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Development of Ethnomathematics-Based Digital Modules Inspired by Bima Traditions to Enhance Middle School Students' Geometry Problem-Solving Skills

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Abstract

This study explores the integration of ethnomathematics-based digital learning materials to enhance students' problem-solving abilities in geometry. The research focuses on developing an interactive e-module incorporating Bima's cultural elements, such as tembe nggoli, sarau, uma lengge, and mpa'a gopa, to create a contextual learning experience. A quasi-experimental design was applied, comparing students using the e-module with those using conventional printed modules. The findings indicate that the experimental group achieved a significantly higher post-test score ($M = 4.0223$, $SD = 1.25488$) than the control group ($M = 2.9784$, $SD = 1.18472$), as confirmed by an independent t-test ($p < 0.05$). These results highlight the effectiveness of integrating cultural contexts into geometry learning, improving students' comprehension, motivation, and engagement. Interviews with teachers and students further emphasize the e-module's alignment with students' digital learning habits, making mathematical concepts more accessible.

Keywords: *Ethnomathematics, Digital Learning, Geometry Problem-Solving, Bima Culture, E-Module.*

Introduction

Mathematics plays a crucial role in developing students' problem-solving skills, particularly in geometry, which requires spatial reasoning and analytical thinking (Sowanto & Mulyadin, 2019). However, many students struggle to grasp geometric concepts when they are taught in an abstract manner without contextual relevance. This challenge has become even more apparent in the digital era, where students are more accustomed to technology-based learning than conventional approaches.

To bridge this gap, integrating cultural elements into mathematics education has emerged as an

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effective approach, allowing students to connect mathematical concepts with their daily lives (Astuti et al., 2024). One such approach is ethnomathematics, which links mathematical learning with cultural heritage, making the subject more engaging and meaningful for students (Sowanto & Mulyadin, 2019).

Bima, a region rich in cultural traditions, provides a unique opportunity for integrating ethnomathematics into education (Saputra, 2021). Various traditional objects (Ozlav & Akıncı, 2024), such as tembe nggoli (woven fabric), sarau (conical hats), wonca (circular baskets with square bases), doku (circular sifters), uma lengge (traditional houses), and the mpa'a gopa game, all contain intrinsic geometric properties (Andang et al., 2024; Sowanto & Mulyadin, 2019). These artifacts naturally illustrate mathematical concepts such as symmetry, transformations, area, and volume, making them valuable resources for contextual learning. While numerous studies have explored ethnomathematics in various cultures, research specifically focusing on Bima's cultural heritage in mathematics education remains limited. Therefore, developing a digital ethnomathematics-based module incorporating Bima's cultural elements is an urgent need to enrich teaching methods and enhance students' engagement in understanding geometric concepts.

The advancement of digital technology has provided new opportunities for enhancing mathematics education (Kurban & Yanık, 2024). Digital learning modules, which combine interactive visualizations, animations, and culturally relevant content, have proven effective in improving students' engagement and understanding of mathematical concepts (Aktaş & Hıdıroglu, 2024). However, most available digital modules still focus on theory-based approaches and lack the integration of local culture as a learning aid. This study develops a digital module based on Bima's ethnomathematical elements to facilitate students' comprehension of geometric problem-solving. By leveraging traditional objects as teaching tools, this module offers a contextual and interactive learning experience tailored to the needs of middle school students.

Previous research has highlighted the benefits of ethnomathematics-based approaches in improving students' mathematical reasoning and problem-solving abilities. However, studies specifically focusing on integrating Bima's cultural artifacts into digital learning modules remain scarce. Moreover, research on the effectiveness of ethnomathematics in technology-based learning is still limited, particularly at the middle school level. Therefore, this study is increasingly urgent to address this gap by developing a digital module that not only enhances students' understanding of geometry but also fosters cultural appreciation and identity.

Thus, this study seeks to answer the following questions: (1) How can ethnomathematics-based digital modules be developed using Bima's cultural heritage? (2) To what extent is the developed module valid, practical, and effective in improving middle school students' problem-solving skills in geometry? The findings of this research will contribute to the growing body of literature on ethnomathematics and digital education, offering insights into how local culture can be integrated into modern mathematics teaching. Additionally, the results of this study are expected to serve as a reference for developing a local wisdom-based curriculum that utilizes digital technology to enhance learning effectiveness.

This study is unique in its use of an ethnomathematics-based digital module that specifically adapts Bima's cultural elements into geometry learning. Unlike previous studies, which primarily discuss ethnomathematics in the context of offline learning or printed teaching materials, this research develops an interactive technology-based module that enables students to understand geometric concepts in a more contextual and engaging way. Additionally, this study not only explores the relationship between culture and mathematics but also evaluates the validity, practicality, and effectiveness of the module in improving students' problem-solving skills, providing a more comprehensive picture of the benefits of this approach in mathematics education.

Methodology

Method

This study employs the 4D research and development (R&D) model, which consists of four main stages: identification, design, development, and dissemination Thiagarajan, (1974) (in Hariyanto et al., 2022). The objective is to develop a high-quality e-module that meets the validity, practicality, and effectiveness criteria established (Hendrawensi et al., 2024; Akker et al., 2010).

Research Subjects and Design

The study was conducted from June to August 2024 at a junior high school in Bima City, West Nusa Tenggara, involving 50 eighth-grade students from the 2023/2024 academic year. This study adopts the 4D development model, encompassing four stages as applied by (Luma, 2024).

Defining

At this stage, the researcher analyzes the curriculum to ensure its alignment with Core Competencies and Basic Competencies in geometry. Additionally, student characteristics, cognitive development, and motivation are examined through classroom observations and interviews with teachers and students. The module content is then systematically structured, selecting relevant geometry concepts and designing tasks, questions, and exercises.

Designing

This e-module integrates geometry with Bima's cultural heritage through traditional objects, linking geometric concepts to real-life artifacts. *Tembe nggoli* reinforces symmetry, repetition, and proportion, while *sarau* illustrates cone geometry. *Wonca* and *doku* highlight the relationship between circles and squares, covering diameter, radius, and area. *Uma lengge* introduces three-dimensional geometry and the Pythagorean theorem, while *mpa'a gopa* enhances understanding of symmetry and spatial relationships.

Tembe Nggoli

The woven patterns of *tembe nggoli* incorporate triangles, polygons, squares, and circles, creating symmetrical designs that enhance understanding of geometric concepts. These patterns reinforce symmetry, pattern repetition, and proportional reasoning, making them a valuable contextual tool for learning geometry. Through analyzing these motifs, students can explore mathematical relationships in cultural artifacts, fostering a deeper appreciation for both geometry and local heritage.

Wonca, Doku dan Sarau

Wonca, a circular basket with a square base, and *doku*, a circular rice strainer, both illustrate the relationship between two-dimensional shapes, particularly circles and squares, while reinforcing concepts such as diameter, radius, and area. Meanwhile, *sarau*, a conical hat, represents cone geometry, helping students understand height, radius, slant height, surface area, and volume.

Uma Lengge

Uma lengge, a traditional structure with a square base and conical roof, illustrates three-dimensional geometry concepts. Its shape helps students understand the properties of cubes and cones while applying the Pythagorean theorem to measure height and slant height. This real-life example makes abstract mathematical concepts more tangible and relevant. By analyzing its structure, students can explore geometric relationships in architectural design.

Mpa'a Gopa

Mpa'a gopa is played on geometric fields such as squares, rectangles, and trapezoids, reinforcing concepts of symmetry and spatial relationships. The game encourages students to analyze shapes, angles, and proportions in a practical context. Through its structured playing area, it enhances geometric reasoning and problem-solving skills. This integration of culture and mathematics makes learning more engaging and meaningful.

Developing

At this stage, the e-module undergoes expert validation, practicality testing, and effectiveness evaluation in the learning process. Validation is conducted by two mathematics education lecturers and two eighth-grade teachers from SMPN 1 Kota Bima. The assessed aspects include content suitability, presentation, language, and e-module design. The validation instrument uses a Likert scale of 1–4 to measure validity levels, ranging from "Not Valid" to "Highly Valid." Revisions are made based on feedback from validators to ensure the e-module meets the established standards.

Following validation, practicality testing is conducted through questionnaires and interviews with students. Practicality criteria are determined based on a minimum of 61% positive responses from students. The questionnaire instrument assesses aspects such as ease of use, attractiveness, and effectiveness in supporting learning.

To measure the effectiveness of the e-module, pretests and posttests are conducted to evaluate students' geometry problem-solving skills. The pretest and posttest data are analyzed using a paired T-test after testing for data normality. This analysis helps determine the improvement in students' understanding before and after using the e-module.

The selection of instructional media indicates that cultural integration within this e-module enhances student engagement in the learning process. This approach provides a more meaningful learning experience by connecting mathematical concepts to students' everyday lives (Alghiffari et al., 2024). Consequently, this e-module not only strengthens students' understanding of geometric concepts but also fosters their appreciation of local culture.

Disseminating

In the final stage, the e-module is distributed to schools and educators through digital platforms, ensuring broader accessibility. Links are shared via WhatsApp groups, allowing teachers and students to access the materials easily, while YouTube provides instructional videos to enhance understanding. This distribution method facilitates wider implementation and enables feedback collection for future improvements. By leveraging online platforms, the e-module reaches a larger audience, supporting its integration into classroom learning.

Data Analysis Techniques

The validity of the e-module was assessed through expert validation, with scores categorized into four levels: highly valid, valid, fairly valid, and invalid (et al., 2024). The overall validity score was determined by averaging the ratings given by the validators. Practicality was evaluated using student response questionnaires, where the e-module was considered practical if at least 60% of students responded positively. The practicality level was further classified into very practical, practical, fairly practical, impractical, and very impractical categories based on the percentage of positive responses (Hendrawensi et al., 2024).

The effectiveness of the e-module was analyzed using a quasi-experimental pre-test and post-test design with a control group (Wilandika & Kamila, 2022). This method aimed to measure students' improvement in geometry problem-solving skills by comparing their performance before and after using the e-module. The assessment was based on key problem-solving indicators, such as understanding the problem, organizing information, recognizing patterns, developing solutions, verifying accuracy, and applying solutions in different contexts. A statistical test was conducted to compare pre-test and post-test scores, ensuring that the data met normality requirements for valid interpretation (Ghasemi & Zahediasl, 2012). The findings provided essential insights into the impact of the e-module on students' ability to solve geometry problems effectively (Hidayati et al., 2024).

Results

Research Findings in the Defining Phase

In the planning phase, the researcher identifies the Core Competencies and Basic Competencies relevant to the geometry material being developed. Initial analysis indicates that students' ability to solve geometry problems remains relatively low. Classroom observations and teacher interviews reveal that students struggle to apply geometric concepts to real-life situations. For example, in the context of online ride-hailing applications, students are often given standard textbook problems that focus solely on cognitive aspects without encouraging critical thinking skills or practical applications in daily life.

A review of conventional teaching materials also shows that textbook problems primarily emphasize theoretical problem-solving without providing relevant real-world contexts that align with students' experiences. As a result, students find it challenging to connect geometric concepts to real-world applications. Furthermore, current teaching methods offer limited opportunities for students to engage in critical thinking and develop more advanced problem-solving skills. To address these limitations, an ethnomathematics-based e-module is developed, incorporating local cultural elements such as traditional weaving patterns and household tools. This approach not only aligns with the established Core Competencies and Basic Competencies but also aims to enhance students' critical thinking skills and their ability to apply geometric concepts in practical contexts. By bridging the gap between theory and application, this approach makes geometry learning more meaningful and relevant for students (Suryawan et al., 2023).

Research Findings in the Design Phase

The research findings in the design phase indicate that the development of this ethnomathematics-based e-module has been systematically structured by integrating geometric concepts with Bima's cultural heritage. The key steps taken include test instrument development, selection of instructional media, and determination of the e-module format.

In the development of test instruments, problem-solving questions were designed to assess students' geometric reasoning skills. One of the primary approaches used was the analysis of symmetrical patterns in tembe nggoli (traditional woven cloth), which helps students understand the concepts of symmetry, pattern repetition, and proportion.

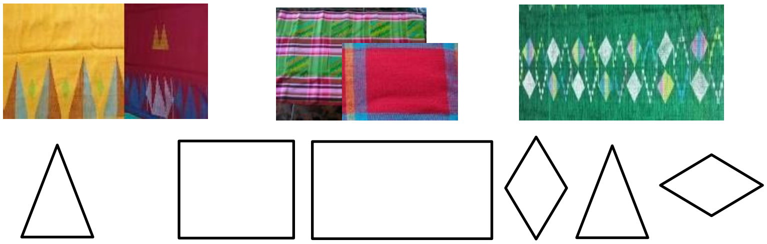

Figure 1. Traditional Bima Woven Cloth

Additionally, this e-module connects geometric concepts with Bima's cultural artifacts. Traditional agricultural and household tools, such as sarau (conical hat), are introduced to explain cone geometry, while wonca and doku are used to explore the relationship between circles and squares.

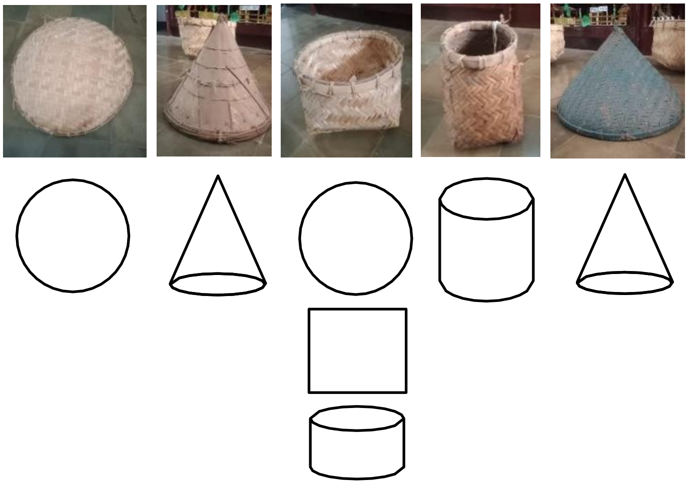

Figure 2. Traditional Bima Agricultural and Household Tools

Bima's traditional house, known as uma lengge, serves as a real-world example for learning three-dimensional geometry and applying the Pythagorean theorem. The structural design of the house incorporates triangular and rectangular elements, making it an effective model for geometry instruction.

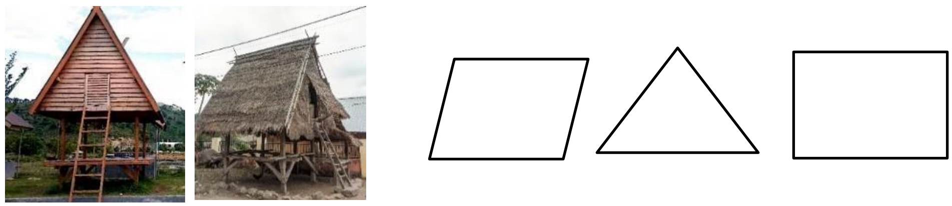

Figure 3. Bima Traditional House

Furthermore, the traditional game mpa'a gopa is integrated into the e-module to enhance students' understanding of symmetry and spatial relationships in a more meaningful context. The geometric patterns within this game reflect various plane figures such as squares, rectangles, and semicircles.

Figure 4. Traditional Bima Children's Games

The selection of instructional media revealed that the cultural integration within this e-module enhances student engagement in the learning process. This approach provides a more meaningful learning experience by linking mathematical concepts to students' daily lives. Consequently, this e-module not only strengthens students' understanding of geometric concepts but also fosters their appreciation of local culture. Through this strategy, mathematics is no longer perceived as an abstract subject but as an integral part of real-life experiences that can be learned in an engaging and relevant manner

Research Results of the Development Phase

At the development stage, this study conducted a series of validation tests, practicality tests, and effectiveness tests on the ethnomathematics-based e-module. The process began with the creation of an initial draft, which was then revised based on expert feedback and small-scale trial results. Validation was carried out by two mathematics education lecturers and two eighth-grade teachers from SMPN 1 Kota Bima to assess the content suitability, presentation, language, and design of the e-module. The validation instrument used a Likert scale of 1–4, ranging from "Not Valid" to "Very Valid." Revisions were made based on feedback from the validators to ensure the e-module met the established standards.

After the validation stage, a practicality test was conducted through questionnaires and interviews with students. The practicality criteria were determined based on a minimum of 61% positive responses from students. The questionnaire assessed aspects of ease of use, attractiveness, and effectiveness in supporting learning. To measure the effectiveness of the e-module, pretests and posttests were conducted to assess students' geometry problem-solving skills. The pretest and posttest data were analyzed using a paired T-test after performing a normality test. The results of this analysis were used to evaluate students' understanding before and after using the e-module.

Based on the validation results, the e-module obtained an average validity score of 3.49, which falls into the "Very Valid" category (with an average score range of 3 to 4). This indicates that the e-module meets the validity standards set by the validators and does not require further revisions. The readability and practicality test results show that the e-module was well received by students, with a positive response rate reaching 86%, proving that the e-module is practical and easy to use in the learning process. Additionally, the paired T-test analysis results revealed a significant improvement in students' geometry problem-solving skills after using the e-module, demonstrating that this e-module is effective in enhancing students' understanding of geometric concepts. The complete results of the validity test are presented in Table 1 below:

No	**Validator**	**Score**	**Validity**	**Criteria Remarks**
1	X-1	3.45	Very Valid	No revision needed
2	X-2	3.50	Very Valid	No revision needed
3	X-3	3.52	Very Valid	No revision needed
4	X-4	3.48	Very Valid	No revision needed
Average		**3.49**	**Very Valid**	**No revision needed**

Table 1. Validity of the E-Module

Effectiveness of the E-Module

Findings from interviews and questionnaires indicate that the e-module is classified as highly practical, achieving an attainment percentage of 81.23 %, which reflects the proportion of students who responded with "strongly agree" and "agree." Table 2 presents an analysis of the questionnaire results regarding the implementation of the e-module in the learning process. As shown in Table 2, the majority of students provided positive feedback, particularly emphasizing the clarity of the content and its relevance to their daily experiences. The final competencies embedded within the e-module have been proven to effectively assess students' ability to solve geometric problems. Moreover, the activities incorporated into the e-module are systematically designed to establish connections between mathematics learning and Bima's local wisdom. Cultural elements integrated into the e-module include *tembe nggoli* weaving patterns, traditional household tools, and indigenous games. This integration aims to enhance students' learning experiences by providing a more contextual approach, making their understanding of geometric concepts more meaningful and relatable.

No.	**Aspect**	**Indicator**
1.	Content	a. The material in the e-module is well-aligned with the learning objectives (Strongly Agree 84.00%)
		b. The instructional steps in the e-module are easy to follow (Strongly Agree 78.00%)

		c. The activities provided are engaging as they relate to students' daily experiences (Strongly Agree 82.00%)
2.	Language	a. The e-module text is clearly readable (Strongly Agree 80.00%)
		b. The material is presented in an easy-to-understand manner (Strongly Agree 82.00%)
		c. The language used is communicative (Strongly Agree 78.00%)
		d. The instructions, learning objectives, and activities in the e-module are sufficiently clear (Strongly Agree 84.00%)
3.	Benefit	a. The e-module is user-friendly (Strongly Agree 85.00%)
		b. The e-module enhances students' learning motivation (Strongly Agree 80.00%)
		c. The inclusion of images in the e-module supports hands-on activities (Strongly Agree 82.00%)
4.	Technology	a. The e-module is accessible on various devices (Strongly Agree 77.00%)
		b. The features within the e-module function properly (Strongly Agree 84.00%)
		c. The e-module does not experience technical issues during use (Strongly Agree 80.00%)
Average		Strongly Agree 81.23 %

Table 2. Indicators of the E-Module Usage Questionnaire

Effectiveness of the E-Module

E-module effectiveness in pretest

The effectiveness of the e-module was assessed using an Independent Sample T-Test, comparing two student groups: the experimental group, which utilized the ethnomathematics-based e-module, and the control group, which relied on conventional printed modules. Before proceeding with further analysis, a normality test was conducted to verify that the data were normally distributed. The study involved 30 student participants. As indicated in Tables 1 and 2, the pretest scores of both the experimental and control groups did not exhibit any significant differences, suggesting that students in both groups had comparable initial problem-solving abilities before the intervention.

As presented in Table 3, the average pretest score for the experimental group was 1.6120, with a standard deviation of 0.75530, whereas the control group recorded an average score of 1.5230, with a standard deviation of 0.67280. These findings imply that, prior to the intervention, both groups demonstrated relatively similar competencies in solving geometry problems. The relatively small standard deviations in both groups further indicate that student scores were fairly consistent, enabling a more precise evaluation of whether the ethnomathematics-based e-module had a substantial impact on improving students' problem-solving skills.

As illustrated in Table 4, the analysis of pretest data from both groups did not reveal any statistically significant differences. The Independent Sample T-Test yielded $t(26.345) = 0.223$, $p > 0.05$, indicating that the mean pretest scores between the experimental and control groups were not significantly different. The obtained significance value (Sig.) of 0.824 further confirms that students' initial abilities in both groups were at an equivalent level before the intervention. Additionally, Levene's test for equality of variances reported an F value of 0.924 with Sig. = 0.341, suggesting that the assumption of equal variances was not met, necessitating the use of an adjusted analysis under the assumption of unequal variances.

Furthermore, the mean difference between the two groups was recorded as 0.02847, with a standard error of 0.19435. The 95% confidence interval for this mean difference ranged from -0.37491 to 0.43185, which includes zero, further reinforcing the conclusion that no significant difference existed between the initial problem-solving abilities of students in the experimental and control groups before the intervention was implemented.

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	25	1.6120	0.75530	0.15106
Control Class	25	1.5230	0.67280	0.13456

Table 3. The Results of Pretest Data Analysis

F	Sig.	t	df	Mean Difference	Std. Error Diference	95% Confdence Inter. of the Difference	
						Lower	Upper
0.924	0.341	0.221	28	0.02847	0.19583	-0.35635	0.42201
		0.221	26.345	0.02847	0.19435	-0.37491	0.43185

Table 4. The Comparison of Pretest Score Using Independent Sample T-Test

E-Module Effectiveness in Post-Test

Referring to the data presented in Table 7, the average post-test score of students in the experimental class is 4.0223, with a standard deviation of 1.25488 and a standard error mean of 0.32388. Meanwhile, students in the control class achieve an average score of 2.9784, with a standard deviation of 1.18472 and a standard error mean of 0.30600. These results indicate that students who engaged with the ethnomathematics-based e-module outperformed those who relied on conventional printed modules.

This improvement highlights that integrating local cultural elements into the e-module provides a more effective strategy for enhancing students' problem-solving skills in geometry. Additionally, the lower standard deviation observed in the control class suggests a more uniform performance among students, whereas the higher variability in the experimental class may imply that some students benefited more significantly from the e-module than others. Overall, these findings reinforce the effectiveness of the ethnomathematics-based e-module in promoting a contextual and culturally relevant approach to learning geometry.

A comparative analysis of post-test scores between the experimental and control classes further confirms a statistically significant difference. The t-value for the independent t-test under the assumption of equal variances is 4.191, with $p < 0.05$, whereas under the assumption of unequal variances, the t-value is 4.276, also with $p < 0.05$ (Table 6). These statistical results confirm a substantial difference between the two groups. In other words, the significant variation in post-test scores between students utilizing the ethnomathematics-based e-module and those using traditional printed modules demonstrates the module's strong impact on improving students' problem-solving abilities in geometry (Putri & Junaedi, 2022).

Group	N	Mean	Std. Deviation	Std. Error Mean
Experiment Class	25	4.0223	1.25488	0.32388
Control Class	25	2.9784	1.18472	0.30600

Table 5. The Results Of Posttest Data Analysis

F	Sig.	t	df	Mean Difference	Std. Error Diference	95% Confdence Interval of the Difference	
						Lower	Upper
1.256	0.272	4.191	28	1.0439	0.24963	0.5087	1.5791
		4.276	24.21	1.0439	0.24468	0.5396	1.5481

Table 6. The Comparison of Posttest Score Using Independent Sample T-Test

Discussion

The research findings indicate that the use of an ethnomathematics-based e-module significantly enhances students' ability to solve geometry problems. Interviews with teachers and students revealed that the e-module was well received, as it aligns with students' learning habits, which are increasingly influenced by digital technology. Unlike conventional textbooks that emphasize theory and often lack real-life relevance, this e-module offers a more interactive approach and motivates students to engage in active learning (Tong et al., 2022). According to Piaget (in Pakpahan & Saragih, 2022), learning that connects abstract concepts with students' real-life experiences is more effective in building deep understanding. This is further supported by Vygotsky's research (McLeod, 2024), which emphasizes the importance of social interaction in learning to enhance conceptual understanding.

The integration of Information and Communication Technology (ICT) in this e-module plays a crucial role in increasing students' engagement, motivation, and curiosity in learning mathematics. Additionally, the e-module helps students overcome various difficulties in understanding geometric concepts through a culturally contextual approach. Jonassen (in Persichitte et al., 2018) stated that the use of technology in learning can enhance interactivity and provide students with a more profound learning experience. Furthermore, Brown et al. (1989) (in Ojose, 2008) asserted that technology in education allows for broader concept exploration and helps students develop a better understanding. The learning structure in this e-module is designed to facilitate systematic problem-solving through six main stages: (1) observing the case, (2) organizing information, (3) identifying patterns, (4) formulating solutions, (5) validating solutions, and (6) generalizing patterns.

Students are introduced to mathematical problems linked to the cultural elements of Bima, such as the geometric motifs of tembe nggoli, the structural form of sarau, the architectural patterns of uma lengge, and the traditional shape of mpa'a gopa. For example, in the initial learning stage, students are asked to analyze geometric patterns found in the woven fabric tembe nggoli. They then identify and predict the next patterns before formulating and generalizing them in the context of geometry. According to Bishop (in Andang et al., 2024), the ethnomathematical approach helps students understand mathematics in everyday contexts, thereby enhancing their comprehension and interest in the subject. D'Ambrosio (in Rosa & Orey, 2011) also stated that ethnomathematics serves as a bridge between local culture and formal mathematical concepts, enriching students' learning experiences.

The post-test analysis (Table 6) indicates that the experimental class using the ethnomathematics-based e-module achieved an average score of 4.0223 with a standard deviation of 1.25488, whereas the control class using conventional printed modules only attained an average score of 2.9784 with a standard deviation of 1.18472. This significant difference in scores suggests that students who learned using the e-module demonstrated a better understanding of solving geometry problems compared to those who used conventional printed modules. Additionally, a p-value of $p < 0.05$ in the independent t-test (Table 7) confirms a statistically significant difference between the two groups, reinforcing the evidence that the ethnomathematics-based e-module positively contributes to students' problem-solving skills.

Furthermore, feedback from students highlighted that the integration of local cultural elements in learning materials made mathematics more engaging and meaningful. This aligns with Bruner's theory of learning, which emphasizes that contextual learning strengthens cognitive development by allowing students to construct their own knowledge based on their environment (Bruner, 1966). In addition, previous studies (Greer et al., 2009) have demonstrated that culturally relevant mathematics education enhances students' engagement and fosters critical thinking and problem-solving skills.

These findings have significant implications for mathematics education. First, they suggest that integrating local cultural heritage into digital learning resources can bridge the gap between abstract mathematical concepts and students' lived experiences. Second, the success of this e-module indicates the potential for similar educational interventions in other regions with diverse cultural backgrounds. Finally, educators can adopt this model to design more contextualized and interactive learning materials that align with students' cognitive and social development needs.

Thus, this e-module not only serves as an innovative learning tool but also as an effective medium for connecting mathematics education to students' real-life experiences through familiar cultural contexts. Future research can explore the scalability of this approach in different educational settings and investigate its long-term impact on students' mathematical reasoning and achievement

Conclusion

This study demonstrates the effectiveness of an ethnomathematics-based e-module that integrates elements of Bima's cultural heritage in enhancing students' geometry problem-solving skills at SMP Negeri 1 Kota Bima. The findings reveal that incorporating local cultural aspects-such as tembe nggoli, sarau, uma lengge, and mpa'a gopa-into the learning process significantly improves students' post-test performance compared to those using conventional printed modules. This suggests that contextualizing mathematical concepts within familiar cultural frameworks not only enhances conceptual understanding but also fosters greater engagement and motivation in learning.

Furthermore, the integration of digital instructional materials aligns with students' increasing reliance on technology, making the learning experience more interactive and accessible. This approach effectively bridges the gap between abstract mathematical principles and real-world applications, helping students relate geometry to their daily lives. However, while the study presents promising outcomes, further research is needed to evaluate the scalability of the e-module across diverse educational settings and assess its long-term impact on students' mathematical proficiency. Future studies should also investigate how variations in students' learning styles and technological access influence the module's effectiveness, ensuring its broader applicability in different classroom environments.

Limitations of the Study

Although this study shows positive results, several limitations need to be considered. The research was conducted in a single school, making it difficult to generalize the findings to a broader context. Additionally, the study focused primarily on short-term improvements in geometry problem-solving skills without measuring long-term retention. Technological accessibility is also a concern, especially for schools with limited digital infrastructure. Therefore, further research is needed to examine the effectiveness of the e-module in diverse learning conditions and to ensure broader access for students.

Author Contributions

Andang was responsible for conceptualizing the study, drafting the original manuscript, revising content, overseeing the trial process, creating visual representations, and managed the software used in the study. Arnasari Merdekawati Hadi contributed to reviewing and refining the manuscript, conducting formal analysis, and developing the research methodology. Sowanto played a key role in validating the e-module, handled data management, conducted investigations. Juryatina coordinated the research implementation, managed project administration, and facilitated collaboration with schools and relevant stakeholders. Nur Rahmi Akbarini, Fajar Budiyono, Edi Mulyadin, and Muh Fitrah contributed to data processing and publication.

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Conflict of Interest

The authors affirm that there are no conflicts of interest related to this research.

Ethical Considerations

This study adhered to ethical research standards, ensuring the protection of participants' rights and maintaining confidentiality. Prior to data collection, informed consent was obtained from all participants, and ethical approval was granted by the relevant institutional review board.

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