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Instructional Material Design of Project-Based Learning to Train Creative Thinking Skills in Society 5.0 Era

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Abstract

The integration of creative and environmentally relevant instructional materials is anticipated to foster a range of competencies, particularly in creative thinking. This study aims to evaluate the effects of project-based learning (PBL) on enhancing students' creative thinking skills. Adopting a quasi-experimental approach with a two-group pretest-posttest design, the study encompasses a population of 153 second-semester students distributed across five classes. A sample of 70 students was selected through cluster random sampling and subsequently assigned to either an experimental or a control group. The primary instrument employed was a project-based creative thinking skills test, designed as a set of essay questions aligned with key dimensions of creative thinking. Data were analyzed via a t-test to determine the significance of observed differences. Findings indicate that project-based learning incorporating elements of local Papuan wisdom significantly enhanced creative thinking abilities in the experimental group, which demonstrated an average post-test score increase of 26%. The t-test results confirmed a statistically significant difference between the two groups ($p < 0.05$). This research underscores the value of integrating local cultural wisdom into educational practices, highlighting its role in enhancing student creativity and advancing culturally responsive pedagogy—an essential component for equipping students with 21st-century skills.

INTRODUCTION

Background of the Study

The advent of Society 5.0—a civilization characterized by accelerated technological advancements—represents a significant paradigm shift from the era of Industry 5.0, with profound effects on various aspects of human life, particularly in developing nations. This transition necessitates that younger generations acquire competencies in technology management and innovation, essential for success in a technologically-driven society. The implications extend beyond individual skill development to impact broader socio-cultural dynamics, especially within third-world and developing countries. These societies must equip their youth with skills to harness and innovate with technology within educational contexts. Widisuseno (2020), underscores the tension between traditional values and Western influences, calling for educational systems to adapt through e-learning as a bridge for addressing critical skill gaps. Cultural transformations, as discussed by Varnum and Grossmann (2021), shape individual behaviors and societal norms, highlighting the need for a holistic, culturally responsive approach in education.

Instructional materials, especially textbooks, play a foundational role in shaping educational experiences for teachers, students, and families by offering structured content aligned with educational standards and objectives. Research demonstrates that textbooks exert a significant influence on classroom practices and learning outcomes, particularly in resource-constrained environments, by providing stable and dependable information (Bellens et al., 2019; Haulle & Kabelege, 2020). Beyond content delivery, textbooks contribute substantially to fostering students' critical and creative thinking skills, essential for addressing complex 21st-century challenges (Handayani et al., 2023; Sujastika & Abdulkarim, 2022). By incorporating inquiry-based activities and problem-solving tasks that reflect local cultural contexts, textbooks can enhance the relevance and impact of learning (Aditya, 2023; Ayu, 2020). This culturally responsive approach promotes student engagement and prepares learners for active participation in diverse, multicultural societies (Sujastika & Abdulkarim, 2022).

Creative thinking stands out as a vital competency, empowering students to approach problems with innovative solutions that contribute to an enhanced quality of life. Research identifies that the cultivation of creativity is influenced by both personality traits, such as perseverance, and the educational setting. Studies show that activities designed to stimulate creativity and divergent thinking can substantially enhance students' creative capacities (Aziz, 2023; Öncü, 2016). Moreover, factors such as gender and individual personality traits further influence creative potential (Lin et al., 2012). Educational strategies that prioritize creativity contribute not only to personal growth but also to professional success (Runco et al., 2010. Supportive environments, including collaborative and interactive learning, also play an essential role in strengthening creative thinking and problem-solving skills (Chiu et al., 2018; Tse et al., 2017; Laisema & Wannapiroon, 2014; Meitiyani et al., 2022).

Creative thinking, however, varies individually, reflecting unique approaches to problem-solving. To foster students' creative thinking, educators can encourage them to generate ideas or perspectives distinct from their peers. The core dimensions of creative thinking include (1) Fluency, or the ability to think smoothly and generate multiple ideas; (2) Flexibility, or adaptability in thinking; (3) Originality, or the capacity for novel thinking; and (4) Elaboration, or the ability to expand on ideas in detail. Table 1 presents these aspects alongside specific indicators of creative thinking skills.

Table 1. Aspects and indicators of creative thinking skills

Aspects		Indicators
Fluency	1.	Sparks many answers, ideas, problem-solving and questions
	2.	Provides many ways or suggestions for doing various things

Aspects		Indicators
	3.	Always think of more than one answer
Flexibility	1.	Generates a variety of ideas, answers, and questions
	2.	Able to 'change the way of approach or thinking
Originality	1.	Able to produce unique and new expressions
	2.	Able to create unusual combinations of parts or elements
	3.	Able to 'change the way of approach or thinking
Elaboration	1.	Developing, adding, enriching an idea
	2.	Able to detail the details of an object so that it becomes interesting

The Project-Based Learning (PjBL) model actively engages students in designing, planning, and executing projects, effectively enhancing their creative thinking abilities. By allowing students to investigate real-world problems and propose innovative solutions, PjBL fosters a participatory approach to learning. The integration of local wisdom into PjBL further enriches this process, making learning experiences more relevant and meaningful to students. Research demonstrates that PjBL promotes creativity through experiential learning, critical analysis, and problem-solving (Kokotsaki et al., 2016). Local wisdom offers diverse, observable phenomena that students can directly engage with, making it a particularly suitable medium for cultivating creative thinking skills. Studies show that the incorporation of culturally relevant materials into PjBL improves creative outputs, including in areas such as creative writing (Santosa et al., 2019). Selecting local wisdom as a thematic focus in projects not only stimulates creative thinking but also deepens students' understanding of their cultural heritage, particularly within STEAM (Science, Technology, Engineering, Arts, and Mathematics) education (Aini, 2024). Moreover, PjBL's emphasis on collaboration and real-world problem-solving aligns with creativity objectives by encouraging students to explore a variety of perspectives and solutions (Shofyana et al., 2022).

Problem of The Study

Preliminary research highlights a notable gap in instructional resources that incorporate local Papuan wisdom to foster creative thinking skills among students in the Unimuda Sorong PGSD Study Program. Project-Based Learning (PjBL) presents a promising solution to this challenge, promoting active participation, collaboration, and hands-on engagement—key factors in cultivating creative thinking. In the context of Society 5.0, students must develop not only creative thinking skills to stay globally competitive but also an awareness of local cultural wisdom to address specific regional challenges. Consequently, there is an urgent need for instructional materials that blend PjBL with local Papuan wisdom to better equip students with the competencies required in today's evolving educational landscape.

Nevertheless, several obstacles remain within current pedagogical practices. Many students struggle to articulate ideas and collaborate effectively in discussions. Despite opportunities for engagement, few actively participate, often hindered by fear or uncertainty. This lack of confidence in expressing opinions and developing solutions reveals a critical gap in their training. Moreover, most students rely heavily on lecturer-provided resources, maintaining a passive stance and often lacking critical thinking skills. These limitations highlight the need for a more dynamic pedagogical approach, such as PjBL, to stimulate independent thought and creative problem-solving.

Research's State of the Art

Instructional materials play a fundamental role in shaping the educational experience by influencing students' engagement and comprehension of complex concepts. Studies reveal that the design and cultural relevance of instructional resources are essential for improving student outcomes, particularly when these resources resonate with students' sociocultural backgrounds (Kelly et al.,

2021). Culturally responsive materials not only validate students' identities but also bridge the gap between theoretical knowledge and practical application, especially when local wisdom is incorporated (Keehne et al., 2018). Integrating local wisdom into learning materials enhances relevance, intrinsically motivating students and promoting deeper learning. This method positions Project-Based Learning (PjBL) as a highly effective tool for fostering higher-order thinking skills, as it immerses students in collaborative, problem-solving activities that require the application of knowledge in practical contexts (Illahi & Arsih, 2022). In this way, PjBL not only supports active learning but also cultivates critical thinking skills essential for navigating complex challenges (Luga, 2021).

However, the implementation of PjBL still presents challenges, particularly in stimulating original and divergent thinking. Marshall and Khalifa (2018), found that these issues extend beyond academic testing, affecting students' real-world problem-solving abilities. This reveals a gap between theoretical advocacy for PjBL and its practical effectiveness in enhancing creative thinking skills. Future research should focus on refining PjBL methodologies to address these challenges and fully realize students' creative potential.

Gap Study & Objective

Prior studies have demonstrated the effectiveness of Project-Based Learning (PjBL) in fostering creative thinking skills among students. However, there remains a notable gap in understanding the impact of integrating instructional materials grounded in local Papuan wisdom within this pedagogical framework. The absence of culturally relevant materials has been shown to hinder student engagement and inhibit their ability to engage in creative problem-solving across varied educational settings (Saputri et al., 2022; Mpuangnan, 2023). This deficiency underscores the critical need for research focused on how curricula that incorporate local cultural elements can effectively cultivate creative thinking skills among students. The integration of culturally relevant pedagogy is essential for enhancing both student engagement and learning outcomes. Research indicates that tailoring curricula to reflect students' cultural backgrounds can improve educational experiences and increase student involvement (Capper, 2021; Ava, 2020). For example, involving community members in curriculum development has been linked to higher quality and relevance in educational content, which subsequently fosters greater learner engagement (Mpuangnan, 2023). These findings suggest that a culturally responsive curriculum—particularly one that integrates local wisdom—may be an effective tool in promoting creative thinking abilities.

Furthermore, the dimensions of creative thinking—fluency, flexibility, originality, and elaboration—are critical for assessing students' creative capacities (Saputri et al., 2022; Madyani et al., 2020). These dimensions can be effectively nurtured through PjBL methodologies that encourage students to explore and apply their knowledge within culturally relevant contexts (Putri et al., 2021). By investigating how PjBL can be adapted to incorporate local Papuan wisdom, this research seeks to address the existing gap and provide insights into the potential for culturally responsive education to foster creative thinking among students.

Accordingly, this study aims to compare the effectiveness of PjBL-based instructional materials that incorporate local Papuan wisdom with conventional learning approaches in enhancing students' creative thinking skills. Conducted as a comparative study, this research examines the extent to which integrating local culture into PjBL can impact students' creative thinking abilities. This inquiry not only addresses the lack of culturally informed instructional practices but also contributes to broader discussions on culturally responsive pedagogy, which advocate for recognizing and utilizing students' cultural backgrounds as integral components of the learning process (Levine & Tamburrino, 2024).

METHOD

Type and Design

This research was conducted in the Primary School Teacher Education Study Program at Muhammadiyah University of Education (Unimuda) Sorong in July, during the even semester of the 2022/2023 academic year. The study employed a true experimental quantitative design within a comparative framework. The selection of a true experimental design was guided by the need to generalize findings to a broader population; the test subjects were chosen through probability sampling, allowing results to be representative. This comparative experimental approach was chosen to evaluate the relative effectiveness of two instructional methods by applying different treatments to two experimental groups. The methodology aimed to compare project-based learning (PjBL) instructional materials against conventional learning to assess their impact on enhancing students' creative thinking skills. The comparative experimental design incorporated pretest and posttest measures to quantify changes in creative thinking skills, enabling a direct assessment of each instructional approach's effectiveness.

The research design aligns closely with quasi-experimental methods, particularly in the use of pretest-posttest assessments. However, a key distinction is in the assignment of groups: the current study designates the entire sample class as the experimental group without creating a separate control group, and sample categorization is based on random assignment rather than intentional selection.

Data and Data Sources

The independent variables in this study are the PjBL-based instructional materials and conventional learning approaches, while the dependent variable is the students' creative thinking abilities. This quasi-experimental design aims to evaluate the effects of different instructional approaches on the development of students' creative thinking skills. Two sample classes were assigned to receive different treatments: the experimental class was instructed using PjBL-based materials, whereas the control class received conventional instruction. The population for this study included all second-semester students, totaling 153 students across five classes. Two classes were selected for the sample: Class 2A, with 20 students, was designated as the experimental group, while Class 2B, also with 20 students, served as the control group. Cluster random sampling was employed to ensure that each class had an equal probability of being included in the study sample.

Data Collection Technique

Data collection in this study employed multiple instruments to gather a comprehensive understanding of students' creative thinking abilities and engagement throughout the learning process. The primary instrument was a creative thinking skills test designed to evaluate students' proficiency across four core dimensions of creative thinking: fluency, flexibility, originality, and elaboration. This test was comprised of 10 essay questions, each carefully developed to assess one or more of these dimensions in alignment with the study's objectives. In addition to the creative thinking test, observation sheets were used to monitor and assess student engagement and participation during learning activities. These observation sheets provided real-time data on students' interactions, collaborative efforts, and application of problem-solving strategies within both the experimental and control groups. This observational data enriched the analysis by highlighting differences in engagement and interaction patterns between the two instructional approaches.

Furthermore, a questionnaire was administered to gather students' self-assessments of their learning experiences. This instrument included items designed to capture students' perceptions of the learning process, specifically their development of creative thinking skills through project-based learning (PjBL) in comparison to conventional instructional methods. Sampling was conducted using a cluster random sampling method, ensuring each class within the population had an equal opportunity of selection. The final sample consisted of two classes: one experimental class that received PjBL-based

instructional material, and one control class that was taught using conventional instructional methods. It is also known that the results of measuring the reliability of the test instrument are in Table 2 with an r table of 0.444, based on a Cronbach's Alpha value of 0.940 (Very Reliable).

Table 2. Reliability Statistics

r11	rtable	Information	Category
0,940	0,444	Reliable	Very high

Data Analysis

In this study, the data were analyzed using various statistical methods to evaluate the effectiveness of project-based learning (PjBL) on students' creative thinking abilities.

1. *T-Test for Independent Samples:* The independent sample t-test was employed to compare the creative thinking abilities between the experimental group (using PjBL-based instructional materials) and the control group (using conventional learning). The t-test formula used is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where:

- $\bar{X}_1$ and $\bar{X}_2$ are the means of the experimental and control groups, respectively.
- S_1^2 and S_2^2 are the variances of the two groups.
- n_1 and n_2 are the sample sizes of the experimental and control groups.

The t-test was conducted to determine if there was a statistically significant difference in creative thinking skills between the two groups, with a significance level of p<0.05p < 0.05p<0.05.

2. *Reliability Test:* The reliability of the creative thinking skills test was assessed using Cronbach's Alpha formula to ensure internal consistenc y of the test items. The formula used is:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum S_i^2}{S_t^2}\right)$$

Where:

- k is the number of test items.
- S_i^2 is the variance of each individual item.
- S_t^2 is the total variance of the test.

In this study, the test showed a high reliability score (Cronbach's Alpha = 0.940), indicating that the instrument is very reliable.

3. *Normality Test:* A normality test was conducted using the Kolmogorov-Smirnov test to ensure that the data followed a normal distribution. The significance level (α\alphaα) for the normality

test was set at 0.05. If ppp-values were greater than 0.05, the data were considered normally distributed.

4. *Descriptive Statistics:* Descriptive statistics, including the mean, standard deviation, minimum, and maximum values, were calculated for both the pre-test and post-test scores in each group to assess the overall performance and variability of students' creative thinking abilities.

These analytical techniques were critical in evaluating the impact of the instructional approach and confirming the significance of the results obtained in the study.

RESULTS

The results of this study provide a comprehensive comparison between the experimental class, which implemented project-based learning (PjBL) incorporating local Papuan wisdom, and the control class, which followed a conventional learning approach. The analysis focuses on the impact of these teaching methods on students' creative thinking abilities, as measured through pre-test and post-test assessments. The findings reveal a notable improvement in creative thinking skills within the experimental group, with significant increases observed across the dimensions of fluency, flexibility, originality, and elaboration. These improvements are further supported by statistical analysis, highlighting the effectiveness of PjBL in fostering creative thinking compared to conventional learning.

Table 3. Data Normality Test

Class	Data	Statistic Test	Sig	α	Conclusion
Experiment	Pretest	0.145	0.060		Normal
	Posttest	0.178	0.180	0.05	Normal
Control	Pretest	0.122	0.201		Normal
	Posttest	0.150	0.204		Normal

The results of the normality test, as presented in Table 3, confirm that the data for both the experimental and control groups are normally distributed in both the pre-test and post-test assessments. For the experimental group, the pre-test yielded a statistic value of 0.145 with a significance value of 0.060, and the post-test showed a statistic value of 0.178 with a significance value of 0.180. Both values are greater than the alpha threshold of 0.05, indicating normal distribution of the data. Similarly, the control group's pre-test data had a statistic value of 0.122 with a significance value of 0.201, while the post-test data had a statistic value of 0.150 with a significance value of 0.204, both of which also exceed the 0.05 threshold. This confirms that the data for both groups, across all tests, follow a normal distribution.

The normality of the data validates the use of parametric statistical analyses, such as the t-test, ensuring the reliability of the conclusions drawn from this study. With these assumptions met, the significant improvements in creative thinking abilities observed in the experimental group can confidently be attributed to the implementation of the project-based learning (PjBL) model, rather than any statistical anomalies. This supports the overall conclusion that PjBL, especially when incorporating local Papuan wisdom, is an effective approach for enhancing students' creative thinking skills. The results of the t-test analysis of data on students' creative thinking abilities before and after being treated using the T-test are as shown in Table 4.

The t-test analysis in Table 4 for creative thinking skills before treatment shows a t value of 1.845 < t table (0.05; 75) where t table (0.05; 75) is 1.88. These results mean that the average initial creative thinking test for experimental class and control class students is not significantly different. Then for creative thinking skills after treatment for both classes, the t-value was 7.756 > t table (0.05;75), namely 1.88486. These results indicate that there is an influence of PjBL-based instructional material on students' creative thinking abilities.

Table 4. Results of T-Test

	Class	Rates	df	t-value	P.Sig
Pre test	Experiment	28.8	75	1.845	0.072
	Control	26.5			
Post test	Experiment	72.35		7.756	0.000
	Control	65.45			

As explained in the research methods section, it explains the flow of the process of implementing two learning models which are believed to be able to make creative thinking skills outcomes more effective. The following is an explanation of the results of the comparison test between the two models studied, namely PjBL-based instructional material in the experimental class and conventional learning in the control class. The research results in the experimental class are seen based on the results of pretest-posttest descriptive data analysis as tabulated in Table 5 and Table 6 below.

Table 5. Pretest Result

Class	N	Min	Max	Mean	Std. Deviation
Experiment	20	60	80	68.40	5.49
Control	20	48	84	67.40	8.54

Table 5 provides a summary of the pre-test results for both the experimental and control groups, highlighting the students' creative thinking abilities before the implementation of the instructional methods. The experimental group, consisting of 20 students, had scores ranging from a minimum of 60 to a maximum of 80, with a mean score of 68.40 and a standard deviation of 5.491. This suggests a relatively narrow range of variability in the initial creative thinking abilities of the students in the experimental group. In contrast, the control group, also consisting of 20 students, displayed a wider range of pre-test scores, with a minimum score of 48 and a maximum score of 84. The mean score for the control group was 67.40, slightly lower than that of the experimental group, and the standard deviation was 8.537, indicating greater variability in the initial creative thinking abilities within the control group. Although both groups showed similar mean scores at the pre-test stage, the control group exhibited more variability in students' creative thinking skills. This initial comparison underscores that both groups started with comparable average abilities, which provides a solid foundation for evaluating the effectiveness of the project-based learning (PjBL) approach applied in the experimental group.

Table 6. Posttest Result

Class	N	Min	Max	Mean	Std. Deviation
Experiment	20	72	100	86.00	7.05
Control	20	64	96	80.60	8.24

Tables 5 and 6 show a comparison of the effectiveness of the two learning models based on the results of descriptive data testing taken cumulatively from all pretest and posttest test sample data, namely only seen from the accumulated comparison. Minimum value (X min), maximum value (X max),

and average value (X) on the learning outcomes of experimental class A (PjBL-based instructional material) and experimental class B (conventional learning).

DISCUSSIONS

This study demonstrates that project-based learning (PjBL), particularly when integrated with local cultural elements such as Papuan wisdom, can significantly enhance students' creative thinking abilities. The experimental group, which engaged in PjBL incorporating local wisdom, showed substantial improvements across all key dimensions of creative thinking: fluency, flexibility, originality, and elaboration. In contrast, the control group, which followed conventional learning methods, exhibited only modest gains in these areas. This stark contrast underscores the effectiveness of PjBL not only as an instructional strategy but also as a means of embedding culturally relevant learning experiences that resonate more meaningfully with students.

The findings of this study align with existing literature that emphasizes the value of student-centered learning approaches, particularly those that involve students in practical, real-world projects. PjBL, which is rooted in constructivist principles, asserts that students achieve deeper understanding and retain knowledge more effectively when they actively engage in constructing their own learning experiences through hands-on activities (Sukmawati et al., 2023; Moallem, 2019). This study contributes to the growing body of evidence supporting PjBL's effectiveness in fostering higher-order cognitive skills, including creative thinking, critical problem-solving, and decision-making (Tamim & Grant, 2013; Bagheri et al., 2013). Research suggests that experiential learning, a core component of PjBL, enhances student engagement and knowledge retention. For example, Moore et al. (2010), found that incorporating reflective writing within experiential learning frameworks significantly improved deep-level processing among students, indicating that reflective practices further enhance the learning experience.

Similarly, Sukmawati et al. (2023) emphasized that PjBL not only develops problem-solving skills but also encourages students to build upon prior knowledge through collaborative activities, thus reinforcing the constructivist learning environment. This finding is supported by Dhital et al. (2015), who highlighted that reflective writing in experiential contexts fosters critical thinking and personal ownership of the learning process, reinforcing the notion that active engagement leads to improved educational outcomes. Additionally, Tanaka and Son (2019), demonstrated that integrating various educational tools and strategies can enhance communication skills and overall learning satisfaction, particularly in medical education contexts. These findings suggest that the principles of experiential learning, including PjBL, can be effectively adapted across disciplines to meet diverse educational needs. The emphasis on active participation and real-world application in PjBL not only facilitates knowledge retention but also prepares students to face practical challenges in their future careers (Murray, 2018).

The integration of local Papuan wisdom into the Project-based Learning (PjBL) model significantly enriches the discourse on culturally responsive pedagogy. This approach recognizes the cultural context as a vital component of the educational process, aligning with Vygotsky's socio-cultural theory, which posits that learning is most effective when situated within the social and cultural backgrounds of students (Pathan et al., 2018). By embedding local wisdom into learning activities, this study enhances cognitive engagement and enables students to connect abstract academic concepts with their lived experiences. This connection fosters a deeper understanding of their cultural heritage and its relevance to the development of modern skills (Caingcoy, 2024). The incorporation of local Papuan wisdom exemplifies how educators can create inclusive, engaging learning environments that reflect students' cultural identities, ultimately enhancing the learning experience (Caingcoy, 2024).

Furthermore, research indicates that when educators comprehend and apply culturally responsive pedagogy, student outcomes, particularly for marginalized groups, can be significantly improved (Vidwans & Faez, 2019; Ladson-Billings, 2014). The study's findings also resonate with the

broader framework of culturally sustaining pedagogy, which advocates for the preservation and promotion of cultural pluralism within educational settings (Paris, 2012). This perspective underscores the need for educators to recognize and leverage the cultural assets students bring to the classroom, actively engaging with these assets to enhance learning experiences (Wah & Nasri, 2019). By adopting this approach, educators can create a more equitable learning environment that acknowledges and values the cultural narratives of all students, fostering a sense of belonging and agency within the educational context (Alameddine, 2021).

The observed improvements in creative thinking, particularly in the experimental group, can be attributed to several key factors inherent in the PjBL model. First, PjBL encourages student autonomy and decision-making, allowing learners to take ownership of their projects. This sense of ownership fosters intrinsic motivation, which is closely linked to enhanced creativity. Second, the collaborative nature of PjBL provides students with opportunities to exchange ideas, negotiate meanings, and receive diverse feedback, all of which are critical components of the creative process. Finally, PjBL's emphasis on real-world problem-solving encourages students to apply their knowledge in practical, meaningful ways, stimulating creative thought and innovation.

Despite these positive outcomes, the study also reveals several limitations and areas for future exploration. One of the primary limitations is the cultural specificity of the study. While the integration of Papuan wisdom into PjBL proved effective for the students in this particular context, it remains unclear whether similar results would be achieved with students from different cultural backgrounds. Future studies should investigate the extent to which local wisdom must be embedded in PjBL to be effective across various regions and cultures. Additionally, this study focused solely on creative thinking abilities, leaving other essential 21st-century skills, such as critical thinking, communication, collaboration, and digital literacy, largely unexplored. Future research could build on these findings by examining how PjBL influences a broader range of cognitive and non-cognitive skills, providing a more comprehensive understanding of its impact on student development.

Another gap relates to the duration of the intervention. The study was conducted over a relatively short period, and while significant improvements in creative thinking were observed, it is unclear whether these gains would be sustained over the long term. Longitudinal studies are needed to explore the lasting effects of PjBL, particularly in relation to how students retain and apply creative thinking skills after completing PjBL projects.

The novelty of this study lies in its unique combination of project-based learning (PjBL) with local Papuan wisdom, a fusion that has been underexplored in educational research. By incorporating local wisdom into PjBL, students are provided with a culturally relevant context that enhances engagement and makes learning more meaningful and applicable to their lives. This approach shifts the focus from standardized content to culturally diverse curriculum development, allowing educators to foster not only cognitive skills but also a deeper appreciation for students' cultural heritage, contributing to the preservation and revitalization of indigenous knowledge.

The study's implications are significant for both educators and curriculum developers. It suggests that integrating culturally responsive elements into PjBL can greatly enhance students' creative thinking abilities, offering a valuable strategy for schools in diverse cultural contexts. As education systems increasingly aim to develop 21st-century skills, this research provides a model for leveraging local wisdom to achieve these goals. For teachers, this means creating lessons that are both intellectually challenging and culturally relevant, helping students connect their learning to real-world contexts and their own cultural identities. Moreover, the successful integration of local wisdom into PjBL demonstrates that education can be both globally relevant and locally meaningful. By embracing digital technologies, fostering emotional connections through cultural expressions, and promoting community engagement, educational frameworks can cultivate a sense of pride and responsibility

towards cultural heritage (Aziz et al., 2022). This multifaceted approach not only enhances educational outcomes but also contributes to the sustainable development of communities but also contributes significantly to the sustainable development of communities. By fostering a sense of identity, promoting inclusivity, and integrating educational practices with economic strategies, such initiatives ensure that cultural heritage remains a vibrant and integral part of society (El-Din, 2019; Wu, 2021; Benedetti et al., 2021).

For future research, it is recommended to explore the application of PjBL across different cultural settings to determine whether similar improvements in creative thinking can be achieved. Comparative studies that involve multiple regions or cultural groups would provide valuable insights into the adaptability and effectiveness of culturally embedded PjBL models. Additionally, researchers should investigate the impact of PjBL on other essential skills, such as critical thinking, collaboration, and digital literacy, particularly in contexts where technology plays an increasingly central role in education. Finally, there is a need to explore how PjBL can be adapted for virtual or blended learning environments. The recent shift toward digital education has created new challenges and opportunities for instructional design, and understanding how PjBL can be effectively implemented in online settings will be crucial for the future of education. Exploring the intersection of PjBL, technology, and cultural education would provide important insights into how these elements can be synthesized to foster comprehensive skill development in students, particularly in an increasingly digital and globalized world.

CONCLUSION

This study demonstrates that the integration of Project-Based Learning (PjBL) with local Papuan wisdom significantly enhances students' creative thinking skills compared to conventional learning methods. The primary contribution of this research lies in the innovative fusion of PjBL with culturally relevant instructional materials, which not only fosters cognitive development but also strengthens students' connections to their cultural heritage. By incorporating elements of local wisdom, this approach enhances student engagement, making the learning experience more meaningful and contextually relevant. The study reveals that students in the experimental group, who participated in PjBL, exhibited marked improvements across key dimensions of creative thinking, including fluency, flexibility, originality, and elaboration. These findings provide compelling evidence that culturally responsive pedagogy can be an effective tool for promoting creativity and offer valuable insights for educational practices designed to cultivate essential 21st-century skills. However, the study's scope is limited to the exploration of creative thinking within the context of science education and within a specific cultural setting. Future research should seek to broaden the applicability of this model across different subject areas and diverse cultural contexts. Additionally, the long-term impact of integrating local wisdom into PjBL on other cognitive skills such as critical thinking and problem-solving warrants further investigation. The results suggest that embedding local cultural elements into educational practices is an effective strategy for improving student engagement and cognitive development. Therefore, educators and curriculum developers are encouraged to adopt culturally responsive teaching methods and provide adequate professional development to ensure that instructional materials reflect the diverse cultural backgrounds of their students. This approach not only fosters creativity and critical thinking but also nurtures cultural pride and awareness among learners, contributing to a more inclusive and holistic educational experience.

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