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TECHNOLOGY-BASED DIFFERENTIATED LEARNING WITH THE ETHNOMATHEMATICAL CONTEXT OF BIMA WOVEN FABRIC TO ENHANCE STUDENTS' MATHEMATICAL LITERACY AND CHARACTER EDUCATION

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Abstract

Mathematical literacy is a key competency for students to actively and critically respond to the challenges of the 21st century. Preliminary observations at SMPN 4 Woha indicated that students' mathematical literacy was still low, largely due to conventional teaching practices. This study aims to describe the implementation of technology-based differentiated learning integrated with ethnomathematics through Bima woven fabric motifs to improve students' mathematical literacy and character education. A descriptive qualitative approach was employed, with purposive sampling used to select three students representing high, moderate, and low literacy levels from a total of 20 seventh-grade students. Data were collected through tests, interviews, and questionnaires, and analyzed descriptively using triangulation techniques to ensure validity. The results show that the integration of Augmented Reality with ethnomathematical contexts enhanced students' ability to formulate problems, apply concepts, interpret solutions, and evaluate outcomes in geometry. High-achieving students demonstrated comprehensive mastery across all indicators, while moderate-achieving students showed conceptual understanding with some procedural errors, and low-achieving students improved in oral explanation though struggled with written representation. Questionnaire findings also revealed positive developments in students' character traits, including honesty, discipline, responsibility, and curiosity. In conclusion, technology-based differentiated learning supported by ethnomathematical contexts not only improved students' mathematical literacy but also fostered holistic character education, highlighting its potential as an effective and culturally responsive instructional approach.

Keywords: Differentiated learning, Technology, Ethnomathematics of Bima woven fabric, Mathematical literacy, Character education.

Abstrak

Literasi matematika merupakan kompetensi penting bagi peserta didik untuk merespons tantangan abad ke-21 secara aktif dan kritis. Hasil observasi awal di SMPN 4 Woha menunjukkan bahwa literasi matematika peserta didik masih rendah, terutama karena penggunaan metode pembelajaran konvensional. Penelitian ini bertujuan untuk mendeskripsikan implementasi pembelajaran berdiferensiasi berbasis teknologi yang terintegrasi dengan etnomatematika melalui motif kain tenun Bima dalam upaya meningkatkan literasi matematika dan pendidikan karakter peserta didik. Pendekatan kualitatif deskriptif digunakan dengan teknik purposive sampling untuk memilih tiga peserta didik yang mewakili kategori tinggi, sedang, dan rendah dari total 20 siswa kelas VII. Data dikumpulkan melalui tes, wawancara, dan kuesioner, kemudian dianalisis secara deskriptif dengan triangulasi untuk menjamin validitas. Hasil penelitian menunjukkan bahwa integrasi Augmented Reality dengan konteks etnomatematika mampu meningkatkan kemampuan peserta didik dalam merumuskan masalah, menerapkan konsep, menafsirkan solusi, dan mengevaluasi hasil pada materi geometri. Peserta didik dengan kategori tinggi mampu menguasai semua indikator, kategori sedang menunjukkan pemahaman konseptual dengan beberapa kesalahan prosedural, sementara kategori rendah mengalami peningkatan dalam penjelasan lisan meski masih kesulitan pada representasi tertulis. Hasil kuesioner juga memperlihatkan perkembangan positif karakter peserta didik, termasuk kejujuran, kedisiplinan, tanggung jawab, dan rasa ingin tahu. Dengan demikian, pembelajaran berdiferensiasi berbasis teknologi yang didukung konteks etnomatematika tidak hanya meningkatkan literasi matematika, tetapi juga membentuk pendidikan karakter secara holistik, sehingga berpotensi menjadi pendekatan pembelajaran yang efektif dan responsif terhadap budaya.

Kata kunci: Kata kunci: Pembelajaran diferensiasi, Teknologi, Etnomatematika kain tenun Bima, Literasi matematika, Pendidikan karakter

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INTRODUCTION

Mathematical literacy is one of the essential competencies that students must master to face the challenges of the 21st century. This skill encompasses aspects of mathematical thinking, including conceptual understanding, procedural application, and interpretation of mathematical information and facts across various situations (Kore & Tauran, 2022; Nisa et al., 2023). Through mathematical literacy, students are able to comprehend and represent phenomena qualitatively, manage information relevant to specific contexts, and articulate their understanding in a coherent and meaningful manner (Taufik et al., 2024). Moreover, this competency equips students with an appreciation for the role of mathematics in everyday life and fosters the ability to make rational decisions based on mathematical analysis (Safina & Budiarto, 2022). One example of implementing mathematical literacy in the classroom is through observation tasks involving geometric objects found in the surrounding environment, such as rectangular whiteboards, square-patterned floor tiles, or circular wall clocks. Students are asked to record their observations using concept maps that include relevant formulas and real-life application examples (Mailani et al., 2025). Such an approach not only makes geometry learning more contextual and enjoyable but also cultivates students' critical and creative thinking skills in solving real-world problems (Mboeik, 2023; Widdah & Faradiba, 2022).

International assessments of students' mathematical literacy are reflected in the results of PISA 2022, which involved 81 countries, including 37 OECD members and 44 partner countries (Azhar et al., 2023). Indonesia showed an improvement in ranking compared to 2018, rising to 69th in literacy and 67th in mathematics. However, despite the improved rankings, the main concern highlighted by PISA is the decline in overall scores, which dropped by 12–13 points, with a global average decline of 21 points (Tyaningsih et al., 2023). These findings, further supported by PISA and TIMSS outcomes, indicate that students' mathematical literacy skills remain suboptimal. The diversity in students' learning styles and the lack of regular practice with literacy-based mathematics problems have contributed to their difficulties in solving problem-based tasks, particularly within the PISA context (Anisa & Ramdani, 2024). An approach that integrates local cultural values through ethnomathematics and interactive technology in classroom learning presents a relevant alternative for embedding mathematical literacy and character education into students' everyday experiences (Paramita Resya & Nurnoviyati, 2022; Putri et al., 2024).

Culturally responsive education is essential to be implemented in schools, as it plays a significant role in shaping students' character (Septiana et al., 2023). Educators must pay attention to students' diverse characteristics based on their intellectual development, interests, and talents, and accordingly adjust the content, methods, and assessment of learning (Ginting et al., 2024). Character education can be fostered through mathematics instruction by cultivating skills such as creative, logical, innovative, and critical thinking, as well as curiosity, independence, and self-confidence (Permatasari et al., 2023). By considering variations in students' learning styles, interests, and cognitive development, differentiated learning emerges as an approach that ensures an inclusive and adaptive learning process aligned with each individual's potential (Arisandi, 2024; Ramdani & Fauzi, 2025).

Differentiated learning is an effort to address the individual learning needs of each student in an independent manner (Arisandi, 2024). The primary goal of differentiated learning is to ensure that every student learns effectively according to their potential. Through this approach, educators are better able to identify and meet diverse learning needs, thereby creating a more inclusive and effective learning environment (Waton, 2024). In line with the progress of globalization and technological advancement, students are expected to compete using modern tools and to maximize their knowledge to become critical, creative, and innovative individuals capable of receiving and processing information effectively (Qauliyah et al., 2022; Ramdhani et al., 2023). One of the current challenges in education is the underutilization of learning media, particularly in the Indonesian context (Sisi et al., 2021). Mathematics is often perceived as a difficult subject by students, which negatively impacts their academic achievement, especially in geometry, which is abstract and filled with confusing symbols and formulas (Merdja & Restianim, 2022; Purnamasari et al., 2024).

Observations conducted at SMPN 4 Woha on September 24, 2024, revealed a low level of student interest in mathematics. This was due to students' difficulties in formulating word problems, applying mathematical concepts, interpreting solutions, and evaluating results when solving problems. These challenges were influenced by limited use of instructional media and the minimal integration of contextualized problems in the learning process

(Ramdhani et al., 2023). Improving the quality of mathematics instruction remains a key focus in the field of education today. One strategy considered effective in addressing these issues is the integration of cultural context into the learning process, namely through the ethnomathematics approach (Sawita & Ginting, 2022).

The concept of ethnomathematics was introduced by Brazilian mathematician Ubiratan D'Ambrosio in 1977. He defined ethnomathematics as a discipline that combines mathematics and culture while exploring the relationship between the two (Auliani & Suripah, 2024; Irvan, 2023). Ethnomathematics serves as a bridge between culture and education, particularly in the teaching of mathematics (Wahyuni & Kusaeri, 2024). Ethnomathematics-based instruction can motivate students because the content is directly connected to their cultural background and everyday activities, making it easier to understand. In the context of mathematics education, ethnomathematics is a relatively new area of study that holds strong potential for development into a contextual learning innovation while also introducing Indonesian cultural heritage to students (Az-zahra et al., 2024).

Previous studies have shown that the motifs found in Bima woven fabric are rich in historical, artistic, and philosophical values. In producing these traditional textiles, Bima's weavers strictly adhere to local customs, which prohibit the creation of motifs depicting animals or human figures. Instead, artisans design geometric patterns and nature-inspired motifs, such as *Kakando* (bamboo shoots), and floral motifs including *Wunta Satako* (a cluster of flowers), *Wunta Samobo* (a single flower), and *Wunta Aruna* (pineapple blossom) (Amalia et al., 2021; Rosady et al., 2024). Several mathematical concepts are embedded in these motifs, particularly two-dimensional geometry, which includes shapes such as triangles, squares, rhombuses, circles, and rectangles, as well as various types of lines (Harahap & Hasanah, 2023).

The explanation above inspired the researcher to implement a learning model that integrates local cultural contexts into mathematics instruction. Based on this rationale, the present study was conducted under the title **"Technology-Based Differentiated Learning with the Ethnomathematical Context of Bima Woven Fabric to Enhance Students' Mathematical Literacy and Character Education."** This research aims to help students improve their mathematical problem-solving abilities while simultaneously enhancing their mathematical literacy and character development.

METHODS

This study employed a descriptive qualitative approach. The research population consisted of 20 seventh-grade students from class VII-1 at SMPN 4 Woha. The sampling technique used was purposive sampling, in which subjects were selected based on specific criteria to provide a more in-depth exploration of the research problem. Three students were chosen as research subjects based on teacher recommendations and pre-test results, representing high, moderate, and low levels of mathematical literacy. This rationale was intended to capture diverse profiles of student ability and to illustrate variations in mathematical literacy and character development across different levels of achievement.

The instruments used in this study included tests, interviews, and questionnaires. The test items were developed by the researcher in the form of geometry problems contextualized with Bima woven fabric motifs. To ensure content validity, the instruments were reviewed by two mathematics education experts and subsequently refined based on their feedback. A small-scale pilot test was also conducted with students outside the research sample to confirm clarity, reliability, and appropriateness of the items. The final version of the instruments was then administered to the participants.

In the learning process, technology-based differentiated instruction was supported by the use of an Augmented Reality (AR) application focused on two-dimensional shapes (Sukma et al., 2022). The AR application was employed as a learning aid to facilitate visualization of plane geometry, but it was not used to construct the test items. Instead, the AR-supported ethnomathematical context served to enhance students’ engagement and conceptual understanding.

The collected data were analyzed descriptively through three stages: data reduction, data display, and conclusion drawing. To ensure the credibility of the findings, triangulation techniques were employed, which included triangulation of data (cross-checking results from tests, interviews, and questionnaires), triangulation of sources (confirming findings with teachers and peer feedback), and methodological triangulation (comparing outcomes across different data collection methods). This rigorous validation process strengthened the trustworthiness and reliability of the research results.

RESULTS AND DISCUSSION

The analysis of data from the mathematical literacy test and questionnaire on the topic of plane geometry conducted in class VII-1 at SMPN 4 Woha revealed that, prior to the implementation of the Augmented Reality (AR) application, most students demonstrated a limited understanding of plane geometry concepts. Out of the 20 students who participated in the study, pre-test results showed that only 5 students (25%) were categorized as having high mathematical literacy. Nine students (45%) were in the moderate category, and the remaining 6 students (30%) were categorized as low. These results indicate that students struggled to identify the shapes, properties, and applications of plane figures in abstract form without the aid of concrete visualization. These categories were determined based on students' performance on non-routine problems designed to assess their ability to formulate problems, apply concepts, interpret solutions, and evaluate results related to plane geometry. The test items were closely aligned with the mathematics curriculum on plane figures previously taught in class (Anisa & Ramdani, 2024).

The implementation of the Augmented Reality (AR) application as a visualization tool for plane geometry shapes, integrated with the context of Bima woven fabric motifs, resulted in a significant improvement in post-test outcomes. The number of students categorized as having high mathematical literacy increased to 10 students (50%), while those in the moderate category decreased to 7 students (35%), and only 3 students (15%) remained in the low category. This improvement indicates that the use of Augmented Reality technology not only helped students understand the shapes and properties of plane figures more concretely but also strengthened their ability to relate mathematical concepts to local cultural contexts, particularly the motifs found in Bima woven fabrics. Table 1 presents the classification of students' mathematical literacy levels.

Table 1. Classification of Mathematical Literacy Levels

Category	Score Interval	Pre-Test (n=20)	Post-Test (n=20)	Change (%)
High	59–80	5 students (25%)	10 students (50%)	+25%
Moderate	37–58	9 students (45%)	7 students (35%)	–10%
Low	15–36	6 students (30%)	3 students (15%)	–15%
Mean Score	—	**42.6**	**61.4**	**+44.1%**

From Table 1, the average score increased from 42.6 in the pre-test to 61.4 in the post-test, reflecting a 44.1% gain in mathematical literacy performance. The proportion of students in the high category doubled from 25% to 50%, while those in the low category decreased by half from 30% to 15%. These results indicate that the integration of Augmented Reality with ethnomathematical contexts significantly improved students' ability to understand plane geometry concepts and apply them in problem-solving situations.

A more detailed analysis can be conducted using the mathematical literacy test instrument, which was developed based on ethnomathematical concepts found in Bima woven fabric motifs. In this study, 20 students completed five test items assessed using a rubric comprising four literacy indicators: problem formulation, concept application, solution interpretation, and result evaluation (Elyasarikh & Masriyah, 2024). Each indicator was scored on a scale of 0 to 4, resulting in a total weight of 16 points per item. Thus, the maximum total score per student was 5 items × 16 points = 80 points, with the minimum score being 16 points. Student performance was categorized into three levels: high, moderate, and low. The score intervals were determined using a formula that yielded a score range of 22 points (Voznyuk et al., 2023).

The implementation of technology-based differentiated learning that integrates mathematical literacy and character education also showed a significant impact on students' character development, as indicated by the questionnaire responses from all 20 participants. The findings revealed notable improvements in various character dimensions, including more positive attitudes, increased motivation, stronger discipline, and enhanced ability to apply mathematical concepts practically and effectively in diverse contexts. The table below presents the classification results of the students' character education questionnaire:

Table 2. Classification of Students' Character Education Questionnaire

Indicator	Total Score	Mean Score	High (≥ 3.0)	Moderate (2.0–< 3.0)	Low (< 2.0)
Honesty	56	3.7	15 students	3 students	2 students
Creativity	50	3.3	13 students	6 students	1 student
Responsibility	45	3.0	10 students	7 students	3 students
Cooperation	39	2.6	8 students	11 students	1 student

Indicator	Total Score	Mean Score	High (≥ 3.0)	Moderate (2.0–< 3.0)	Low (< 2.0)
Discipline	33	2.2	5 students	13 students	2 students
Curiosity	29	1.9	6 students	5 students	9 students
Patience & Perseverance	25	1.6	2 students	4 students	14 students

The results of the questionnaire presented in Table 2 provide an overview of students' character profiles in relation to honesty, creativity, responsibility, cooperation, discipline, curiosity, and perseverance. The mean score for each indicator was calculated using a standard formula, with interpretation criteria as follows: scores ≥ 3.0 were categorized as high, scores between 2.0 and < 3.0 as moderate, and scores < 2.0 as low.

Based on these criteria, honesty (M = 3.7) and creativity (M = 3.3) emerged as the strongest traits, with the majority of students classified in the high category. Responsibility (M = 3.0) was positioned at the threshold of high, while cooperation (M = 2.6) and discipline (M = 2.2) were generally moderate. In contrast, curiosity (M = 1.9) and patience and perseverance (M = 1.6) were relatively weak, with most students falling into the low category. These findings highlight the need for greater reinforcement in developing students' perseverance and curiosity, while also leveraging honesty and creativity as existing strengths to support character education. Overall, the results underscore the potential of technology-based differentiated learning to not only strengthen mathematical literacy but also nurture essential character traits through a culturally relevant and engaging learning environment (Sulikah et al., 2021).

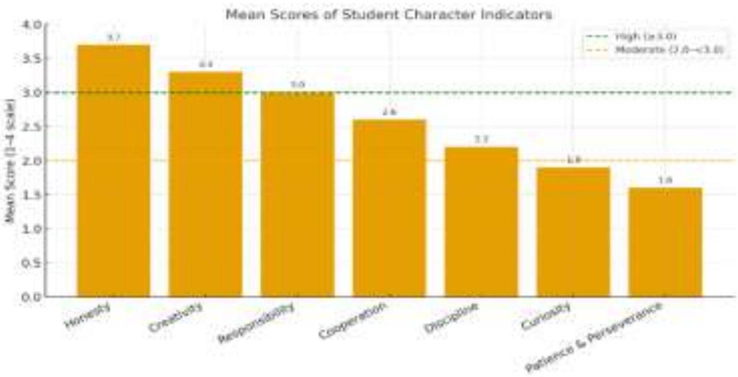


Figure 1. Mean Score of Student Character Indicators

Traditionally, weaving activities in Bima society have been primarily understood as processes for making traditional clothing and sarongs. However, ethnomathematical studies reveal that behind the *salungka* motif lies the application of mathematical elements, particularly in the subjects of plane geometry and geometric transformations. Table 3 presents the five woven fabric motifs used in the written test items, along with their cultural meanings and integration into mathematics instruction focused on plane geometry concepts.

Table 3. Meanings and Mathematical Integration of Bima Woven Fabric Motifs

Woven Fabric Motif	Cultural Meaning and Integration into Mathematics Instruction
Kakando (Bamboo Shoot) 	The kakando motif itself contains the meaning of life that is full of dynamics, and we must live it with patience and enthusiasm. The kakando motif also embodies the concept of an isosceles triangle, which is often used in weaving patterns to provide visual balance in the design, and it can also be applied in mathematics learning (Fajarriny & Sunarya, 2021).
Isi Mangge (Tamarind Seed) 	The *isi mangge* (tamarind seed) motif is a symbol of hope that a child will grow into a devout and pious individual devoted to Allah SWT. This motif is simplified into a rhombus geometric pattern in woven fabric, symbolizing the simplicity of nature that holds essential benefits for human life. The *isi mangge* (tamarind seed) motif also embodies the concept of a rhombus shape, which can be used in mathematics learning (Rosmini et al., 2018).
Aruna (Pineapple Blossom) 	The pineapple motif consists of 99 scales (layers). It symbolizes the 99 names of Allah, which serve as guidance for humans in living a prosperous life both in this world and the hereafter. The aruna motif embodies the concept of a parallelogram shape, which can be used in mathematics learning (Anisa & Ramdani, 2024).
Gari (Line) 	The *gari* (line) motif emphasizes that humans must possess honesty and firmness in their actions and responses. This trait is also commonly found among the local community. The *gari* (line) motif is often used to create stable patterns and provide a strong foundation in the design of *Tembe Nggoli*. This motif embodies the concept of a rectangle shape, which can be applied in mathematics learning (Sofiani et al., 2024).

Anggo (Grape) 	The philosophy of the *anggo* (grape) motif, which is arranged in a repeated circular pattern, can be interpreted as a symbol of prosperity, blessings, and hope for an abundant life. The *anggo* (grape) motif also embodies the geometric concept of a circle pattern, which can be integrated into mathematics learning (Amalia et al., 2021).

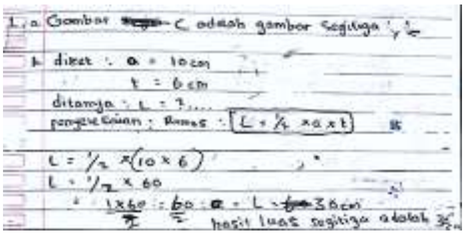
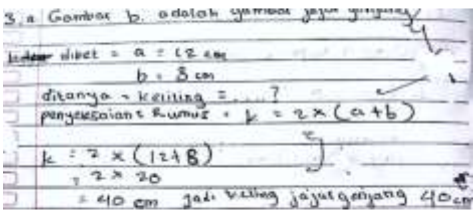
The integration of Bima woven fabric motifs into mathematics instruction aligns with global trends in ethnomathematics research, which emphasizes the role of local cultural practices in enhancing mathematical literacy. For example, ethnomathematics studies in Africa have demonstrated how traditional beadwork and basket weaving support the teaching of geometric concepts such as symmetry, patterns, and transformations (Gerdes, 1994). Similarly, research in Latin America highlights the use of Mayan textiles to contextualize algebraic and geometric thinking (Rosa et al., 2016). In Asia, studies have incorporated Batik patterns in Indonesia and traditional origami in Japan to strengthen spatial reasoning and cultural awareness (Payadnya et al., 2024). These international findings resonate with the results of this study, in which Bima woven fabric motifs provided a meaningful cultural context for students to connect abstract geometric concepts with real-life practices. Such approaches not only improve mathematical literacy but also contribute to character education by fostering appreciation of cultural heritage, creativity, and problem-solving skills in line with global educational objectives.

Observations of students' mathematical literacy skills in solving non-routine problems were conducted through the analysis of written test results, interviews, and student questionnaires. In this qualitative phase of the study, three students were selected to represent each performance category: low, moderate, and high (Fitriana & Lestari, 2022). The student with low mathematical literacy was coded as RD, the moderate-level student as KH, and the high-level student as AF. The triangulated results of the written tests and interviews are presented as follows:

Subject with High-Level Mathematical Literacy

To provide a deeper understanding of students' mathematical literacy performance, this section presents the case analysis of subject AF, who represents the high-level category.

Table 4. Summarizes AF's Problem-solving Results on Four Items and Excerpts from the Interview.

Problem-Solving Description	**Excerpts from Subject Interview**
	**P** : How do you understand the problem in this question? **AF** : To understand this problem, first I read the instructions carefully and looked at the picture of the weaving motif. I tried to understand the meaning of the question, which was to find the triangular shape from the three motif images shown. So, I understood the problem by matching the given picture with the help of an augmented reality application by scanning the flat shape marker that had been prepared. **P** : What information can you get from the question? **AF** : From the problem, it is known that the base length of the triangle is 10 cm and its height is 6 cm, and it asks to determine the area of the triangle. **P** : What do you do to solve the problem? **AF** : After finding the triangular shape, I took the data from the question, which is a base of 10 cm and a height of 6 cm. Then I used the area formula of a triangle, namely ½ × base × height. I substituted the numbers into the formula: ½ × 10 × 6, and then calculated the result, which is 30 cm². So, the steps I did were recognizing, recording the data, and calculating the area
	**P** : Did you experience any difficulties or obstacles during the process of solving this mathematical literacy problem? If yes, in which part? **AF** : At first, I was a bit confused when looking at the motif image, because not all shapes clearly looked like parallelograms. I needed to spend more time observing and comparing which ones were truly parallelograms. But after I managed to recognize the shape, the rest was not too difficult because I already memorized the formula. **P** : What were the next steps you took to solve the problem? **AF** : The steps I used were applying the augmented reality application as a visual aid to confirm the geometric shape I identified was correct and then determining the appropriate formula, namely $K = 2(a + b)$. After that, I substituted the given data into the formula $K = 2(12 + 8)$, then I calculated it and

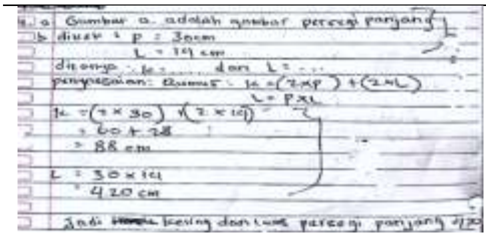
	obtained the perimeter of the parallelogram motif as 40 cm.
 4. a Gambar a adalah gambar persegi panjang b diket : p = 30 cm L = 14 cm penyelesaian: Rumus L = P x L = 60 + 28 = 88 cm L = 30 x 14 = 420 cm	**P** : From question number four, what information did you obtain? **AF** : From this problem, I obtained the information that the length of the rectangle is 30 cm and the width of the rectangle is 14 cm, and it asks to determine the perimeter and area of the rectangle. **P** : What did you do to solve this problem? **AF** : After I identified the rectangle shape, I wrote down the data from the problem, namely the rectangle's length of 30 cm and width of 14 cm. Then I used the formula for the perimeter of a rectangle $K = 2 \times (p + l)$ and the formula for the area$L = P \times L$. After that, I substituted the numbers from the problem into the formulas. So, the steps I followed were starting from observing, recording the data, and finally calculating the perimeter and area.
 = 2 x 22/7 x 15 Jadi keliling lingkaran adalah 94.28	**P** : What can you understand from this problem? **AF** : What I understood from question number five is that there is a circle pattern from one of the weaving motifs with a given radius of 15 cm, and the problem asks for the circumference of the circle pattern. **P** : What did you do next to solve the problem? **AF** : After observing the problem and identifying the given information, I wrote the formula for the circumference of a circle, which is $K = 2 \times \pi \times r$. Then I substituted the value of $\pi \left(\frac{22}{7}\right)$ and the radius (r), which is 15, into the formula. **P** : What conclusion did you get from the problem you worked on? **AF** : After solving the problem step by step and calculating correctly, the conclusion I obtained was that the circumference of the circle motif in the weaving pattern is 94.28 cm

Table 4 presents the written test results and interview excerpts from subject AF, who demonstrated strong mathematical literacy within the ethnomathematical context of Bima woven fabric, supported by the Augmented Reality (AR) application. AF systematically applied appropriate formulas to solve problems involving triangles, parallelograms, rectangles, and circles, achieving a score of 75 out of 80 (93.7%), consistent with the high category. The interview confirmed AF's logical and evaluative thinking, aligning with prior studies that high-performing students are capable of formulating and evaluating contextual problems effectively (Rohendi et al., 2023). Character indicators such as honesty, discipline, responsibility, and creativity also emerged, particularly in AF's independent work and innovative use of AR. These findings reinforce that integrating technology with ethnomathematics effectively enhances both mathematical literacy and character development (Umam et al., 2024). Table 5 shows AF's response to question 2.

Table 5. Problem-Solving Result for Question 2 and Interview Excerpt – High-Level Category

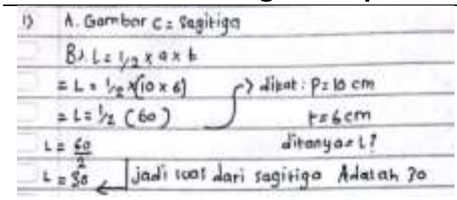
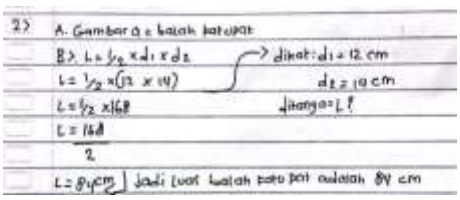
Problem-Solving Description	Excerpt from the Subject Interview
	**P** : Could you explain to me how you planned to solve this problem? **AF** : Well, Ma'am, the first step I took was to identify which shape was the rhombus from the three images provided. After that, I wrote down the given information from the problem, such as the length of diagonal 1 being 12 cm and the length of diagonal 2 being 14 cm, as well as the question, which asked for the area of the rhombus motif in the woven fabric. **P** : What steps did you take to solve this problem? **AF** : The method I used was going through several stages, including writing the formula for the area of a rhombus $L = \frac{1}{2} \times D_1 \times D_2$, then substituting the given numbers into the formula, namely $L = \frac{1}{2} \times 12 \times 14$. After calculating, I obtained the area of the motif as 84 cm². **P** : Why in your written answer did you not include the unit "square centimeters" and the conclusion of the problem you solved? **AF** : (the subject fell silent for a moment while thinking of an answer) I forgot to write it down, Ma'am.

Table 5 presents AF's response to question 2, which illustrates the ability to apply all key indicators of mathematical literacy (Fitriana & Lestari, 2022). AF identified the rhombus pattern, noted the known values (D_1 = 12 cm and D_2 = 14 cm), recognized the unknown (area of the rhombus), and correctly applied the formula $A = \frac{1}{2} \times D_1 \times D_2$ to obtain the result of 84 cm². However, AF showed a slight lack of attention at the evaluation stage by not providing a concluding statement, although the solution process was accurate and coherent (Wahyuni & Kusaeri, 2024).

Subject with Moderate-Level Mathematical Literacy

To illustrate the performance of a student in the moderate-level category, this section highlights the case of subject KH. Table 6 summarizes KH's problem-solving results on three items together with excerpts from the interview.

Table 6. Problem-Solving Results for Questions 1, 2, 4 and Interview Excerpt – Moderate-Level Category

Problem-Solving Description	Excerpt from the Subject Interview
	**P**: How do you understand the problem in this question? **KH**: I understand it by observing the pattern of the fabric design. I can comprehend this question by drawing the shape using the augmented reality application with the scan marker of the provided area. **P**: What information can you gather from the question? **KH**: The information I can gather is that the length of the triangle's base is 10 cm and the height is 6 cm. Determine the area of the triangle. **P**: What will you do to solve that question? **KH**: After determining the shape of the triangle, I will use the formula for the area of a triangle, which is $\frac{1}{2} \times base \times height$. I will take the values from the question, which are 10 cm for the base and 6 cm for the height. I will calculate using the formula: $\frac{1}{2} \times 10 \times 6$, and I will get the result of 30 cm².
	**P**: Can you explain, how do you plan to solve this question? **KH**: Alright, Ma'am, the first step I will take is to understand what is given in the question, which is a rectangle based on the three images. After that, I will note that the information about the diagonal lengths is 12 cm and 14 cm, and the elements being asked are the area and the motif of the fabric. **P**: Next, how will you proceed to solve that question? **KH**: I will use several steps in solving the question, namely writing the formula for the area of a rectangle, which is $L = \frac{1}{2} \times D_1 \times D_2$. After that, I will

	substitute the values found into the formula, which are $L = \frac{1}{2} \times 12 \times 14$. Next, I will calculate it and find that the area of the motif is 84 cm².
	**P**: From question number four, what information did you gather? **KH**: From the question, I obtained information that the length of the rectangle is 30 cm and the width is 14 cm, and I am asked to determine the perimeter and area of the rectangle. **P**: What will you do to solve that question? **KH**: After finding the pattern of the rectangular motif on the fabric, I will write down the known dimensions of the rectangle, which are 30 cm (length) and 14 cm (width). Then I will use the formula for the perimeter of a rectangle $P = 2 \times length + 2 \times width$ and the area formula $L = P \times L$. After that, I will substitute the numbers into the formulas accordingly. **P**: What result can you obtain for the perimeter of the rectangle with a length of 900 cm? **KH**: The result is 85 cm, Ma'am, because previously I found that the perimeter of a rectangle with a length of 420 cm is 84 cm. Therefore, if I calculate the perimeter with the given dimensions, it will be 88 cm².

Table 6 presents KH's performance as a representative of the moderate-level category. The written test and interview results show that KH partially achieved the four indicators of mathematical literacy. In questions 1 and 2 (triangle and rhombus), KH correctly identified the known and unknown elements, applied the appropriate formulas, and achieved accurate results. In question 4 (rectangle), KH successfully computed the area but miscalculated the perimeter due to an error in substituting values. Nevertheless, interview responses confirmed that KH could coherently explain all four literacy indicators, reflecting structured reasoning despite technical mistakes (Aini & Budiarto, 2022). KH's questionnaire results indicated moderate character traits, such as honesty, creativity, discipline, and responsibility, though consistency and initiative still required reinforcement. Overall, KH demonstrated a sound conceptual understanding with moderate character support, highlighting potential for further development through continuous guidance. Table 7 presents KH's responses to questions 3 and 5.

Table 7. Problem-Solving Results for Questions 3 and 5 and Interview Excerpt – Moderate-Level Category

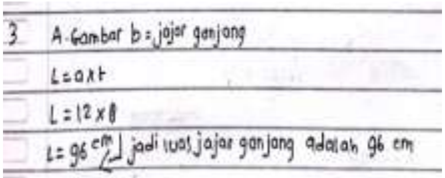
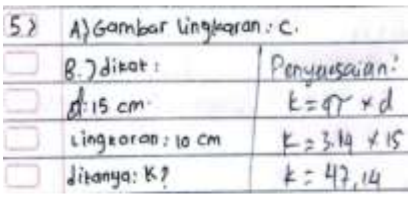
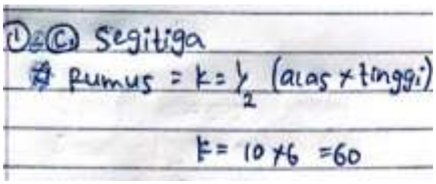
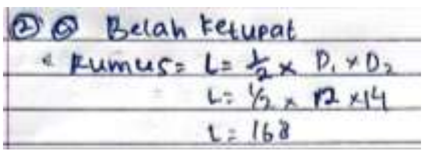
Problem-Solving Description	Excerpt from Subject Interview
 3 A. Gambar b : jajar genjang L = a x t L = 12 x 8 L = 96 cm jadi luas jajar genjang adalah 96 cm	**P**: What information do you know from question number three? **KH**: I know the lengths of the sides of the trapezoid are 12 cm and 8 cm. And I am asked for the perimeter of the trapezoid. **P**: "Next, what are the steps to solve that question?" **KH**: I will confirm the geometric pattern that I need to determine correctly and find the formula for the perimeter of the trapezoid, which is $K = 2 \times (a + b)$. **P**: Why does it seem in your answer sheet that you wrote the formula for the perimeter of a trapezoid, while what we explained was the perimeter of the trapezoid? **KH**: (The subject is similar to the previous answer) The formula $K = 2 \times (a + b)$ is actually used to find the perimeter of the trapezoid, Ma'am, but I made an error in writing the formula.
 5) A) Gambar lingkaran : c. B.) dikat : / Penyelesaian: d: 15 cm / k = π × d Lingkaran : 10 cm / k = 3.14 × 15 ditanya: K? / k = 47,14	**P**: What can you tell us about that question? **KH**: What I know from question number five is that it refers to a circle shown in the image (c) provided in the question, and it asks to calculate the circumference of the circle with a radius of 15 cm. **P**: Next, what are the steps to solve that question? **KH**: After understanding the question and knowing the available information, I evaluated my understanding and realized that I was mistaken in writing the given information, which is that the diameter of the circle is 15 cm, while it should be the value of the radius of the circle. Therefore, I incorrectly wrote the formula $K = \pi \times d$ when I should have written the formula for the circumference of the circle, which is $K = 2 \times \pi \times r$. Because the time was not enough, I just filled in the answer sheet without correcting my formulas.

Table 7 presents KH's performance on questions 3 (parallelogram) and 5 (circle). The written test showed major errors in applying formulas and providing accurate information, leading to incorrect answers. In contrast, the interview revealed that KH could clearly articulate each problem-solving stage, including the correct formulas for the perimeter of a parallelogram ($P = 2 \times (a + b)$) and the circumference of a circle ($C = 2 \times \pi \times r$). This contrast highlights KH's adequate conceptual understanding and structured reasoning, even though inconsistencies persisted in the written work (Kehi & Naimnule, 2023)

Subject with Low-Level Mathematical Literacy

The performance of the student in the low-level category, represented by subject RD, is presented in Table 8.

Table 8. Problem-Solving Results for Questions 1, 2, 4 and Interview Excerpt – Low-Level Category

Problem-Solving Description	Excerpt from Subject Interview
	**P**: How do you understand the problem in this question? **RD**: I understand it by observing the pattern of the fabric design shown in part (c). **P**: What information can you gather from the question? **RD**: I can mention information about the length of the base and the width of the triangle, but I remember that the length of the base is 10 cm and the height is 6 cm, so I need to determine the area of the triangle. **P**: What will you do to solve that question? **RD**: I will use the formula for the area of a triangle, which is $12 \times base \times height$. I will substitute the numbers into the formula: $12 \times 10 \times 6$, and I get the result of 30 cm². However, I mistakenly wrote down the mathematical statement that results in 10×6, which gives 60. **P**: Why did you write the information that was not accurate in the question? **RD**: I was confused and did not pay attention to the details.
	**P**: Can you explain, how do you plan to solve this question? **RD**: Alright, Ma'am, I will use the formula for the area of a rectangle, and I will find the pattern of the rectangle in part (a). After that, I will write the formula $L = 12 \times D_1 \times D_2$. I input the information that the length of diagonal 1 is 12 cm and the length of diagonal 2 is 14 cm, I calculate it and get the value of 168 cm². **P**: How did you get 168 cm²? Why didn't you divide it by 2 as stated in the formula? **RD**: I thought that the formula for the area should be

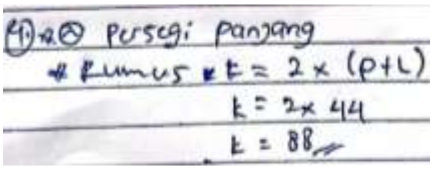
	divided by 2, so I should have divided it by 2 to get the result of 84 cm².
	**P**: From question number four, what information did you gather? **RD**: My information is that the length of the rectangle is 30 cm and the width of the rectangle is 14 cm, and I am asked to determine the perimeter and area of the rectangle. **P**: What will you do to solve that question? **RD**: After determining the pattern of the rectangle in the fabric design, I will write the perimeter formula $K = 2 \times (P + L)$. Then I will calculate it directly as 30+14 and get the value of 88 cm. **P**: Why did you only calculate the perimeter without calculating the area of the rectangle? **RD**: I was in a hurry to solve the next question without going back to read what was asked in the question.

Table 8 presents RD's performance on questions 1, 2, and 4. The written test showed limited ability to apply formulas correctly, as RD failed to explicitly state key information or use appropriate procedures, leading to inaccurate answers (e.g., perimeter of a triangle and area of a rhombus). In contrast, the interview revealed that RD could orally identify essential elements, such as the base and height of a triangle and the diagonals of a rhombus. Some improvement appeared in question 4, where RD correctly applied the formula for the perimeter of a rhombus, though errors persisted in calculating the area of a rectangle due to carelessness. Overall, these findings suggest that RD's oral conceptual understanding is stronger than the written representation, which requires reinforcement through systematic instruction. The character education questionnaire further confirmed low perseverance, honesty, and discipline, with tendencies toward inattention and distraction. This indicates the need for targeted interventions that combine conceptual strengthening with character development to improve RD's mathematical literacy (Siregar, 2018).

Table 9. Problem-Solving Results for Questions 3 and 5 and Interview Excerpt – Low-Level Category

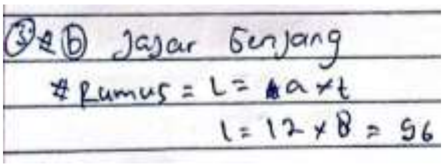
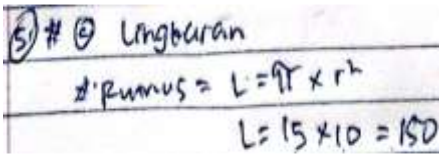
Problem-Solving Description	Excerpt from Subject Interview
	**P**: What information do you gather from question number 3? **RD**: I know the lengths of the sides of the trapezoid are 12 cm and 8 cm. And I am asked for the perimeter of the trapezoid. **P**: "Next, what are the steps to solve that question?" **RD**: I will confirm the geometric pattern that I need to determine correctly and find the formula L=a×h. **P**: Why does it seem in your answer sheet that you wrote the formula for the area of the trapezoid, while what we explained was the perimeter of the trapezoid? **RD**: (The subject is similar to the previous answer) The formula for the perimeter of the trapezoid is $K = 2 \times (a + b)$, which I used to calculate the perimeter of the trapezoid, but I mistakenly wrote the area formula.
	**P**: What can you tell us about that question? **RD**: It is known that the radius of the circle is 15 cm and there are 10 identical circles. The question asks for the total circumference of the circles. **P**: Next, what formula will you use to solve that question? **RD**: I wrote the formula for the area of a triangle, which is $L = \pi r^2$. **P**: But the question asked you to calculate the circumference of the circle, not the area of the circle. Why did you choose the wrong formula? **RD**: I misunderstood the question and did not pay attention to the instructions properly; I should have used the formula K=2×π×r because what was given was the radius of the circle.

Table 9 presents RD's performance on questions 3 and 5. The written responses showed difficulties in writing formulas and outlining problem-solving steps, which resulted in incomplete and inaccurate answers. However, the interview revealed that RD could verbally identify key elements, such as the sides of a parallelogram and the radius of a circle, and correctly explain the formulas for perimeter and circumference. This contrast highlights a gap between oral comprehension and written representation, suggesting that RD requires structured practice and guided support to strengthen written mathematical expression (Saleha et al., 2024).

The broader implementation of technology-based differentiated learning with ethnomathematics using Bima woven fabric motifs was positively received by students, as it increased motivation and accommodated diverse learning styles. Overall, the integration of mathematical literacy, character education, and technology-based approaches contributed to students' holistic development, aligning with learner-centered educational principles that emphasize individual needs and characteristics as essential for educational success (Husnul Fauzan & Khairul Anshari, 2024; Taufik, 2019).

The comparative analysis of students across high, moderate, and low categories reveals distinct patterns in mathematical literacy. Subject AF (high-level) demonstrated consistent mastery of all four literacy indicators, both in written and oral tasks, though with minor lapses in concluding statements. Subject KH (moderate-level) showed adequate conceptual understanding and could verbally articulate problem-solving processes but struggled with consistency and accuracy in written representation. Meanwhile, subject RD (low-level) displayed basic oral comprehension yet significant challenges in translating understanding into systematic written solutions.

These findings confirm that oral comprehension does not always translate into written performance, highlighting the need for instructional approaches that bridge this gap through structured practice and scaffolding. They also reinforce global research emphasizing the role of technology and cultural contexts in enhancing mathematical literacy (e.g., Cai et al., 2017; OECD, 2019). By embedding Bima woven fabric motifs into AR-supported learning, this study not only contextualizes geometry in students' cultural experiences but also motivates diverse learners through differentiated pathways. Thus, the integration of technology, ethnomathematics, and character education collectively strengthens both cognitive and affective domains, providing a holistic contribution to mathematics education.

CONCLUSION

The findings of this study indicate that the integration of Augmented Reality (AR) technology in geometry instruction, combined with the ethnomathematical context of Bima woven fabric, effectively enhances students' mathematical literacy and character development. Pre-test results from subjects AF, KH, and RD revealed initial limitations in identifying geometric shapes and applying geometry concepts in contextual settings. Following the implementation of the AR application, post-test outcomes showed significant improvements, particularly for subject AF (high-level category), who successfully met all mathematical literacy indicators, including problem formulation, concept application, solution interpretation, and result evaluation, although a minor omission in the written conclusion for one item was later accurately explained during the interview. Subject KH (moderate category) demonstrated conceptual understanding with some procedural errors in written tasks but was able to articulate reasoning steps clearly in oral responses. Subject RD (low-level category) showed progress in basic conceptual understanding and verbal explanation, though written representation remained an area for improvement. Questionnaire results further revealed that students' character traits ranged from low to high levels, emphasizing the importance of individualized, technology-based differentiated learning in optimizing mathematical literacy outcomes. This approach not only improved academic performance but also fostered positive traits such as honesty, discipline, and curiosity. Overall, the use of Augmented Reality within the context of Bima ethnomathematics proved effective in strengthening students' visual-spatial understanding, increasing engagement and motivation, and nurturing reflective, communicative, and context-aware character traits essential for culturally responsive mathematics education.

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