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Optimization of Project Based Learning (PJBL) Model to Improve Vocational High School Students' Skills

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Abstract, *Project-Based Learning (PjBL) model is an approach that focuses on the active involvement of students in the learning process through real projects. This study aims to optimize the implementation of the PjBL model in improving the skills of Vocational High School (SMK) students, both in terms of technical skills (hard skills) and non-technical skills (soft skills). The research method used is a qualitative approach with case studies in several vocational schools. Data were collected through observation, interviews with teachers and students, and analysis of learning documents. The results of the study indicate that optimal implementation of PjBL can improve students' understanding of concepts, problem-solving skills, and collaboration and communication skills. In addition, challenges in implementing PjBL include limited facilities, teacher readiness, and the need for industry support in project development. Therefore, synergy between schools, industry, and government is needed to increase the effectiveness of PjBL in equipping students with skills relevant to the world of work.*

Keywords: *Project-Based Learning, student skills, vocational education, vocational high school*

1. INTRODUCTION

In preparing students to face the demands of the industrial world of work, vocational education is very important, especially in Vocational High Schools (SMK). Traditional learning methods that mainly focus on theory often do not provide students with the skills and practical experience needed to achieve professional success. Therefore, a learning approach is needed that strengthens the connection between theoretical knowledge and real-world application, emphasizing the importance of contextual learning. The Project-Based Learning (PjBL) model is a promising solution to overcome this shortcoming. PjBL facilitates active learning where students are involved in projects that are directly related to their field of study, thereby fostering practical experience. Research shows that the application of PjBL in a vocational environment can significantly increase student engagement and skill acquisition, important factors for adapting to industry needs (Roemintoyo & Budiarto, 2023). PjBL enriches theoretical understanding and equips students with the hands-on experience needed for their respective industries. Similarly, a project-based approach in vocational education can increase entrepreneurial interest, emphasizing that practical engagement drives motivation, and the development of skills relevant to industry demands (Kusumaningrum et al., 2015).

The integration of industry-relevant skills through PjBL is highly in line with labor market expectations. Yudiono et al. (2019) asserted that a production-based learning model, similar to PjBL, effectively prepares students by emphasizing teamwork, problem-solving, and

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decision-making skills. This practical focus ensures that students become proficient in their technical skills and are able to navigate interpersonal dynamics in the workplace environment (Yudiono et al., 2019; Wibisono et al., 2020). Furthermore, Widiantara et al. emphasized the need for vocational education to maintain an effective balance between practical and theoretical components, indicating that in-depth experiences through projects enhance ethical and personal development, which are important in a professional environment (Widiantara et al., 2022).

Integrating simpler project tasks and encouraging collaborative learning through PjBL encourages students to develop metacognitive skills, as supported by Mahande et al. (2021). These skills are essential for individual learning and are important for fostering a collaborative working environment as students learn to reflect on their processes and continuously improve themselves. In this context, PjBL serves as an effective pedagogical model that promotes self-directed learning, critical thinking, and creativity, all of which are highly valued attributes in the modern workforce (Chang & Isa, 2024).

Ultimately, Project-Based Learning emerges as an important pedagogical strategy, enabling vocational high school students to develop the competencies necessary for successful integration into the industrial workforce. It fosters adaptability, equips learners with relevant skills, and fosters a rich educational environment that supports continuous development and collaboration (Zhao, 2023; Yulianti et al., 2023). In particular, the alignment of PjBL with industry standards highlights its significance in developing vocational education to face contemporary challenges, including those posed by Industry 4.0 (Yulianti et al., 2023; Wu et al., 2023; Effendi, 2024).

Several studies have highlighted the effectiveness of PjBL in improving students' skills at various levels of education. For example, a study conducted by Thomas (2000) showed that PjBL can improve students' understanding of complex concepts and encourage them to be more active in learning. Meanwhile, research by Bell (2010) confirmed that PjBL not only improves technical skills (hard skills), but also develops social skills (soft skills), such as communication, collaboration, and problem solving (Effendi, 2024). In the field of vocational education, several other studies have also confirmed that the implementation of PjBL can improve the work readiness of vocational high school students, especially in facing the challenges of industry 4.0 (Krajcik & Blumenfeld, 2006; Doppelt, 2003). However, although many studies have discussed the benefits of PjBL, there are still challenges in its implementation, such as the lack of teacher readiness in implementing this method and limited facilities that support project-based learning. Although PjBL has been widely studied in the context of general and vocational education, there is still a gap in research on how to optimize the implementation of PjBL

effectively in vocational schools. Several studies tend to focus more on the impact of PjBL in general without exploring more deeply the concrete strategies that can be used to overcome implementation barriers in vocational schools. In addition, there is still little research that discusses the involvement of industry in supporting the implementation of PjBL in vocational schools.

The involvement of the industrial world is very important to ensure that the projects developed by students are relevant to the needs of the job market.

Based on the gap analysis, this study aims to optimize the implementation of the Project-Based Learning Model in improving the skills of vocational school students, both in technical and non-technical aspects. By identifying effective implementation strategies as well as supporting and inhibiting factors, this study is expected to contribute to the development of more innovative and applicable learning methods in vocational schools. The novelty of this study lies in a more comprehensive approach in optimizing PjBL by involving various stakeholders, including teachers, students, and industry, in order to create a learning environment that is more in line with the demands of today's work world.

2. RESEARCH METHODS

This study uses a qualitative approach with a descriptive method to analyze the effectiveness of the Project-Based Learning (PjBL) model in improving the skills of Vocational High School (SMK) students. The design of this study aims to observe and describe how the application of PjBL can contribute to the development of students' technical and soft skills in a vocational learning environment.

Population and Sample

The population in this study were students in grades XI and XII from several Expertise Concentrations in SMK who had implemented the PjBL method in their learning. The sample was selected using a purposive sampling technique, namely students from the Mechanical Engineering, Computer and Network Engineering (TKJ), and Visual Communication Design (DKV) departments who had been involved in industry-based projects or real case studies. In addition, teachers who implemented the PjBL method were also involved as informants in this study.

Data Collection Techniques

Data were collected through several techniques, namely:

1. Direct observation, to observe how students interact in projects and how teachers guide project-based learning;

2. In-depth interviews, conducted with students and teachers to explore experiences and challenges in implementing PjBL;
3. Documentation, in the form of student project reports, assessment rubrics, and recordings of the learning process that support the analysis of research results.

Data Analysis Techniques

Data analysis was carried out using a thematic analysis approach, namely identifying patterns or themes from data obtained through observation and interviews. The collected data will be categorized based on factors that support the success of PjBL, obstacles faced, and their impact on student skills. Data validity is checked using source triangulation techniques, namely comparing the results of interviews, observations, and documentation in order to obtain accurate conclusions.

3. RESULTS AND DISCUSSION

Implementation of Project-Based Learning in Vocational High School Learning

This study identifies how the Project-Based Learning (PjBL) model is implemented in the learning environment in vocational high schools. Data obtained from observations, interviews, and documentation indicate that the implementation of PjBL allows students to work in teams, complete industrial-based projects, and improve critical and creative thinking skills.

The following table presents the level of student involvement in project-based activities in several departments that are the study samples:

Table 1. Level of Student Involvement in PjBL Learning

No.	**Jurusan**	**Persentase Siswa yang Terlibat Aktif**	**Persentase Siswa yang Pasif**	**Rata-rata Nilai Proyek**
1	Teknik Pemesinan	85%	15%	82
2	Teknik Komputer dan Jaringan	90%	10%	88
3	Desain Komunikasi Visual	92%	8%	90

From the results, it can be seen that the majority of students are active in project-based learning, with the highest level of involvement in the Visual Communication Design department (92%), followed by Computer and Network Engineering (90%), and Mechanical Engineering (85%).

Improvement of Technical Skills and Soft Skills

The results of interviews and analysis of assessment rubrics show that project-based learning has a positive impact on students' technical skills and soft skills. Some of the soft skills that develop through the implementation of PjBL include communication skills, teamwork, and problem-solving. One of the research participants stated:

"I feel more confident in completing projects because I am used to working in groups and facing real challenges in the field." (Mechanical Engineering Student, Interview, 2025)

In addition, teachers also admit that this model helps students understand concepts better and increases their learning independence.

"Students look more enthusiastic when learning with projects because they feel responsible for the final results. They are more active in discussing and finding their own solutions." (TKJ Teacher, Interview, 2025)

Obstacles in Implementing PjBL

Although it has many benefits, this study also found several obstacles in implementing PjBL, including:

1. Limited Facilities and Infrastructure - Some schools experience obstacles in providing facilities that support industry-based projects.
2. Lack of Teacher Training - Not all teachers have a deep understanding of how to manage project-based learning effectively.
3. Time Management - Some students have difficulty in managing time to complete projects according to the specified deadline.

The results of this study indicate that despite the challenges, the implementation of Project-Based Learning (PjBL) in vocational schools has generally succeeded in improving students' skills, both in terms of technical and soft skills needed in the world of work.

Interpretation of Results

Project-Based Learning (PjBL) has emerged as an important approach in vocational education, effectively enhancing both technical and non-technical skills among students. The integration of PjBL not only encourages student engagement but also emphasizes collaborative problem-solving, which is essential to prepare students for real-world challenges. As highlighted in various studies, PjBL facilitates the development of critical competencies that

align with modern industry demands.

Research suggests that vocational education must shift to learning methodologies that promote inquiry, problem-solving, and project-based frameworks tailored to various disciplines (Jaedun et al., 2022). This shift recognizes the need for students to engage in projects that mirror the workplace environment, thereby bridging the gap between theoretical knowledge and practical skills. By engaging in PjBL, students become active participants in their learning process, allowing them to plan, execute, and reflect on their projects, which enhances their metacognitive skills and overall learning outcomes (Mahande et al., 2021).

Collaboration in PjBL is essential in vocational education, as it fosters essential teamwork skills that are valued by employers (Roemintoyo & Budiarto, 2023). The collaborative nature of PjBL helps students learn to engage with their peers, find collective solutions, and develop interpersonal skills, which are critical in today's workplace. Furthermore, research confirms that engaging in such collaborative projects significantly increases students' motivation and commitment to their education (Chiang & Lee, 2016), thereby transforming their learning experience.

The relevance of PjBL in vocational education is further strengthened by its alignment with industry expectations. As vocational programs increasingly focus on equipping students with skills that meet the needs of the labor market, PjBL serves as an effective model to enhance both practical and theoretical learning components (Isnaini et al., 2024). Students not only gain hands-on experience but also learn to navigate the complexities of group projects, ultimately preparing them more effectively to work in a variety of sectors (Et.al, 2021).

In vocational education, students are expected to attain technical competencies and non-technical skills that prepare them for successful careers. Technical competencies are often demonstrated through the completion of projects that meet or exceed industry standards. For example, research shows that project-based learning (PBL) significantly improves students' ability to meet technical benchmarks by engaging them in real-world problems and encouraging them to apply their knowledge in practical ways. This approach not only prepares students for the demanding nature of the workplace but also instills a sense of accomplishment in meeting industry expectations (Bercial et al., 2024).

Additionally, non-technical skills such as collaboration, communication, leadership, and time management are gaining importance in vocational training. Research highlights that the PjBL framework is particularly beneficial in nurturing these non-technical skills as it inherently incorporates teamwork and collective problem-solving activities. For example, studies have shown that students who engage in collaborative projects report improvements in their

communication and leadership skills, which are essential skills for their future professional lives (Dogara et al., 2019; Nasanjargal & Ganbat, 2022). These skills are critical in today's job market, where employers look for candidates who can demonstrate both technical expertise and interpersonal skills (Castillo et al., 2021).

The primary objective of vocational training is to equip graduates with marketable skills that are in line with industry demands. Findings suggest that involvement in projects under PjBL not only develops technical knowledge but also fosters significant growth in students' non-technical skills, thereby producing well-rounded professionals who can contribute effectively to their respective fields. This dual focus on hard and soft skills is necessary to foster employability and adaptability in a dynamic work environment (Hartati et al., 2022). The interactive and applied nature of PjBL serves to meet the educational goals of vocational programs by ensuring that students complete their training equipped with a comprehensive skill set that includes both technical and essential soft skills that are vital in a variety of professional contexts (Dogara et al., 2020).

The findings of various studies are in line with the premise that Project-Based Learning (PjBL) significantly enhances students' conceptual knowledge and practical competencies. For example, Thomas (2000) argued that PjBL fosters higher-order thinking, problem-solving abilities, and teamwork skills among students, which are critical for their academic and professional growth Markula & Aksela (2022). In practice, students who engage in well-structured PjBL engagement are more likely to develop a deeper understanding of the subject matter, as they are required to synthesize information and apply it in realistic contexts. This observation is supported by Merritt (2017), who found that PjBL improved academic achievement, including knowledge retention and conceptual development, demonstrating its effectiveness compared to traditional teaching methods.

In a comparative context, Markham (2011) asserted that PjBL improved information retention compared to conventional teaching methodologies. This statement is in line with the broader scientific consensus that active learning strategies, such as PjBL, facilitate better retention and understanding of material because they require students to engage in careful inquiry and collaborative problem solving, as noted by (Chiang & Lee, 2016). Research has shown that when students are actively engaged in their learning process through projects, they tend to retain knowledge longer and demonstrate better practical skills compared to those who learn in a passive format, a sentiment echoed by (Jalinus et al., 2023).

The impact of PjBL goes beyond mere information retention; it fosters critical skills that are essential in today's workforce. The practical application of knowledge in a project setting

builds confidence and prepares students to effectively address real-life challenges. As highlighted by (Eshetu & Assefa, 2018), teaching approaches that incorporate contextual problem solving significantly enhance students' ability to analyze and create solutions, equipping them with critical technical and soft skills needed for their future careers (Eshetu & Assefa, 2018).

The implementation of Project-Based Learning (PjBL) in vocational education presents significant opportunities to improve student learning outcomes, but it is not without challenges. In particular, research has identified lack of teacher training and inadequate facilities as critical barriers to effective PjBL implementation. Research emphasizes that many educators struggle to implement PjBL successfully due to inadequate preparation and resources Nurkanti et al. (2024).

The challenges of implementing PjBL are particularly evident in vocational schools. Research suggests that teacher preparedness plays a critical role in the successful implementation of PjBL methodologies. This includes not only technical knowledge of PjBL but also pedagogical approaches that support cooperative learning environments (Hujjatusnaini et al., 2022). Furthermore, the need for professional development is emphasized, as teachers require comprehensive training and ongoing support to implement PjBL effectively (Norawati & Puspitasari, 2022).

Limited infrastructure further exacerbates the difficulties faced by educators. As observed in various studies, the effectiveness of PjBL often depends on the resources available, which can include technology, learning materials, and physical learning spaces that support collaboration and project work (Pratami et al., 2024). The absence of these essential elements can hinder the exploration and creativity that PjBL aims to foster. Therefore, addressing these infrastructural deficiencies is critical to enable a more robust implementation of PjBL in vocational contexts (Yamin et al., 2023).

Furthermore, the lack of teacher training directly impacts how PjBL is perceived and implemented in practice. Educators often report feeling unprepared or unsure about facilitating project-based initiatives, which reduces their confidence and willingness to engage with this approach (Sirait & Maulida, 2023). As the educational landscape continues to evolve, the integration of PjBL into vocational education in Indonesia requires a deliberate focus on these challenges to ensure that its implementation can truly optimize the learning experience for students.

The results of this study lend theoretical credibility to the idea that, compared to more conventional approaches, project-based learning can significantly improve the standard of vocational education. To produce graduates with skills desired by employers, vocational schools that use PjBL can be a good choice. The findings of this study can thus serve as a foundation for vocational schools to expand the use of project-based learning.

Several caveats should be noted, although this study offers useful insights: (1) Limitations on the Sample. First, there were time constraints; second, this study only covered a small portion of vocational schools in Indonesia; and third, its conclusions may not apply to all. Third, variations in the implementation of PjBL; and (4) the short duration of the study make it impossible to draw any conclusions about the long-term effects of PjBL on student skills. The success of PjBL may vary based on teacher readiness and available resources because each teacher approaches its implementation differently.

The limitations and findings of this study provide many suggestions for further research, including: (1) Developing a more comprehensive research agenda. A more complete picture can be obtained by using samples from various vocational schools in various places; (2) The long-term effects of PjBL can be studied. Looking at the development of student skills over a longer period of time using longitudinal research. (3) Investigating potential solutions to problems found when implementing PjBL. Looking for practical methods to improve teacher readiness and provide spaces that facilitate project-based learning. It is believed that with additional research, vocational schools can better implement Project-Based Learning (PjBL) to better prepare students for the increasingly competitive job market.

4. CONCLUSION

This study shows that the implementation of Project-Based Learning (PjBL) in Vocational High Schools (SMK) significantly improves students' skills, both in technical and soft skills. PjBL allows students to be more active in the learning process, honing critical thinking skills, collaboration, and problem-solving which are very much needed in the industrial world. In addition, this approach also encourages students to be more independent and responsible for their learning outcomes. In terms of implementation, the results of this study support previous findings which state that PjBL is an effective learning method in improving understanding and practice-based skills. However, several challenges such as limited facilities and infrastructure and teacher readiness in implementing PjBL are still obstacles that need to be overcome so that the effectiveness of this method can be maximized.

Although this study provides valuable insights, there are several limitations that need to be considered. This study was only conducted in a limited scope, both in terms of the number of samples and the duration of the study. In addition, variations in the implementation of PjBL in various schools can also affect the results obtained. Therefore, further research is needed to explore more effective strategies in overcoming these obstacles and evaluating the long-term impact of PjBL implementation in SMK. Overall, this study contributes to the development of more innovative learning models in vocational education. By optimizing the implementation of PjBL, it is expected that vocational high school students can be better prepared to face the demands of the world of work and have higher competitiveness in the modern industrial era.

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