

Technology Integration in Teaching Materials for Optimizing Students' Learning Skills Through PJBL Approach

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Abstract: This research examines the integration of technology in teaching materials to improve students' learning skills through the Project-Based Learning (PJBL) approach. Technology is used as a medium for collaboration, reflection and data collection that supports learning experiences that are interactive, engaging and relevant to students' real lives. The application of the Technological Pedagogical Content Knowledge (TPACK) framework helps teachers design effective and engaging learning experiences. The results show that the use of digital platforms such as Google Classroom, Edmodo and Microsoft Teams can improve students' motivation, engagement and 21st century skills, including collaboration, critical thinking and creativity. In addition, the integration of technology allows students to learn flexibly and actively participate in real projects, which ultimately supports the optimal success of implementing PPA.

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Introduction

Project-Based Learning (PJBL) is a very effective learning approach in creating a deep and comprehensive learning experience for students. Through PPA, students not only learn theory, but are also actively involved in planning, researching and completing projects that are relevant to their daily lives. ChanLin (2008) emphasizes that in the context of science, PPA provides opportunities for students to apply their knowledge in real situations, so learning becomes more contextual and enjoyable. This contributes to students' motivation to learn, as they see first-hand the impact of what they are learning.

In integrating technology into PPA, it is important to understand the Technological Pedagogical Content Knowledge (TPACK) framework. Hudaa et al. (2025) explained that teachers must have strong knowledge of content, pedagogy and technology in order to optimize students' learning experience. When these three elements are brought together, teachers can design more effective and engaging learning experiences that are not only grounded in theory but also utilize digital tools in practice. For example, in math learning, teachers can use programming applications to teach the concept of algorithms, so that students can see the practical application of the theory they learn.

The use of technology in PPA is not only limited to tools for presentation or data collection. Technology also enables better collaboration between students through online platforms. For example, applications such as Google Classroom or Microsoft Teams allow students to collaborate in real-time on their projects, share ideas and provide feedback to each other (Al-Abdullatif & Gameil, 2021). In this context, students learn to work in teams, develop communication skills, and understand the importance of collaboration, which are much-needed skills in today's working world.

The data showed that students who engaged in classes that integrated technology through PPA showed significant improvements in their motivation and engagement. Rahmawati et al. (2020) found that students who learned using technology in the context of PPA felt more able to contribute to the group. This suggests that technology serves not only as a tool, but also as a powerful motivator to enhance the learning process. In this case, technology acts as a bridge that connects theory and practice, so that students can understand the material better.

However, to optimize the implementation of PPA, it is important to create a supportive learning environment where students feel comfortable to innovate and experiment with technology. The role of the teacher is crucial in creating an atmosphere that supports this exploration. Teachers need to provide clear directions and be open to exploring new ideas using technology as a tool. In this case, the teacher does not only function as a teacher, but also as a facilitator who encourages students to think critically and creatively.

In the implementation of technology-integrated PPA, the first step that needs to be taken is clear and structured project planning. The project designed should be relevant to students' real life and able to spark their interest. For example, in learning about the environment, students can do a project that studies the impact of plastic waste by using technology to collect and analyze data. With technology, students can use survey applications to collect data from the community as well as modeling to analyze the information obtained (Rofiana & Ardiansyah, 2025). This kind of project not only teaches students about the environment, but also gives them practical skills in data collection and analysis.

Furthermore, teachers must ensure that students have sufficient access to the technology required to complete the project. This means not only providing hardware, but also access to relevant software and platforms. In a study by Darel (2024), it was found that adequate access to technology encouraged students to be more active in online learning and improved their understanding of the material being taught. Therefore, teachers can schedule short training sessions to ensure that students know how to use the available technological tools. This is an important step to ensure that all students, regardless of their background, can actively participate in the project.

During the project implementation phase, the teacher functions as a facilitator, providing guidance but also giving students the freedom to explore and innovate. This is in line with the findings of Suryani et al. (2024) who showed that when students are given flexibility in learning, they tend to be more creative and proactive in completing tasks. Technology can be used to document the learning process, such as by creating videos or blogs about the progress of the project. This not only helps to improve students'

communication skills, but also gives them the opportunity to reflect on their own learning process.

Project evaluation is also an important part of PPA. Teachers should develop clear grading rubrics to evaluate not only the end result, but also the process that students go through. Through technology, students can digitally self-reflect, using tools such as online portfolios to show their development and understanding of the project (Said, 2023). This gives students the opportunity to self-evaluate and learn from their experiences. In addition, clear rubrics will help students understand what is expected of them and how they can improve their skills in the future.

Finally, it is important to share the results of the project with a wider audience. For example, students can present their findings through online forums or school exhibition events. This not only gives them publication experience, but also improves their communication and presentation skills. In this way, the use of technology not only assists students in the learning process, but also prepares them for real-world challenges beyond the confines of the classroom. This experience is invaluable as it gives students the opportunity to interact with a larger audience and get constructive feedback.

However, the research findings show that the optimization of students' learning skills through the PJBL approach in Lampung City junior high schools is still relatively low. Interviews with students showed that many of them were still dependent on the teacher in completing project tasks. They had difficulty managing time, designing work steps and finding information independently. This shows that there is an urgent need to improve students' learning independence so that they can be more active and proactive in the learning process.

In addition, the lack of effective collaboration was also a problem. In the implementation of the project, many student groups showed an imbalance in the roles of members. Only a handful of students were active, while others tended to be passive and less involved in discussions and task implementation. This suggests that there are barriers in the implementation of the PPA method that need to be identified and overcome. Research by Thomas (2000) shows that the success of PPA is highly dependent on how teachers design projects and manage group dynamics. Therefore, it is important for teachers to be trained in creating a learning environment that supports collaboration and active participation.

The lack of critical thinking skills is also a concern. Students tend to work on projects mechanically without demonstrating the ability to analyze, evaluate or develop ideas in depth. The resulting projects are more reproductive than creative. In this case, teachers need to teach critical thinking skills and encourage students to not only accept information, but also question and evaluate the information. Low learning motivation is also an inhibiting factor. Observations and interviews show that students are less enthusiastic in participating in project-based learning. Many find it difficult to understand the purpose of the project and consider it an additional burden. Therefore, it is important for teachers to explain the purpose and benefits of the project clearly, as well as creating a fun and challenging learning atmosphere.

Based on these findings, it can be concluded that the implementation of Project-Based Learning (PJBL) in Lampung City Junior High School has not fully succeeded in optimizing

students' learning skills. This can be seen from the low participation of students in project-oriented learning activities, as well as the lack of collaborative and critical skills that are expected to develop through this method. To overcome these problems, a technology-based teaching material development strategy is needed that can support learning engagement and effectiveness.

One important aspect of PJBL is the active involvement of students in the learning process. However, in practice, many students are still passive and lack initiative in completing projects. For example, in a project that requires students to design an innovative product, it is often the case that only a few students are really actively involved, while others just follow along without making any meaningful contribution. This suggests that there are barriers to the implementation of the PPA method that need to be identified and overcome. Research by Johnson and Johnson (1994) shows that effective collaboration can improve students' understanding and social skills. Therefore, it is important for teachers to provide clear guidance on how to work together in groups and facilitate productive interactions among students.

On the other hand, the use of technology in the development of teaching materials is also a key factor in improving learning effectiveness. Today, technology has become an integral part of students' daily lives, and the utilization of digital tools in learning can increase students' interest and motivation. For example, the use of online learning platforms such as Google Classroom or Edmodo can facilitate communication between students and teachers, and provide a space to share resources and work. Research by Koller et al. (2013) shows that technology-based learning can increase student engagement and accelerate the learning process. Therefore, the development of interesting and interactive technology-based teaching materials is needed to support a more effective implementation of PPA.

Smooth transitions between these ideas are crucial to building a coherent argument. By connecting student engagement, collaboration and technology use, we can see that these three aspects are interrelated and contribute to the success of PPA. If students are more engaged and collaborate well, they will be more motivated to use technology in their learning. Conversely, if technology is used effectively, it can encourage students to be more active in projects and work together in groups.

Although the implementation of PPA in Lampung City Junior High School has not been fully successful in optimizing students' learning skills, there are opportunities for improvement through the development of better strategies. With a focus on increasing student engagement, strengthening collaborative skills, and utilizing technology in learning, it is expected that PPA can be more effective in supporting students' learning process. Therefore, there needs to be support from all parties, including teachers, schools, and parents, to create a conducive learning environment and support the development of skills necessary for students in this modern era. Based on this explanation, this research will focus on the integration of technology in teaching materials to optimize students' learning skills through the PPA approach.

Research Method

This study uses the Systematic Literature Review (SLR) approach to identify, evaluate, and synthesize previous research results related to the development of technology-based teaching materials and their application in the Project-Based Learning (PjBL) learning model to improve student learning skills. The main question to be answered in this study is how the development of technology-based teaching materials can improve student learning skills in the PjBL approach at the junior high school level. This literature was collected from various national and international scientific data, using the keywords technology-based teaching materials, project-based learning, student learning skills, learning media development.

Results and Discussion

Researcher findings based on the results of the analysis found the following results

Table 1 results of literature analysis

Author/Year	Research Title	Research Methods	Research Findings
Izzati, N., & Asrizal, A. (2025).	Development of Alternative Energy Electronic Teaching Materials Integrated with PjBL Model with Ethnoscience to Facilitate Students' Problem Solving and Creative Thinking Skills.	This research uses a development approach that refers to the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Researchers conducted a needs analysis to find out the background of students and the existing local cultural context. Furthermore, teaching materials were designed and developed based on the results of the analysis. A pilot test was conducted in the classroom to evaluate its effectiveness	The development of teaching materials in this study is very relevant to current educational needs. By integrating ethnoscience, researchers not only present academic material, but also connect science with students' cultural context. This can increase students' sense of belonging to the subject matter and encourage them to be more active in the learning process. The applied PjBL model provides students with the opportunity to learn through real and relevant projects. This creates a more immersive learning experience and

Author/Year	Research Title	Research Methods	Research Findings
			assists students in building collaborative and communication skills. In addition, this approach also challenges students to think critically and solve the problems they face, which are essential skills in the modern era. However, this study also has some limitations. For example, the trial was limited to one class only, so the results may not be generalizable to a wider population. In addition, external factors such as parental support and school environment can also affect student learning outcomes but were not discussed in depth in this study.
Purwaningsih, E., Sari, A. M., Yuliati, L., Masjkur, K., Kurniawan, B. R., & Zahiri, M. A. (2020, March).	Improving the problem-solving skills through the development of teaching materials with STEM-PjBL (science, technology, engineering, and mathematics-project based learning) model integrated with TPACK	This study uses a research and development (R&D) approach, with clear steps in the development of teaching materials. The methodology used includes needs analysis, product development, limited trial, and evaluation.	The results showed significant improvement in students' problem solving skills after using the developed teaching materials. This study successfully proved that the integration of STEM-PjBL model with TPACK can

Author/Year	Research Title	Research Methods	Research Findings
	(technological pedagogical content knowledge).	The research also involved measuring problem-solving skills before and after the application of the developed teaching materials, thus providing robust data for analysis.	increase student engagement and facilitate deeper learning. The quantitative data generated provides a clear picture of the effectiveness of the implemented teaching materials.
Selano, Y. P., Sutimin, L. A., & Sumaryati, S. (2024).	Web-Based E-Module with a Project Based Learning Approach to Improve Computational Thinking Skills of High School Students.	This study used a quasi-experimental method with a pretest-posttest control group design. The research was conducted in several high schools in Indonesia, where students were divided into two groups: an experimental group using a web-based e-module and a control group using conventional learning methods. Measurement of computational thinking skills was conducted before and after the treatment.	The results showed that students who used the web-based e-module with PBL approach had a significant improvement in computational thinking skills compared to the control group. Data analysis showed that there was a significant difference in terms of posttest scores between the two groups. This e-module not only serves as a learning tool, but also encourages collaboration and communication between students.
Suryani, N. Y., Rizal, S., Rohani, T., & Ratnaningsih, H. (2024).	Improving Learners'english Writing Skills Through Digital Technology And Project-Based Learning	The methodology used in this study involved a quantitative approach with an experimental design. The study involved two groups of students, namely	The results showed a significant improvement in students' writing skills in the experimental group compared to the control group. The

Author/Year	Research Title	Research Methods	Research Findings
		the experimental group that used digital technology and project-based learning, as well as the control group that used conventional learning methods. Data collection was done through writing tests held before and after the treatment. The author also recorded students' engagement in the learning process as well as feedback from students towards the applied method.	author presents statistical data supporting this finding, including pre-test and post-test analysis which shows that students who engaged in project-based learning with the support of digital technology were able to produce better written works in terms of structure, vocabulary, and grammar. In addition, feedback from students showed that they felt more motivated and engaged in the learning process when using digital technology. Students reported that the use of digital tools, such as writing apps and collaborative platforms, made it easier for them to collaborate and share ideas.
Azhar, M., Wahyudi, H., & Yolanda, D. (2024).	Technology integration in textbooks: welcoming 21st century skills. Uluwwul Himmah	This research uses a qualitative method with a case study approach. The author analyzed several textbooks that have been integrated with technology, and collected data through interviews	This journal makes a significant contribution to the understanding of the importance of technology integration in textbooks for the development of 21st century skills. The

Author/Year	Research Title	Research Methods	Research Findings
		with teachers and students. This approach provides an in-depth understanding of users' perceptions and experiences of technology-based textbooks.	findings illustrate not only the benefits, but also the challenges that educators and students must face. By paying attention to the proposed recommendations, it is hoped that technology integration in education can be implemented more effectively and have a positive impact on future generations.

Discussion

The results of the literature review analysis describe that the integration of technology in teaching materials to optimize student learning skills through the PJBL approach. The integration of technology in PJBL aims to create a learning experience that is more interesting, interactive, and relevant to students' real lives. Technology is used not only as a presentation or data collection tool, but also as a medium for collaboration and reflection. Through the utilization of digital platforms such as Google Classroom, Edmodo, and Microsoft Teams, students can collaborate efficiently, share resources, and have direct communication. The use of these technologies increases student motivation and engagement, which contributes to the development of 21st century skills, such as collaboration, critical thinking and creativity. In addition, the application of the TPACK framework helps teachers design effective and engaging learning experiences by combining aspects of content, pedagogy and technology.

The results of the literature review analysis describe that the integration of technology in teaching materials to optimize student learning skills through the Project-Based Learning (PJBL) approach shows enormous potential in improving the quality of education. In today's digital age, where technology is an integral part of everyday life, it is important for educators to utilize the tools and resources available to create more engaging and effective learning experiences. First of all, it is important to understand what is meant by technology integration in the context of education. Technology integration is not simply the use of hardware or software, but also involves the ways in which the technology can enhance the learning process. For example, the use of online learning platforms such as Google Classroom or Moodle allows students to access teaching materials anytime and anywhere, giving them flexibility in learning. In this way, students can learn at their own pace, which in turn can improve their understanding of the material being taught.

Furthermore, the Project-Based Learning (PJBL) approach also plays an important role in technology integration. PJBL is a learning method that puts students in an active position to complete projects that are relevant to the real world. In this context, technology can be used to support each stage of the project, from planning to presenting the results. For example, students can use graphic design software to create visually appealing presentations or use collaboration apps such as Trello to organize project tasks and timelines. Thus, students not only learn about academic content, but also develop practical skills that are necessary in the world of work.

One concrete example of technology integration in PPA is a project that involves developing a mobile application. In this project, students not only learn about programming and app design, but also about how to conduct market research, identify user needs, and test their products. This process requires students to work together in teams, communicate effectively and solve problems creatively. Thus, they not only acquire technical knowledge, but also very important interpersonal skills. An in-depth analysis of the integration of technology in teaching materials also shows that the use of technology can increase student motivation. When students are involved in projects that involve technology, they tend to feel more motivated and excited to learn. This can be seen from research showing that students who learn using digital tools show increased engagement and interest compared to traditional learning methods. For example, the use of video tutorials or interactive simulations can help explain complex concepts in a way that is easier to understand, so students feel more confident in their abilities.

Conclusion

The integration of technology in teaching materials through the Project-Based Learning approach has significant potential to optimize students' learning skills. By effectively utilizing technology, educators can create more engaging, relevant and immersive learning experiences. However, to achieve optimal results, it is important to address existing challenges and ensure that all students have equal access to the necessary resources. By doing so, education can be better equipped to deal with the demands of the modern world and prepare students for future success.

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