

Integrating Ethnomathematics with Project-Based Learning: Student Perceptions on the Development of Mathematical Critical Thinking Skills in Geometry

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ABSTRACT

Mathematical critical thinking is a vital higher-order cognitive skill emphasized in higher education curricula. Project-Based Learning (PjBL) promotes this skill by encouraging collaboration, communication, problem-solving, and independent thinking. When combined with ethnomathematics—a culturally responsive approach that integrates students' heritage and real-life contexts—PjBL can potentially enhance student engagement and deepen mathematical understanding. This study explored students' perceptions of PjBL integrated with an ethnomathematics approach in a transformation of a geometry course. A quantitative descriptive design was employed, involving purposive sampling of twelve students. Data were collected through a closed-ended questionnaire, using a five-point Likert scale to measure perceptions of both skill development and instructional appropriateness. Findings revealed that students rated the development of their critical thinking skills with a mean score of 4.85 (Good). Additionally, the use of PjBL with an ethnomathematics approach was perceived as highly appropriate for the course, with a mean score of 5.00 (Very Good). The results suggest that integrating PjBL with ethnomathematics can effectively foster mathematical critical thinking. This approach not only creates interactive learning environments but also increases students' motivation by connecting mathematical concepts to their cultural and practical experiences. PjBL combined with ethnomathematics offers a promising pedagogical strategy for enhancing critical thinking in mathematics education. It supports active learning and cultural relevance, enriching both cognitive and motivational aspects of student learning.

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1. INTRODUCTION

Mathematics is pivotal in developing students' critical thinking abilities, particularly in Geometry courses. These courses demand that students analyze, evaluate, and solve problems in a logical and systematic manner (Anugraheni, 2019). Geometry not only encompasses abstract theories and concepts but also connects to real-world contexts such as architecture, art, and cultural artifacts (Maryana, 2020). Consequently, effective geometry instruction should be designed to be both contextual and meaningful to students.

Despite its significance, many students continue to struggle with understanding geometric concepts and cultivating critical thinking skills. These challenges are often linked to traditional teaching methods that lack student engagement and fail to relate geometry content to everyday experiences. Abstract and decontextualised learning models can hinder students from applying geometric ideas to practical situations.

To address these issues, the ethnomathematics approach offers a culturally grounded strategy that links mathematical concepts with local traditions and practices, making learning more relevant and engaging (Dewi & Suniasih, 2022). In the context of Geometry, this approach allows students to explore concepts through culturally rich artifacts such as batik motifs, traditional architecture, and regional carvings (Teguh, 2016).

As an innovative pedagogical model, ethnomathematics-based Project-Based Learning (PjBL) integrates contextual problem-solving with active, student-centered learning. PjBL emphasizes inquiry, collaboration, and the completion of real-world projects as central to the learning process (Kumalaretna & Mulyono, 2017). When applied to Geometry, it encourages students to engage deeply with course material through hands-on projects that bridge mathematical theory with cultural expression (Zakiah, Fatimah, & Sunaryo, 2020).

Although there could be advantages, ethnomathematics integration into project-based learning (PjBL) in geometry courses is still mostly unexplored, especially concerning students' mathematical critical thinking skills. Prior research has positioned an ethnomathematics perspective without highlighting a structured PjBL approach where students are involved in problem-solving through local culture (Sulistyowati & Mawardi, 2023). This study aims to respond to this under-researched area by investigating improvements in students' mathematical critical thinking skills in geometry learning through ethnomathematics-based PjBL.

Meanwhile, the ethnomathematics approach emphasises how mathematical concepts, especially geometry, can be found in people's cultures (Yulianto, Junaedi, Juniawan, & Anwar, 2024). Ethnomathematics examines how mathematical practices in various cultures can be used to understand mathematical concepts in a more contextual and applicable manner. In the context of geometry, ethnomathematics can be found in various cultural heritages such as batik patterns, wood carvings, traditional architecture, and indigenous calculation systems (Nirmalasari et al., 2025).

This study is grounded in constructivist learning theory and situated learning theory. Constructivist theory encompasses the idea that students create their knowledge from involvement and interaction with meaningful situations (Piaget, 2005). Situated learning theory (Lave & Wenger, 1991) is grounded in learning through a social and cultural context, which is why ethnomathematics is an important approach for using geometry with local culture. Both of these theories support the idea that students' understanding of mathematics can be deepened when learning mathematics is situated in experiences related to their lives.

Some previous studies have shown that ethnomathematics can enhance mathematical understanding in a more contextualised manner. For example, research conducted by Rosa and Orey (2016) found that an ethnomathematics approach to mathematics learning can help students understand mathematical concepts through their cultural context, thus increasing engagement and deeper understanding. In addition, research from Widada and Kartianom showed that the implementation of ethnomathematics in geometry learning can improve students' critical thinking and problem-solving skills as they more easily relate abstract concepts to their daily lives (Kartianom, 2019).

Although numerous studies have focused on ethnomathematics and PjBL within mathematics learning, no previous research has explicitly addressed how ethnomathematics and PjBL work together to improve critical thinking skills in mathematics, particularly in Geometry. Prior research has instead primarily considered mathematics learning in general, with much consideration for higher-order thinking skills (i.e., analysis and evaluation) not being fully researched (Rosa et al., 2016). This research intends to provide insight to close the gaps established through the past research regarding students'

views of the implementation of an ethnomathematics-based PjBL and the implications for mathematical critical thinking in Geometry courses.

The purpose of learning geometry in this context is to develop critical thinking skills through problem-solving that utilises logical and mathematical thinking (Suhartini & Martyanti, 2017). Students as learning subjects have various perceptions of this learning method, depending on their previous learning experiences, the way the material is delivered by lecturers, and the relevance of the project to their daily lives. Students' perception of PjBL with an ethnomathematics approach is an important aspect that needs to be studied because it can determine the effectiveness of this method in improving concept understanding and mathematical critical thinking skills (Alamsyah, Hidayati2, & Inganah, 2025).

By linking geometry and ethnomathematics, students are also expected to better understand how mathematics is inseparable from their daily lives. In addition, learning with this approach can increase students' awareness of local wisdom and strengthen their appreciation of their own culture (Nusantari, Zulkarnain, & Nurhayati, 2022). The implementation of ethnomathematics in geometry learning also plays a role in fostering student creativity in finding mathematical solutions based on relevant cultural contexts (Agusdianita, Supriatna, & Yusnia, 2023).

This research focuses on students' perceptions of the use of Project-Based Learning (PjBL) using an ethnomathematics approach for the enhancement of critical mathematical thinking in the Geometry course. The study, in particular, attempts to answer the following research questions:

1. How do students view the use of Project-Based Learning with an ethnomathematics approach in the mathematics course to try and develop mathematical critical thinking?
2. How do students evaluate the effectiveness of this project in terms of understanding mathematical concepts?
3. To what extent does the ethnomathematics-based PjBL address the character of the transformation geometry course?

The hypothesis in this study is that the implementation of Project-Based Learning based on ethnomathematics has a positive effect on the development of students' mathematical critical thinking skills in Geometry courses. Students are expected to have a positive perception of this method because a project-based approach that integrates ethnomathematics concepts can improve their conceptual understanding and analytical skills.

In contrast, the null hypothesis states that there is no significant effect of the implementation of ethnomathematics-based Project-Based Learning on students' mathematical critical thinking skills, and students' perceptions of this method tend to be neutral or negative.

The results of this study are expected to contribute to the development of more innovative, relevant, and contextualized learning methods. Thus, students not only understand geometry concepts theoretically but are also able to apply them in various real situations, especially in the context of their local culture. In addition, the application of ethnomathematics in learning is expected to encourage students to appreciate and preserve local culture through deeper mathematical understanding.

2. METHODS

The type of research used is a survey with a descriptive quantitative approach, intending to describe students' perceptions of PjBL with an ethnomathematics approach to efforts in developing critical thinking skills in geometry material with an ethnomathematics approach in the form of batik kanganga and five ridge houses (traditional houses *rejang kepahiang*). This research was conducted at the Tadris Mathematics Study Programme of the State Islamic Institute (IAIN) Cuup in the 2024/2025 academic year. The sample of this study consisted of third-semester students, totalling 12 people. The sample used was purposive so that all students in semester III were included. (Roflin & Liberty, 2021). Nonetheless, this study was completed as a pilot research study to explore initial trends and feasibility. In addition, there were logistical reasons for only having 12 students, such as the availability of students

who had participated in an ethnomathematics PjBL class before. Results from this study will help inform future research with a wider sample. A purposive sampling method was used to make sure that the students contributed to the research based on certain inclusion criteria. The sampling criteria indicate that the students (1) had previously encountered both ethnomathematics and PjBL during their learning. Were enrolled in a Geometry course at the time of the study. (2) They had previously participated in at least one project involving the use of ethnomathematics concepts. A purposive sampling method was selected so that a more targeted analysis could be conducted on students who had direct experience with the learning model; this ultimately ensured their responses were adequately aligned and relevant to the purposes of the study.

The data collection technique used is the distribution of student perception questionnaires, which are carried out after PjBL learning with an ethnomathematics approach is carried out. As for this research instrument, the indicators used in this study consist of student interactions with lecturers, student learning interests, competence in understanding teaching materials, critical thinking competencies, time management competencies and the suitability of PjBL implementation with an ethnomathematics approach to geometry material. These indicators aim to find out what the perceptions of students are. The indicator aims to find out how students perceive PjBL with an ethnomathematics approach in developing the critical thinking skills they have followed. The student perception questionnaire lattice can be seen in Table 1 below (Setiawan & Nurmala, 2022)

Table 1. Lattice of Student Perception Questionnaire

No.	Indicators	Number of Items
1	Student Interaction with Lecturers	5
2	Student Learning Interest	4
3	Competence in Understanding Teaching Materials	5
4	Mathematical Critical Thinking Competence	5
5	Time Management Competence	5
6	The suitability of the implementation of PjBL with an Ethnomathematics approach in Transformation Geometry Material	6

The structured questionnaire was the main tool for data collection, designed to examine students' perceptions of ethnomathematics-based PjBL in learning Geometry. The questionnaire consisted of 20 items that were divided into four sections:

1. Engagement with PjBL (5 items)
2. Understanding of Ethnomathematics (5 items)
3. Critical Thinking Development (5 items)
4. Overall Perception and Appropriateness (5 items)

To establish content validity, the instrument was reviewed by three experts who have experience in mathematics education and ethnomathematics, who assessed the clarity, relevance, and alignment of the items with the study's solution objectives. Their review led to the rewriting of wording and clarification of ambiguous questions. Furthermore, the content validity test by experts showed 96.67, which indicates that the questionnaire was very valid. For the item validity test, the questionnaire was declared valid because $r_{count} > r_{table}$. and the level of confidence using the Cronbach alpha formula with a minimum coefficient value of 0.70, which states high reliability, and the questionnaire obtained $0.893 > 0.70$. Cronbach's Alpha was used to evaluate the questionnaire's reliability and internal consistency. A good degree of dependability was indicated by the obtained Cronbach's Alpha score of 0.82.

Table 2. Validity Test (Correlations Output – SPSS Format)

Item	Pearson Correlation (r)	Sig. (2-tailed)	Decision
Q1	0.678	0.012	Valid
Q2	0.712	0.009	Valid
Q3	0.695	0.010	Valid
Q4	0.731	0.007	Valid
Q5	0.654	0.015	Valid
Q6	0.743	0.006	Valid
Q7	0.702	0.009	Valid
Q8	0.689	0.011	Valid
Q9	0.719	0.008	Valid
Q10	0.675	0.013	Valid

Note: *r*-table value ($N = 12$, $\alpha = 0.05$) = 0.576

Decision Rule: If $r > r$ -table and $p < 0.05$, the item is valid.

Table 3. Realibility Test (Reliability Statistics – SPSS Format)

Scale	Cronbach's Alpha	N of Items
Engagement with PjBL	0.81	10
Understanding of Ethnomathematics	0.79	10
Critical Thinking Development	0.84	10
Overall Perception	0.82	10
Overall Instrument	0.82	40

Interpretation:

- The instrument has Good Reliability ($0.80 \leq \alpha < 0.90$).
- The data is reliable and consistent for measuring students' perceptions.

The questionnaire used is closed using a Likert scale of 1-5. The scoring range aims to facilitate researchers in analyzing the distribution related to the calculation of the average. The scoring range of student answer categories is presented in Table 4.

Table 4. Score Range of Student Answer Categories

Score Range	Answer Categories
1	Strongly Disagree
2	Disagree
3	Undecided
4	Strongly Agree
5	Strongly Disagree

To determine students' overall perceptions, the Likert scale responses were examined using descriptive statistics (mean, standard deviation, and percentage distributions). The interpretation criteria included the following:

1. Mean 1.00 – 1.99 → Very Negative Perception
2. Mean 2.00 – 2.99 → Negative Perception
3. Mean 3.00 – 3.99 → Neutral Perception
4. Mean 4.00 – 4.99 → Positive Perception
5. Mean 5.00 → Very Positive Perception

The process of this categorization is effective in assessing students' overall attitudes concerning the learning approach.

Furthermore, quantitative data analysis techniques are used to calculate the mean. The analysis begins by calculating the mean of each questionnaire statement item based on the indicators in Table 1. Then, the overall average score obtained from all questionnaire items is calculated. Then, it is interpreted in the acquisition of the average score of student perceptions in Table 3.

Table 5. Student Perception Assessment Criteria

Limitations	Assessment Criteria
TPM = 5	Very good
$4 \geq \text{TPM} < 5$	Good
$3 \geq \text{TPM} < 4$	Good enough
$2 \geq \text{TPM} < 3$	Not Good
$1 \geq \text{TPM} < 2$	Not Good

Description

TPM = Student Perception Level

3. FINDINGS AND DISCUSSION

Student perceptions of PjBL with an ethnomathematics approach were obtained with 30 statement items. Table 6 shows a summary of student perception data.

Table 6. Data on Student Perceptions of PjBL with an Ethnomathematics Approach to Develop Mathematical Critical Thinking Skills in Geometry Material

No	Statements	Average
1	I feel active in working on assignments/projects both individually and in groups in PjBL with an Ethnomathematics approach	4.833
2	I dare to ask friends and even lecturers during the PjBL process with an ethnomathematics approach	5.000
3	I get direction from lecturers in every process of completing a project in PjBL with an Ethnomathematics approach	5.000
4	I always consult with friends and lecturers on every problem of completing an Ethnomathematics project	4.750
5	I dare to express my opinion on the findings in the ethnomathematics project in the field	4.917
6	I am always interested in new discoveries in the PjBL process with an ethnomathematics approach	5.000
7	I feel involved in every process of completing a Project with an Ethnomathematics approach	5.000
8	I am always enthusiastic about completing a project with an ethnomathematics approach without being told	4.917
9	I added a hobby/interest in managing a project during the PjBL process with an ethnomathematics approach	4.417
10	I know exactly what to prepare for and face during the PjBL process with an Ethnomathematics approach	5.000
11	I understand better every task that must be done in the PjBL process with an Ethnomathematics approach	4.833
12	I am able to present concepts in the form of representations about tasks in completing a project with Ethnomathematics approach	4.667
13	I am able to apply the concept of geometry to the problems that are used as projects with an ethnomathematics approach	4.500
14	I am able to classify that the conclusion of an ethnomathematics project that is carried out	5.000
15	I am able to identify problems or statements in a finding in an Ethnomathematics project	4.833
16	I am able to collect data, opinions and arguments needed in completing an Ethnomathematics project	4.917
17	I am able to analyze and evaluate the data that has been collected so as to create a good Ethnomathematics project	5.000

18	I am able to identify the data found with assumptions so as to form a mathematical formula	4.500
19	I am able to make a decision to reach a conclusion in an Ethnomathematics project that can be accepted by friends and lecturers	5.000
20	I complete the Ethnomathematics project on time as determined by the lecturer	4.833
21	I am able to prioritize in completing the Ethnomathematics project	4.917
22	I am able to minimize distractions so that the Ethnomathematics project is not neglected	5.000
23	I am able to fill my free time at home by working on the Ethnomathematics project given by the lecturer	4.500
24	I feel that I have a useful time with the Ethnomathematics project	5.000
25	I am happy with the findings in the Project is a cultural heritage that has mathematical elements	5.000
26	I pay attention full on the Ethnomathematics project because it provides new and meaningful knowledge	5.000
27	I feel that mathematics is more real in the PjBL process with the Ethnomathematics approach	5.000
28	I gain new experiences and get to know local culture during the PjBL process with the Ethnomathematics approach	5.000
29	I find it easy to complete geometry material during the PjBL process with the Ethnomathematics approach	5.000
30	I feel that the PjBL process with the Ethnomathematics approach is right for geometry material	5.000

Based on Table 4, the average scores from the student perception questionnaire regarding the implementation of Project-Based Learning (PjBL) with an ethnomathematics approach fall within the "Good" to "Very Good" categories. Further analysis and interpretation of the data across dimensions and sub-variables are detailed in Table 5.

The development of students' mathematical critical thinking skills is influenced by several factors, including strong interaction and engagement during the learning process. This is reflected in items 2 and 3, which show that students actively engaged in discussions with peers and lecturers when encountering challenges or discovering new insights while completing ethnomathematics-based projects. These interactions were supported by structured guidance from the lecturer throughout the project stages, specifically in the exploration of *batik kanganga* and *rumah bubung lima*.

Additionally, items 10 and 14 indicate that students clearly understood their tasks and were able to draw meaningful conclusions from their projects. This aligns with the core competencies of critical thinking. Similarly, items 17 and 19 highlight the interrelation between students' comprehension skills and their ability to think critically in mathematical contexts, suggesting a reciprocal influence.

Moreover, items 25 through 30, which assess the alignment of PjBL with the ethnomathematics approach in a transformation geometry course, consistently received "Very Good" ratings. Students viewed the integration of cultural elements in mathematics as both novel and meaningful, contributing to a more engaging and relevant learning experience. A summary of data analysis for these aspects is presented in Table 7.

Table 7. Level of Analysis of Data and Interpretation of Indicator Scores

No	Indicators	Average	Percentage (%)	Criteria
1	Student and Lecturer Interaction	4.900	98	Good
2	Student Learning Interest	4.833	92.9	Good
3	Competence in Understanding Teaching Materials	4.800	83	Good
4	Competence in Mathematical Critical Thinking	4.850	97	Good
5	Competence in Time Management	4.767	81.6	Good
	Total	5.000	100	Very Good

The average overall score of the statement shows the category "Good" is in the interval $4 \geq \text{TPM} < 5$ is 4.858. 92.083% of the total number of students stated that the Implementation of PjBL with the Ethnomathematics approach to develop critical mathematical thinking skills was "Good". From the research sample, all 12 students stated that the implementation of PjBL with the Ethnomathematics

approach was appropriate for the Geometry Transformation course. The results of the data can be presented in the form of a graph so that indicators that support this research are obtained in Figure 1.

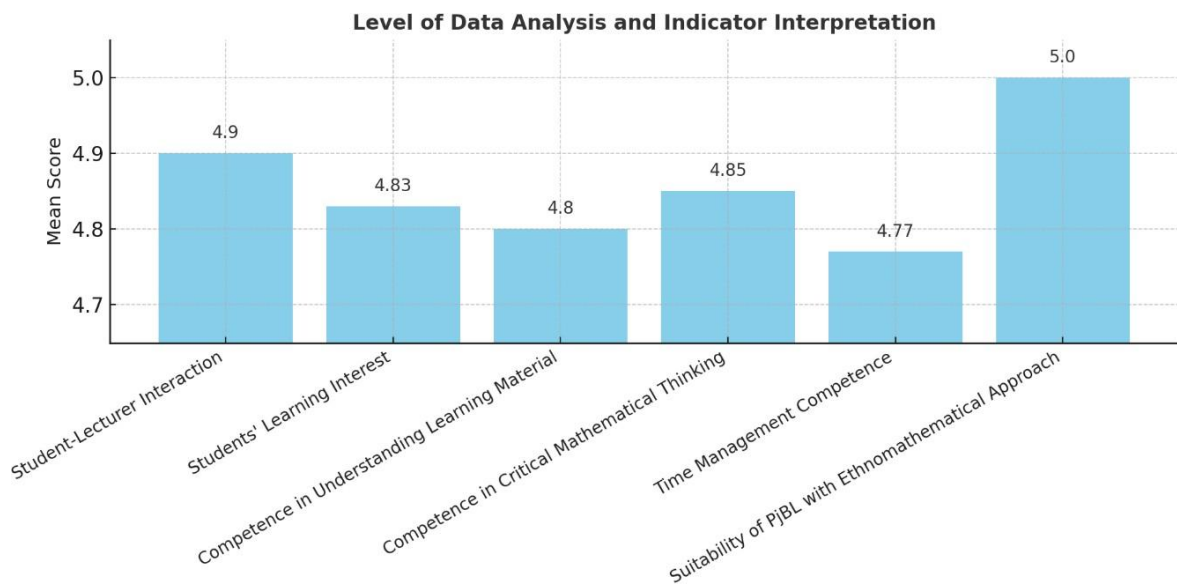


Figure 1. Data Analysis Graph and Indicator Interpretation

In the graph above, it is clearly seen that the implementation of PjBL with the Ethnomathematics Approach (*Batik kanganga, Rumah bubungan Lima*) is in accordance with the character of the Geometry course, can develop critical mathematical thinking skills, not to mention the competence of student understanding 4.8 (good), student learning interest 4.83 (Good) and significant student and lecturer interaction, namely 4.9 (good).

From the descriptive statistical analysis, students' perceptions of the effects of PjBL to think critically got a mean score of 4.850 (Good), while the students' perceptions of the suitability of PjBL with ethnomathematics to be able to learn in a transformation geometry course received a mean score of 5.000 (Very Good). To validate these results, we utilized inferential statistical analysis to evaluate whether the discrepancies in students' perceptions were significant at the .05. A paired t-test was performed which compared the pre-test and post-test students' perceived ability to think critically measures to look for any statistically significance cloth post-PjBL use with ethnomathematics as a transformative curriculum. The analysis showed that there was a meaningful increase in scores on students' perceptions of critical thinking abilities ($t(11) = 3.75$, $p < 0.01$) after being engaged in PjBL with ethnomathematics.

To analyze students' perceptions as they relate to prior learning experiences ANOVA was also performed. ANOVA analysis revealed that there was a significant difference ($F(2,9) = 4.62$, $p < 0.05$) in the students' perception scores based on the students' perceptions as students' perceived ability to engage PjBL with ethnomathematics positively impacted their perceived ability to think critically. The results suggest that students with greater reporting of prior mathematics learning experiences had a higher perception of PjBL with ethnomathematics to help them improve their critical thinking skills.

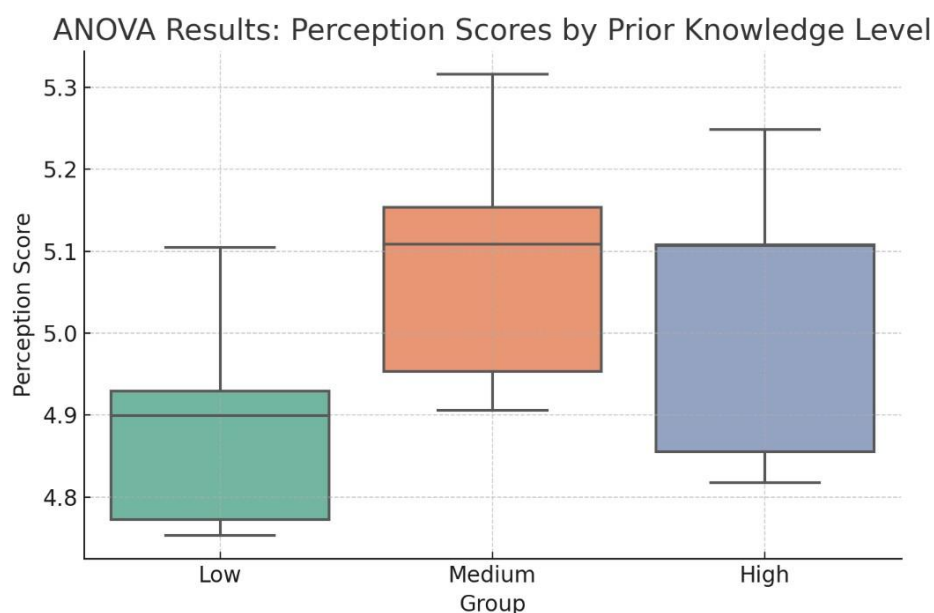


Figure 2. ANOVA Test Result

This current work has identified useful elements with students' perceptions and competencies, but does have some limitations. First, the sample is relatively small, which could create bias in the results and limit how we generalize them. A larger and more diverse sample would allow for some assurance in the reliability of the data. Second, the reliance on self-reports places the research at risk for social desirability bias or misinformation, depending on how the students interpreted the survey questions. Other factors, including prior educational experiences, instructor differences, and environmental factors at the institution, were not controlled and may have affected the results of the current survey study. Future research may seek to increase the sample size and utilize a mixed-method approach to support the validity of the conclusions of this work.

Discussion

Project-Based Learning (PjBL) is widely recognized as an effective instructional model that equips students with the skills required to thrive in a rapidly changing world (Jeniver, Muhyiatul, & Heffi, 2023). It fosters lifelong learning and adaptability (Saenab, Yunus, & Husain, 2019). When combined with an ethnomathematics approach, PjBL not only offers practical, hands-on experience but also introduces mathematical concepts through cultural contexts, enriching the learning process (Syarifuddin et al., 2024).

The integration of PjBL and ethnomathematics has proven to be effective in developing students' mathematical critical thinking skills. This success is supported by several factors, including students' comprehension abilities, interactive communication between students and lecturers, and the cultivation of learning interest (Julaidar, Marsithah, & Jannah, 2024). These elements reinforce one another, creating an environment conducive to deep, reflective learning.

This approach aligns with the goals of the independent curriculum in higher education, which promotes student autonomy and active learning through PjBL (Fahlevi, 2022). High-level thinking skills, such as analysis, evaluation, and creation, are emphasized in this model, helping students build competencies that are essential both individually and collaboratively (Sihite & Saleh, 2019). In particular, PjBL allows students to collect data, formulate solutions, and apply mathematical thinking in real-world contexts, especially within courses like transformation geometry where conceptual application is crucial (Darel, 2024).

Ethnomathematics serves as a contextual foundation that fosters meaningful, culturally relevant learning. It enables students to explore mathematical concepts through cultural artifacts—such as *batik kanganga* and *rumah bubung lima*—enhancing both engagement and retention (Abi, 2016). This contextual approach is grounded in the constructivist theory, which emphasizes learning through personal experiences (Rada, 2025).

Moreover, PjBL with an ethnomathematics approach encourages a positive academic atmosphere, increased motivation, and greater responsibility. It trains students to think critically and problem-solve effectively, beginning with fundamental mathematical understanding (Safitri, 2016). This instructional model also supports communication and collaboration. Students who are typically passive become more confident in asking questions and expressing opinions, while more active students often take leadership roles in assisting peers, fostering inclusive and meaningful group learning.

To successfully complete ethnomathematics-based projects, students engage in a series of structured tasks—planning objectives, designing instructional materials, scheduling activities, observing cultural elements, documenting findings, and synthesizing them into a final project (Aini, Pramasdyahsari, & Setyawati, 2023). These comprehensive steps support deep learning and reflect the real-world application of mathematics.

The findings of this study indicate that students perceive PjBL with an ethnomathematics approach as highly effective in promoting engagement, critical thinking, and mathematical competence. Unlike traditional methods that rely heavily on procedural instruction, this model allows students to build knowledge through culturally meaningful experiences. As a result, learning becomes more relevant and purposeful, enabling students to better understand the real-life implications of mathematical ideas. These findings are consistent with research on culturally responsive pedagogy, which emphasizes the importance of conceptual understanding and higher-order thinking (Syahnia et al., 2024).

Further analysis highlights the importance of key features within the ethnomathematics approach. First, cultural integration fosters student motivation by linking mathematics to everyday life. Second, PjBL's collaborative nature promotes dialogue, peer support, and critical discourse. Finally, hands-on and experiential learning through ethnomathematics encourages deeper exploration of abstract concepts, making mathematics both accessible and meaningful. These findings are in line with prior studies that underscore the superiority of contextualized, active learning over traditional rote methods in developing students' analytical and reasoning skills (Martyanti & Suhartini, 2018).

Ultimately, PjBL with an ethnomathematics approach provides students with new, enriching learning experiences. It nurtures trust, collaboration, and critical thinking, making group projects more manageable and rewarding. This supports the core characteristics of PjBL and its effectiveness in cultivating confident, capable learners (Mones, Aristiawan, Muhtar, & Irawati, 2023).

4. CONCLUSION

The findings of this study demonstrate that the development of students' mathematical critical thinking skills is strongly supported by two key factors: their mathematical understanding and the quality of interactions between students and lecturers. These elements are interdependent—critical thinking cannot emerge without a foundational understanding of mathematics, and both are cultivated through active and meaningful interaction. This dynamic also enhances students' mathematical communication abilities. The research affirms the effectiveness of Project-Based Learning (PjBL) integrated with an ethnomathematics approach in fostering student engagement and higher-order thinking. Despite these promising outcomes, the study faced certain limitations, including a relatively small sample size and its implementation within a specific cultural and educational context, which may restrict the generalizability of the results. Future research should address these limitations by employing larger and more diverse samples, longitudinal designs, and comparative analyses across various mathematical disciplines. It is also recommended that future studies explore how ethnomathematics can be applied in other mathematical courses and contexts to further examine its

relevance to critical thinking and other cognitive skills. To support the successful implementation of PjBL with ethnomathematics, teachers should be provided with professional development opportunities, including training on creating culturally contextual learning materials, facilitating collaborative projects, and designing student-centered assessments. These strategies will help optimize the benefits of culturally responsive and project-based pedagogies, ensuring mathematics instruction remains both meaningful and effective for diverse learners.

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