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THE IMPACT OF PROJECT-BASED LEARNING ON CREATIVE THINKING AND COGNITIVE LEARNING OUTCOMES AMONG HIGH SCHOOL STUDENTS

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ABSTRACT

Creative thinking skills in 21st-century learning have become essential competencies that students must possess. However, these skills have not been fully explored within the learning process, leading to suboptimal learning outcomes. To address this, we undertook a study to evaluate an alternative instructional model that could actively engage students in the learning process-Project-Based Learning (PjBL). The practical implications of this study are significant, as it provides insights into a model that can enhance students' creative thinking abilities and cognitive learning outcomes. The research was conducted at SMAN 11 Kota Jambi, using a quantitative method. The research design employed was quasi-experimental, specifically the Non-randomized Control-Group Pretest-Posttest Design. The subjects were 10th-grade students (Phase E), selected through purposive sampling. Data analysis was conducted using One Way MANCOVA. Results from the study indicate that the PjBL model significantly impacts students' creative thinking and cognitive learning outcomes, showing a moderate effect on creative thinking skills and a substantial impact on cognitive learning outcomes.

INTRODUCTION

Creative thinking skills are not just desirable but essential competencies for students in 21st-century learning. The 21st-century competencies required in the workplace and industry, including critical thinking, creativity, innovation, problem-solving, communication, and collaboration, have been extensively studied (Ma'sumah & Nurwahyunani, 2024; Tahmid, Nurkhoiri, & Hayat, 2024; Wijaya et al., 2016). However,

the role of creative thinking in the learning process, a skill crucial for enhancing students' engagement in facing learning challenges, has not been fully explored. Khoerudin et al. (2023) note that creative thinking skills are essential for adapting to changes, tackling challenges, and solving problems in daily life.

The lack of optimization in students' creative thinking skills is a pressing issue that leads to difficulty generating new ideas, resulting in a less effective learning process. Creative thinking enables individuals to solve problems innovatively and create new, beneficial solutions, helping them find more efficient or effective ways to tackle issues. Susilo et al. (2016) assert a positive relationship between creative thinking and cognitive learning outcomes; the higher the level of creative thinking, the higher the learning outcomes students achieve. Learning outcomes refer to changes in a person's abilities due to the learning process (Fitriani, 2016). Factors influencing students' learning outcomes include interest, motivation, teaching methods, and learning media (Kurniawan et al., 2018).

Preliminary studies through interviews conducted at SMAN 11 Kota Jambi reveal that the school primarily uses the Inquiry Learning model. The learning process involves presenting material, discussions, and structured assignments, yet not all students are actively engaged, which affects both the learning process and outcomes. According to student surveys, creative thinking skills averaged only 72%, while learning outcomes were low at an average of 48.36%, indicating significant room for improvement. Nationally, creative thinking skills among students remain low.

Teachers must have appropriate learning strategies, such as choosing the right learning model to improve students' creative thinking abilities (Bariroh et al., 2024). Wulandari (2019) suggests that creative skills can be improved through engaging learning models that boost student enthusiasm and motivation. One such model is Project-Based Learning (PjBL), which allows educators to manage learning through project-based activities (Eliza et al., 2019). PjBL, with its potential to develop 21st-century skills, such as creativity and critical thinking, is a promising avenue for educational research.

Implementing PjBL also increases students' active participation in problem-solving through projects, ultimately enhancing their creativity and critical thinking skills (Wicaksana & Sanjaya, 2022). Therefore, this study, titled *The Impact of Project-Based Learning on Creative Thinking Skills and Cognitive Learning Outcomes among SMAN*

11 Kota Jambi Students, focuses on applying the PjBL model within the environmental change subject area, using pretest and posttest evaluations to measure its impact on creative thinking and cognitive learning outcomes.

This study offers a unique contribution to educational research by examining the impact of Project-Based Learning (PjBL) on creative thinking skills and cognitive learning outcomes among high school students, specifically in environmental change. While PjBL has been widely studied, its effect on enhancing creative thinking and cognitive learning outcomes in high school students, particularly in Indonesia, remains underexplored. This research, titled 'The Impact of Project-Based Learning on Creative Thinking Skills and Cognitive Learning Outcomes among SMAN 11 Kota Jambi Students', aims to fill this gap by providing valuable insights into the effectiveness of PjBL. The study applies PjBL within the context of environmental change, a subject that demands critical and creative thinking to address real-world issues. The research also compares the PjBL model with the Inquiry Learning model, providing a deeper understanding of how PjBL explicitly fosters creativity and learning outcomes. This study, conducted at SMAN 11 Kota Jambi, adds local relevance and insights into how PjBL can be implemented in Indonesian schools. Using a Non-randomized Control-Group Pretest-Posttest design and the statistical method One Way MANCOVA, this research offers a rigorous analysis of the effects of PjBL on both creative thinking and cognitive learning outcomes, distinguishing it from previous studies in this field.

MATERIALS AND METHODS

Two classes of grade 10th made up the sample for this study, which was carried out at SMA Negeri 11 Kota Jambi: Classroom X E5, consisting of 36 students, served as the control group and Class X E6, consisting of 36 students, as the experimental group. While the control group was instructed using the Inquiry Learning model, the experimental group was treated using the Project-Based Learning (PjBL) model. In this study, the application of Project-Based Learning (PjBL) to the topic of environmental change focuses on addressing the issue of waste management by transforming waste materials into valuable products.

The Non-randomized Control-Group Pretest-Posttest method is a quasi-experimental method used in this study to examine how these instructional styles affect students' learning outcomes. According to the research design, both groups take a pretest (T_1) to determine baseline abilities and a post-test (T_2) to gauge learning gain following treatment. The research design is based on the framework modified by Leedy & Ormrod (2019). X_1 represents the use of the PjBL model for the experimental group, whereas X_2 denotes the Inquiry Learning model applied to the control group.

Both test and non-test instruments were used in this study's data collection. Pre-test and post-test questions were included in the test instrument to evaluate students' cognitive learning outcomes and capacity for creative thought. The test instrument's validity, reliability, discriminatory power, and difficulty were thoroughly assessed to ensure its effectiveness in measuring students' cognitive knowledge. The validity test revealed that 9 out of 20 questions were valid, with validity scores ranging from 0.469 to 0.632, indicating that these questions accurately measure students' cognitive abilities. The reliability of the test, measured using Cronbach's Alpha, resulted in a value of 0.614, which is considered acceptable, ensuring consistency in measuring students' knowledge.

Regarding discriminatory power, nine questions showed sufficient ability to distinguish between higher and lower-performing students, with indices ranging from 0.211 (moderate) to 0.532 (excellent). Finally, the difficulty level analysis revealed that the test had a balanced distribution of questions, with some items classified as "easy" (indices ranging from 0.544 to 0.876) and others as "moderate," ensuring the test is appropriately challenging for students at different cognitive levels. These results confirm that the test instrument is valid, reliable, and well-constructed for assessing students' cognitive learning outcomes.

The PjBL model's implementation process was tracked throughout the study using an observation sheet, which served as the non-test instrument. Two of the dependent variables, creative thinking abilities and cognitive learning outcomes, and one of the independent variables, the instructional model (PjBL), are included in this study. Pretest data were gathered as variables before the treatment using the selected design. One Way MANCOVA, a statistical method that enables the simultaneous analysis of multiple dependent variables, was used to evaluate the data. This method gave detailed insights into how the PjBL model affected creative thinking and cognitive outcomes.

RESULTS AND DISCUSSION

The research results demonstrate that the implementation of Project-Based Learning (PjBL) follows several structured phases: (1) formulating fundamental questions and project determination, (2) designing steps for project completion, (3) creating a project implementation schedule, (4) facilitating and monitoring project completion by the teacher, (5) preparing a report and presenting or publishing project results, and (6) evaluating the project process and outcomes. These phases maximize student engagement, fostering critical and creative thinking. Before instruction began, students in both the experimental and control classes were given a pretest and a posttest was conducted after instruction to measure progress in learning outcomes and creative thinking skills.

In this study, the effect of PjBL on students' creative thinking and cognitive learning outcomes was analyzed through regression slope homogeneity testing. The results, which showed regression slope homogeneity between the PjBL model and creative thinking skills in the posttest data [$F(2,56) = 0.169$, $p = 0.845$], and cognitive learning outcomes [$F(2,56) = 0.492$, $p = 0.614$], confirmed that the homogeneity assumption was met ($p > 0.05$). The homogeneity of variance and covariance was further confirmed through *Box's Test*, with a Box's M value of 3.382 ($p = 0.353$), fulfilling the assumption for covariance matrix equality (Leedy & Ormrod, 2019). The homogeneity results in this study confirm that the assumptions for analyzing the effects of the PjBL model on students' creative thinking and cognitive learning outcomes were met. Regression slope homogeneity testing showed no significant differences between groups ($p > 0.05$), indicating consistent relationships. Additionally, the Kolmogorov-Smirnov normality test indicated that posttest residual data for creative thinking [$D(62) = 0.101$, $p = 0.187$] and cognitive learning outcomes [$D(62) = 0.112$, $p = 0.052$] were typically distributed ($p > 0.05$). These results validate the assumptions for the analysis, ensuring the reliability of the study's findings and providing a solid foundation for future research and practice. Homogeneity results can be seen below.

Table 1. Test of Between Subjects Effects Univariate Test

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Kelas Pretest_ Creative Thinking Pretest_ Cognitive Learning Outcomes	Posttest_Kemampuan_Berpikir_Kreatif	40,475	2	20,237	0,169	0.845	0.006
	Posttest_Hasil_Belajar_Kognitif	131,024	2	65,521	0.492	0.614	0.017

The homogeneity and covariance analysis results indicate a clear conclusion: the *Box's M* value obtained is 3.382, with a significance level of p = 0.353. With the significance value being more significant than 0.001 (0.353 > 0.001), we can confidently conclude that there is homogeneity in the covariance matrix between the classes. This means the covariance matrices can be assumed to be similar across the sample groups, meeting the *Box's M* requirement for the homogeneity of variance-covariance test, where p > 0.001. Detailed results of the variance and covariance homogeneity test can be seen below.

Table 2. Test of Between Subjects Effects Univariate Test

Box's M	**3,382**
F	1,087
df1	3
df2	648000,000
Sig.	0,353

The Kolmogorov-Smirnov normality test was also conducted to analyze the normal distribution of creative thinking skills and cognitive learning outcomes in the posttest residual data. The results show that the posttest residual data for creative thinking skills has a value of [D(62) = 0.101, p = 0.187], and for cognitive learning outcomes, the value is [D(62) = 0.112, p = 0.052]. Both p-values are more significant than 0.05, indicating that the posttest residual data is usually distributed. This is a significant finding that underlines the importance of our research. Thus, the multivariate normality assumption for the residual data is met. The full results of this normality test can be seen below.

Table 3. Test of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Residual for Creative Thinking	0,101	62	0,187
Residual for Cognitive Learning Outcomes	0,112	62	0,052

The PjBL model significantly influences students' creative thinking skills and cognitive learning outcomes, a result we obtained through rigorous testing using One Way MANCOVA. The multivariate analysis results demonstrate the robust effect of the PjBL learning model on creative thinking skills and cognitive learning outcomes, even when controlling for students' initial levels [F(2,57) = 6.632, p = 0.003, Partial Eta Squared = 0.189]. This thorough testing process instills confidence in the reliability of our findings.

Table 3. Multivariat Test

Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's trace	0,189	6,632[a]	2,000	57,000	0,003	0,189
Wilks' lambda	0,811	6,632[a]	2,000	57,000	0,003	0,189
Hotelling's trace	0,233	6,632[a]	2,000	57,000	0,003	0,189
Roy's largest Root	0,233	6,632[a]	2,000	57,000	0,003	0,189

Our study, which examined the effect of the PjBL model on creative thinking skills while controlling for students' initial creative thinking skills, found a significant result. The PjBL model was found to have a moderate impact on creative thinking skills [F(1,58) = 4.307, p = 0.042, Partial Eta Squared = 0.069]. This key finding underscores the potential of the PjBL model in enhancing students' creative thinking skills.

Table 4. Univariat Test

Dependent Variable		Sum of Squared	df	Mean Squared	F	Sig.	Partial Eta Squared
Posttest_ Creative Thinking	Contrast	502,463	1	502,463	4,307	0,042	0,069
	Eror	6766,177	58	116,658			

The univariate analysis results assessing the effect of the PjBL model on students' cognitive learning outcomes, while controlling for initial cognitive learning outcomes, indicate a significant impact of the PjBL model on cognitive learning outcomes when controlling for initial cognitive scores [F(1,58) = 10.185, p = 0.002, Partial Eta Squared = 0.149]. This finding is particularly engaging as it highlights that the PjBL model is more effective than the Inquiry Learning model in influencing students' creative thinking skills and cognitive learning outcomes.

Table 5. Univariat Test

Dependent Variable		Sum of Squared	df	Mean Squared	F	Sig.	Partial Eta Squared
Posttest_ Cognitive Learning Outcomes	Contrast	1332,487	1	1332,487	10,185	0,002	0,149
	Eror	7587,767	58	130,824			

The hypothesis testing results indicate that students' creative thinking abilities and cognitive learning outcomes are significantly higher among those engaged in Project-Based Learning (PjBL) than those participating in Inquiry Learning. This improvement is attributed to the student-centered nature of PjBL, where teachers serve primarily as facilitators, empowering students to take an active role in their learning process. This active involvement allows students to engage in hands-on problem-solving experiences. In this study, the application of Project-Based Learning (PjBL) to the topic of environmental change focuses on addressing the issue of waste management by transforming waste materials into valuable products. The PjBL model allows students to actively engage in real-world problem-solving by working on projects requiring them to think creatively and critically about managing waste. Through this process, students are encouraged to research, design, and develop practical solutions, such as creating products from recycled materials, thus directly applying their knowledge to a meaningful environmental issue. By focusing on a hands-on, student-centred approach, PjBL facilitates more profound learning and enhances students' creative thinking and cognitive learning outcomes as they take ownership of their learning process and work collaboratively to find solutions to real-life problems. This aligns with the observations of Sukmana & Amalia (2021), who argue that project-based learning emphasizes student-centred approaches, encouraging active and innovative involvement from students as they address solvable problems and generate creative project-based outcomes.

Beyond the influence of the learning model, other factors also contribute to learning success, including psychological, family, and school factors, as Paramita et al. (2021) noted. School factors, such as adequate infrastructure, also play a crucial role, along with practical classroom management. According to Erwinsyah (2017), classroom management is not just a necessity, but an essential tool to creating and maintaining a supportive learning environment. Educators can enhance student motivation and participation by fostering a positive classroom atmosphere. Effective classroom management can create a comfortable and engaging environment that nurtures students' creative potential by promoting an atmosphere conducive to learning.

Students in the experimental class who participated in PjBL exhibited more excellent creative thinking than those in the control class. This is a direct result of PjBL's emphasis on active and creative thinking, as supported by Asni et al. (2018). In this study,

students showed a high level of curiosity, demonstrated by their active questioning, proposing ideas, defending opinions, and contributing meaningfully to project development. This active and creative thinking, fostered by PjBL, is a significant contributor to the improved learning outcomes observed in the experimental class.

Regarding cognitive learning outcomes, the study reveals a significant difference in average scores between students in the PjBL class and those in the Inquiry Learning class. After the intervention, students in the experimental class exposed to PjBL achieved better learning outcomes than those in the control class. This aligns with the research of Harlis, Budiarti, & Mataniari (2022), who found that project-based learning can provide experience in solving or solving problems that impact increasing students' knowledge. This improvement is attributed to the PjBL model's ability to foster active and creative project-based learning, positively impacting student learning outcomes. Research by Kencana & Rifa'i (2021) supports this, showing that PjBL promotes tremendous enthusiasm in students, encouraging them to be more engaged in project creation and active learning.

The Project-Based Learning (PjBL) model consisted of six stages: defining essential questions and project selection, designing project steps, creating a project schedule, completing the project, preparing reports and presentations, and evaluating the project outcomes. Each stage contributed to enhancing students' creative thinking skills. During the first stage, students formulated questions and selected projects, improving their originality as they actively engaged in discussions and proposed innovative project ideas. In the second stage, designing project steps, students developed excellent elaboration skills and detailed project plans. As they created their project schedules, their flexibility in thinking improved as they negotiated and adapted their ideas, showcasing problem-solving skills. The final stages, project completion and presentation, significantly boosted students' fluency and elaboration. By solving challenges during project execution, students demonstrated creative problem-solving abilities. The report and presentation phase enhanced their elaboration skills as they communicated their ideas confidently and clearly. In the last stage, evaluating the project process and outcomes, students demonstrated metaphorical thinking by reflecting on their experiences and offering creative solutions to challenges. The PjBL model effectively fostered creative thinking and problem-solving, improving cognitive learning outcomes.

Similarly, Wicaksono & Iswan (2019) emphasize that students who actively participate by asking questions, sharing arguments, and offering solutions tend to achieve higher learning outcomes, which is reflected in their increased comprehension of learning themes. Teacher-centered approaches, on the other hand, often lead to student disengagement, reducing cognitive development and learning achievement. As highlighted by Kencana & Rifa'i (2021), creative teaching strategies such as PjBL are necessary to maintain student engagement and foster effective learning outcomes.

CONCLUSION

Implementing the Project-Based Learning (PjBL) model significantly impacts students' creative thinking skills and cognitive learning outcomes compared to the Inquiry Learning model, with a large effect size favouring the PjBL model. This influence is primarily due to the nature of PjBL, which actively trains students to think creatively and critically throughout the learning process. Applying PjBL further encourages students to be more engaged and inventive as they work on project-based tasks, directly enhancing their learning outcomes. By fostering active participation and creativity in project development, PjBL creates a dynamic and interactive learning environment that supports students in achieving more profound understanding and improved performance. This research suggests that educators should consider adopting Project-Based Learning as a core teaching strategy, particularly in subjects requiring problem-solving and creativity. The findings support the integration of PjBL into curricula to enhance cognitive and creative skills, preparing students for the demands of the 21st century. Moreover, schools may benefit from investing in professional development for teachers to effectively implement PjBL, fostering more innovative and student-centred learning environments and highlighting the integral role of educators in this process.

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