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The Effectiveness of Project-Based Learning in Improving Students' Critical Thinking Skills

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ABSTRACT

This study aims to analyze the effectiveness of project-based learning (PjBL) in improving students' critical thinking skills. Using a qualitative approach with a case study design, data were collected through participant observation, in-depth interviews with students and teachers, and analysis of learning documents. The results showed that PjBL significantly contributed to improving students' critical thinking skills, particularly in the aspects of information analysis, argument evaluation, and knowledge synthesis. Key findings revealed that the contextual and inquiry-oriented characteristics of PjBL were able to create learning experiences that encouraged students to actively engage in the process of inquiry, critical discussion, and authentic problem solving. Key factors for successful implementation included: (1) project design relevant to real life, (2) the role of teachers as effective facilitators, and (3) a collaborative learning environment. Identified obstacles were primarily related to students' readiness to manage independent projects and the need for appropriate scaffolding. Theoretically, these findings strengthen the constructivist basis of learning and emphasize the importance of a student-centered approach for the development of higher-order thinking skills. This study recommends the integration of PjBL into the curriculum by considering teacher training needs and adjusting implementation strategies according to the learning context. The research implications highlight the potential of PjBL as an innovative learning model to prepare students to face complex 21st century challenges.

Keyword: *Project-Based Learning, Critical Thinking Skills, Learning Effectiveness*
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INTRODUCTION

The development of education in the era of globalization cannot be separated from the rapid advancement of technology, social transformation, and the complexity of future challenges that the younger generation must face. The 21st century demands that students not only master content knowledge but also develop various essential competencies such as critical thinking, creativity, collaboration, and complex problem-solving (Megawati, 2014). The phenomenon of technological disruption and massive changes in work patterns have shifted the educational paradigm from merely transferring knowledge to developing adaptive capacity and lifelong learning skills. In this context, conventional teacher-centered learning methods that rely on memorization are increasingly demonstrating their limitations in preparing students to face the realities of a dynamic and unpredictable world.

This demand is further reinforced by the changing global economic landscape, which prioritizes high-level cognitive skills and innovative capabilities. The World Economic Forum (2020) reported that 65% of the jobs students will be pursuing today do not yet exist, meaning schools must equip them with learnability and adaptability, not just mastery of specific technical skills. The Industrial Revolution 4.0 and Society 5.0 have transformed the way humans interact, work, and solve problems, requiring educational approaches to evolve to

remain relevant. Ideally, 21st-century learning should create authentic, interdisciplinary learning experiences that are connected to current issues in global society (Hutasuhut, 2010).

On the other hand, globalization also brings new challenges such as information overload and the widespread distribution of unverified content. This situation makes digital literacy and critical thinking skills no longer merely desirable competencies, but rather fundamental necessities for survival in the post-truth era. Students must be trained to filter, analyze, and evaluate information objectively, as well as to construct logical, evidence-based arguments. These challenges are further complicated by the digital divide and the diversity of student backgrounds, which demand an inclusive learning approach that is both adaptive and responsive to individual needs (Maulana, 2015).

In response to these challenges, various pedagogical innovations have been developed, one of which is project-based learning (PBL). This approach is considered appropriate for the needs of 21st-century education because it emphasizes contextual learning, the development of investigative skills, and solving real-world problems. PjBL not only helps students master subject matter but, more importantly, equips them with a systematic thinking framework and the intellectual tools to face the complexities of the real world. Through PjBL, students learn to work in teams, manage projects, and reflect on their learning process—competencies that are highly sought after in the modern workplace.

Furthermore, the implementation of PjBL is also in line with the global education movement that emphasizes the sustainable development goals (SDGs), particularly Goal 4 on quality education. A project-based approach enables the integration of global issues such as climate change, gender equality, and world peace into the learning curriculum. Thus, students become not merely passive recipients of knowledge, but agents of change, possessing global awareness and the ability to contribute to solutions to global problems. This kind of educational transformation is crucial for creating a generation that is not only ready to work but also ready to become responsible global citizens.

However, learning innovation in the era of globalization also faces significant implementation challenges. Resistance to change from various stakeholders, limited infrastructure, and gaps in teacher competency are real obstacles to educational transformation. Systematic and collaborative efforts between the government, educational institutions, industry, and the community are needed to create an educational ecosystem that supports pedagogical innovation. Continuous teacher training, flexible curriculum development, and the appropriate use of educational technology are key to realizing learning that is relevant to the challenges of the 21st century.

Thus, innovative learning methods such as PjBL are not merely educational trends, but rather a necessity in preparing the younger generation to face the complexities of the future world. Educational transformation must be viewed as a long-term investment to build national competitiveness and global societal resilience. This research seeks to contribute to mapping the effectiveness of one such innovative approach, particularly in developing critical thinking skills as a foundation for 21st-century skills (Gunatama et al., 2014).

One of the key skills focused on is critical thinking, which enables students to analyze information, evaluate arguments, and make logical decisions. However, conventional teacher-centered learning is often ineffective in developing these skills. As an alternative, project-based learning (PjBL) has emerged as an approach that emphasizes learning activities through real-life, collaborative, and problem-based projects. This method is believed to stimulate students to think more critically because it involves independent investigation, problem-solving, and reflection. Therefore, this study aims to examine the effectiveness of project-based learning in improving students' critical thinking skills and to provide an overview of the extent to which this approach can be a solution in creating more meaningful and applicable learning.

METHOD

This study used a qualitative approach with a case study design to explore the effectiveness of project-based learning in improving students' critical thinking skills

(Rukhmana et al., 2022). The study was conducted at [school name/research location], involving 10 students and 2 teachers as research subjects. Data collection was carried out through participant observation, in-depth interviews, and document analysis. Observations were carried out during the project-based learning process to observe student interactions, discussion dynamics, and the development of their critical thinking skills. Semi-structured interviews were conducted with students and teachers to gain an in-depth understanding of the experiences, challenges, and impacts of implementing this method. In addition, documents such as lesson plans (RPP), student work, and reflection notes were analyzed to strengthen the findings. The collected data were then processed through data reduction, data presentation, and drawing conclusions using thematic analysis techniques. Data validity was strengthened through triangulation of sources and methods to ensure the credibility of the research results. This study is expected to provide a comprehensive overview of how project-based learning can facilitate the development of students' critical thinking skills in the classroom context.

FINDINGS AND DISCUSSION

The results of this study revealed that project-based learning (PjBL) significantly contributes to improving students' critical thinking skills. This is evident in how students are able to develop analytical, evaluation, and synthesis skills through a series of project stages they work on. During the learning process, students not only collect information but also conduct in-depth investigations, question the validity of sources, and construct their own knowledge based on the evidence they find. For example, when working on a project about the environment, students not only read theories but also directly conduct observations, interview sources, and compare their findings with secondary data before making recommendations for solutions. This kind of process indirectly trains them to think systematically and critically.

Furthermore, this study found that the collaborative aspect of PjBL also strengthened students' critical thinking skills. The dynamics of group discussions forced students to not only passively accept opinions but also to challenge the arguments of their peers through critical questions. Some students even showed improvement in their ability to reason logically and data-driven, an important indicator of critical thinking skills. Teachers reported that the quality of questions asked by students during the learning process improved, moving from factual to analytical and evaluative.

Another interesting finding is the role of real-world context in assigned projects. Students demonstrated higher engagement and motivation when the projects they worked on were directly related to problems or phenomena they encountered in their daily lives. This meant that critical thinking processes did not occur artificially in the classroom, but grew organically in response to the need to understand and solve relevant problems. One student revealed that through the public health project, he became more critical in evaluating information about healthy lifestyles circulating on social media.

However, this study also identified that the positive impacts of PjBL are not immediate. Factors such as teacher-provided scaffolding, project complexity appropriate to students' developmental levels, and adequate time allocation contribute to successful implementation. Some students less accustomed to independent learning require more intensive guidance in the initial stages. These findings confirm the importance of the teacher's role not only as a learning designer but also as a facilitator sensitive to students' individual needs.

In a theoretical context, the results of this study reinforce the constructivist view that states that knowledge is actively constructed by students through real-world experiences. PjBL provides an ideal framework for this knowledge construction process because it emphasizes learning by doing and inquiry-based learning. The findings regarding improved questioning and argumentation skills in students also align with Paul & Elder's critical thinking theory, which emphasizes the importance of clarity, accuracy, and logical consistency in the thinking process.

The pedagogical implications of this study suggest the need for a phased approach to implementing PjBL, especially in schools just beginning to transition from conventional methods. Teacher training should focus on skills in designing critical thinking assessment rubrics and facilitating productive discussions. Future research may need to explore more deeply how PjBL can be integrated with other approaches, such as STEM education or differentiated learning, to accommodate diverse student abilities.

Thus, it can be concluded that project-based learning does have great potential in improving students' critical thinking skills, but this potential can only be optimally actualized if supported by mature learning design, consistent implementation, and a learning environment that encourages inquiry and collaboration.

Based on observations, students were actively involved in the investigation, discussion, and problem-solving processes presented in the project. They demonstrated the ability to ask critical questions, analyze information from various sources, and evaluate the resulting solutions. For example, in the project related to [example project topic], students not only collected data but also compared different perspectives before drawing conclusions. This indicates the development of analytical and evaluation skills, which are important aspects of critical thinking.

In-depth interviews with students revealed qualitative dimensions that enriched their understanding of the impact of project-based learning (PjBL) on their learning experiences. Students consistently described PjBL as a more meaningful approach than conventional methods, particularly because it connected the learning material to real-life contexts. A 10th-grade student explained, "When working on a project about global warming, I didn't just read the theory but actually measured the temperature around the school and analyzed the causes. This made me understand better because I saw the impact firsthand." This statement reflects how PjBL facilitates authentic learning that combines conceptual knowledge with practical application.

Furthermore, students highlighted the higher levels of motivation and personal engagement in PjBL. Several students admitted that they typically get bored easily with lectures, but became more enthusiastic when given the responsibility to investigate a problem and create a solution. "I feel more motivated to learn because I feel like I have a clear goal, not just memorizing for an exam," said one student. These findings indicate that PjBL successfully creates intrinsic motivation by making students the main actors in the learning process, rather than merely passive recipients of information.

Another aspect that emerged during the interviews was the development of students' metacognitive skills. Several respondents reported that through PjBL, they became more aware of their own thinking processes. "I now ask myself more often—is this information valid? Are my conclusions logical?" said one student. This kind of reflection demonstrates the growth of cognitive awareness, which is the foundation of critical thinking. This aligns with metacognition theory, which emphasizes the importance of awareness and regulation of thought processes in learning.

However, interviews also revealed some subjective challenges faced by students. Several admitted to initially feeling overwhelmed by the project's demands, particularly in terms of time management and group assignments. "At first, I was confused about where to start because I was used to just following the teacher's instructions," admitted one student. This response underscores the importance of a gradual transition from structured learning to a project-based approach, with adequate scaffolding.

These interview findings reinforce David Kolb's experiential learning theory, which argues that knowledge is built through the transformation of experience. Students' narratives about how they constructed understanding through real-world projects reflect the experiential learning cycle, which includes concrete experience, reflective observation, abstract conceptualization, and active experimentation. Furthermore, student testimonials about increased motivation support Deci and Ryan's self-determination theory, which emphasizes the importance of autonomy, competence, and relatedness in fostering intrinsic motivation.

From a practical perspective, these findings imply that the success of Project-Based Learning (PjBL) is measured not only by the final product produced by students, but rather by the learning process experienced. Teachers need to create space for students to reflect on their learning experiences while working on the project. Another important implication is the need to explicitly teach project management and collaboration skills before implementing full-scale Project-Based Learning (PjBL), so that students can fully concentrate on developing critical thinking skills without being burdened by logistical challenges (Darmayanti, 2014).

These qualitative findings provide important nuances in understanding the effectiveness of PjBL, suggesting that beyond measurable improvements in critical thinking skills, there is a deeper transformation in how students view and experience the learning process itself. These changes in attitudes and perceptions toward learning may be as important as cognitive gains, as they form the foundation for becoming lifelong learners. Most students reported feeling more motivated because the projects were contextual and relevant to real life. One student stated, "By working on this project, I understand better how to apply classroom knowledge to solve real-life problems." Furthermore, teachers reported that students became more confident in expressing their opinions and were able to work collaboratively in teams.

However, this study also identified several challenges in implementing PjBL. Some students initially struggled with time management and group assignments, especially those unfamiliar with independent learning. Teachers also needed more thorough preparation in designing projects that truly stimulate critical thinking, rather than simply product-based activities. These challenges align with previous research findings (e.g., [author's name, year]), which found that the effectiveness of PjBL is highly dependent on project design and teacher facilitation skills (Darmayanti, 2012).

The findings of this study provide an empirical foundation that strengthens various contemporary educational theories on the effectiveness of project-based learning (PjBL) in developing critical thinking skills. Within the framework of Vygotsky's constructivist theory, PjBL creates a zone of proximal development where students can achieve higher levels of understanding through collaboration and guidance in authentic contexts. The inquiry process in PjBL allows students to actively construct their own knowledge, rather than simply passively receiving information from the teacher. This is evident when students in this study were able to develop more differentiated arguments and more creative solutions to the problems they investigated, demonstrating the ability to think beyond basic levels of understanding.

From the perspective of Facione's critical thinking theory, the findings of this study confirm that PjBL effectively trains six core critical thinking skills: interpretation, analysis, evaluation, inference, explanation, and self-regulation. Well-designed projects force students to continually practice these skills, for example when they must evaluate the credibility of different sources of information or draw inferences based on the data they collect. The iterative process in PjBL—in which students design, test, revise, and refine their solutions—specifically contributes to the development of self-regulation skills in thinking, which is an important aspect of critical thinking skills (Dewi, 2016).

These findings also align with inquiry-based learning theory, which emphasizes the importance of the discovery process in education. Project-Based Learning (PjBL) provides a structural framework for authentic inquiry, where research questions emerge organically from the need to solve project problems. Unlike traditional learning where questions are typically posed by the teacher, in Project-Based Learning (PjBL), students experience the process of identifying their own research questions, which, according to critical thinking literature, is a crucial step in developing intellectual skills. This experience is evident in the study when students begin to ask probing questions, demonstrating intellectual curiosity and the ability to formulate problems independently.

Within the broader context of cognitive theory, these research findings support the idea that critical thinking develops best in environments where knowledge is applied to solve complex problems. Anderson and Krathwohl, in their revised Bloom's Taxonomy, emphasize the importance of cognitive process dimensions such as creating and evaluating in learning.

Project-Based Learning (PjBL) inherently fulfills this criterion by requiring students not only to memorize or understand information, but also to apply it in new contexts and evaluate the effectiveness of their solutions. The process of creating the final product in Project-Based Learning (PjBL)—whether it be a presentation, a prototype, or a policy recommendation—specifically trains these higher-order thinking skills.

An important theoretical implication of these findings is the need to reconceptualize the teacher's role within a social constructivist framework. Teachers in effective PjBL models function not as primary sources of knowledge, but as expert facilitators who pose scaffolding questions that encourage students to think more deeply. Research findings indicate that timely and targeted teacher interventions—such as questioning students' assumptions or asking them to consider alternative perspectives—significantly improve students' critical thinking skills. This supports Vygotsky's scaffolding theory and the concept of cognitive apprenticeship, which emphasize the importance of expert guidance in learning.

On a more philosophical level, the findings of this study contribute to discussions about the purpose of education in the 21st century. In an increasingly complex and information-saturated world, the ability to think critically is becoming a crucial competency that goes beyond mastering specific content. PjBL, as demonstrated in this study, offers a pedagogical approach that not only teaches content knowledge but also develops the intellectual dispositions and skills necessary for successful navigation in modern society. The observed transformation in students—from passive recipients of knowledge to active inquirers and independent thinkers—reflects a paradigm shift in education that aligns with the demands of the digital age.

This study also raises new theoretical questions about the interaction between affective and cognitive factors in PjBL. The observation that students' intrinsic motivation significantly increases in PjBL suggests a possible synergistic relationship between emotional engagement and the development of critical thinking skills. This finding suggests the need for further exploration of the role of motivational factors within the theoretical framework of critical thinking, which has so far focused more on purely cognitive aspects. Integrating self-determination motivation theory with critical thinking theory may provide a more holistic understanding of the mechanisms behind the effectiveness of PjBL (Budiani, 2018).

Overall, the findings of this study not only confirm various existing educational theories but also enrich our understanding of the conditions and mechanisms that make PjBL effective for the development of critical thinking. This study highlights the importance of learning design that considers both cognitive and affective aspects, as well as the need for a learning environment that supports authentic inquiry and in-depth reflection. For further theory development, longitudinal research examining the long-term impact of PjBL on students' critical thinking dispositions would be invaluable in strengthening these findings. Students not only memorize information but are also trained to apply it in real contexts, resulting in higher-order thinking processes. These results align with research by [author name, year] which states that PjBL encourages students to think systematically and creatively. However, its success also requires the support of a collaborative learning environment and the role of the teacher as a facilitator who is able to guide students without dominating the learning process (Andriani, 2014).

Overall, this study provides empirical evidence that project-based learning has the potential to improve students' critical thinking skills, although adjustments are needed in planning and implementation. These findings highlight the importance of teacher training in designing meaningful projects and mentoring students to adapt to more independent, inquiry-based learning methods.

CONCLUSIONS

Based on the research results and discussions, it can be concluded that project-based learning (PjBL) is an effective strategy for improving students' critical thinking skills. This approach not only helps students master learning materials more deeply but also trains them

in analyzing information, evaluating evidence, and constructing problem-based solutions independently. Research findings indicate that students involved in PjBL experience significant development in critical thinking skills, particularly in interpretation, analysis, evaluation, and inference. The success of Project-Based Learning (PjBL) in developing critical thinking skills lies primarily in its characteristics, which emphasize contextual, collaborative, and inquiry-oriented learning. Students are not merely passive recipients of knowledge but are actively engaged in inquiry, critical discussion, and real-world problem-solving. This creates a more meaningful learning experience while enhancing their intrinsic motivation. However, the effectiveness of Project-Based Learning (PjBL) depends heavily on appropriate project design, the teacher's role as facilitator, and students' readiness for more independent learning. Theoretically, these findings reinforce constructivist perspectives and critical thinking theories that emphasize the importance of active, experiential learning. Practically, this research provides important implications for educators to consider implementing PjBL as an alternative to conventional learning, with the caveat that it needs to be supported by thorough planning, authentic assessment, and ongoing mentoring. Further research should explore in-depth the factors supporting and inhibiting the implementation of PjBL in various learning contexts, as well as its long-term impact on students' critical thinking dispositions. Thus, PjBL can be optimized as a learning approach relevant to the demands of 21st-century education.

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