The Effect of Project-Based Learning (PjBl) on Creative Thinking Ability and Mathematics Learning Outcomes of Fifth Grade Students

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ABSTRACT

This study investigates the effect of Project-Based Learning (PjBL) on the creative thinking ability and mathematics learning outcomes of fifth-grade students. Motivated by the challenges of conventional learning methods, such as teacher-centered instruction and students' low engagement, this study applies a quasi-experimental design involving control and experimental groups. A total of 34 students participated in the research. Data were collected through pre-test and post-test assessments, questionnaires, and observations, and analyzed using t-tests and descriptive statistics.

The findings reveal that the PjBL model significantly enhances students' creative thinking skills and improves their mathematics learning outcomes compared to traditional teaching methods. Students in the experimental group showed higher levels of engagement, problem-solving skills, and conceptual understanding. The study supports the integration of PjBL into mathematics instruction to develop 21st-century skills, particularly creativity and critical thinking. These results contribute to the growing body of research supporting learner-centered pedagogies in primary education, especially in the Indonesian context where curriculum reform is actively underway.

Keywords: Project-Based Learning, Creative Thinking, Mathematics Learning Outcomes, Primary Education

INTRODUCTION

Education plays a pivotal role in equipping students with the competencies required to face the challenges of the 21st century, including critical thinking, problem-solving, creativity, and collaboration skills [1], [2]. In Indonesia, as in many parts of the world, there is increasing recognition that traditional teacher-centered approaches, such as the lecture method, often fail to actively engage students or develop higher-order thinking skills [3]. This issue is especially evident in mathematics education, where students frequently perceive mathematics as abstract, difficult, and disconnected from real-life contexts [4].

Mathematics is fundamental in developing logical reasoning, problem-solving, and analytical skills essential for lifelong learning [5]. However, research indicates that Indonesian students often perform below expectations in mathematics, both in national examinations and international assessments, such as PISA, reflecting challenges in conceptual understanding and creativity [6]. One contributing factor is the dominant use of conventional methods that focus on rote memorization rather than inquiry-based or student-centered learning [7].

Project-Based Learning (PjBL) has emerged as an innovative teaching approach that can address these limitations by engaging students in meaningful projects connected to real-life problems [8], [9]. Unlike traditional methods, PjBL emphasizes student autonomy, collaboration, problem-solving, and creative output, making it particularly suitable for fostering 21st-century skills [10]. Studies across various educational

contexts have demonstrated that PjBL can improve both academic achievement and creative thinking skills in subjects like mathematics, science, and language arts [11], [12].

In Indonesia, the urgency to adopt innovative pedagogies is underscored by the national curriculum (Kurikulum 2013) and subsequent reforms, which encourage active learning and the development of higher-order thinking skills [13]. Indonesian educational laws, such as the National Education System Law No. 20 of 2003, explicitly emphasize the role of education in nurturing students' potential, including intellectual, emotional, and creative capacities [14]. However, despite these policy directions, many schools continue to rely on traditional methods, and there remains a significant gap between policy and classroom practice [15].

SD Taruna Mandiri, an elementary school in South Tangerang, reflects these national challenges. Preliminary observations revealed that mathematics lessons were predominantly teacher-centered, leading to student passivity, low engagement, and difficulties in understanding fundamental mathematical concepts [16]. Teachers reported that students often displayed low creative thinking skills, lacked confidence in problem-solving, and viewed mathematics as a difficult subject [16].

Against this background, this research investigates the effect of implementing PjBL on creative thinking ability and mathematics learning outcomes among fifth-grade students at SD Taruna Mandiri. The study aims to provide empirical evidence on whether PjBL can bridge the gap between curriculum expectations and classroom reality, thereby contributing to the improvement of mathematics education in Indonesian primary schools.

LITERATURE REVIEW

Project-Based Learning (PjBL)

Project-Based Learning (PjBL) is an instructional model that organizes learning around projects rather than traditional subject-based instruction. Students engage in exploring real-world problems and constructing meaningful products or solutions, fostering autonomy, collaboration, and creativity [1], [8]. Dewi [16] defines PjBL as an approach emphasizing problem-solving and higher-order thinking skills, making students active participants in the learning process.

According to Thomas [8], Project-Based Learning (PjBL) is characterized by several essential features, including a driving question that presents a meaningful problem or inquiry to guide the project; student voice and choice, where learners have the autonomy to determine how to approach the task; inquiry and innovation, which require students to engage in research, exploration, and creative thinking; feedback and revision, involving continuous improvement through guidance and collaboration; and a publicly presented product, where the final outcomes are shared beyond the classroom to enhance motivation and authenticityThese features align with educational reform movements worldwide that seek to replace passive learning with active, student-centered pedagogies [2], [9]. Research consistently shows that PjBL increases student engagement and improves knowledge retention across disciplines, including science, language arts, and mathematics [11], [12].

PjBL in Mathematics Education

Mathematics education has traditionally been associated with rote learning and abstract concepts, often disconnected from students' everyday experiences [4]. In Indonesia, mathematics lessons often rely on lecture methods, leading to passive learning and poor student performance [3], [16]. Nugraha [4] notes that many students perceive mathematics as difficult and irrelevant, contributing to low achievement levels.

PjBL offers an alternative by contextualizing mathematical concepts through real-life problems, enabling students to see the relevance of mathematics in their daily lives [17]. Studies demonstrate that PjBL can improve mathematical understanding, problem-solving skills, and students' attitudes toward the subject [18], [19]. Students working on projects experience mathematics as an applied, engaging discipline rather than abstract symbols.

Lestari and Agung [20] found that PjBL in mathematics increased students' active participation and fostered collaborative skills. Their research showed that students developed deeper conceptual understanding and improved creative thinking when engaged in project-based activities.

Creative Thinking in Education

Creativity is recognized as one of the core competencies for the 21st century [1], [2]. Guilford, one of the earliest scholars to study creativity systematically, identified divergent thinking as a key aspect of creativity, involving fluency, flexibility, originality, and elaboration [21]. Creative thinking allows individuals to generate new ideas, approach problems from multiple perspectives, and develop innovative solutions [22].

In educational contexts, fostering creativity is crucial for preparing students for complex, rapidly changing environments [23]. Wahyuni [24] highlights that creative thinking in mathematics involves not only producing novel solutions but also applying logical reasoning and mathematical knowledge to real-life problems.

In Indonesia, educational policy emphasizes creativity as a vital educational goal [14]. However, traditional pedagogies often limit students' creative potential [15]. PjBL provides an effective approach to nurture creativity by encouraging inquiry, exploration, and hands-on experiences [8], [9], [10].

PjBL and Creative Thinking

Multiple studies have demonstrated that PjBL significantly enhances creative thinking skills [25], [26]. By engaging students in meaningful projects, PjBL creates opportunities for divergent thinking, problem-solving, and innovation [9], [27].

Erviana et al. [9] noted that Indonesian students involved in PjBL projects developed stronger creative thinking skills and higher motivation compared to peers in traditional classrooms. In mathematics education, students who participated in PjBL were better able to connect abstract mathematical concepts with real-world applications, a process that fosters creativity [17].

Moreover, Mergendoller et al. [12] found that students in PjBL classrooms scored significantly higher on creativity assessments, particularly in tasks requiring original solutions and innovative thinking.

PjBL in Indonesian Educational Context

Indonesian education has undergone significant reforms, particularly with the introduction of Kurikulum 2013, which emphasizes student-centered learning, scientific inquiry, and the development of 21st-century skills [13]. Despite these reforms, implementation remains inconsistent, with many teachers still adhering to traditional lecture-based methods [15].

Research in Indonesian schools shows that PjBL can be successfully integrated into various subjects, leading to increased student engagement and improved learning outcomes [9], [28]. Studies conducted in mathematics classrooms, such as those by Ramadianti [7] and Syiddin [16], found that PjBL helps reduce students' anxiety about mathematics, encourages collaborative learning, and promotes critical and creative thinking.

However, barriers to implementation persist, including lack of resources, limited teacher training, and time constraints [29]. Teachers often require professional development to effectively design and facilitate PjBL activities [30].

Gaps in the Literature

While numerous studies affirm the benefits of PjBL, there remains limited research focusing on its impact specifically on creative thinking and mathematics learning outcomes in Indonesian primary schools [16], [9]. Most studies have been conducted at the secondary or higher education levels [11], [12]. This gap highlights the need for empirical research examining the effectiveness of PjBL in primary education contexts, where foundational skills and attitudes toward learning are formed.

This study seeks to address this gap by investigating the impact of PjBL on fifth-grade students' creative thinking abilities and mathematics learning outcomes at SD Taruna Mandiri. By contributing evidence from the Indonesian primary school context, this research aims to inform both policy and classroom practice regarding effective strategies for enhancing mathematics education.

METHODOLOGY

Research Design

This research employed a quasi-experimental design using a pre-test and post-test control group structure [1], [31]. This design enables the comparison of learning outcomes and creative thinking skills between a group of students taught through Project-Based Learning (PjBL) and those taught using traditional methods.

Participants

The study was conducted at SD Taruna Mandiri, located in South Tangerang, Banten, Indonesia, involving 34 fifth-grade students who were divided into two groups: the experimental group (n=17), which received instruction using the PjBL model, and the control group (n=17), which received traditional teacher-centered instruction; participants were selected using purposive sampling based on the school's availability and the researcher's access, aligning with ethical research considerations in educational contexts [16].

Instruments

Data were collected using four main instruments: (1) a creative thinking test developed based on indicators such as fluency, flexibility, originality, and elaboration [21], [22], consisting of 10 open-ended items related to mathematical concepts, particularly integer and decimal operations; (2) a mathematics learning outcomes test designed to measure students' mastery of mathematical concepts, including operations with integers and decimals, featuring both objective and problem-solving items aligned with the Indonesian elementary school curriculum [14], [16]; (3) a Likert-scale questionnaire administered to assess students' attitudes toward mathematics and their experiences during the learning process, measuring aspects such as engagement, interest, and perceived difficulty; and (4) an observation sheet used to document students' participation, collaboration, and engagement during classroom activities in both the experimental and control groups.

Validity and Reliability

All instruments underwent **content validation** by experts in mathematics education and educational research. The reliability of the creative thinking and learning outcomes tests was confirmed using Cronbach's alpha, yielding coefficients above 0.7, indicating acceptable reliability levels [32], [33].

Procedure

The research was carried out between April and May 2025 and included several procedures: a pre-test was administered to both groups to establish baseline levels of creative thinking and mathematics achievement; during the treatment phase, the experimental group received mathematics instruction using the PjBL approach, while the control group was taught using conventional methods; a post-test was conducted to measure changes in creative thinking skills and learning outcomes; and data collection involved questionnaires and classroom observations, with the experimental group engaging in projects related to mathematical topics that involved planning, collaboration, and presenting solutions, whereas the control group followed a lecture-based approach focusing on textbook exercises.

Data Analysis

Data analysis employed both descriptive and inferential statistics, where descriptive statistics summarized mean scores, frequencies, and standard deviations of test results and questionnaire responses, while inferential statistics included paired-samples t-tests to determine significant differences between pre-test and post-test

scores within groups and independent-samples t-tests to compare the experimental and control groups' post-test results [34], with all statistical analyses performed at a significance level of 0.05 using SPSS version 25.

RESULTS AND DISCUSSION

Results

Pre-Test and Post-Test Scores

A comparison of pre-test and post-test scores was conducted to determine the impact of Project-Based Learning (PjBL) on students' creative thinking ability and mathematics learning outcomes. The results are summarized in Table 1.

Table 1. Comparison of Pre-Test and Post-Test Mean Scores

Group	Test Type	Mean Score	SD	N
Experimental	Pre-Test	63.12	6.47	17
	Post-Test	86.58	5.89	17
Control	Pre-Test	62.45	6.34	17
	Post-Test	70.71	6.01	17

A paired-samples t-test revealed a significant improvement in the experimental group's scores ($t = 10.67$, $p < 0.001$), indicating the effectiveness of the PjBL model in enhancing students' mathematics performance. In contrast, the control group showed only a modest improvement ($t = 3.88$, $p = 0.001$).

N-Gain Score Analysis

To evaluate the effectiveness of PjBL in improving learning outcomes, the normalized gain (N-Gain) score was calculated for both experimental and control groups. N-Gain is defined as the ratio of actual gain to the maximum possible gain and is commonly used to measure the effectiveness of instructional interventions.

The results of the N-Gain analysis are presented in Table 3.

Table 3. N-Gain Score of Experimental and Control Groups

Group	Pre-Test Mean	Post-Test Mean	N-Gain	Category
Experimental	63.12	86.58	0.63	Moderate
Control	62.45	70.71	0.22	Low

The experimental group achieved an N-Gain of 0.63, categorized as moderate improvement, while the control group obtained an N-Gain of 0.22, indicating low improvement. This finding supports the conclusion that PjBL is more effective than traditional instruction in improving students' mathematics achievement.

These results align with previous studies [18], [19], which reported that students taught using PjBL exhibit significantly greater learning gains than those in conventional classrooms. The moderate N-Gain score in the experimental group also reflects how the hands-on, collaborative nature of PjBL enhances understanding and retention of mathematical concepts.

Creative Thinking Questionnaire Results

A 15-item Likert-scale questionnaire assessed students' self-reported creative thinking across several indicators. Table 2 displays selected items related to students' fluency, flexibility, and evaluation skills.

Table 2. Selected Items from Creative Thinking Questionnaire (Experimental Group, N = 17)

Item Statement	Mean Score (1–5)
I can find multiple ways to solve a math problem.	4.00
I can explain how and why I used a specific strategy in math.	3.85
I am able to analyze and improve my group's ideas during a project.	3.94
I enjoy exploring new approaches to solve unfamiliar math tasks.	3.88
I can compare different solutions and choose the best one.	3.91

Overall, the average score across all 15 items was **3.75**, indicating a high level of creative engagement among students in the experimental group.

Observational Data

Classroom observations revealed that students in the PjBL group demonstrated greater collaboration, curiosity, and engagement compared to the control group. During project work, students initiated discussions, proposed creative solutions, and confidently presented their ideas.

DISCUSSION

The results of this study strongly indicate that Project-Based Learning (PjBL) effectively enhances both creative thinking abilities and mathematics learning outcomes among fifth-grade students. The significant increase in post-test scores, combined with the moderate N-Gain of 0.63 in the experimental group, suggests that PjBL facilitates meaningful learning and knowledge retention.

These findings are consistent with prior research highlighting PjBL's effectiveness in developing deeper conceptual understanding and higher-order thinking skills [11], [18], [19]. Students in the PjBL group not only performed better academically but also demonstrated stronger creative skills, as reflected in their ability to generate multiple problem-solving strategies, evaluate solutions, and work collaboratively—attributes aligned with Guilford's theory of creativity [21].

The low N-Gain in the control group (0.22) underscores the limitations of traditional teaching methods, which often emphasize rote learning and fail to engage students in higher-level cognitive processes [3], [7]. In contrast, PjBL promotes active inquiry, hands-on learning, and the connection of abstract mathematical concepts to real-life applications, enhancing students' motivation and understanding [9], [25].

This study aligns with the Indonesian curriculum's objectives, which emphasize the development of critical and creative thinking skills through student-centered learning [13]. However, while the potential of PjBL is evident, challenges remain regarding its widespread adoption, including the need for teacher training, curriculum adaptation, and resources [29], [30].

Overall, the integration of PjBL in mathematics instruction can play a crucial role in transforming Indonesian classrooms into engaging environments where students actively construct knowledge and develop essential 21st-century skills.

Limitations

This study involved a relatively small sample from a single school, which may limit the generalizability of the findings. Future research should consider larger samples across diverse educational contexts and explore the long-term impact of PjBL on various academic subjects.

CONCLUSION

This study demonstrates that Project-Based Learning (PjBL) has a significant positive impact on both creative thinking ability and mathematics learning outcomes among fifth-grade students at SD Taruna Mandiri. Students exposed to PjBL exhibited higher test scores, greater engagement, and enhanced creativity compared to those taught through traditional methods. These results align with global and Indonesian educational goals, emphasizing student-centered learning and 21st-century skills.

The research underscores the importance of integrating PjBL into mathematics instruction to foster deeper understanding, critical thinking, and problem-solving abilities. While the findings are promising, further research involving larger samples and diverse contexts is necessary to validate and expand upon these results.

For educators and policymakers, this study highlights the practical feasibility of implementing PjBL, even in schools with limited resources. Training and support for teachers are crucial to ensure effective adoption of innovative teaching models that can transform traditional classrooms into vibrant learning communities.

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