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Enhancing elementary students' numeracy skills through a ngadhu bhaga ethnomathematics-based learning approach

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Abstract

Background: Numeracy is an essential skill that enables students to interpret and apply numerical information in everyday life. However, mathematics learning often lacks connections to students' cultural contexts, limiting the development of numeracy skills.
Aims: This study aims to examine the effectiveness of the Ngadhu Bhaga ethnomathematics-based learning approach in enhancing elementary students' numeracy skills and to explore students' learning experiences, teachers' perceptions, and teacher–student interactions during its implementation.
Method: This study employed a mixed-methods design with a post-test control group experiment. The participants were 40 fifth-grade students from Regina Pacis Bajawa Elementary School, Indonesia. Quantitative data were collected using numeracy tests, while qualitative data were obtained through questionnaires, interviews, and classroom observations.
Results: The findings show that students who learned through the Ngadhu Bhaga ethnomathematics-based approach achieved higher numeracy scores than those who learned through conventional instruction. The approach also promoted active participation, strengthened teacher–student interaction, and increased students' engagement in mathematics learning.
Conclusion: Integrating local cultural contexts through the Ngadhu Bhaga ethnomathematics approach can effectively support the development of elementary students' numeracy skills and create a more meaningful learning environment.

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INTRODUCTION

In contemporary education, numeracy has become an essential competence that students need in order to function effectively in an increasingly data-driven society (Sakurai & Goos, 2023). The ability to interpret numerical information, analyze quantitative relationships, and apply mathematical reasoning is not only important for academic achievement but also for everyday decision-making. Numeracy skills enable students to understand information presented in numerical form and to use mathematical thinking when dealing with practical situations in daily life (Hoogland, 2023; Reyna & Brainerd, 2023). For this reason, strengthening numeracy competence has become a central objective of mathematics education.

The development of numeracy skills is particularly important during the elementary school years. At this stage, students begin to build foundational mathematical understanding that supports their learning in subsequent levels of education. Early experiences in mathematics learning shape

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students' attitudes toward the subject and influence their confidence in solving mathematical problems. When students develop strong numeracy skills from an early age, they are more likely to approach mathematical tasks with greater confidence and are better prepared to apply mathematical reasoning in various contexts (Bittner & Bull, 2022).

However, many students still encounter difficulties in developing adequate numeracy skills (Díez-Palomar et al., 2023). In many classroom settings, mathematics learning tends to emphasize procedural calculations rather than conceptual understanding. As a result, students may be able to perform mathematical operations but experience difficulties when they are required to interpret numerical information or solve contextual problems. Such conditions indicate that mathematics instruction does not always provide meaningful learning experiences that support the development of numeracy competence (Koskinen & Pitkäniemi, 2022; Polman et al., 2021).

Another factor that influences students' numeracy development is the limited connection between mathematics instruction and students' real-life experiences. Mathematical concepts are frequently presented in abstract forms that are detached from students' social and cultural environments. When learning activities do not relate to students' everyday experiences, mathematics may appear distant and difficult to understand. This situation can reduce students' interest in mathematics learning and limit their opportunities to develop meaningful mathematical understanding (Bang et al., 2023; Hwang et al., 2021).

To respond to these challenges, mathematics education needs instructional approaches that make mathematical learning more relevant to students' lives (Barwell et al., 2022; Sachdeva & Eggen, 2021). One way to achieve this is by incorporating cultural contexts into mathematics instruction. Cultural traditions often contain activities that implicitly involve mathematical thinking, such as counting, measuring, comparing, and organizing spatial structures. Integrating cultural elements into mathematics learning may therefore provide meaningful learning experiences that help students develop stronger numeracy skills (Fanoga, 2025).

Meaningful mathematics learning is closely related to constructivist perspectives that view learning as an active process in which students construct knowledge through interaction with their environment. Within this perspective, students develop mathematical understanding when they engage in exploration, discussion, and reflection during learning activities. Learning environments that encourage participation and interaction allow students to develop deeper conceptual understanding rather than relying solely on memorized procedures (La Braca & Kalman, 2021). One approach that reflects these principles is ethnomathematics. Ethnomathematics examines the relationship between mathematics and cultural practices that exist within a community (Batiibwe, 2025). Cultural artifacts, traditions, and daily activities often embody mathematical ideas that can be explored as learning resources in mathematics education. By connecting formal mathematical concepts with cultural experiences, ethnomathematics allows students to perceive mathematics as something meaningful and closely related to their everyday lives. Learning activities that incorporate cultural contexts can also contribute to increased student engagement in mathematics (Anyichie, Butler, & Nashon, 2023; Lazarinis, 2025). When students encounter mathematical ideas within familiar cultural practices, they may find learning more meaningful and easier to understand. In addition, culturally contextualized learning environments can encourage students to participate actively in discussions and collaborative problem-solving activities, which may support the development of numeracy skills.

Although ethnomathematics has attracted increasing attention in mathematics education, the integration of specific cultural contexts into classroom instruction remains relatively limited (Kyeremeh et al., 2025; Lidinillah et al., 2022). Many studies discuss the potential of ethnomathematics as a culturally responsive approach to mathematics learning. However, fewer

studies provide detailed explanations of how particular cultural traditions can be systematically integrated into classroom activities that support the development of numeracy skills (Daucourt et al., 2021). Within the Indonesian context, cultural traditions provide rich opportunities to explore mathematical ideas embedded in everyday practices. Nevertheless, many cultural elements that contain implicit mathematical concepts have not yet been widely utilized as part of mathematics learning. One example is the Ngadhu Bhaga cultural tradition of the Ngada community in Flores. This cultural symbol represents important social and cultural values and includes activities that reflect mathematical thinking, yet its potential as a context for mathematics learning has not been widely explored (Dede et al., 2021; Hunter, 2021). In addition, previous studies frequently focus primarily on learning outcomes without examining other dimensions of the learning process (Mejía-Rodríguez & Kyriakides, 2022). As a result, there is still limited understanding of how ethnomathematics-based learning influences students' learning experiences, teachers' perceptions, and classroom interactions during the learning process.

Considering the potential of ethnomathematics to connect mathematical concepts with cultural practices, integrating local cultural contexts into mathematics learning may provide meaningful learning opportunities for students (Batiibwe, 2025; Payadnya et al., 2025). Cultural traditions can serve as contextual learning resources that help students understand mathematical ideas through experiences that are familiar within their community (Kurniawan et al., 2023). The Ngadhu Bhaga cultural tradition represents an important cultural heritage of the Ngada community and reflects various activities that involve mathematical reasoning. Exploring these cultural elements within mathematics instruction may help students develop a deeper understanding of mathematical concepts while strengthening their awareness of local cultural values. Investigating the use of the Ngadhu Bhaga ethnomathematics-based learning approach is therefore important for understanding how cultural contexts can support the development of students' numeracy skills. This approach has the potential to create learning environments that are both meaningful and relevant to students' everyday experiences.

Based on the issues described above, this study aims to examine the implementation of a Ngadhu Bhaga ethnomathematics-based learning approach in mathematics instruction. The study seeks to understand how the integration of cultural contexts influences students' learning experiences, teachers' perceptions, and teacher–student interactions during mathematics learning. In addition, the study aims to evaluate the effectiveness of this learning approach in enhancing elementary students' numeracy skills within culturally meaningful learning environments.

METHOD

Research Design

This study adopted a mixed-methods approach to examine the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach and its potential contribution to improving elementary students' numeracy skills. The quantitative component employed an experimental design with a post-test control group structure to compare students' numeracy performance between two instructional conditions. One group of students learned mathematics through an ethnomathematics-based approach that integrated cultural elements related to the Ngadhu Bhaga tradition, while the other group experienced conventional lecture-based instruction.

Alongside the quantitative analysis, qualitative data were also collected to gain a deeper understanding of the learning process that occurred during the implementation of the approach. These qualitative data helped capture students' learning experiences, teachers' perceptions, and classroom interactions. By combining both types of data, the study aimed to provide a more

comprehensive understanding of how the Ngadhu Bhaga ethnomathematics-based approach functioned in the classroom and how it influenced students' numeracy development.

Participants

The participants involved in this study were fifth-grade students from Regina Pacis Bajawa Elementary School located in Flores, East Nusa Tenggara, Indonesia. In total, 40 students participated in the research and were organized into two existing classes. The research site was selected purposively because the cultural context of the Ngada community is closely related to the Ngadhu Bhaga tradition, which served as the ethnomathematical context explored in this study. The two classes were assigned as the experimental group and the control group. Students in the experimental class participated in mathematics learning activities designed using the Ngadhu Bhaga ethnomathematics approach, whereas students in the control class received instruction through conventional teaching methods commonly used in the school. Both classes were assumed to have relatively similar academic backgrounds. Therefore, the study employed a post-test control group design without conducting a pre-test.

Research Procedure

The study was conducted through several sequential stages, including research preparation, participant selection, learning implementation, data collection, and data analysis. The overall research procedure is presented in Figure 1.

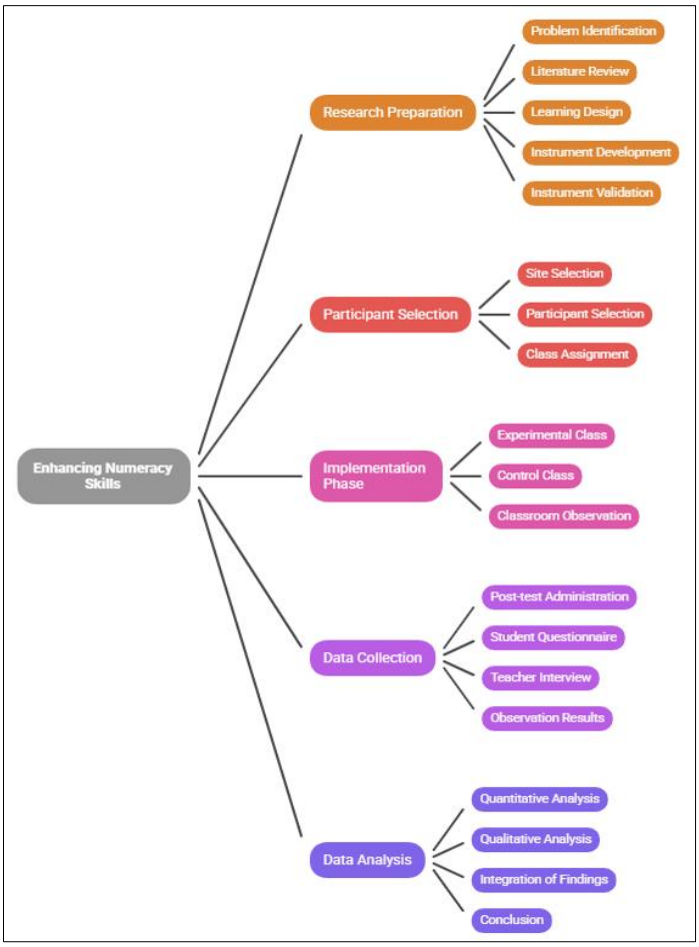

Figure 1. Flowchart of the research procedure

During the preparation stage, the researchers first identified the research problem and reviewed relevant literature related to numeracy skills and ethnomathematics in mathematics education. Based on this review, a learning design integrating the Ngadhu Bhaga ethnomathematical

context was developed. In addition, several research instruments were prepared, including numeracy test items, questionnaires, observation sheets, and interview guidelines. Before being used in the study, the instruments were reviewed and validated by an elementary school teacher and a mathematics education lecturer to ensure their clarity and appropriateness.

The next stage involved selecting the research site and determining the participants. Two classes were then assigned to serve as the experimental and control groups. The experimental class implemented mathematics learning activities that incorporated cultural contexts derived from the Ngadhu Bhaga tradition, while the control class followed conventional mathematics instruction.

Following participant assignment, the implementation phase of the learning activities was conducted. In the experimental class, mathematical concepts were introduced through contexts connected to the Ngadhu Bhaga cultural tradition in order to create meaningful learning experiences. Meanwhile, students in the control class studied the same mathematical topics through traditional lecture-based instruction. Classroom observations were carried out during this stage to document teacher–student interactions and learning activities.

After the learning activities were completed, data collection was conducted. Students in both groups completed a numeracy post-test designed to measure their ability to apply mathematical concepts in contextual situations. Students also completed a questionnaire that explored their learning experiences during the instructional process. In addition, the teacher involved in the study participated in interviews to provide insights regarding the implementation of the ethnomathematics-based learning approach.

Instruments

Several instruments were used to collect both quantitative and qualitative data. The primary instrument used to measure students' numeracy skills was a numeracy test consisting of ten multiple-choice items. These items were designed to evaluate students' ability to interpret and apply mathematical ideas within contexts related to the Ngadhu Bhaga cultural tradition. To explore students' learning experiences, a questionnaire consisting of ten items was administered after the completion of the learning activities. The questionnaire aimed to capture students' perceptions of the learning process, their engagement during classroom activities, and their understanding of the mathematical concepts introduced through the ethnomathematical context. Semi-structured interviews were conducted with the teacher involved in the learning process to obtain deeper insights into the implementation of the approach. In addition, classroom observations were conducted using an observation sheet consisting of ten indicators designed to document interactions between teachers and students during mathematics learning. Before being used in the study, the research instruments were reviewed by an elementary school teacher and a mathematics education lecturer. This process ensured that the instruments were appropriate for the research context and that the questions could be clearly understood by the students.

Data Analysis

The data obtained in this study were analyzed using both quantitative and qualitative techniques. Quantitative data derived from the numeracy test were analyzed using descriptive statistical methods to determine the mean score, variance, and standard deviation of students' numeracy performance in both the experimental and control groups. To determine whether there was a significant difference between the two groups, an independent samples t-test was conducted. Prior to performing the t-test, Levene's test was applied to examine the homogeneity of variance between the groups. Qualitative data collected through questionnaires, interviews, and classroom observations were analyzed using descriptive qualitative analysis. The researchers examined students' responses, observation notes, and interview transcripts to identify patterns related to

students' learning experiences, teachers' perceptions, and classroom interactions during the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach.

RESULTS AND DISCUSSION

Results

This section presents the findings of the study related to students' learning experiences, teacher student interactions during the learning process, and the effectiveness of the Ngadhu Bhaga ethnomathematics-based learning approach in enhancing students' numeracy skills. The results are described based on both qualitative and quantitative analyses obtained during the implementation of the learning activities.

Students' Learning Experiences

Students' learning experiences during the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach were examined using a questionnaire distributed to students in the experimental class. The questionnaire consisted of ten items designed to explore students' perceptions of the learning activities, their engagement during the lessons, and their understanding of mathematical concepts introduced through the ethnomathematical context.

The responses indicate that students generally perceived the learning experience very positively. Most students reported that the learning activities helped them understand mathematical concepts more easily because the problems and examples were connected to cultural contexts familiar to them. The integration of cultural elements appeared to make the learning activities more meaningful and engaging for students. Overall, 95% of the students selected "strongly agree," while 5% selected "agree" in response to the questionnaire items. These results suggest that the Ngadhu Bhaga ethnomathematics-based learning approach was able to create a supportive learning environment that encouraged students to participate actively in the learning process.

A summary of the mean scores related to students' learning experiences, teacher perceptions, and teacher student interactions is presented in Figure 2.

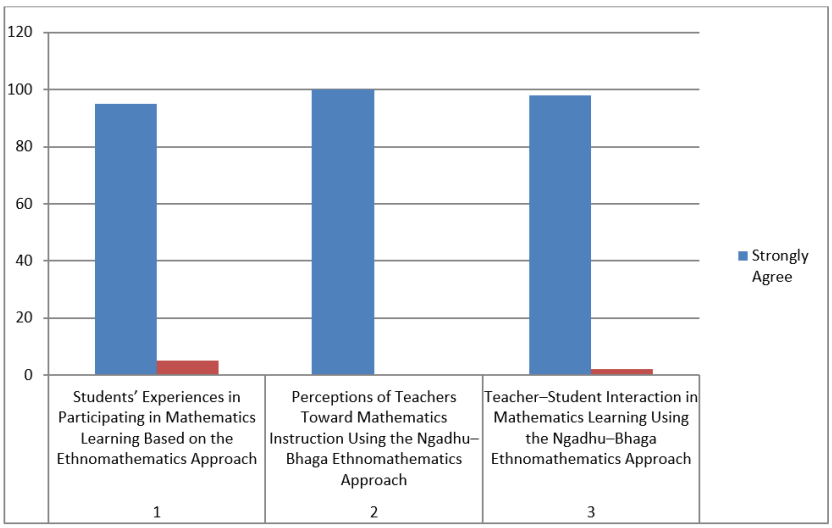

Figure 2. Summary of mean scores for students' learning experiences, teacher perceptions, and teacher student interactions in mathematics learning using the Ngadhu Bhaga ethnomathematics approach.

As illustrated in Figure 2, the implementation of the ethnomathematics-based learning approach resulted in high mean scores across the observed aspects. These results indicate that the learning activities were perceived positively by both students and teachers. The use of cultural contexts in mathematics learning appeared to strengthen students' engagement and create more interactive learning situations in the classroom.

Teacher–Student Interaction

Teacher–student interaction during the implementation of the learning activities was examined through classroom observations. The observation instrument consisted of ten indicators designed to assess communication patterns, student participation, and teacher guidance during mathematics learning.

The observation results show that the level of interaction during the learning process was very high. Specifically, 98% of the observation indicators were categorized as "strongly agree," while 2% were categorized as "agree." These findings indicate that the ethnomathematics-based learning approach encouraged active interaction between teachers and students during classroom learning.

During the learning activities, students demonstrated a high level of participation in classroom discussions. They actively responded to questions posed by the teacher and were willing to share their ideas when discussing mathematical problems related to the Ngadhu Bhaga cultural context. Teachers also played an important role in facilitating the learning process by guiding students' discussions and encouraging them to explore mathematical ideas independently.

The observation results suggest that the integration of cultural contexts into mathematics instruction helped create a more interactive learning environment, where students felt comfortable expressing their thoughts and participating in problem-solving activities.

Students' Numeracy Skills

To examine the effectiveness of the Ngadhu Bhaga ethnomathematics-based learning approach in improving students' numeracy skills, students' post-test scores from the experimental and control groups were analyzed using descriptive statistical techniques. The summary of the descriptive statistics results is presented in Table 1.

Table 1. Summary of descriptive statistics and inferential statistics results after post-tests in the experimental group and control group

	Eksperimen			**Kontrol**		
	Pre Test	Post Tes	N Gain Score	Pre Test	Post Tes	N Gain Score
N	20	20	20	20	20	22
Mean	45,33	81,14	0,75	45,33	63,50	0,47
Varians	65,86	43,21	0,86	53,43	68,33	0,51
Standar Deviasi	7,71	6,45	0,213	6,78	5,86	0,013

The descriptive statistics show that the experimental group consisted of 20 students who learned mathematics through the Ngadhu Bhaga ethnomathematics-based learning approach. The control group also consisted of 20 students who received conventional mathematics instruction. The mean score obtained by the experimental group was 81.14, with a standard deviation of 6.45, whereas the control group obtained a mean score of 63.50, with a standard deviation of 5.86.

These results indicate that students who participated in the ethnomathematics-based learning approach achieved higher numeracy scores compared with students who learned through conventional teaching methods. In addition, the N-gain score obtained by the experimental group (0.75) was higher than that of the control group (0.47), indicating greater improvement in students' numeracy skills after the implementation of the learning approach. To further determine whether the difference between the two groups was statistically significant, an independent samples t-test was conducted. The results of the inferential statistical analysis are presented in Table 2.

Table 2. Summary of inferential statistics results after the post-test in the experimental and control groups

Group	N	Mean	SD	t	df	p
Experimental	20	81.14	6.45	8.73	38	.000
Control	20	63.50	5.86			

The results of the independent samples t-test indicate that the significance value (Sig. 2-tailed) is 0.000, which is lower than the significance level of 0.05. This finding indicates that there is a statistically significant difference between the numeracy scores of students in the experimental group and those in the control group.

Overall, these findings suggest that the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach contributed positively to improving elementary students' numeracy skills.

Discussion

The findings of this study demonstrate that the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach contributed positively to the development of elementary students' numeracy skills. Students who participated in learning activities that incorporated cultural contexts achieved higher numeracy scores compared with those who experienced conventional instruction. In addition to the quantitative improvement observed in students' test results, the qualitative findings also reveal that the learning approach fostered more meaningful learning experiences and encouraged active participation during mathematics instruction.

One important factor that may explain these results is the contextual nature of the learning activities. When mathematical ideas are introduced through cultural practices that are familiar to students, the concepts become easier to interpret and relate to everyday experiences [citation needed]. In this study, the Ngadhu Bhaga cultural context provided meaningful situations through which students could explore mathematical ideas. As a result, students were able to connect abstract mathematical concepts with concrete cultural experiences, which supported their understanding of numerical relationships and problem-solving processes (Torres-Peña et al., 2025).

The positive responses reported by students further suggest that culturally contextualized learning environments can increase students' engagement in mathematics learning (Anyichie, Butler, Perry, et al., 2023). The questionnaire results indicate that most students perceived the learning activities as interesting and relevant to their daily lives. When mathematical problems reflect situations that students recognize within their own cultural environment, they tend to participate more actively in classroom discussions and learning activities. Such participation is an important element in the development of numeracy skills because it encourages students to express their reasoning, evaluate different ideas, and reflect on their understanding of mathematical concepts (Mukuka et al., 2023).

The classroom observation results also highlight the role of teacher–student interaction in supporting the learning process (Ong & Quek, 2023). During the implementation of the ethnomathematics-based learning activities, students were frequently involved in discussions related to the cultural contexts presented in the lesson. Teachers facilitated these discussions by guiding students to interpret the cultural elements from a mathematical perspective. This interaction created a learning environment where students felt encouraged to share their ideas and ask questions, which contributed to a more dynamic learning atmosphere (Rusticus et al., 2023).

From a broader perspective, the findings of this study illustrate how ethnomathematics can serve as a bridge between formal mathematics and cultural knowledge within a community. Mathematics is often perceived by students as abstract and disconnected from their everyday experiences. By integrating cultural traditions such as the Ngadhu Bhaga practice into mathematics

instruction, the learning process becomes more meaningful because students can see how mathematical ideas are embedded in cultural activities. This connection helps students develop a deeper understanding of mathematical concepts while simultaneously strengthening their awareness of local cultural values (Kurniawan et al., 2023).

Another important implication of the findings is related to the role of culture in mathematics education. Incorporating local cultural knowledge into mathematics learning not only supports the development of cognitive skills such as numeracy but also contributes to the preservation of cultural heritage (Tomora & Jirata, 2025). When students learn mathematics through cultural contexts, they become more aware of the cultural traditions within their community and develop a sense of appreciation for these traditions. In this way, ethnomathematics-based learning can support both educational and cultural objectives simultaneously (Marsigit et al., 2025).

Despite the positive outcomes observed in this study, several limitations should be considered when interpreting the results. The research involved a relatively small number of participants from a single elementary school, which may limit the extent to which the findings can be generalized to other educational contexts. Furthermore, the learning intervention was implemented over a limited period of time, which means that the long-term impact of the ethnomathematics-based approach on students' numeracy development has not yet been fully explored.

Future studies may expand this line of research by investigating the implementation of ethnomathematics-based learning approaches in different cultural contexts and educational levels (Pratama & Yelken, 2024). Additional research could also examine how teachers design culturally contextualized learning activities and how such approaches influence other mathematical competencies beyond numeracy skills (Rubel & McCloskey, 2021). Exploring these aspects may provide a deeper understanding of how cultural knowledge can be integrated into mathematics education to support students' learning in meaningful ways.

Implications

The results of this study highlight the potential value of incorporating cultural contexts into mathematics learning at the elementary school level. The use of the Ngadhu Bhaga ethnomathematics-based learning approach shows that mathematical ideas can be introduced through cultural practices that are already familiar within students' communities. When mathematics is presented in ways that relate to students' cultural experiences, the learning process becomes more meaningful and accessible. This contextual connection appears to encourage students to participate more actively in classroom activities while also supporting their understanding of numerical relationships. From a practical perspective, these findings suggest that teachers may benefit from integrating elements of local culture into mathematics instruction in order to create learning environments that are both engaging and relevant to students' everyday lives. At the same time, the integration of cultural knowledge into classroom learning may contribute to strengthening students' awareness of the cultural traditions that exist within their communities.

Limitations

Although the findings of this study indicate positive outcomes from the implementation of the Ngadhu Bhaga ethnomathematics-based learning approach, several limitations should be considered. The study involved a relatively small group of participants drawn from a single elementary school, which means that the results may not fully represent conditions in other schools or cultural settings. Differences in cultural backgrounds, educational environments, and teaching practices may influence how similar approaches function in other contexts. In addition, the learning intervention was conducted within a limited time frame, making it difficult to observe the long-term influence of the approach on students' numeracy development. The focus of the study was also limited to numeracy skills, so other aspects of mathematical competence were not examined in detail.

These factors suggest that the results should be interpreted within the scope of the study's design and context.

Suggestions

Further studies are encouraged to explore the use of ethnomathematics-based learning approaches in a wider range of educational contexts. Research involving larger samples from different schools and cultural communities may provide a deeper understanding of how culturally contextualized mathematics learning influences students' mathematical development. Future investigations could also examine the impact of such approaches on other mathematical competencies, including problem-solving ability, mathematical reasoning, and students' attitudes toward mathematics learning. In addition, studies focusing on how teachers design and implement culturally based mathematical activities may help identify practical strategies for integrating cultural knowledge into classroom instruction. Expanding research in these directions may contribute to the development of mathematics learning models that connect academic knowledge with cultural experiences in meaningful ways.

CONCLUSION

This study explored how mathematics learning that incorporates the Ngadhu Bhaga ethnomathematical context can support the development of numeracy skills among elementary school students. The results show that learning activities grounded in cultural contexts can provide meaningful situations through which students interpret and apply mathematical ideas. Students who experienced mathematics instruction through the Ngadhu Bhaga ethnomathematics-based approach demonstrated stronger numeracy performance compared with those who learned through conventional instruction. Beyond the improvement in test results, the learning process also appeared to encourage more active participation and richer interaction between teachers and students during classroom activities. When mathematical ideas were connected to cultural experiences familiar to students, the learning environment became more engaging and accessible. These findings suggest that integrating local cultural knowledge into mathematics instruction can help bridge the gap between abstract mathematical concepts and students' everyday experiences. In this way, ethnomathematics-based learning may contribute not only to the development of students' numeracy abilities but also to the recognition of cultural knowledge as a meaningful resource within mathematics education.

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AUTHOR CONTRIBUTIONS STATEMENT

Melkior Wewe was responsible for conceptualizing the study, designing the research framework, collecting and analyzing the data, interpreting the findings, and preparing the initial draft of the manuscript. Maria E. Bela contributed to reviewing the research design, revising the manuscript, and providing critical feedback to improve the clarity and quality of the study. Maria C. T. Wangge assisted in the data collection process, supported the interpretation of the research findings, and contributed to revising the manuscript. Wilibalduss Bhoke contributed to the

development of the research instruments, assisted in analyzing the research results, and participated in editing the final version of the manuscript. All authors have read and approved the final version of the manuscript.

REFERENCES

Anyichie, A. C., Butler, D. L., & Nashon, S. M. (2023). Exploring Teacher Practices for Enhancing Student Engagement in Culturally Diverse Classrooms. *Journal of Pedagogical Research*, *7*(5), 183–207.

Anyichie, A. C., Butler, D. L., Perry, N. E., & Nashon, S. M. (2023). Examining Classroom Contexts in Support of Culturally Diverse Learners' Engagement: An Integration of Self-Regulated Learning and Culturally Responsive Pedagogical Practices. *Frontline Learning Research*, *11*(1), 1–39. https://doi.org/10.14786/flr.v11i1.1115

Bang, H. J., Li, L., & Flynn, K. (2023). Efficacy of an Adaptive Game-Based Math Learning App to Support Personalized Learning and Improve Early Elementary School Students' Learning. *Early Childhood Education Journal*, *51*(4), 717–732. https://doi.org/10.1007/s10643-022-01332-3

Barwell, R., Boylan, M., & Coles, A. (2022). Mathematics education and the living world: A dialogic response to a global crisis. *The Journal of Mathematical Behavior*, *68*, 101013. https://doi.org/10.1016/j.jmathb.2022.101013

Batiibwe, M. S. K. (2025a). Ethnomathematics as a pedagogical tool for mathematics education: Opportunities and challenges. *SN Social Sciences*, *5*(12), 221. https://doi.org/10.1007/s43545-025-01260-0

Batiibwe, M. S. K. (2025b). Ethnomathematics as a pedagogical tool for mathematics education: Opportunities and challenges. *SN Social Sciences*, *5*(12), 221. https://doi.org/10.1007/s43545-025-01260-0

Bittner, K., & Bull, R. (2022). Understanding educator attitudes towards and perceptions of mathematics in early childhood. *Journal of Early Childhood Research*, *20*(3), 341–356. https://doi.org/10.1177/1476718X211052785

Daucourt, M. C., Napoli, A. R., Quinn, J. M., Wood, S. G., & Hart, S. A. (2021). The home math environment and math achievement: A meta-analysis. *Psychological Bulletin*, *147*(6), 565–596. https://doi.org/10.1037/bul0000330

Dede, Y., Akçakın, V., & Kaya, G. (2021). Mathematical, Mathematics Educational, and Educational Values in Mathematical Modeling Tasks. *ECNU Review of Education*, *4*(2), 241–260. https://doi.org/10.1177/2096531120928089

Díez-Palomar, J., Ramis-Salas, M., Močnik, I., Simonič, M., & Hoogland, K. (2023). Challenges for numeracy awareness in the 21st century: Making visible the invisible. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1295781

Fanoga, S. (2025). A Literature Review of Multicultural Approaches in Mathematics Education: Integrating Culture, Equity, and Pedagogical Practices. *Journal of Education, Learning, and Management*, *2*(2), 406–415. https://doi.org/10.69739/jelm.v2i2.1241

Hoogland, K. (2023). The changing nature of basic skills in numeracy. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1293754

Hunter, J. (2021). An Intersection of Mathematics Educational Values and Cultural Values: Pāsifika Students' Understanding and Explanation of Their Mathematics Educational Values. *ECNU Review of Education*, *4*(2), 307–326. https://doi.org/10.1177/2096531120931106

Hwang, W.-Y., Hariyanti, U., Abdillah, Y. A., & Chen, H. S. L. (2021). Exploring Effects of Geometry Learning in Authentic Contexts Using Ubiquitous Geometry App. *Educational Technology & Society*, *24*(3), 13–28.

Koskinen, R., & Pitkäniemi, H. (2022). Meaningful Learning in Mathematics: A Research Synthesis of Teaching Approaches. *International Electronic Journal of Mathematics Education*, *17*(2). https://doi.org/10.29333/iejme/11715

Kurniawan, H., Purwoko, R. Y., & Setiana, D. S. (2023a). Integrating cultural artifacts and tradition from remote regions in developing mathematics lesson plans to enhance mathematical

literacy. *Journal of Pedagogical Research*, *8*(1), 61–74. https://doi.org/10.33902/JPR.202423016

Kurniawan, H., Purwoko, R. Y., & Setiana, D. S. (2023b). Integrating cultural artifacts and tradition from remote regions in developing mathematics lesson plans to enhance mathematical literacy. *Journal of Pedagogical Research*, *8*(1), 61–74. https://doi.org/10.33902/JPR.202423016

Kyeremeh, P., Kwadwo Awuah, F., & Clark Orey, D. (2025). Challenges regarding the integration of ethnomathematical perspectives into geometry teaching: The faculty reflection. *Asian Journal for Mathematics Education*, *4*(3), 416–430. https://doi.org/10.1177/27527263251326330

La Braca, F., & Kalman, C. S. (2021). Comparison of labatorials and traditional labs: The impacts of instructional scaffolding on the student experience and conceptual understanding. *Physical Review Physics Education Research*, *17*(1), 010131. https://doi.org/10.1103/PhysRevPhysEducRes.17.010131

Lazarinis, F. (2025). Embedding Math Problems in Cultural City Tours to Increase Student Engagement and Inclusion. *Education Sciences*, *15*(12), 1683. https://doi.org/10.3390/educsci15121683

Lidinillah, D. A. M., Rahman, R., Wahyudin, W., & Aryanto, S. (2022). Integrating sundanese ethnomathematics into mathematics curriculum and teaching: A systematic review from 2013 to 2020. *Infinity Journal*, *11*(1), 33–54. https://doi.org/10.22460/infinity.v11i1.p33-54

Marsigit, Irfan, M., & Sukoco, H. (2025). Evaluation of pedagogical quality in ethnomathematics learning practices. *Discover Education*, *5*(1), 25. https://doi.org/10.1007/s44217-025-01026-z

Mejía-Rodríguez, A. M., & Kyriakides, L. (2022). What matters for student learning outcomes? A systematic review of studies exploring system-level factors of educational effectiveness. *Review of Education*, *10*(3), e3374. https://doi.org/10.1002/rev3.3374

Mukuka, A., Balimuttajjo, S., & Mutarutinya, V. (2023). Teacher efforts towards the development of students' mathematical reasoning skills. *Heliyon*, *9*(4). https://doi.org/10.1016/j.heliyon.2023.e14789

Ong, S. G. T., & Quek, G. C. L. (2023). Enhancing teacher–student interactions and student online engagement in an online learning environment. *Learning Environments Research*, *26*(3), 681–707. https://doi.org/10.1007/s10984-022-09447-5

Payadnya, I. P. A. A., Putri, G. A. M. A., Suwija, I. K., Saelee, S., & Jayantika, I. G. A. N. T. (2025). Cultural integration in AI-enhanced mathematics education: Insights from Southeast Asian educators. *Journal for Multicultural Education*, *19*(1), 58–72. Scopus. https://doi.org/10.1108/JME-09-2024-0119

Polman, J., Hornstra, L., & Volman, M. (2021). The meaning of meaningful learning in mathematics in upper-primary education. *Learning Environments Research*, *24*(3), 469–486. https://doi.org/10.1007/s10984-020-09337-8

Pratama, R. A., & Yelken, T. Y. (2024). Effectiveness of ethnomathematics-based learning on students' mathematical literacy: A meta-analysis study. *Discover Education*, *3*(1), 202. https://doi.org/10.1007/s44217-024-00309-1

Reyna, V. F., & Brainerd, C. J. (2023). Numeracy, gist, literal thinking and the value of nothing in decision making. *Nature Reviews Psychology*, *2*(7), 421–439. https://doi.org/10.1038/s44159-023-00188-7

Rubel, L. H., & McCloskey, A. V. (2021). Contextualization of mathematics: Which and whose world? *Educational Studies in Mathematics*, *107*(2), 383–404. https://doi.org/10.1007/s10649-021-10041-4

Rusticus, S. A., Pashootan, T., & Mah, A. (2023). What are the key elements of a positive learning environment? Perspectives from students and faculty. *Learning Environments Research*, *26*(1), 161–175. https://doi.org/10.1007/s10984-022-09410-4

Sachdeva, S., & Eggen, P.-O. (2021). Learners' Critical Thinking About Learning Mathematics. *International Electronic Journal of Mathematics Education*, *16*(3), em0644. https://doi.org/10.29333/iejme/11003

Sakurai, J., & Goos, M. (2023). Revisiting tools in numeracy learning: The role of authentic digital tools. *Frontiers in Education*, *8*. https://doi.org/10.3389/feduc.2023.1291407

Tomora, D. D., & Jirata, T. J. (2025). Indigenous knowledge and its contribution to early childhood numeracy development. *SN Social Sciences*, *5*(4), 43. https://doi.org/10.1007/s43545-025-01077-x

Torres-Peña, R. C., Peña-González, D., Lara-Orozco, J. L., Ariza, E. A., & Vergara, D. (2025). Enhancing Numerical Thinking Through Problem Solving: A Teaching Experience for Third-Grade Mathematics. *Education Sciences*, *15*(6), 667. https://doi.org/10.3390/educsci15060667