

ETHNOMATHEMATICS BASED MPA'A GOPA GAME LEARNING MEDIA TO IMPROVE MATHEMATICAL LITERACY AND CULTURAL CHARACTER

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Abstract

Mathematics plays a crucial role in developing students' problem-solving, reasoning, and communication skills. Students in Indonesia, particularly in Bima Regency, still face challenges with low mathematical literacy. This problem is often attributed to limited classroom engagement and the dominance of teacher-centered approaches, which hinder students from bridging conceptual understanding with real-world applications. To address this gap, ethnomathematics-based learning offers an innovative approach by contextualizing mathematical concepts through local culture. This study aims to develop and evaluate mathematics learning media based on the traditional game Mpa'a Gopa, integrating cultural identity and mathematical concepts to improve students' literacy and character. This study adopted the 4D development model (Define, Design, Develop, Disseminate) and was conducted with 20 fourth-grade students of SD Negeri 2 Maria. Data were collected through expert validation sheets, student questionnaires, teacher and student observation sheets, pretest-posttest assessments to measure validity, practicality, and effectiveness. The results showed that the developed media met all quality standards; Expert validation rated the product as good to excellent, while student responses were very positive, with 99% agreeing that the media increased motivation and understanding. Teacher and student observations indicated smooth implementation in the classroom. The average student score increased from 66.19 (pre-test) to 82.23 (post-test), the mastery level increased from 52.38% to 90.47%, and the N-Gain score of 0.60 was categorized as moderate. In conclusion, ethnomathematics-based traditional games in mathematics learning not only strengthen students' mathematical literacy and motivation but also increase cultural awareness, making Mpa'a Gopa a meaningful learning tool and cultural preservation strategy.

Keywords: Ethnomathematics, Game Based Learning, Mathematical Literacy, Cultural Character, Traditional Games

Abstrak

Matematika memainkan peran penting dalam mengembangkan keterampilan pemecahan masalah, penalaran, dan komunikasi siswa. Pelajar di Indonesia khususnya Kabupaten Bima, masih menghadapi tantangan dengan literasi matematika yang rendah. Masalah ini sering dikaitkan dengan keterlibatan terbatas di kelas dan dominasi pendekatan yang berpusat pada guru, yang menghambat siswa menjembatani pemahaman konseptual dengan aplikasi dunia nyata. Untuk mengatasi kesenjangan ini, pembelajaran berbasis etnomatematika menawarkan pendekatan inovatif dengan mengontekstualisasikan konsep matematika melalui budaya lokal. Penelitian ini bertujuan untuk mengembangkan dan mengevaluasi media pembelajaran matematika berbasis permainan tradisional Mpa'a Gopa, mengintegrasikan identitas budaya dan konsep matematika untuk meningkatkan literasi dan karakter siswa. Penelitian ini mengadopsi model pengembangan 4D (*Define, Design, Develop, Disseminate*) dan dilakukan dengan 20 siswa kelas empat SD Negeri 2 Maria. Data dikumpulkan melalui lembar validasi ahli, kuesioner siswa, lembar observasi guru dan siswa, penilaian pretest-posttest untuk mengukur validitas, kepraktisan, dan efektivitas. Hasil penelitian menunjukkan bahwa media yang dikembangkan memenuhi semua standar kualitas; Validasi pakar menilai produk dari baik hingga sangat baik, sementara respons siswa sangat positif, dengan 99% setuju bahwa media meningkatkan motivasi dan pemahaman. Observasi guru dan siswa menunjukkan kelancaran implementasi di kelas. Skor rata-rata siswa meningkat dari 66,19 (tes awal) menjadi 82,23 (tes akhir), tingkat penguasaan meningkat dari 52,38% menjadi 90,47%, dan skor N-Gain sebesar 0,60 dikategorikan sedang. Kesimpulannya, permainan tradisional berbasis etnomatematika

dalam pembelajaran matematika tidak hanya memperkuat literasi matematika dan motivasi siswa, tetapi juga meningkatkan kesadaran budaya, menjadikan Mpa'a Gopa sebagai alat pembelajaran yang bermakna dan strategi pelestarian budaya.

Kata kunci: Etnomatematika, Pembelajaran Berbasis Permainan, Literasi Matematika, Karakter Budaya, Permainan Tradisional

INTRODUCTION

Mathematics is a fundamental science that plays a crucial role in developing students' critical thinking, problem-solving, and reasoning abilities. It is not only concerned with numbers and formulas but also involves understanding concepts and applying them in real-life situations. According to Hui and Mahmud (2023), mathematics is an essential skill for facing the challenges of the 21st century, where students are required to develop higher-order thinking skills, creativity, and adaptability. However, various national and international assessments indicate that students' mathematical literacy in Indonesia is still relatively low.

Based on the Programme for International Student Assessment (PISA) 2018 results, Indonesia ranked 72nd out of 79 participating countries in mathematics literacy, with an average score of only 379, far below the OECD average of 489 (OECD, 2019). This data shows that Indonesian students have difficulty connecting mathematical concepts with real-life situations. Similarly, the results of the Trends in International Mathematics and Science Study (TIMSS) 2019 revealed that Indonesia ranked 45th out of 58 countries, indicating that students' problem-solving abilities are still limited (Mullis et al., 2020). These findings highlight the urgent need for innovative learning approaches to improve mathematical literacy.

One of the causes of low mathematical literacy is the dominance of teacher-centered learning methods. Teachers often rely on lectures and rote memorization, leading students to focus only on formulas without understanding the underlying concepts (Budarsini et al., 2018). As a result, students become passive learners and struggle to relate mathematics to real-life contexts. Shifting towards student-centered, contextual learning models is necessary to foster active participation and deeper conceptual understanding.

An effective approach to overcoming these challenges is to integrate ethnomathematics into mathematics learning. Ethnomathematics, as recently reviewed, refers to the relationship between culture and mathematics and how mathematical concepts are embedded in cultural practices, traditions, and daily life. For example, a literature review

by Batiibwe (2024) found that cultural games, weaving, buildings, meals, and local number systems frequently embody mathematical ideas and that embedding these in school mathematics enhances students' reasoning, creativity, and problem-solving. Studies such as Unu and Santoso (2025) show that using culturally contextualized instruction significantly improves students' ability to express mathematical ideas in verbal, symbolic, and visual forms. Through this approach, mathematics becomes more meaningful because students can relate abstract concepts to real-world cultural contexts (Agustin et al., 2022).

Indonesia, as a culturally rich nation, has a wealth of traditions and local games that can be used as learning resources. One example is the Mpa'a Gopa traditional game from Bima, West Nusa Tenggara, which contains elements of counting, geometry, and strategy that can be linked to mathematical concepts. Utilizing such cultural elements in learning can increase student engagement, foster appreciation of local traditions, and enhance mathematical literacy (Sholihah et al., 2021).

In addition to improving mathematical literacy, ethnomathematics-based learning can strengthen students' cultural character. According to Khatimah and Fatimah (2023), integrating local cultural values into learning helps preserve cultural heritage and instills a sense of identity and pride in students. It also aligns with the objectives of the Indonesian national curriculum, which emphasizes character education alongside cognitive skills development.

However, the integration of ethnomathematics into mathematics education remains limited. Many teachers are not yet familiar with how to design innovative learning media that combine mathematical concepts with cultural practices. Developing effective learning media based on traditional games like Mpa'a Gopa is therefore crucial to bridging this gap and achieving meaningful mathematics learning.

This study aims to develop, validate, and evaluate ethnomathematics-based learning media using the Mpa'a Gopa traditional game to improve mathematical literacy and strengthen cultural character. The research focuses on designing instructional materials that are valid, practical, and effective in engaging students and enhancing learning outcomes.

METHODS

This study utilized a Research and Development (R&D) methodology by adopting the 4D development model, which includes four systematic stages: Define, Design, Develop, and

Disseminate. This model was chosen because it is suitable for developing innovative learning media based on local culture that are valid, practical, and effective. The Define stage involved analyzing students' needs, the curriculum, and learner characteristics. The Design stage included formulating learning objectives, designing the learning media based on the traditional Mpa'a Gopa game, and creating the initial prototype. The Develop stage consisted of expert validation, media revisions, and limited trials with students, while the Disseminate stage focused on socialization, implementation guidance, and publication of the research findings.

The participants of this study were 20 fourth-grade students from SD Negeri 2 Maria, Kota Bima, consisting of 9 male students and 11 female students. The class teacher was also involved in the learning process as a facilitator and provided input regarding the feasibility and practicality of the developed learning media.

Several research instruments were used to collect comprehensive data. Expert validation sheets were used to assess the validity of the learning media in terms of content, language, presentation, and cultural relevance. In addition, a student response questionnaire was distributed to evaluate the practicality of the media, including students' motivation, engagement, and ease of use. During the learning process, observation sheets for teachers and students were utilized to monitor lesson implementation and students' interactions with the media. Finally, pretest and posttest questions were administered to measure the effectiveness of the learning media in improving students' learning outcomes.

Data were analyzed based on three main aspects: validity, practicality, and effectiveness. Validity was determined by calculating the expert evaluation scores on the developed media. Practicality was analyzed using the results of lesson implementation observations and students' responses to the media. Meanwhile, effectiveness was measured by comparing students' pretest and posttest scores, followed by the calculation of the N-Gain. The effectiveness category in learning evaluation is often measured using the Normalized Gain (N-Gain) index, which classifies outcomes into three levels: high effectiveness if $N\text{-Gain} > 0.7$, moderate effectiveness if $0.3 \leq N\text{-Gain} \leq 0.7$, and low effectiveness if $N\text{-Gain} < 0.3$. Recent studies continue to apply and validate these thresholds. For instance, Nuraini et al. (2024) showed that the integration of digital comic media in environmental education achieved an average N-Gain of 0.58, which falls into the moderate effectiveness category.

Wahab & Azhar (2021) reported an N-Gain of 0.62 in statistics education, confirming its moderate effectiveness. These findings indicate that N-Gain remains a reliable benchmark for evaluating the impact of innovative learning strategies in recent educational research.

RESULTS AND DISCUSSION

Result

Define Stage

The define stage aimed to identify the fundamental learning problems and student needs. The preliminary observation revealed that students' mathematical literacy was still low, as indicated by the average pretest score of 66.19, with only 52.38% of students achieving mastery. Out of 20 students, 11 met the minimum criteria, while 9 did not. This implies that conventional teaching methods have not been sufficiently effective in motivating and engaging students.

Furthermore, curriculum analysis confirmed that the selected materials were in line with the fifth-grade mathematics competencies, especially basic operations and logical thinking. Student analysis also showed that they tend to learn better when engaged in concrete and playful activities. Therefore, integrating the local traditional game Mpa'a Gopa into mathematics lessons was considered relevant. This is consistent with) Husna, Samin, & Abidin (2021), who emphasized that local culture-based learning media can improve students' understanding as it relates to their daily life experiences.

Design Stage

In this stage, the learning media was designed by integrating mathematical content into the traditional game Mpa'a Gopa. The product was complemented with a student pocketbook, evaluation instruments, and teaching guidelines. The design emphasized clarity, language simplicity, and alignment with the curriculum, while also considering aesthetic aspects such as color, layout, and attractiveness.

The design process also included the preparation of validation sheets, student questionnaires, observation forms, and test instruments to measure effectiveness. Stated, the design stage is crucial because it determines the quality of the final product. By carefully planning the instructional design, the media was expected to facilitate active student engagement and support teachers in creating joyful learning experiences.

Develop Stage

At this stage, the designed product was developed and validated by experts, followed by limited and field trials.

Table 1. Expert Validation Results

Assessed Aspect	Average Score	Category
Relevance to curriculum and learning goals	3.5 – 4.0	Good – Very Good
Language clarity	3.0 – 4.0	Good
Media design and visual appeal	3.0 – 4.0	Good – Very Good
Pocketbook illustrations and content	3.5 – 4.0	Good – Very Good
Overall Average	3.6 – 4.0	Good

The results showed that the media was valid and suitable for classroom use. These findings are consistent with Fajriyah (2018), who stated that ethnomathematics-based media generally fulfill the criteria of content and design validity.

In the limited trial, more than 95% of students reported feeling happy, motivated, and active during learning. Teacher and student observations also showed average scores of 3–4, categorized as good to very good. This indicates that the product is practical and easy to implement. Similar findings were reported by Sarafiah & Khatimah (2023), who demonstrated that traditional game-based media encouraged student participation in mathematics lessons.

The field trial confirmed the effectiveness of the media. The average posttest score increased from 66.19 to 82.23, while classical mastery rose from 52.38% to 90.47%. Normality tests showed that both pretest and posttest scores were normally distributed, and the calculated N-Gain of 0.60 (60.7%) was categorized as medium effectiveness.

Tabel 2. Students' Responses to Learning

Statement	Yes	No	% Yes	% No
I find it easier to understand plane geometry using the Mpa'a Gopa game media	20	0	100 %	0 %
I am more active when learning in groups	18	2	90%	10 %
Connecting the material to real-life experiences motivates me to learn more	20	0	100 %	0 %
Relating the material to what I have learned before helps me understand better	20	0	100 %	0 %
I enjoy learning through games, so I do not feel bored studying mathematics	20	0	100 %	0 %
The Mpa'a Gopa game media enhances my understanding of both culture and mathematics	20	0	100 %	0 %
Applying mathematical ideas to problem-solving improves my understanding	20	0	100 %	0 %
Completing exercises in the booklet motivates me to build deeper comprehension	20	0	100 %	0 %
I feel challenged and motivated when solving evaluation activities	20	0	100 %	0 %
The exercises in the booklet train me to connect mathematical concepts to solve problems	20	0	100 %	0 %

Total	198	2	99%	1%
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Table 2 shows that the majority of students gave a positive response toward the use of the ethnomathematics-based Mpa'a Gopa game in learning plane geometry. A total of 99 % of responses indicated "Yes," while only 1 % responded "No."

Statements with the highest approval rate (100 %) indicate that the learning media successfully enhanced understanding of mathematical concepts, increased motivation, and introduced cultural values. Meanwhile, the lowest agreement (90 %) came from the statement about group learning, showing that a small portion of students still prefer individual learning styles.

Statistic	Pretest	Posttest
Average score	66.19	82.23
Classical mastery (%)	52.38	90.47
Number of students pass	11	19
Number of students fail	9	1

Table 3 shows the comparison between students' pretest and posttest scores before and after using the ethnomathematics-based Mpa'a Gopa learning media. Based on the results, there was a significant improvement in students' mathematical literacy.

Statistic	Value
Average Pretest	69.5
Average Posttest	86.35
Average N-Gain	0.60
Category	Medium
Effectiveness (%)	60.7 (Fairly Effective)

This table shows that the use of Mpa'a Gopa-based learning media provided a moderate but meaningful improvement in students' mathematical literacy. With an effectiveness percentage of 60.7%, the media successfully helped students understand mathematical concepts better, engage more actively in the learning process, and relate mathematics to real-life cultural contexts.

These results support Hui & Mahmud (2023), who found that game-based learning enhances both cognitive and affective learning outcomes.

Disseminate Stage

The dissemination stage was carried out through the publication of research results and limited implementation at the partner school. This ensured that the developed product could

be adopted by other schools as an alternative mathematics learning innovation. The Mpa'a Gopa media has been proven valid, practical, and effective, thus recommended for broader use.

In addition to publications, dissemination also included teacher workshops, allowing educators to implement the media sustainably. Rosa & Orey (2016) emphasized that ethnomathematics should serve as a bridge between culture and formal education. Hence, dissemination is not merely the conclusion of a project but an important step in ensuring that cultural-based mathematics learning benefits more learners.

Discussion

The findings of this study confirm that the Mpa'a Gopa learning media met the three essential criteria of development: validity, practicality, and effectiveness. The improvement in average scores from 66.19 to 82.23 and the increase in classical mastery from 52.38% to 90.47% demonstrate a significant positive impact, an N-Gain score of 0.3–0.7 indicates medium effectiveness, which aligns with the results of this study.

The findings demonstrate that the ethnomathematics-based Mpa'a Gopa game significantly improves students' mathematical literacy, especially in understanding plane geometry and connecting mathematical concepts. Integrating local cultural contexts into mathematics learning provides meaningful experiences, making abstract concepts easier to grasp. This aligns with Susanti, & Syahril (2021), who found that ethnomathematics-based learning can improve students' mathematical literacy by allowing them to solve problems rooted in their cultural context.

Students' responses to statement 6 reveal that 100 % agreed the media improved their cultural knowledge. The integration of the Mpa'a Gopa traditional game not only enhances mathematical understanding but also serves as a medium to preserve local wisdom. Similarly, Mulyono & Putra (2020) reported that embedding traditional games into mathematics learning fosters cultural character development and raises students' awareness of local heritage. Through ethnomathematics-based approaches, students experience identity-building alongside academic learning.

These findings are consistent with Izzati & Kurniawati. (2022), who demonstrated that Game-Based Learning (GBL) improves both motivation and mathematical problem-solving skills, with an average performance improvement of 56 %. However, this study contributes

uniquely to the field by combining GBL principles with cultural integration, which makes learning more contextually relevant and meaningful. Recent systematic reviews also highlight the effectiveness of game-based learning in mathematics education. For example, Nguyen et al. (2024) found that digital GBL improves engagement and problem-solving skills in primary school mathematics. This reinforces the argument that traditional games like Mpa'a Gopa can be just as impactful, especially when designed with ethnomathematical perspectives.

These findings are consistent with recent studies showing that ethnomathematics helps connect abstract mathematical concepts with students' cultural contexts. Sari and Kurniasari (2024) demonstrated that the traditional process of making Ketan Pencok incorporates various mathematical concepts such as two- and three-dimensional geometry, division, proportionality, social arithmetic, and systems of linear equations. Similarly, (Agustin et al., 2022) found that culture-based learning media improved not only mathematical literacy but also motivation and creativity. Positive student responses (95–100%) further support Hendrawati, Mutaqqin & susabti (2019), who emphasized that contextual and cultural-based learning environments foster joyful classrooms.

Therefore, the Mpa'a Gopa media serves not only as an instructional tool but also as a medium for preserving local culture and strengthening students' character. This dual function highlights the relevance of integrating ethnomathematics into elementary education, particularly in culturally rich contexts such as Bima.

The findings of this study have significant implications for mathematics education, particularly in integrating ethnomathematics-based learning media into classroom instruction. The use of the Mpa'a Gopa traditional game provides a contextual and meaningful learning experience that enhances students' mathematical literacy while simultaneously preserving local culture. Teachers can adopt this learning media to promote active participation, improve students' problem-solving skills, and foster a deeper understanding of mathematical concepts. Furthermore, the integration of cultural elements into mathematics lessons supports the implementation of the Merdeka Curriculum, which emphasizes character development and student-centered learning.

Although the study demonstrates positive results, several limitations should be acknowledged. First, the research involved a relatively small sample size of only 20 fourth-grade students from a single school (SD Negeri 2 Maria, Kota Bima), which may limit the

generalizability of the findings. Second, the study only measured students' learning outcomes through pretest and posttest assessments without examining long-term retention or transfer of knowledge. Third, the implementation of the learning media was conducted under controlled classroom conditions, which may differ from regular instructional settings where teacher expertise, classroom environment, and student diversity could affect outcomes.

Future research should consider several directions to build upon the findings of this study. First, studies with larger and more diverse samples across different schools and regions are needed to enhance the generalizability of the results. Second, researchers could explore the long-term effects of using ethnomathematics-based learning media on students' mathematical literacy and cultural awareness. Third, future studies may integrate technology-enhanced tools, such as interactive multimedia or augmented reality, to expand the potential of ethnomathematics in mathematics education. Lastly, further research could examine teachers' perceptions, challenges, and readiness in adopting culturally contextualized learning media within diverse classroom environments.

CONCLUSION

Based on the findings, it can be concluded that the Mpa'a Gopa learning media meets the criteria of being valid, practical, and effective. The validation results confirmed its suitability in terms of content, language, and design. Student responses and observation data showed that the media was highly engaging and easy to implement. Effectiveness testing revealed a significant improvement in learning outcomes, with a medium N-Gain score and mastery level exceeding 90%. These results indicate that integrating traditional games into mathematics learning not only improves students' mathematical literacy but also fosters motivation, cultural awareness, and positive classroom interaction. For future studies, it is recommended to expand the implementation to larger and more diverse student populations, integrate digital elements into the media, and explore its impact on higher-order thinking skills. Such efforts will strengthen the role of ethnomathematics based learning as a meaningful and sustainable educational innovation.

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