitators, guiding students through clearly organized project procedures and measurable competency targets. As a result, students demonstrate strong technical competencies and structured problem-solving abilities through project completion activities.

Meanwhile, private vocational schools tend to implement PjBL more flexibly and adaptively. Teachers often modify learning projects to align with institutional goals, industry collaboration opportunities, and students' learning needs. This flexibility allows students to explore creative ideas, contextual problems, and innovative solutions more independently. In several cases, private vocational schools emphasize entrepreneurial projects and real-world applications that encourage students to connect learning experiences with practical community or industrial contexts. Consequently, students in private schools frequently demonstrate stronger creativity, adaptability, and communication skills during project activities.

The quality of learning generated through PjBL in both contexts also reflects different educational strengths. Public vocational schools generally demonstrate stronger instructional structure, competency alignment, and systematic assessment mechanisms. Students benefit from clear learning guidance, standardized practical activities, and organized project management processes. Conversely, private vocational schools often create more flexible and interactive learning environments that encourage active participation, autonomy, and contextual engagement. These conditions support the development of meaningful learning experiences from a deep learning perspective, as students actively construct understanding through authentic project-based activities.

From the perspective of learning outcomes, both public and private vocational schools show positive impacts from implementing PjBL. In public schools, learning outcomes are primarily reflected in improved technical competencies, academic performance, competency examination achievement, and structured project

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completion. In contrast, private schools demonstrate learning outcomes in creativity, entrepreneurship, communication skills, and adaptive problem-solving. Although the forms of outcomes differ slightly, both school contexts indicate that PjBL effectively supports higher-order thinking skills and authentic competency development.

Furthermore, from a deep learning perspective, the findings suggest that PjBL promotes meaningful learning experiences in both educational contexts. Students are not only encouraged to complete academic tasks but also to reflect on learning processes, solve contextual problems, collaborate with peers, and apply knowledge in authentic situations. Despite differences in implementation patterns between public and private vocational schools, both environments demonstrate the potential of PjBL to support equivalent learning quality through active, reflective, and experience-based learning processes.

Discusion of table 2

Based on the results of observations, interviews, and documentation, the implementation of Project-Based Learning (PjBL) at Muhammadiyah 2 Vocational School, Pekanbaru, and Public Vocational School 1 Pucuk Rantau demonstrated clear differences, influenced by school environment, student characteristics, facilities, and learning orientation. Muhammadiyah 2 Vocational School, Pekanbaru, as a private school located in an urban area, had better access to technology, digital media, and modern learning facilities. Students were highly active on social media but showed limited direct social engagement and limited environmental awareness. Therefore, PjBL in this school focused on social projects and character strengthening through Civic Education subjects, aiming to transform students from passive social media audiences into active participants in social action. In this context, teachers acted as facilitators of social reflection and character development by directly accompanying students during project activities.

In contrast, Public Vocational School 1 Pucuk Rantau, as a state school located in a relatively remote area, experienced limitations in facilities and access to technology. However, students were more familiar with practical work, local environmental conditions, and skill-based activities. As a result, PjBL implementation in this school focused on entrepreneurship and production-based projects, such as soap-making activities using local resources. Despite limited facilities, students demonstrated stronger practical engagement and adaptability in completing hands-on projects. Teachers primarily served as technical mentors, guiding students throughout the production process and ensuring that projects aligned with vocational learning objectives.

The findings indicate that both schools implemented PjBL in line with their respective educational contexts and student needs. Muhammadiyah 2 Vocational School emphasized social empathy, character development, and reflective learning, while Public Vocational School 1 Pucuk Rantau emphasized technical skills, entrepreneurship, and the utilization of local resources. Although the implementation patterns differed, both schools successfully created meaningful learning experiences and supported students' critical thinking, collaboration, creativity, and real-world problem-solving skills through project-based learning.

Discussions of Table 3

The findings in the table indicate that implementing Project-Based Learning (PjBL) at both Muhammadiyah 2 Vocational School Pekanbaru and Public Vocational School 1, Pucuk Rantau, had positive impacts on students' learning and development, although the focus and outcomes differed across schools. At Muhammadiyah 2 Vocational School, Pekanbaru, PjBL primarily influenced students' social attitudes, empathy, communication skills, and social awareness through socially based projects and character education activities. Students became more active in social participation, discussions, and collaborative learning processes. Meanwhile, at Public Vocational School 1 Pucuk Rantau, PjBL had a stronger influence on students' practical skills, responsibility, independence, and vocational competencies through entrepreneurship and production-based projects.

The implementation of PjBL also contributed significantly to students' creativity, motivation, and deep learning experiences in both schools. Students at Muhammadiyah 2 Vocational School, Pekanbaru,

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demonstrated creativity through social campaigns and community-based activities, while students at Public Vocational School 1 Pucuk Rantau demonstrated creativity through product innovation and the utilization of local resources. In addition, students from both schools reported higher learning motivation because learning activities were directly connected to real-life experiences and practical applications, rather than focusing solely on theoretical instruction.

Furthermore, the findings confirm that PjBL effectively supports the development of 21st-century skills and deep learning processes in different educational contexts. Students in both schools demonstrated improvements in collaboration, critical thinking, communication, creativity, and problem-solving skills. Although the learning outputs varied across schools and subject areas, both institutions successfully implemented PjBL as a meaningful learning approach that encouraged active participation and authentic learning experiences.

Discussion of Table 4

The findings in the table show that implementing Project-Based Learning (PjBL) at both Muhammadiyah 2 Vocational School Pekanbaru and Public Vocational School 1 Pucuk Rantau produced positive learning outcomes in the affective, cognitive, and psychomotor domains, although the dominant outcomes differed across schools, reflecting each school's learning orientation. At Muhammadiyah 2 Vocational School Pekanbaru, the affective domain was more prominent because students demonstrated increased empathy, social awareness, and concern for the surrounding community through social-based project activities. Meanwhile, at Public Vocational School 1 Pucuk Rantau, psychomotor skills were more dominant, as students were actively involved in practical production activities, such as soap-making and product packaging. These differences indicate that the implementation of PjBL was tailored to each school's educational focus and project orientation.

In the cognitive domain, students in both schools showed improvements in understanding and applying knowledge through authentic learning experiences. Students at Muhammadiyah 2 Vocational School, Pekanbaru, developed cognitive abilities through social reflection, discussion, and contextual problem analysis, while students at Public Vocational School 1, Pucuk Rantau, improved their understanding through analysis of production processes, entrepreneurship activities, and practical problem-solving. Observation results revealed that students became more capable of connecting theoretical concepts to real-life situations than in previous conventional learning approaches.

Furthermore, implementing PjBL in both schools also improved students' problem-solving, collaboration, and teamwork skills. Students became more independent in solving project-related challenges and demonstrated better cooperation during group activities. Although the forms of learning outputs differed, both schools successfully created meaningful, contextually relevant learning experiences from a deep learning perspective. Muhammadiyah 2 Vocational School Pekanbaru produced learning outputs in the form of social action and character development, while Public Vocational School 1, Pucuk Rantau, produced entrepreneurial products and vocational work skills. Overall, the findings indicate that PjBL effectively supported authentic and meaningful learning outcomes in both educational contexts.

CONCLUSIONS AND RECOMMENDATION

Based on this study's findings, implementing Project-Based Learning (PjBL) in both public and private vocational schools had positive impacts on students' learning experiences and outcomes. However, differences in school environment, facilities, student characteristics, and educational orientation influenced how PjBL was implemented in each school context.

1. Muhammadiyah 2 Vocational School, Pekanbaru, implemented PjBL through social and character-based projects that emphasized empathy, social awareness, communication, collaboration, and reflective learning experiences. Meanwhile, Public Vocational School 1 Pucuk Rantau focused more on

production-based and entrepreneurship-oriented projects that developed vocational skills, responsibility, independence, and practical problem-solving abilities.

2. The implementation of PjBL in both schools positively influenced students' creativity, critical thinking, collaboration, learning motivation, and 21st-century skills. From a deep learning perspective, students were able to connect learning activities with authentic and real-life experiences through meaningful project work.
3. Despite these positive impacts, several challenges were identified. Public Vocational School 1 Pucuk Rantau faced limitations in facilities, project funding, access to technology, and teacher quality due to its rural location. In contrast, Muhammadiyah 2 Vocational School, Pekanbaru, had adequate facilities and technological support but faced challenges in developing students' social empathy and in fostering direct community involvement.

Based on the challenges identified in this study, several recommendations are proposed to improve the implementation of Project Based Learning (PjBL) in both public and private vocational schools.

1. Public Vocational School 1 Pucuk Rantau should strengthen collaboration with local companies, industries, parents, and school committees to support project funding, improve facilities, and provide students with better practical equipment.
2. Educational institutions and policymakers should improve teacher recruitment systems and provide continuous professional training, especially for teachers in rural vocational schools, to strengthen their competence in implementing PjBL and deep learning approaches.
3. Muhammadiyah 2 Vocational School, Pekanbaru, should increase students' participation in social activities, community service, and environmental programs to strengthen empathy, social responsibility, and real-life social engagement alongside technological competencies.

Credit authorship contribution statement

The first author conceptualized the study and led the research design; the second and third authors conducted data collection and field implementation; the fourth author performed data analysis and interpretation; the fifth author contributed to the literature review and manuscript drafting; and the sixth author supervised the overall research process and provided critical revisions. All authors reviewed and approved the final version of the manuscript.

Declaration of competing interest

We, the authors, declare that we have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Ethical Declaration

This study was conducted in accordance with ethical standards in educational research. Permission was obtained from the participating schools, and informed consent was secured from students and their parents or guardians, as required. Participation was voluntary, and students had the right to withdraw at any time without consequences. The implementation of Project-Based Learning (PjBL), including activities conducted outside the classroom, was carried out under proper supervision to ensure students' safety and well-being, and no harm, coercion, or discrimination occurred during the study.

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