

Effectiveness of an Ethnomathematics-Based E-Module on Malay Songket Fabric in Improving Students' Mathematical Literacy Skills

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Abstract

Mathematical literacy is an essential competency that enables students to apply mathematical concepts in real-life situations. However, Indonesian students continue to demonstrate relatively low mathematical literacy performance, highlighting the need for innovative and contextual learning resources. This study aimed to determine the validity and effectiveness of an ethnomathematics-based e-module on Malay songket fabric in improving students' mathematical literacy skills in transformation geometry learning. The study employed a Research and Development (R&D) approach using the ADDIE model. The participants were 29 ninth-grade students at SMP Negeri 1 Pulo Bandring in the 2025/2026 academic year. Data were collected through material expert validation sheets, media expert validation sheets, and mathematical literacy tests administered through a pretest and posttest. The data were analyzed using descriptive quantitative analysis, normalized gain (N-gain), and classical learning mastery criteria. The results indicated that the developed e-module was categorized as very valid, with validation scores of 85.9% from the material expert and 85.7% from the media expert. Students' mathematical literacy scores improved from a mean pretest score of 68.14 to a mean posttest score of 81.07, with an N-gain score of 0.41 in the moderate category. Classical learning mastery reached 96.55%. These findings indicate that the ethnomathematics-based e-module on Malay songket fabric is valid and effective in improving students' mathematical literacy skills.

INTRODUCTION

Mathematics is a discipline that plays an important role in everyday life because it supports the development of logical, analytical, and creative thinking skills (Yuli et al., 2024). In modern learning, the competencies that need to be developed are not limited to conceptual understanding but also include mathematical literacy. Mathematical literacy refers to the ability to formulate, use, and interpret mathematics in various real-life contexts (Afidah & Waluya, 2024). Therefore, mathematical literacy has become an important indicator in assessing students' ability to meaningfully apply mathematical concepts (Panjaitan et al., 2025).

However, international studies show that Indonesian students' mathematical literacy remains relatively low. The Programme for International Student Assessment (PISA) reported that Indonesia's mathematics score was 379 in 2018 (OECD, 2019) and 366 in 2022 (OECD, 2023). This condition indicates that there are still challenges in mathematics learning, particularly in developing higher-order thinking skills and problem-solving abilities (Panjaitan, 2021). In addition, the results of the Minimum Competency Assessment (AKM) also indicate that students' numeracy skills remain below the expected standard (Putri, 2024). Furthermore, recent studies have emphasized that mathematical literacy is closely related to students' ability to connect mathematical concepts with authentic situations and make reasoned decisions based on quantitative information (Pratama & Yelken, 2024; Meilina & Marsigit, 2025). Therefore, mathematics instruction should provide meaningful learning experiences that encourage students to apply mathematical knowledge in contextual situations rather than merely solving routine exercises (Rahayu et al., 2026).

One approach that can be used to address this issue is ethnomathematics, which links mathematical concepts to cultural practices within society (Sawita et al., 2022). One form of local culture that can be integrated into mathematics learning is Malay songket fabric. Malay songket contains various motifs that reflect mathematical concepts such as patterns, symmetry, and geometric transformation (Sukmawati et al., 2022). Integrating Malay songket fabric into mathematics learning through an ethnomathematics approach can improve students' mathematical literacy while also fostering appreciation for local culture (Panjaitan, 2023).

On the other hand, the development of educational technology requires the use of innovative and interactive teaching materials. Based on observations conducted at SMP Negeri 1 Pulo Bandring, mathematics learning still relies primarily on printed textbooks and worksheets, with limited use of interactive digital teaching materials that have not optimally supported the development of students' mathematical literacy. Students also struggle to understand abstract concepts because the learning process lacks visualization. Based on students' previous mathematics learning outcomes, only 22.22% of students achieved the Minimum Mastery Criterion (KKM). This indicates the need for innovative and technology-based teaching materials (Bin et al., 2025).

One possible solution is the development of an e-module. An e-module is an electronic teaching material that is systematically designed and can be accessed through digital devices. The use of e-modules allows learning materials to be presented in a more interactive, flexible, and engaging way, which can support a more meaningful learning process and help students understand mathematical concepts more effectively (Susmawathil et al., 2025). Recent studies have shown that ethnomathematics-based e-modules are generally valid, practical, and effective in supporting mathematics learning (Paramita et al., 2024; Yanti et al., 2025). Digital learning materials provide opportunities for students to learn independently while simultaneously engaging with contextual problems that promote mathematical literacy (Rahayu et al., 2025). Therefore, integrating ethnomathematics and digital learning resources may offer a promising alternative for improving students' mathematical literacy skills.

Previous studies have investigated ethnomathematics-based learning and the use of e-modules separately. Several studies reported that ethnomathematics-based learning improved students' mathematical understanding and literacy, while others demonstrated the effectiveness of digital e-modules in supporting mathematics learning (Pratama & Yelken, 2024). However, studies integrating Malay songket ethnomathematics into a digital e-module specifically designed to improve mathematical literacy in transformation geometry remain limited. In addition, previous studies have rarely combined local cultural contexts, digital learning resources, and OECD-oriented mathematical literacy processes within a single instructional product. Therefore, this study addresses this gap by developing and evaluating an ethnomathematics-based e-module on Malay songket fabric. The novelty of this study lies in

the integration of Malay songket motifs into a digital ethnomathematics-based e-module specifically designed to facilitate students' mathematical literacy in transformation geometry learning. Accordingly, this study aimed to determine the validity and effectiveness of the developed e-module in improving students' mathematical literacy skills.

METHOD

This study employed a Research and Development (R&D) design aimed at developing an ethnomathematics-based e-module using Malay songket fabric and examining its quality in terms of validity and effectiveness. The development model used in this study was ADDIE, which consists of Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). The study was conducted at SMP Negeri 1 Pulo Bandring in the 2025/2026 academic year. The participants were 29 ninth-grade students.

The product developed in this study was an ethnomathematics-based e-module on transformation geometry by utilizing Malay songket fabric motifs as the learning context. The research instruments included: material expert validation sheets, media expert validation sheets, and mathematical literacy test items administered through pretest and posttest. The indicators of mathematical literacy referred to the OECD mathematical literacy framework, which includes the ability to formulate, employ, and interpret mathematics in various contexts (OECD, 2023).

The ADDIE model was implemented through five stages. The Analysis stage involved identifying learning problems, analyzing students' characteristics, reviewing the curriculum, and examining students' mathematical literacy needs in transformation geometry learning. The Design stage focused on planning the structure of the e-module, determining learning objectives, preparing mathematical literacy-based learning activities, and integrating Malay songket motifs into transformation geometry content. The Development stage involved creating the e-module, designing learning materials and exercises, and conducting expert validation by material and media experts. Revisions were made based on the validators' suggestions to improve the quality of the product. The Implementation stage consisted of classroom use of the validated e-module with 29 ninth-grade students to examine its effectiveness in supporting mathematical literacy learning. During this stage, students completed pretests and posttests to measure learning improvement. The Evaluation stage involved analyzing the validation and learning outcome data and revising the product based on the findings to ensure its suitability for mathematics learning.

The validation data obtained from material and media experts were analyzed using percentage scores and interpreted according to the following criteria: 81–100% = very valid, 61–80% = valid, 41–60% = moderately valid, 21–40% = less valid, and 0–20% = invalid.

The effectiveness of the e-module was evaluated using students' mathematical literacy test results through pretest and posttest scores, normalized gain (N-gain), and classical learning mastery. The N-gain value was used to determine the level of improvement achieved after the implementation of the e-module (Hake, 1998). The N-gain score was calculated using Equation 1.

$$N - Gain = \frac{Posttest - Pretest}{Maximum Score - Pretest} \quad (1)$$

The N-gain values were interpreted using the following criteria: high ($g > 0.70$), medium ($0.30 \leq g \leq 0.70$), and low ($g < 0.30$) (Hake, 1998). Classical learning mastery was determined based on the percentage of students who achieved the Minimum Mastery Criterion (MMC). Learning

was considered classically complete when at least 85% of students achieved the established Minimum Mastery Criterion (MMC).

RESULTS AND DISCUSSION

Material and media experts validated the developed ethnomathematics-based e-module before it was implemented in classroom learning. [Table 1](#) presents the validation results.

Table 1. Expert Validation Results

Validator	Percentage	Category
Material expert	85.9%	Very valid
Media expert	85.7%	Very valid

The material expert validation score was 85.9%, and the media expert validation score was 85.7%, both categorized as very valid. These findings indicate that the developed e-module fulfilled the feasibility criteria in terms of content accuracy, language, presentation, and media design. Therefore, the e-module was considered suitable for implementation in mathematics learning.

The high validation scores suggest that the integration of Malay songket motifs into transformation geometry materials was appropriate and aligned with the intended learning objectives. Incorporating local cultural contexts enabled the presentation of mathematical concepts in a more meaningful, contextual manner. This finding supports the ethnomathematics perspective proposed by D'Ambrosio ([Payadnya et al., 2024](#)), which emphasizes the importance of connecting mathematical concepts with cultural practices familiar to learners. The results are also consistent with recent studies indicating that ethnomathematics-based learning resources can improve the relevance and quality of mathematics instruction by linking mathematical concepts to students' cultural environments ([Maulina et al., 2025](#); [Widodo & Astuti, 2026](#)).

The effectiveness of the developed e-module was evaluated through students' mathematical literacy test results. [Table 2](#) presents the comparison of students' pretest and posttest scores.

Table 2. Students' Pretest and Posttest Scores

Assessment	Mean Score
Pretest	68.14
Posttest	81.07

The results indicate that students' mathematical literacy skills improved after learning with the ethnomathematics-based e-module. The average score increased from 68.14 in the pretest to 81.07 in the posttest, suggesting that the developed e-module positively contributed to students' mathematical literacy achievement in learning transformation geometry.

To further examine the magnitude of improvement, the study conducted an N-gain analysis. The results are presented in [Table 3](#).

Table 3. N-Gain Analysis

Pretest Mean	Posttest Mean	N-Gain	Category
68.14	81.07	0.41	Moderate

The N-gain score of 0.41 indicates a moderate improvement in students' mathematical literacy skills. Furthermore, classical learning mastery reached 96.55%, indicating that most students successfully achieved the Minimum Mastery Criterion after using the developed e-module. These findings demonstrate that the e-module was effective in supporting students' mathematical literacy development and helping them achieve the expected learning outcomes.

The improvement in students' mathematical literacy can be explained by the contextual nature of the learning materials. Transformation geometry concepts were introduced through Malay songket motifs that reflected mathematical ideas such as symmetry, translation, reflection, and patterns. By relating abstract mathematical concepts to familiar cultural objects, students were provided with meaningful contexts for formulating, employing, and interpreting mathematical ideas. This learning process is closely aligned with the mathematical literacy framework proposed by the [OECD \(2023\)](#), which emphasizes the application of mathematics in real-life situations.

The findings of this study are consistent with previous research demonstrating the positive contribution of ethnomathematics-based learning to students' mathematical literacy and conceptual understanding. [Pratama and Yelken \(2024\)](#) reported that ethnomathematics-based learning significantly improves students' mathematical literacy compared with conventional instruction. Similarly, [\(Lita, 2024; Iffah et al., 2025\)](#) found that the integration of cultural contexts into mathematics learning helps students construct mathematical meaning from familiar experiences and supports the development of problem-solving skills. These studies suggest that contextual cultural learning environments provide opportunities for students to apply mathematical concepts in meaningful situations, thereby strengthening mathematical literacy.

In addition to the ethnomathematics approach, the use of digital learning resources also contributed to the effectiveness of the developed e-module. The digital format enabled the presentation of transformation geometry concepts through visual representations, structured learning activities, and contextual exercises that supported students' understanding of mathematical concepts. This finding is in line with previous studies reporting that e-modules can facilitate independent learning and improve students' learning outcomes by providing flexible and interactive learning experiences [\(Gesty & Leonard, 2025; Nuraini et al., 2024\)](#).

The findings also highlight the contribution of integrating Malay songket motifs, transformation geometry concepts, and OECD-oriented mathematical literacy processes within a single digital learning resource. This integration represents the novelty of the present study, as previous studies have generally focused either on ethnomathematics-based learning or on digital teaching materials separately. By combining local cultural contexts and digital learning resources in one instructional product, the developed e-module provides a contextual approach to supporting students' mathematical literacy development.

Overall, the findings indicate that the ethnomathematics-based e-module on Malay songket fabric met the validity criteria and effectively improved students' mathematical literacy skills in learning transformation geometry. These results directly support the objective of this study, which was to determine the validity and effectiveness of the developed e-module in improving students' mathematical literacy skills.

CONCLUSION

This study demonstrates that the ethnomathematics-based e-module on Malay songket fabric is a valid and effective learning resource for supporting mathematical literacy in transformation geometry learning, as it fulfilled the required validity criteria based on expert evaluations and contributed to improvements in students' mathematical literacy performance

after implementation. The novelty of this study lies in integrating Malay songket motifs, transformation geometry concepts, and OECD-oriented mathematical literacy processes within a single digital learning resource. Unlike previous studies that primarily focused on cultural exploration or the development of digital teaching materials separately, this study combines local cultural contexts with mathematical literacy-oriented learning activities in a validated instructional product and evaluates its effectiveness in classroom learning. The findings imply that local cultural heritage can be systematically integrated into technology-based mathematics instruction to create more contextual and meaningful learning experiences. Therefore, the developed e-module may serve as an alternative teaching material for junior high school mathematics learning, particularly in transformation geometry. Future studies are recommended to involve larger samples and experimental research designs to provide stronger evidence regarding the effectiveness of ethnomathematics-based e-modules in improving students' mathematical literacy skills.

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