



Ethnomathematics-Problem Based Learning in the “Baloy Adat Tidung” Context: Effects on Students’ Mathematical Creativity and Growth Mindset

Sury Adellia Ramadhanta¹, Marsigit²

^{1,2}Department of Mathematics Education, Universitas Negeri Yogyakarta, Indonesia

*Email: suryadellia.2023@student.uny.ac.id

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ABSTRACT

Purpose - This study aimed to examine the effectiveness of Ethnomathematics-based Problem-Based Learning (PBL) and Ethnomathematics-based Student Teams Achievement Division (STAD) in enhancing students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM), and to determine which instructional model is more effective

Methodology - A quasi-experimental, nonrandomized control-group pretest-posttest design was employed at a public junior secondary school in Indonesia during the 2025/2026 academic year. The sample consisted of two intact ninth-grade classes (32 students each) assigned to the PBL and STAD groups. Data were collected using a mathematical creative thinking test and a growth mindset questionnaire administered at pretest and posttest. Data analysis involved one-sample t-tests to assess the effectiveness of each learning model against the established effectiveness criteria; differences in effectiveness between groups were analyzed using a multivariate test (Hotelling's T^2) to see the simultaneous effect on MCTA and GM, independent-samples t-tests to compare group differences, and a superiority analysis to identify the more effective approach.

Findings - Both Ethnomathematics-based PBL and STAD were effective in improving students' MCTA and GM. However, the PBL model demonstrated significantly greater effectiveness than the STAD model in enhancing both variables.

Contribution - This study provides empirical evidence supporting the integration of the ethnomathematical context “Baloy Adat Tidung” into mathematics instruction. The findings contribute to the literature on culturally responsive pedagogy by demonstrating that ethnomathematics-based PBL is a more impactful approach for strengthening students' creative thinking skills and growth mindset at the junior secondary level.

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INTRODUCTION

Creativity in mathematics is a crucial competency for both individual and societal development because it directly supports problem solving and knowledge construction. In mathematics education, this creativity is reflected in Mathematical Creative Thinking Ability (MCTA), which comprises fluency, flexibility, originality, and elaboration, enabling students to generate and develop new mathematical ideas (Bruhn & Luken, 2023; Bicer et al., 2020). In addition, a growth mindset (GM) serves as an important motivational factor, strengthening students' perseverance and readiness to face learning challenges, as students with a GM tend to perceive failure as feedback for improving their learning strategies (Qin et al., 2021; Yeager et al., 2022).

However, empirical evidence shows that both MCTA and the internalization of GM among Indonesian students remain low. National and international evaluations, including creativity achievements at the junior high school level and PISA mathematics results, indicate weaknesses in creative thinking and mathematical literacy (OECD, 2019). At the local level, several studies show that most junior high school students are only able to meet some of the MCTA indicators (Bahagia et al., 2022; Junaedi et al., 2021; Sahliawati & Nurlaelah, 2020), while GM internalization is still weak in many schools (Saefudin et al., 2023; OECD, 2019). This condition is also supported by observations and interviews with teachers at one public junior high school, which revealed low MCTA scores, the dominance of a fixed mindset among ninth-grade students, and the limited effectiveness of the current learning model.

These findings indicate that mathematics learning in many schools has not yet effectively supported the development of students' MCTA and GM. The problem becomes more apparent in learning about solid figures with flat faces, which requires high-level analytical thinking and is considered one of the most difficult topics for junior high school students. Leonard et al. (2022) classify this topic as one of the hardest in mathematics at the junior high school level, while Suprayo et al. (2023) note that students' main difficulties include understanding concepts, applying formulas, interpreting problems, and planning and executing problem-solving strategies. In practice, the learning models currently used are still not fully aligned with these demands, so they have not been able to develop students' thinking skills and creativity optimally.

Another issue lies in the limitations of commonly used cooperative learning models, such as Student Teams Achievement Division (STAD). Although STAD can support group learning, it often emphasizes mastery of material and quiz performance, leaving little room for students to explore creative ideas independently and deeply (Putri & Kaivalya, 2024; Slavin, 1980). As a result, the current learning approach is not yet optimal in fostering both MCTA and GM, especially in mathematics topics that require analytical reasoning and open-ended thinking. This shows that a more suitable learning strategy is needed, one that can simultaneously strengthen students' mathematical creative thinking and cultivate a growth mindset.

Exploring MCTA is essential for students' learning experience and academic achievement in mathematics (Kozlowski et al., 2019). MCTA is important not only as a means of mastering mathematical competence but also as a bridge connecting cognitive development with students' cultural and social contexts (Soler Pastor et al., 2022). In this regard, ethnomathematics offers a meaningful approach by linking mathematical practices with cultural experiences, thereby broadening students' perspectives and encouraging creative thinking (Suherman & Vidakovich, 2022). Likewise, exploring GM is equally important because the mindset and the learning behaviors it produces have a significant impact on academic performance. Students with a growth mindset generally perform better than those with a fixed mindset, especially when facing difficulty (Wilson & Conyer, 2020).

In response to these issues, ethnomathematics-based Problem-Based Learning (PBL) has become a promising focus in mathematics education research because it connects learning to real problems, encourages metacognition, and strengthens self-regulation. Previous studies have shown that ethnomathematics-based PBL is effective in improving students' self-directed learning in mathematics problem solving (Amidi et al., 2024), mathematical literacy (Pratama & Yelken, 2024; Zaenuri et al., 2020), critical thinking skills (Syahnia et al., 2024), and problem-solving ability through traditional games (Setiyadi

et al., 2019). Nevertheless, these studies have not comprehensively examined the effectiveness of ethnomathematics-based PBL using "Baloy Adat Tidung" in Tarakan, focusing on both MCTA and GM, especially on the topic of solid figures with flat faces at the junior high school level.

This constitutes the main research gap. Although "Baloy Adat Tidung" contains rich mathematical and aesthetic values, these values have not yet been systematically utilized in mathematics learning. In addition, prior research has not thoroughly tested the simultaneous effect of ethnomathematics-based learning on both MCTA and GM, nor has it clearly compared the effectiveness of ethnomathematics-based PBL and ethnomathematics-based STAD in the same local cultural context. Therefore, this study focuses on determining whether learning mathematics within a local cultural context can more effectively improve students' creative thinking and growth mindset than conventional learning approaches.

The novelty of this study lies in its comprehensive investigation of the effectiveness of ethnomathematics-based PBL "Baloy Adat Tidung" in improving MCTA and GM on the topic of solid figures with flat faces at the junior high school level, as well as its comparison with ethnomathematics-based STAD as a comparative approach. This study is intended to fill empirical gaps related to the use of local ethnomathematics that has not been thoroughly explored, the simultaneous impact on MCTA and GM, and the comparative effectiveness of PBL and STAD when both are integrated with the same cultural context. In this way, the study is expected to contribute both methodologically and practically to the development of culture-based mathematics learning and the improvement of educational quality at the secondary level.

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The purpose of this research is to describe the effectiveness of ethnomathematics-based Problem-Based Learning (PBL) "*Baloy Adat Tidung*" in terms of students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM), as well as to describe the effectiveness of ethnomathematics-based Student Teams Achievement Division (STAD) in relation to these two aspects. Furthermore, this study aims to compare the effectiveness of both learning models to determine which is more effective in improving students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM).

METHODOLOGY

Research Design

This study used a quasi-experimental design with a nonrandomized control group and a pretest-posttest to evaluate the effectiveness of two learning models. Two whole classes were designated as experimental groups, with one class receiving ethnomathematics-based Problem-Based Learning (PBL) and

one class receiving ethnomathematics-based Student Teams Achievement Division (STAD) learning. Pretest and posttest measurements were conducted to assess students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM). This design was chosen because individual random assignment was not possible in the school context, so the initial equality of the groups was controlled through pretesting and monitoring of learning implementation.

Participant

The research population comprised all ninth-grade students at a public junior high school in North Kalimantan, totaling 7 classes ($N = 224$). The sample was selected using cluster sampling, with two whole classes selected and designated as the PBL and STAD groups, each consisting of 32 students. The participants were aged 14-15 years. The same teacher taught both classes to minimize the variable of teacher differences. The participants were regular students who attended the entire learning series during the study.

Furthermore, the equivalence of the two groups' initial abilities was examined using a multivariate mean vector test, namely Hotelling's T^2 test. The decision criterion for Hotelling's T^2 test was to reject the null hypothesis (H_0) if the obtained T^2 value exceeded the critical value or if the p-value was less than 0.05. The results of Hotelling's T^2 test indicated that there was no significant difference in the multivariate mean vectors between the experimental and control groups. This finding suggests that the students' initial conditions regarding MCTA and GM were statistically equivalent.

Data Collection

Data collection was conducted in the first semester of the 2025/2026 academic year across seven meetings: one pretest session, five learning treatment sessions, and one posttest session. Data were obtained through mathematical creative thinking ability tests, growth mindset questionnaires administered at the pretest and posttest, and observation sheets documenting the implementation of the learning. The observations were carried out by an independent observer, namely a subject teacher at the school where the research was conducted, to ensure objectivity in recording the implementation of the instructional activities.

Instrument

The research instruments consisted of: (1) a mathematical creative thinking essay test comprising eight items that measured indicators of fluency, flexibility, originality, and elaboration; (2) a 10-item Likert scale growth mindset questionnaire, with a response range from 1 to 4, that measures beliefs about intelligence, responses to challenges, effort orientation, acceptance of feedback, and learning from the success of others; and (3) an observation sheet to monitor the suitability of learning implementation with the model syntax. Content validity was established through expert assessment, while construct validity was analyzed using confirmatory factor analysis. Reliability tests indicated adequate internal consistency, with a Cronbach's alpha coefficient of approximately 0.70.

Data Analysis

Data analysis was conducted descriptively and inferentially. Descriptive statistics were used to present the mean and standard deviation of pretest and posttest scores. Prerequisite tests included normality tests, outlier detection, and homogeneity of variance-covariance. The One-Sample t-Test was used to assess each learning model's effectiveness against the established effectiveness criteria. Learning in both the experimental and control classes was considered effective in improving MCTA if the posttest score exceeded 74.99.

Furthermore, learning was considered effective in improving GM if the posttest score on the growth mindset questionnaire exceeded 27.99. Differences in effectiveness between groups were analyzed using a multivariate test (Hotelling's T^2) to see the simultaneous effect on MCTA and GM. If a significant multivariate difference was found, an independent-samples t-test was conducted to identify specific differences and determine the superior learning model. All analyses were performed using statistical software, with effect sizes and confidence intervals reported to strengthen practical interpretations.

FINDINGS

Normality and Homogeneity Test

The data analysis in this research was conducted systematically, beginning with assumption testing, followed by effectiveness testing, comparison of initial and final abilities using Hotelling's T^2 , and concluding with follow-up univariate analysis to examine differences in each dependent variable. The assumption tests indicated that the data met all required statistical criteria.

Table 1. Summary of Normality Test Results

Type of Normality Test	Method Used	p-values
Multivariate Normality	Henze-Zirkler Test	0.295; 0.517; 0.869; 0.628
Univariate Normality	Shapiro-Wilk Test	0.069 - 0.234

Outlier detection using boxplots and Mahalanobis distance revealed no univariate or multivariate outliers. Multivariate normality testing using the Henze-Zirkler test produced p-values of 0.295, 0.517, 0.869, and 0.628 (> 0.05), while univariate normality testing using the Shapiro-Wilk test yielded p-values ranging from 0.069 to 0.234, indicating normality. Furthermore, homogeneity assumptions were satisfied based on Box's M test ($p = 0.531$ for pretest and $p = 0.1101$ for posttest) and Levene's test (all p-values > 0.05). These results confirm that the data were appropriate for further parametric analysis.

Table 2. Summary of Homogeneity Test Results

Homogeneity Test	Data Type	p-value	Interpretation
Box's M Test	Pretest	0.531	Homogeneous covariance matrices
	Posttest	0.1101	Homogeneous covariance matrices
Levene's Test	All groups	> 0.05	Homogeneous variances

The effectiveness of the learning models was first evaluated using the one-sample Hotelling's T^2 test, which showed that both PBL-etno and STAD-etno were simultaneously effective in improving MCTA and GM ($p < 0.05$ for both groups). Further analysis using one-sample t-tests indicated that both models were also effective individually, as all p-values were below 0.05. However, higher t-values in the experimental group suggest that the PBL-etno model produced greater improvements. To ensure group comparability, the Hotelling's T^2 test on pretest data showed no significant multivariate difference between the experimental and control groups ($T^2 = 3.5705$; $p = 0.1678$), indicating equivalent initial conditions. In contrast, posttest analysis revealed a significant multivariate difference between the two groups ($T^2 = 63.136$; $p < 0.05$), indicating that the learning models differed in their effectiveness in improving MCTA and GM.

Follow-up analysis using independent samples t-tests confirmed that the differences were significant for both variables. The experimental group consistently outperformed the control group in both MCTA and GM. The greatest difference was seen in the GM variable with a practically meaningful mean difference (positive 95% CI). Overall, although both learning models were effective, the Problem-Based Learning model based on ethnomathematics demonstrated greater effectiveness than the STAD model in improving students' MCTA and GM.

Effectiveness Test Results of PBL-Ethnomathematics

The data used in this analysis were obtained from posttest scores of students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM) after the implementation of the ethnomathematics-based Problem-Based Learning model "*Baloy Adat Tidung*" during the instructional sessions. These data were then analyzed using inferential statistical techniques to determine the effectiveness of the learning model in improving both variables.

Statistical analysis shows the effectiveness of ethnomathematics-based PBL "*Baloy Adat Tidung*" convincingly: the One-Sample Hotelling's T^2 test on MCTA and GM data produced $p = 2.4869e-14$ (< 0.05),

the One-Sample t test on MCTA produced $t = 6.9823$ ($p = 3.887e-08 < 0.05$), and for GM, the One-Sample t test produced $t = 11.829$ ($p = 2.514e-13 < 0.05$). Thus, the null hypothesis is rejected. PBL-ethnomathematics has been proven effective in improving both creative cognitive aspects (KBKM) and adaptive learning dispositions (GM).

Table 3. Effectiveness Test Results of PBL-Ethnomathematics

Variable	Test	P-Value	Decision
MCTA and GM	One-Sample Hotelling's T ²	2.4869e-14	H ₀ rejected
MCTA	One-Sample t test	3.887e-08	H ₀ rejected
GM	One-Sample t test	2.514e-13	H ₀ rejected

Effectiveness Test Results of STAD-Ethnomathematics

The data used in this analysis were obtained from posttest scores of students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM) after the implementation of the ethnomathematics-based STAD model "Baloy Adat Tidung" during the instructional sessions. These data were then analyzed using inferential statistical techniques to determine the effectiveness of the learning model in improving both variables.

Table 4. Effectiveness Test Results of STAD-Ethnomathematics

Variable	Test	P-Value	Decision
MCTA and GM	One-Sample Hotelling's T ²	5.740087e-09	H ₀ rejected
MCTA	One-Sample t test	0.00209	H ₀ rejected
GM	One-Sample t test	0.01508	H ₀ rejected

Statistical analysis shows the effectiveness of applying STAD based on ethnomathematics is significant: One-Sample Hotelling's T² for KBKM produces $p = 5.740087e-09$ (< 0.05), One-Sample t for KBKM $t = 3.0923$ ($p = 0.00209 < 0.05$), and One-Sample t for Growth Mindset $t = 2.2722$ ($p = 0.01508 < 0.05$). These findings confirm that the STAD-ethnomathematics intervention not only improves cognitive performance but also strengthens students' adaptive learning dispositions.

The results of the hypothesis test show that ethnomathematics-based PBL is more effective than STAD in improving students' mathematical creative thinking skills and growth mindset. Both models are beneficial because they contextualize mathematics through local culture, making the material relevant and motivating student engagement. However, PBL provides conceptual and procedural advantages: by placing students as problem solvers—identifying problems, formulating questions, and exploring various strategies PBL facilitates the simultaneous development of fluency, flexibility, originality, and elaboration (Supratman et al., 2021). The series of PBL steps (contextualization of problems, strategy design, research & revision, production & reflection) creates a systematic and iterative learning cycle, which not only activates creative skills but also instills the belief that abilities can be developed through continuous effort and reflection.

Overall, the findings of this study confirm that integrating ethnomathematics into cooperative and problem-based learning models can improve the quality of mathematics learning by making it more contextual, meaningful, and closer to students' cultural experiences. However, the characteristics of Problem-Based Learning (PBL), which place students as active problem solvers, provide more room for cognitive exploration than the collaborative Structure of STAD, making it more optimal in developing fluency of ideas, flexibility of strategies, originality of solutions, and elaboration of thinking. At the same time, learning experiences that emphasize independent inquiry, reflection, and cultural meaning reinforce students' belief that mathematical ability can be developed through effort and appropriate strategies, which is the core of a growth mindset. Thus, mathematics learning that combines a problem-based approach with a local cultural context not only improves cognitive performance but also builds adaptive learning dispositions that are important for continuous and culturally relevant learning. The implications of this

synthesis suggest that contextual, reflective, and student-centered learning designs should be prioritized in mathematics education practices to produce learners who are creative, resilient, and adaptable to the challenges of the 21st century.

DISCUSSION

The results of quantitative analysis and observation of implementation show that both learning models, ethnomathematics-based Problem-Based Learning (PBL) "Baloy Adat Tidung" and ethnomathematics-based Student Teams Achievement Division (STAD), are effective in improving students' Mathematical Creative Thinking Skills (MCTA) and Growth Mindset (GM). Statistically, each class showed a significant increase from the pretest to the posttest on both variables (One-Sample Hotelling's T^2 and One-Sample t -test), and the statistical assumptions (normality, homogeneity, and no outliers) were met. However, multivariate comparison analysis (Hotelling's T^2) and follow-up tests (two-independent samples t -test) indicated that PBL-ethnomathematics was superior to STAD-ethnomathematics in improving GM and MCTA; the greatest difference was observed in GM, with a practically meaningful mean difference (positive 95% CI). These findings are consistent with previous empirical evidence highlighting the advantages of PBL in facilitating idea exploration, reflection, and failure management during the learning process (Moust et al., 2021; Yustina et al., 2022).

The finding that ethnomathematics-based PBL is more effective than ethnomathematics-based STAD indicates that there are fundamental pedagogical differences that influence students' cognitive and affective development. Problem-Based Learning places contextual problems as the starting point for learning, encouraging independent inquiry, reflective discussion, and active knowledge construction. This Structure provides ample cognitive space for students to develop fluency, flexibility, originality, and elaboration, the four main indicators of Mathematical Creative Thinking Ability (MCTA) while internalizing a Growth Mindset through authentic experiences in facing challenges and finding solutions (Barrows, 1986; Moust et al., 2021). When students engage in open-ended, unstructured problem-solving, they are encouraged to explore various strategies, evaluate alternative solutions, and reflect on their thinking processes, which are important foundations for the development of mathematical creativity.

The implementation of LKPD, which begins with Connecting with the Problem, introduces culturally relevant open-ended problems that immediately stimulate dual perspectives (architectural-cultural). This stage encourages flexibility because students are guided to consider various interpretations and to open up space for elaboration as they identify information and context. At the same time, this stage instills a mindset that initial ignorance is part of the learning process, thus laying the foundation for GM formation. In setting up the Structure, group planning, and framework development, build orderly thinking that improves fluency (systematic problem-solving) and strengthens elaboration (detailed planning). Planning discussions also train commitment to effort and the ability to accept feedback, so that the aspects of effort and self-regulation in GM develop through the experience of designing, dividing tasks, and revising work plans.

Visiting the Problem stage field observation of Baloy elements encourages original ideas (originality) and enriches elaboration as students relate real findings to mathematical concepts. Observation activities force students to work actively, so that the effort indicator in GM is gained through evidence collection and initial reflection. Furthermore, Independent Research & Revisiting stimulates a more in-depth cognitive process: data collection and synthesis improve fluency (the ability to find solutions), enrich elaboration, and often lead to originality through the combination of different perspectives. The research-revision cycle also reinforces aspects of GM perseverance, acceptance of criticism (constructive criticism), and understanding that competency improvement comes from repeated effort and strategy refinement.

The Producing a Product or Performance stage actualizes all MCTA indicators: students synthesize ideas into products that demonstrate originality, fluency, and elaboration, and sharpen their mathematical communication skills. In practice, the production and presentation process requires resilience and a readiness to accept feedback; seeing the success of other teams serves as an inspiration (the "success of

others" indicator) that strengthens GM through social modeling. Finally, Evaluating Performance and the Problem emphasizes metacognitive and self-regulation competencies: deep reflection strengthens elaboration and flexibility by encouraging the adaptation of strategies for similar tasks in the future. Evaluation also trains students to accept criticism and plan for improvement, key components of a growth mindset, as students experience firsthand that mistakes are a source of information for improvement.

Integrating local cultural contexts through "Baloy Adat Tidung" strengthens the effectiveness of PBL by increasing the relevance and meaning of learning. Cultural contexts close to students' lives serve as cognitive bridges, connecting abstract spatial geometry concepts with real-life experiences, thereby strengthening conceptual understanding and knowledge transfer. The ethnomathematics approach allows students to see mathematics as part of social and cultural practices, rather than just formal symbols and formulas, thereby increasing intrinsic motivation and learning engagement (Rosa & Orey, 2016; Luneta, 2021). When students realize that mathematics is present in architectural structures and local cultural aesthetic values, they are more motivated to understand concepts in depth and develop creative problem-solving perspectives.

From a psychological perspective, challenging yet meaningful problem-based learning experiences also reinforce a growth mindset. Students learn that difficulties are a natural part of the learning process and that success can be achieved through effort, strategy, and perseverance. Gradual successes during the inquiry process help students build self-efficacy and academic resilience. This is consistent with the view that a learning environment that emphasizes process, reflection, and strategy refinement can foster the belief that intellectual ability can be developed through sustained effort.

Conversely, although STAD based on ethnomathematics has been shown to improve MCTA and Growth Mindset, the mechanism of improvement differs. The STAD model emphasizes teamwork, group responsibility, and an effective collective reward system to increase student motivation and engagement. Social interaction and peer feedback in heterogeneous groups provide cognitive and emotional support, helping students understand concepts and improve academic performance. However, the more structured STAD, which is oriented toward achieving team scores or quizzes, tends to limit individual exploration and deep reflection. In some situations, dependence on stronger group members can reduce each student's opportunities to develop independent problem-solving strategies. This condition explains why the improvement in the indicators of originality and internalization of the Growth Mindset in STAD groups is relatively smaller than in PBL (Putri & Kaivalya, 2024).

The implementation of LKPD, which begins with the class presentation stage, links mathematical concepts to the local cultural context, enriching their elaboration by facilitating the understanding of abstract concepts and connecting them to students' experiences. The presentation of material accompanied by sparking questions also increases motivation for exploration, so that this initial presentation is not merely a transfer of information but also fosters the belief that understanding develops through practice and strategy, an important basis for a growth mindset (Suherman & Vidákovich, 2024).

The team's stage is the core of STAD, which produces many effective pedagogical mechanisms: interaction in heterogeneous groups encourages the adjustment of communication styles and thinking strategies, thereby increasing flexibility. At the same time, multiperspective collaboration often sparks original ideas. The process of exchanging explanations, clarifications, and peer teaching deepens elaboration because each member is actively involved in building a shared understanding. In addition, the practice of giving and receiving feedback within teams strengthens indicators of criticism and appreciation for others' success, an important social mechanism that supports motivation and learning resilience (Cervantes-Barraza & Araujo, 2023; Ghufron et al., 2023).

Quizzes and individual improvement scoring work synergistically to improve fluency and effort. Periodic quizzes serve as formative exercises that accelerate response fluency and help students identify areas of weakness. At the same time, assessments that focus on individual improvement reinforce the value of sustained effort, encouraging students to practice, revise strategies, and see tangible evidence of their progress. This formative feedback mechanism is consistent with evidence that repeated practice and

progressive evaluation effectively strengthen growth mindsets (Bui et al., 2023; Xu & Dieckmann, 2025; Zhao et al., 2024).

Team recognition as a collective reward reinforces the motivational dimension of the STAD model: recognition of team achievements motivates the imitation of effective strategies between groups, increases achievement aspirations, and fosters a culture of collaborative effort. This collective reward also serves as a social stimulus that facilitates the transfer of successful learning practices, thereby not only encouraging effort but also strengthening aspects of KBKM, such as originality and elaboration, at the group level (Motwani et al., 2022; Wawan et al., 2023).

In summary, the effectiveness of STAD-ethnomathematics can be explained by the synergy of three elements: (1) cultural contextualization that makes problems meaningful and increases intrinsic motivation, (2) collaborative structures that facilitate the exchange of ideas, peer teaching, and the construction of shared knowledge, and (3) formative assessment that emphasizes personal improvement and effort. This combination allows for increased fluency, flexibility of strategy, originality of solutions, and elaboration of reasoning, as well as reinforcing growth mindset indicators such as perseverance, acceptance of feedback, and appreciation of others' successes (Näslund-Hadley et al., 2025; Suherman & Vidákovich, 2024; Supriyadi et al., 2024). In practice, although STAD-ethnomathematics has proven effective, these results suggest enriching the model with individual exploration phases or independent revision tasks to optimize the development of personal originality and independent thinking. Additionally, training teachers to design culturally rooted, open-ended tasks and to provide feedback that fosters a growth mindset is highly recommended to strengthen the observed cognitive and affective outcomes.

The results of this study also reinforce the argument that integrating cultural context into mathematics learning not only improves conceptual understanding but also enriches students' affective dimension and learning identity. Culturally relevant learning creates a sense of ownership of the knowledge being learned, increases engagement, and encourages students to see mathematics as a tool for understanding their world. Thus, ethnomathematics acts as a catalyst that strengthens the effectiveness of innovative learning models.

The practical implications of these findings suggest that if learning objectives include the development of mathematical creativity and the formation of a growth mindset, educators need to prioritize contextual, open-ended task design that demands independent investigation as facilitated by PBL. However, the constructive, collaborative element that is the strength of STAD remains important to maintain to support social interaction and cooperative learning. A hybrid approach that combines in-depth inquiry in the style of PBL with the collaborative support of STAD has the potential to create a more comprehensive learning environment.

The implementation of ethnomathematics-based PBL requires support from systematic learning tools, such as student worksheets (LKPD) designed to guide inquiry, adequate time for exploration and reflection, and teacher competence in facilitating discussion, scaffolding, and metacognitive reflection. The role of the teacher as a facilitator is crucial in helping students revise strategies, articulate their thoughts, and build a deeper conceptual understanding. When these implementation conditions are met, the cognitive and affective benefits of ethnomathematics-based PBL can be maximized (Moust et al., 2021; Yustina et al., 2022).

Conversely, STAD excels in building social responsibility, cooperation, and group achievement efficiency due to its role structure and team reward mechanisms; however, this orientation tends to limit individual exploration and deep reflection, making it less than optimal for developing originality and internalizing a growth mindset when compared to PBL (Mukuka & Alex, 2024; Odutayo & Fonseca, 2024). Practical implications: if learning objectives emphasize mathematical creativity, independent thinking, and the development of a growth mindset, then an ethnomathematics-based PBL is recommended. For optimal practice, teachers are advised to design culturally rooted, meaningful problems, facilitate independent and collaborative investigation phases, and provide time and mechanisms for reflection and formative feedback (Ahmad et al., 2023; Laia, 2024; Marbun, 2023; Rehman et al., 2023).

In summary, the series of stages in ethnomathematics PBL LKPD forms a learning ecosystem in which cultural context provides meaning (intrinsic motivation), open-ended problems provide room for exploration (creativity), and the research, presentation, reflection cycle fosters perseverance and self-regulation (GM). The combination of contextualization, problem solving, and reflective iteration explains why ethnomathematics-based PBL is effective in simultaneously improving MCTA and GM in students. Overall, these findings confirm that student-centered, culturally contextual, and problem-solving-based mathematics learning has significant potential in developing mathematical creativity and a growth mindset. This approach is relevant to addressing the challenges of 21st-century mathematics education, which demands creative, adaptive, and reflective thinking skills.

CONCLUSION

The findings of this study provide robust evidence that ethnomathematics-based Problem-Based Learning (PBL) "Baloy Adat Tidung" is significantly more effective in enhancing students' Mathematical Creative Thinking Ability (MCTA) and Growth Mindset (GM). At the same time, the ethnomathematics-based Student Teams Achievement Division (STAD) also yields meaningful, albeit comparatively lower, improvements in both domains. The superior effectiveness of PBL suggests that open-ended, contextual, and student-centered problem-based environments create broader cognitive and metacognitive spaces that facilitate the development of fluency, flexibility, originality, and elaboration, while concurrently reinforcing students' beliefs that mathematical competence is malleable and can be developed through sustained effort and reflective practice.

The integration of local cultural context into mathematics instruction demonstrably enriches the learning experience by bridging abstract mathematical concepts with students' sociocultural realities, thereby enhancing relevance, intrinsic motivation, and depth of conceptual understanding. In this respect, "Baloy Adat Tidung" functions not merely as a contextual representation but as a cultural anchor that enables more meaningful and reflective construction of mathematical knowledge.

From a theoretical standpoint, this study advances the field of culture-based mathematics education by providing empirical validation that integrating ethnomathematics and Problem-Based Learning constitutes a coherent and effective framework for simultaneously fostering cognitive (MCTA) and non-cognitive (GM) outcomes. More importantly, this study extends the scope of ethnomathematics by explicitly linking it with growth mindset theory, demonstrating that culturally contextualized learning environments play a critical role in shaping students' epistemic beliefs about learning and intelligence. Consequently, this study contributes to strengthening the theoretical integration between ethnomathematics and growth mindset within a social constructivist paradigm.

Practically, this study offers a substantive contribution to the design of innovative mathematics instruction by proposing an integrative model that synergizes local cultural context, problem-based pedagogy, and mindset development. This model provides a viable pedagogical reference for teachers to design learning environments that are contextual, meaningful, and student-centered, with the dual aim of enhancing mathematical competence and cultivating adaptive learning dispositions. Furthermore, the findings underscore the strategic importance of embedding authentic cultural contexts into classroom practice to promote student engagement and higher-order thinking.

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