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Enhancing students' levels of creative thinking through Project-Based Learning integrated with Osing traditional house ethnomathematics in Polyhedra

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Abstract

This research was conducted to examine the effect of Project-Based Learning (PjBL) integrated with Osing Traditional House Ethnomathematics on students' creative thinking level in Polyhedra. PjBL is a project-oriented learning model and can encourage students to collaborate in designing, implementing, and presenting products. Creative thinking is students' ability to produce new ideas that are different from existing ones. The subjects of this study were students of SMPN 2 Banyuwangi. In the initial stage, a pre-test of creative thinking level was conducted. Next, PjBL integrated with the Osing Traditional House was implemented on Polyhedra. In the final stage, a post-test was conducted to determine students' creative thinking level after PjBL treatment. The hypothesis was proved by Wilcoxon Signed Rank test. Based on the research data, it is known that Sig. is 0.000 ($\rho < 0.05$), so it is concluded that students' creative thinking level before and after participating in PjBL were significantly different. Before PjBL, it was known that students were at the levels of not creative, less creative, quite creative, creative, and very creative, respectively, as many as 12%, 35%, 23%, 18%, and 12%; while after learning as many as 0%, 9%, 12%, 38%, and 41%. This means that the PjBL integrated with the Osing Traditional House can increase students' creative thinking level.

Keywords: Creative thinking level, Project-based learning, Ethnomathematics, Osing

Abstrak

Penelitian ini bertujuan untuk memeriksa pengaruh penerapan Project-based Learning (PjBL) terintegrasi etnomatematika rumah adat suku Osing terhadap tingkat berpikir kreatif siswa pada materi bangun ruang. PjBL merupakan model pembelajaran yang berorientasi proyek, dan dapat mendorong siswa untuk bekerja sama dalam merancang, melaksanakan, dan mempresentasikan produk. Berpikir kreatif adalah kemapuan siswa untuk menghasilkan ide baru yang berbeda dari sebelumnya. Subyek penelitian ini yaitu siswa SMPN 2 Banyuwangi. Tahap awal, diberikan pre-test untuk mengetahui tingkat berpikir kreatif siswa. Berikutnya, dilaksanakan PjBL terintegrasi etnomatematika Suku Osing pada materi Bangun Ruang Sisi Datar. Pada tahap akhir, dilakukan post-test untuk mengetahui tingkat berpikir kreatif siswa setelah pembelajaran. Uji statistik yang digunakan yaitu uji Wilcoxon Signed Rank. Berdasarkan data hasil penelitian, diketahui bahwa Sig. sebesar 0,000 ($\rho < 0,05$) sehingga disimpulkan terdapat perbedaan tingkat berpikir kreatif siswa sebelum dan setelah mengikuti pembelajaran. Sebelum pembelajaran, diketahui siswa berada pada

level tidak kreatif, kurang kreatif, cukup kreatif, kreatif, dan sangat kreatif berturut-turut sebanyak 12%, 35%, 23%, 18%, dan 12%; sedangkan setelah pembelajaran sebanyak 0%, 9%, 12%, 38%, dan 41%. Hal ini berarti PjBL terintegrasi etnomatematika Suku Osing dapat meningkatkan tingkat berpikir kreatif siswa.

Kata kunci: Tingkat kemampuan berpikir kreatif, Project-based learning, Etnomatematika, Suku osing

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INTRODUCTION

The 21st-century learning process should produce graduates who possess creative and critical thinking (Astuti et al., 2022; Sumarni & Kadarwati, 2020). Creative thinking is an essential skill to be taught in schools (Yusuf & Aini, 2023). It can help students broaden their horizons and understand basic knowledge, enabling them to solve various problems (Ndiung & Menggo, 2024b). Creative thinking refer to students' ability to generate ideas when solving mathematical problems and choose the correct answer (Nisa & Waluyo, 2024) and create something new of ideas, descriptions, concepts, experiences, and knowledge. Creative thinking could generate and construct ideas, so it is a main competency for students (Suherman & Vidákovich, 2022). In the revised Bloom's taxonomy, creative thinking occupies the highest level (Aini et al., 2020). Creative thinking encourages students to formulate authentic ideas and find new solutions in problem-solving (Biazus & Mahtari, 2022). Developing creative thinking skills is important to prepare students to face future challenges and solve problems (Yunita et al., 2020).

Mathematical creative thinking is an important competency for students and is based on an underlying process or a manifested product (Suherman & Vidákovich, 2022). The criteria for creative thinking are fluency, flexibility, and novelty (Aini et al., 2020). Creative thinking levels can be differentiated based on the indicators met. The creative thinking levels are presented in the following Table 1 (Siswono, 2011).

In Indonesia, higher-order thinking skills, particularly conceptual understanding, are still low (Astuti et al., 2022). One reason for students' low conceptual understanding is the lack of teacher training in these skills, as evidenced by students' statements that they simply memorize concepts without understanding them (Astuti et al., 2022; Anisa et al., 2023).

A preliminary study conducted at SMPN 2 Banyuwangi showed that students' level of creative thinking was not optimal, as shown in Table 2. The study was carried out by administering a test to determine students' initial level of creative thinking ability prior to the implementation of the learning treatment. The test consisted of four

items on polyhedra, designed to elicit the indicators of fluency, flexibility, originality, and elaboration.

Table 1. Characteristics of CT levels

Level	Name	Characteristics	Components Fulfilled
4	Very Creative	Solves problems with multiple solutions, divergent constructs and novel problems; may lack in some aspects like fluency	Flexibility, novelty, (and fluency in some cases)
3	Creative	Solves problems with original solutions, can pose problems with some divergence but not necessarily all components	Flexibility, and/or novelty, with fluency
2	Quite Creative	Solves with one original solution or poses problems with some divergence, lacking some components	Flexibility or novelty
1	Almost Not Creative	Solves problems with multiple solutions but cannot produce alternatives; poses problems without divergence	Mainly fluency (possibility)
0	Not Creative	Cannot solve with multiple solutions, produce diverging or novel ideas, or pose divergent problems	None (recall only)

Table 2. Prior Student's CT level

Creative thinking level	Frequency	Percentage
Not creative	10	29%
Almost not creative	9	26%
Quite creative	6	18%
Creative	5	15%
Very creative	4	12%
Total	34	100%

The results indicate that students' level of creative thinking ability remains relatively low, with the largest proportions of students categorized as not creative (29%) and almost not creative (26%). This condition can be attributed to the fact that students are not accustomed to thinking creatively in daily learning activities. Teachers have not yet implemented learning activities that train or require students to think creatively, as instruction is generally conducted through direct instruction using the lecture method. Therefore, appropriate action is needed to address the low level of students' creative thinking ability.

Mathematics learning can be developed by selecting the right model (Yunita et al., 2020). Teachers should use innovative strategies by choosing appropriate learning models and methods so they can guide students effectively in problem-solving tasks that require HOTS (Ndiung & Menggo, 2024). One alternative offered to address this problem is through the implementation of Project Based-Learning (PjBL). Meta-analysis studies show that PBL improves students' creative thinking skills (Yunita et

al., 2020). The implementation of PjBL increases creativity, independence, engagement, self-confidence, reasoning, and critical and analytical thinking skills (Suradika et al., 2023). Creativity can also improve students' cognitive aspects and their awareness to assess and evaluate information critically (Ndiung & Menggo, 2024b).

PjBL refers to meaningful learning through providing problems related to real-life context (Biazus & Mahtari, 2022). PjBL is a learning that helps students to better understand the material through tasks, produces real products that have value and relevance (Nisa & Waluyo, 2024) and stimulates students to investigate, make decisions, design, and arrive at products (Sumarni & Kadarwati, 2020) and apply them in everyday life (Astuti et al., 2022). PjBL could train students to communicate and present ideas, collaborate and manage time, research and investigate, self-assess and reflect, discuss within groups, and think critically (Ndiung & Menggo, 2024). Thus, PjBL becomes student-centered learning that is often applied to train students' collaboration and active communication (Biazus & Mahtari, 2022). Through PjBL, teachers can organize learning by involving students in project work that contains complex tasks based on non-procedural questions, problem solving, decision-making, investigating, and providing opportunities for students to work independently (Ndiung & Menggo, 2024b). The provision of authentic phenomena in the application of PjBL is in line with the principles of learning that can be understood, focused, and pay attention to students' cognitive growth and needs (Biazus & Mahtari, 2022).

PjBL is characterized by student engagement in contextual problems solving and team collaboration address the challenges (Ndiung & Menggo, 2024). The syntax of PjBL includes formulating problems, focusing on learning objectives, participating in learning activities, collaboration between students, using scaffolding, and creating real products (Biazus & Mahtari, 2022). Some of the principles of PjBL are: (1) students become the center of learning, (2) PjBL can increase student creativity, (3) PjBL increases challenges and an exciting atmosphere in the classroom, (4) PjBL includes values, beauty, ethics, reasoning, and kinesthetics, and (5) PjBL requires a longer duration to share experiences in diverse learning (Suradika et al., 2023). The learning steps in PjBL are starting learning with relevant questions to the concept, direct group and individual investigations, presenting work results, and assessing the problem-solving process (Suradika et al., 2023). PjBL combines practical attention, collaboration, and practical exercises to enhance student acquire their knowledge (Ndiung & Menggo, 2024).

The implementation of PjBL in the classroom can be integrated with cultural ethnomathematics that are relevant to students. PjBL and Ethno-STEM can equip students to solve problems and make decisions in various areas of life (Sumarni & Kadarwati, 2020). In this case, the culture that can be used as learning material at SMPN 2 Banyuwangi is the culture of the Osing tribe. Osing is an ethnic who lives in Banyuwangi, East Java. This research was carried out with students in Banyuwangi, so that the integrated learning of Osing ethnomathematics is more contextual to the daily lives of students. Cultural elements of the Osing tribe are *Jebeng Thulik* clothing,

traditional houses, Osing language, *Tumpang Sewu*, *Koloan*, *Mepe Kasur*, Gandrung dances, and Barong dances (Noviastuti et al., 2024). In this study, the cultural elements that will be discussed are only traditional houses, because they are relevant to the discussion of Polyhedra. Several forms of traditional Osing tribe houses are presented in Figure 1, while real examples of traditional Osing tribe houses are in Figure 2.

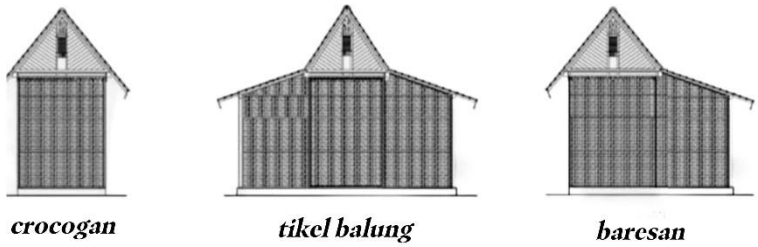

Figure 1. The shape of the traditional house of the Osing tribe



Figure 2. Traditional house of the Osing tribe

Previous research shows that PjBL can improve students' creative thinking in solving mathematics (Ndiung & Menggo, 2024a, 2024b) and physics problems (Biazus & Mahtari, 2022; Fadhil et al., 2021; Anisa et al., 2023). At the elementary school level, PjBL has also successfully improved students' creative thinking (Astuti et al., 2022; Ndiung & Menggo, 2024). The integration of PjBL with ethnomathematics has been done before. Previous research shows that PjBL with ethno-STEM is effective to improve students' creative thinking (Purnamasari & Dhoruri, 2025; Sumarni & Kadarwati, 2020), critical thinking (Pramasdyasari et al., 2024; Purnamasari & Dhoruri, 2025; Syaripah, 2025), mathematical understanding (Dwi Rahmawati et al., 2026), numeracy literacy (Saputro & Oktavia, 2025), higher order thinking skills (Sutama et al., 2025). Other research shows that the application of contextual teaching and learning based on Osing culture could encourage students to think critically (Noviastuti et al., 2024). Therefore, research will be conducted to test the increase in

students' creative thinking levels who participate in PjBL integrated with Osing ethnomathematics.

METHODS

This research conducted to examine the effect of PjBL integrated with ethnomathematics of traditional Osing houses on students' creative thinking level in Polyhedra. It is a quasi-experimental study with a quantitative approach. The study was carried out at SMPN 2 Banyuwangi (class VIII A students). The sample was selected through purposive sampling, considering that this class had received prior instruction related to Polyhedra, had a relatively homogeneous mathematical ability, communicated easily among themselves, and mostly came from the Osing ethnic community, making the implementation of ethnomathematics-integrated PjBL contextually appropriate. The independent variable was the PjBL integrated with ethnomathematics of traditional Osing houses, while the dependent variable was the creative thinking level.

The learning treatment was implemented over 10 instructional hours (each lasting 40 minutes) across five meetings. The instruments used were a pre-test and post-test to determine students' creative thinking levels with components of fluency, flexibility, originality, and elaboration. This instrument contains two questions for each of the pre-test and post-test and has been tested for validity and reliability. The content validity coefficient is 3.5 and the reliability coefficient is 0.724. These values indicate that the instrument is valid and reliable, as the validity coefficient exceeds the minimum threshold of 3.0 and the reliability coefficient exceeds the minimum threshold of 0.6. The data were tested inferentially using the Wilcoxon Signed Ranks Test. Figure 3 shows the polyhedra problem integrating the Osing ethnomathematics.

A traditional Osing house of the "crocogan" model is designed using a combination of a rectangular prism (cuboid) as the main room and a triangular prism as the roof. Suppose the total volume of the house is 9,000 m^3.

1. *Sketch a design of a traditional Osing house of the crocogan model using a combination of a cuboid and a triangular prism that you consider interesting and unique.*
2. *If the volume of the cuboid is 6,000 m^3, determine the possible length, width, and height.*
3. *If the volume of the triangular prism is 3,000 m^3, determine the possible length, base, and height.*

Figure 3. The polyhedra problem

RESULTS AND DISCUSSION

The following presents a comparative overview of students' CT levels prior to and following the implementation of the PjBL integrated Osing ethnomathematics on Polyhedra, involving a total of 34 students across all categories (Figure 4).

The results indicate that the PjBL model integrated with Osing ethnomathematics on polyhedra improved students' creative thinking indicators, with flexibility showing the largest gain (from 9 to 24), followed by originality (from 13 to 21), while fluency

remained unchanged at 19 in both tests. These findings suggest that the learning process was particularly effective in encouraging students to generate varied solution strategies and novel ideas, potentially through the exploration of Osing cultural contexts. However, the absence of improvement in fluency indicates that the quantity of ideas produced did not increase, which warrants further attention in future instructional design. The creative thinking levels are shown in Table 3.

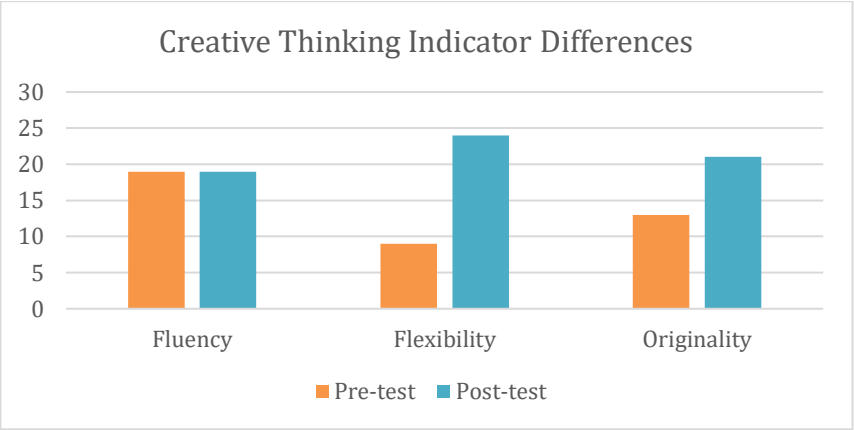

Figure 4. Creative thinking indicator differences

Table 3. Students' creative thinking levels before and after PjBL treatment

Category	Number of students			
	Pre-test	**Percentage**	**Post-test**	**Percentage**
Not Creative	4	12%	0	0%
Lack of creativity	12	35%	3	9%
Quite Creative	8	23%	4	12%
Creative	6	18%	13	38%
Very Creative	4	12%	14	41%
Total	**34**	**100%**	**34**	**100%**

Prior to the intervention, the data indicate that the majority of students were concentrated in the lower creative thinking categories. Table 4 presents the descriptive statistics of students' creative thinking level obtained from both the pre-test and post-test assessments, based on a valid sample of 34 students.

Table 4. Descriptive statistics

Data	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	34	0	4	1.82	1.218
Post-test	34	1	4	3.12	0.946

Taken together, the descriptive statistics presented in Table 4 provide evidence that the PjBL integrated Osing ethnomathematics intervention produced a consistent and meaningful improvement in students' creative thinking levels. The reduction in standard deviation indicates that students not only performed better on average after the treatment, but also demonstrated greater uniformity in their creative thinking

achievement, underscoring the efficacy of PjBL integrated Osing ethnomathematics as an instructional strategy.

The statistical test used is Wilcoxon *Signed Ranks test*, to determine the difference between creative thinking levels before and after the implementation of PjBL integrated with Osing ethnomathematics on the Polyhedra. Because the data on creative thinking levels are ordinal, normality testing of the data was not required. Wilcoxon *Signed Ranks Test* is presented in Table 5.

Table 5. Ranks for Post_test - Pre_test

Data	N	Mean Rank	Sum of Ranks
Negative Ranks	2[a]	10.50	21.00
Positive Ranks	21[b]	12.14	255.00
Ties	11[c]		
Total	34		

The Ranks table shows that out of 34 students, 21 students (Positive Ranks) experienced an increase in score from pretest to posttest with a mean rank of 12.14, while 2 students (Negative Ranks) experienced a decrease with a mean rank of 10.50, and 11 students (Ties) showed no change between pretest and posttest scores. This indicates that the majority of students showed improvement in creative thinking level after the treatment, which is consistent with the negative Z value (-3.590) obtained in the Wilcoxon Signed Ranks Test, as the sum of positive ranks (255.00) substantially exceeds the sum of negative ranks (21.00). The following Table 6 showed statistical test.

Table 6. Wilcoxon Signed Ranks Test

Z	Asymp. Sig. (2-tailed)
-3.590	0.000

The test produced a Z-value of -4.638, with an asymptotic significance value of .000 (2-tailed). The negative Z-value obtained in this analysis was derived based on negative ranks (note b), signifying that the post-test scores were systematically and consistently higher than the pre-test scores across the majority of students. This directional pattern confirms that the PjBL integrated Osing ethnomathematics contributed to a measurable upward shift in students' creative thinking level.

Furthermore, the asymptotic significance value of .000, which falls well below the conventional significance level of $\alpha = 0.05$, provides compelling statistical evidence to reject the null hypothesis. As denoted in note a, this result was produced through the Wilcoxon Signed Ranks Test. The test yielded a Z-value of -4.638, based on negative ranks, indicating that the post-test scores were predominantly higher than the pre-test scores across the majority of students. The asymptotic significance value (2-tailed) was recorded at .000, which is substantially below the conventional alpha threshold of $\alpha = 0.05$. This result confirms that the difference between pre-test and post-test scores is

statistically significant, thereby providing strong evidence that the PjBL integrated Osing ethnomathematics produced a genuine and non-random improvement in students' creative thinking abilities.

To further quantify the magnitude of the observed intervention effect, the effect size was calculated using the following formula appropriate for the Wilcoxon Signed Ranks Test: $r = \frac{Z}{\sqrt{N}} = \frac{-4.638}{\sqrt{34}} \approx 0.795$. The computed effect size of r is categorized as a large effect size. This finding indicates that the PjBL integrated Osing ethnomathematics did not merely produce a statistically significant difference, but also exerted a practically significant and substantively powerful influence on students' creative thinking.

The results indicate that PjBL integrated with the ethnomathematics of traditional Osing houses has a positive effect on students' creative thinking level. It's proved by creative thinking scores after the implementation increase. It can be said that the learning has the potential to improve students' creative thinking level. This finding supports the theory that contextual and meaningful learning, involving students' active participation in real-life projects, can enhance higher-order thinking skills.

The success in increasing students' creative thinking levels is due to students' active participation in the experimental class. More specifically, the PjBL enables students to be more actively involved in learning activities through projects directly related to local life and culture. Using a traditional Osing house as a learning context provides a meaningful experience and fosters a sense of belonging to one's own culture. This aligns with contextual learning theory, which states that learning is more effective when linked to real-world contexts.

Improved scores on creative thinking indicators such as fluency, flexibility, and originality indicate that students are able to generate more varied and original ideas and develop those ideas in depth. This ability is reflected in the results of the students' projects, which demonstrate high creativity in integrating mathematical elements into the shape and structure of traditional Osing houses.

PjBL learning provides sample space for students to explore and develop ideas through group collaboration. Students are required to search for information, design projects, solve problems, and present their results. This process trains creative thinking systematically. Furthermore, the integration of ethnomathematics provides a unique and culturally meaningful learning atmosphere, so that students are more interested and motivated in participating in the learning process. In implementing PjBL, several important points must be considered, such as the number of participants who can participate in the learning process so that learning objectives are achieved (Biazus & Mahtari, 2022). The integration of ethnomathematics within the PjBL framework contributed to a unique and culturally meaningful learning atmosphere that fostered greater student interest and motivation in participating in the learning process, thereby further supporting the development of creative thinking competencies.

PjBL can enrich students' learning experience, where students will show a better ability to find experiences and search for relevant information for the best results (Astuti et al., 2022). PjBL can improve creative thinking, problem solving, collaboration skills, and problem solution discovery through teamwork and fun learning that explores students' skills (Suradika et al., 2023). It's a comprehensive set of competencies that are reflective of the breadth of improvement documented in the present study. PjBL can improve students' creative thinking because through this model they will be trained to construct their knowledge through active participation in a complex learning process (Astuti et al., 2022). Through PjBL, students develop problem-solving skills, critical and creative thinking, communication, collaboration, change adaptation, and evaluation (Suradika et al., 2023).

PjBL is a learning model that can enhance students to have problem solving skills by involving real-world context through projects and product that promote creativity (Ndiung & Menggo, 2024b). This perspective aligns with the ethnomathematics-integrated approach employed in the present study, wherein culturally relevant contexts served as the vehicle through which students engaged with mathematical concepts creatively and meaningfully. Complementing this view, other research stated that through PjBL, mathematics learning outcomes in schools can show real indicators of creative thinking (Nisa & Waluyo, 2024). In PjBL, students gain knowledge and develop their capacity to participate actively in social roles (Ndiung & Menggo, 2024). Collectively, the theoretical and empirical support drawn from the aforementioned studies confirms that the significant enhancement in students' creative thinking levels observed in this research is not an isolated finding, but rather a well-substantiated outcome consistent with the established efficacy of PjBL as an innovative and transformative instructional model.

After PjBL, the students stated that the context of Osing traditional houses made it easier for them to understand polyhedra because it related to their daily lives. Mathematical content, which is often unfamiliar to them, became more relatable. Therefore, it can be said that PjBL with the context of Osing traditional houses is meaningful for the students.

CONCLUSION

The results of this research show a significant effect of the Osing ethnomathematics integrated PjBL on students' creative thinking level on Polyhedra. These findings indicate that the PjBL model has been proven to have a significant influence on increasing students' creative thinking levels. Given the importance of creative thinking, efforts to increase it in students can be done through PjBL integrated with Osing ethnomathematics.

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