

A CASE METHOD-BASED MATHEMATICS MODULE INTEGRATING EAST NUSA TENGGARA ETHNOMATHEMATICS FOR NUMERACY LITERACY

Nur Hasanah Syarief^{1*}, Reschi Vanchristo Ardi Sinlae²

^{1*} Universitas Muhammadiyah Kupang, Kupang, Indonesia

² Universitas Nusa Cendana, Kupang, Indonesia

*Corresponding author: nurhasanahsyarief@gmail.com

Received 04 February 2026; Revised 25 May 2026; Accepted 27 June 2026

Abstract

Improving students' numeracy literacy requires mathematics learning that is contextual, meaningful, and connected to students' cultural experiences. This study aimed to develop a case method-based mathematics learning module integrating East Nusa Tenggara ethnomathematics to improve students' numeracy literacy. The study employed a Research and Development (R&D) approach using the ADDIE model. The module was validated by two subject-matter experts and two media experts, while its practicality was evaluated through teacher and student response questionnaires. Its effectiveness was examined using a one-group pre-test-post-test design, analyzed with a paired-samples t-test and Cohen's d effect size. The subject-matter experts assigned validation scores of 4.6 for content accuracy, 4.8 for ethnomathematics content, 4.7 for instructional strategy, and 3.9 for language, indicating that module was valid to very valid. The media experts assigned scores of 4.4 for visual design, 4.3 for layout, and 4.9 for usability, indicating that the module was very valid. The practicality evaluation yielded scores of 89% for attractiveness, 86% for ease of use, and 88% for both module quality and user guidance, indicating that the module was highly practical. Students' numeracy literacy improved significantly after the implementation of the module ($p=0.007$), with the mean score increasing from 69,63 to 85,25. The module demonstrated a medium effect size (Cohen's $d=0.683$), indicating that the improvement was not only statistically significant but also educationally meaningful. These findings indicate that the developed module is a valid, practical, and effective learning resource for improving students' numeracy literacy while fostering appreciation of local cultural values.

Keywords: ADDIE; case method; ethnomathematics; learning module; numeracy literacy.

Abstrak

Peningkatan literasi numerasi siswa memerlukan pembelajaran matematika yang kontekstual, bermakna, dan terhubung dengan pengalaman budaya yang mereka miliki. Penelitian ini bertujuan untuk mengembangkan modul pembelajaran matematika berbasis case method yang mengintegrasikan etnomatematika Nusa Tenggara Timur untuk meningkatkan literasi numerasi siswa. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan model ADDIE. Validitas modul dievaluasi oleh dua ahli materi dan dua ahli media, kepraktisan dinilai melalui angket respons guru dan siswa, serta efektivitas modul menggunakan desain one-group pre-test-post-test dengan uji paired sample t-test dan analisis effect size Cohen's d. Hasil validasi oleh ahli materi menunjukkan skor 4,6 pada ketepatan materi, 4,8 pada muatan etnomatematika, 4,7 pada strategi pembelajaran, dan 3,9 pada kebahasaan, yang termasuk dalam kategori valid hingga sangat valid. Hasil validasi oleh ahli media menunjukkan skor 4,4 pada desain visual, 4,3 pada layout, dan 4,9 pada kemudahan penggunaan, yang termasuk dalam kategori sangat valid. Hasil uji kepraktisan menunjukkan skor 89% pada daya tarik, 86% pada kemudahan penggunaan, serta 88% pada kualitas modul dan petunjuk penggunaan, yang menunjukkan bahwa modul tergolong sangat praktis. Literasi numerasi siswa meningkat secara signifikan setelah penggunaan modul ($p = 0,007$), dengan rata-rata skor meningkat dari 69,63 menjadi 85,25. Modul memberikan pengaruh sedang (Cohen's $d = 0,683$), yang berarti peningkatan yang terjadi tidak hanya signifikan secara statistik, tetapi juga bermakna dalam pembelajaran. Temuan ini menunjukkan bahwa modul yang dikembangkan merupakan sumber belajar yang valid, praktis, dan efektif untuk meningkatkan literasi numerasi sekaligus menumbuhkan apresiasi terhadap nilai-nilai budaya lokal.

Kata kunci: ADDIE; case method; etnomatematika; modul pembelajaran; literasi numerasi



This is an open access article under the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

INTRODUCTION

Education in the 21st century requires students to master literacy and numeracy skills as fundamental competencies needed to adapt to global demands (World Economic Forum, 2016). Numeracy literacy reflects students' capacity to formulate, apply, and interpret mathematical concepts, procedures, and reasoning to solve a variety of contextual problems (Ahmad Fauzan et al., 2024; Programme for International Student Assessment (PISA), 2016). Mathematical literacy reflects an individual's capacity to understand mathematical concepts and relate them to real-world situations, enabling the appropriate use of mathematical information in decision-making processes that affect personal life, the workplace, and society (Botha & van Putten, 2018). Therefore, mathematical literacy plays a crucial role in supporting students' problem-solving abilities, as it requires systematic, logical thinking grounded in conceptual understanding.

The PISA 2022 report indicates a global decline in mathematics achievement, with more than half of participating countries scoring below the international average. This condition suggests that challenges in numeracy literacy constitute a global issue faced by many countries, particularly developing nations. In this context, Indonesian students' numeracy literacy achievement remains relatively low. Indonesia's PISA 2022 mathematics score was recorded at 366, significantly below the international average of 472 (OECD, 2023). This decline not only reflects the impact of the COVID-19 pandemic but also indicates structural problems in mathematics instruction. Wijaya et al. (2024) revealed that low numeracy literacy achievement is

influenced by various factors, including learning disruptions during the pandemic, curriculum instability, disparities in teacher competence, mathematics anxiety, limited learning resources, and minimal parental involvement. These conditions highlight the need for learning approaches that are more contextual, meaningful, and relevant to students' learning experiences.

These conditions indicate the need for instructional innovations that not only emphasize conceptual mastery but also foster students' ability to connect mathematical concepts with real-life contexts. Integrating culture into mathematics learning through an ethnomathematics approach is considered an effective alternative, as it creates learning experiences that are more contextual, meaningful, and closely aligned with students' daily lives (Dhiki & Bantas, 2021; Mahendra & Panglipur, 2025; Mairing & Nini, 2023; Prahmana & Istiandaru, 2021). Astuti et al. (2024) also reported that ethnomathematics-based instruction contributes positively to improving numeracy literacy skills. Nevertheless, teachers still face limitations in instructional media and learning resources, particularly those oriented toward ethno-constructivist approaches (Syahrial et al., 2020).

Numerous studies have attempted to enhance students' numeracy literacy through ethnomathematics-based approaches. Afgani and Paradesa (2021) and also Juhaevah (2022) developed locally grounded problems to strengthen students' literacy skills. Putri et al. (2022) designed instructional tools based on Lesson Study for Learning Community incorporating Using cultural values, while Gesty (2025), Putri et al. (2023), Rahmadeni et al. (2023), and Widiantari et al. (2022)

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

developed ethnomathematics-integrated e-modules. Although these studies demonstrate the effectiveness of ethnomathematics in improving numeracy literacy, research specifically focusing on the development culture of East Nusa Tenggara (NTT) remains limited.

In addition to cultural aspects, the manner in which problems are presented to students is also crucial. The case method is recognized as an instructional approach that promotes analytical thinking and problem-solving skills through real-world situations. Studies by Fimansyah et al. (2023), Kusumantoro et al. (2022), and Wahyuni et al. (2025) show that case method-based learning improves learning outcomes, motivation, and higher-order thinking skills. Furthermore, the integration of ethnomathematics into e-modules has been shown to strengthen conceptual understanding and students' interest in learning (Supriyadi et al., 2024). However, studies focusing on the development of case method-based mathematics modules integrating East Nusa Tenggara ethnomathematics at the junior secondary level remain limited.

Based on this background, this study aims to develop a case method-based learning module incorporating elements of East Nusa Tenggara (NTT) ethnomathematics that is suitable for improving students' numeracy literacy skills. This study is expected to contribute to the development of contextual and culturally responsive mathematics instruction within national and international mathematics education discourse, while also serving as an alternative learning resource for teachers and a means of preserving local NTT culture through meaningful learning.

METHODS

This study employed a Research and Development (R&D) approach using the ADDIE model to develop a valid, practical, and effective ethnomathematics-based learning module for East Nusa Tenggara. The ADDIE model adopted from Peterson (2003) consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. This model was selected due to its simple and consistent structure, which supports the production of valid instructional products (Ryazanova et al., 2021).

During the analysis stage, curriculum, content, and contextual analyses were conducted. Curriculum analysis was used to determine learning outcomes and objectives, content analysis identified the characteristics and depth of the material included in the module, and context analysis focused on identifying relevant ethnomathematical case contexts. In the design stage, the learning module and research instruments were developed, including validation sheets, student and teacher response questionnaires, and pre-post test instruments. During the development stage, the module was validated by subject matter experts and media experts and revised based on their feedback. The implementation stage involved a limited field trial with 20 seventh-grade students at SMP Negeri 5 Kupang through pre-post testing and instruction using the ethnomathematics-based case method module. The final evaluation stage assessed module practicality through questionnaire responses and effectiveness based on pre-post test results.

Data were collected using questionnaires and tests. Questionnaires were used to assess the practicality of the developed module based on

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

students' and teachers' responses to the case method-based mathematics module integrating East Nusa Tenggara ethnomathematics. The questionnaires were designed as closed-ended instruments using a five-point Likert scale. The assessment aspects included module attractiveness, ease of use, quality, and clarity of instructions, as

presented in Table 1. Tests consisted of pre-test and post-test instruments administered before and after the implementation of the module to measure students' mathematical literacy skills. The pre-test and post-test scores were analyzed to determine the effectiveness of the developed module.

Table 1. Assessment Aspects and Indicators of Student and Teacher Response Questionnaires

Assessment Aspect	Indicator
Attractiveness	- Attractiveness of the module's appearance and design (color, images, layout, and text) - The module's ability to stimulate students' interest and learning motivation - Usefulness of illustrations and visual displays in supporting material comprehension
Ease of Use	- Ease of understanding the structure and sequence of materials in the module - Practicality of using the module anytime and anywhere - The module's ability to support independent learning
Module Quality	- Clarity and accuracy of the module's content - Alignment of the material with curriculum requirements - Effectiveness of examples and exercises in reinforcing conceptual understanding
User Guidance	- Clarity and coherence of usage instructions - Adequacy of guidance for both teachers and students in using the module - Usefulness of the instructions in helping achieve learning objectives

Prior to data collection, the questionnaire and numeracy literacy test underwent content validation through expert judgment to ensure their suitability for measuring the intended constructs. The reliability of both instruments was subsequently assessed using Cronbach's Alpha. The questionnaire and numeracy literacy test yielded Cronbach's Alpha coefficients of 0.809 and 0.769, respectively, indicating that both instruments demonstrated good reliability and were appropriate for use in the study.

Before the implementation stage, the developed module underwent expert validation involving subject-matter experts and media experts. The subject-matter experts evaluated the module in terms of content accuracy, instructional strategies, and language appropriateness, whereas the media experts assessed its visual design, layout, and usability. The assessment aspects and indicators employed in both validation instruments are presented in Table 2.

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

Table 2. Assessment Aspects and Indicators of the Learning Module Validation Instrument

Validator	Assessment Aspect	Indicator
Subject-matter experts	Content	- Alignment of the material with competency standards (completeness, breadth, accuracy, and depth) - Suitability of the material with students' developmental level
	Ethnomathematics	- Accuracy of the use of ethnomathematics elements in the module
	Content	- Relevance of the content to the achievement of learning objectives
	Instructional Strategy	- Clarity of instructions and coherence of the learning flow - Variety of learning activities - Constructivist approaches embedded in the module
	Language	- Appropriateness of language level for students' developmental stage - Concise and clarity of language
Media Expert	Visual Design	- Attractiveness and quality of visual elements in the module
	Layout Design	- Page layout, numbering, illustrations, and other visual components
	Usability	- Effectiveness of visual and design elements in supporting the learning process

Descriptive and inferential statistical analyses were used in this study. The content validity of the developed module was evaluated through expert judgment involving two subject-matter experts and two media experts. The validity score for each assessment aspect was calculated using equation (1).

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n} \quad \dots (1)$$

Where $\bar{X}$ is mean validity score for each assessment aspect, X_i is rating assigned by each validator, and n is number of validators. Then, the mean scores result were subsequently interpreted according to the validity criteria (Table 3).

Table 3. Module Validity Criteria

Validity Criteria	Level of Validity
$4,2 < V \leq 5$	Very valid
$3,4 < V \leq 4,2$	Valid
$2,6 < V \leq 3,4$	Fairly valid
$1,8 < V \leq 2,6$	Invalid
$0 \leq V \leq 1,8$	Very invalid

Juhaevah (2022)

Module practicality was determined based on the teacher and student response questionnaires. The practicality score was calculated as the percentage of the total obtained score relative to the maximum possible score using Equation (2).

$$P = \frac{\sum X}{\sum X_{max}} \times 100\% \quad \dots (2)$$

Where P is practicality Percentage, $\sum X$ is total score obtained from the questionnaires, X_{max} is maximum possible score. Then, the resulting percentages were then interpreted according to the practicality criteria presented in Table 4.

Table 4. Module Practicality Criteria

Practicality Criteria	Level of Practicality
85,01% – 100%	Highly practical
70,01% – 85%	Quite practical
50,01% – 70%	Less practical
01,00% – 50%	Impractical

(Yanuarni et al., 2021)

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

Module effectiveness was evaluated using a one-group pre-test–post-test design. Students' pre-test and

post-test responses were assessed using the numeracy literacy assessment rubric presented in Table 5.

Table 5. Numeracy Literacy Scoring Rubric

Score	Communicating understanding	Representing mathematical	Applying problem-solving strategies	Reasoning and justification	Making mathematical connections
4	Clearly presents all solution steps in a logical sequence; draws accurate and relevant conclusions.	Appropriately selects, uses, and interprets representations (tables, diagrams, symbols, models) consistently.	Selects and applies appropriate, efficient strategies based on correct mathematical concepts.	Demonstrates logical reasoning, identifies patterns or relationships, and provides sound mathematical justification.	Effectively connects mathematical concepts to the problem context in a meaningful way.
3	Presents solution steps fairly logically; conclusion is correct but incomplete.	Uses appropriate representations, but interpretation is incomplete.	Applies appropriate strategies, but with limited efficiency.	Reasoning is generally logical, but justification lacks depth.	Makes relevant connections, but explanations lack depth.
2	Presents partially correct steps; conclusion is unclear or partially incorrect.	Uses representations with limited accuracy or consistency.	Uses partially appropriate strategies that only partly support the solution.	Reasoning is weak and justification is inconsistent.	Makes limited or partially relevant connections.
1	Solution steps are disorganized with major errors; conclusion is incorrect.	Uses inappropriate representations for the problem.	Applies inappropriate or irrelevant strategies.	Reasoning is illogical with no clear justification.	Fails to connect mathematical concepts to the context.
0	No explanation of steps or conclusion is provided.	No representation is used.	No strategy is demonstrated.	No reasoning or justification is shown.	No mathematical connections are demonstrated.

After confirming data normality using the Shapiro–Wilk test, differences between pre-test and post-test scores were analyzed using a paired sample *t*-test. Cohen's *d* effect size was calculated using Equation (3), and its magnitude was interpreted according to the criteria presented in Table 6 (Cohen, 1988; Lakens, 2013).

$$d = \frac{\bar{D}}{SD_D} \quad \dots (3)$$

where *d* is Cohen's effect size, $\bar{D}$ is the mean difference between post-test and pre-test scores, and SD_D is the standard deviation of the difference scores.

Table 6. Interpretation Criteria for Cohen's *d* Effect Size

Cohen's <i>d</i>	Interpretation
> 0,20	Negligible
0,20 – 0,49	Small
0,50 – 0,79	Medium
≥ 0,80	Large

RESULTS AND DISCUSSION

The case method-based learning module integrating East Nusa Tenggara ethnomathematics was developed using the ADDIE model. Analysis results indicated that module development involved curriculum, content, and

contextual analyses. Curriculum analysis aligned the module with Phase D learning outcomes in the number domain, emphasizing students' abilities to explain ratio concepts, distinguish between additive comparison and multiplicative ratio, apply scale factors, connect equivalent ratios with proportions, and apply ratios and rates of change in real-life contexts.

Content analysis determined the scope of materials, including ratios, scales, and unit rates, presented through contextual cases integrated with NTT ethnomathematics. Context analysis focused on culturally relevant phenomena, such as ingredient ratios in traditional foods (jagung boso and jagung katemak), natural dyeing processes in woven fabrics, and size and motif ratios in traditional textiles. These findings align with previous studies highlighting the role of ethno-mathematics in strengthening numeracy literacy,

conceptual understanding, and problem-solving skills (Astuti et al., 2024; Iswara et al., 2022; Masruroh & Amir, 2024).

The design stage resulted in a learning module consisting of three activities aligned with ratio, scale, and rate-of-change subtopics. Each activity followed the case method stages—concept introduction using East Nusa Tenggara ethnomathematical contexts, culturally based case presentation, case analysis guided by Polya's problem-solving steps, summarization, and independent exercises. This structure, adapted from Puri (2020) case method framework of preparation, analysis, discussion, and reflection, was designed to support meaningful conceptual understanding, real-life application, and the development of students' critical thinking skills. An example of the learning activity design is shown in Figure 1.

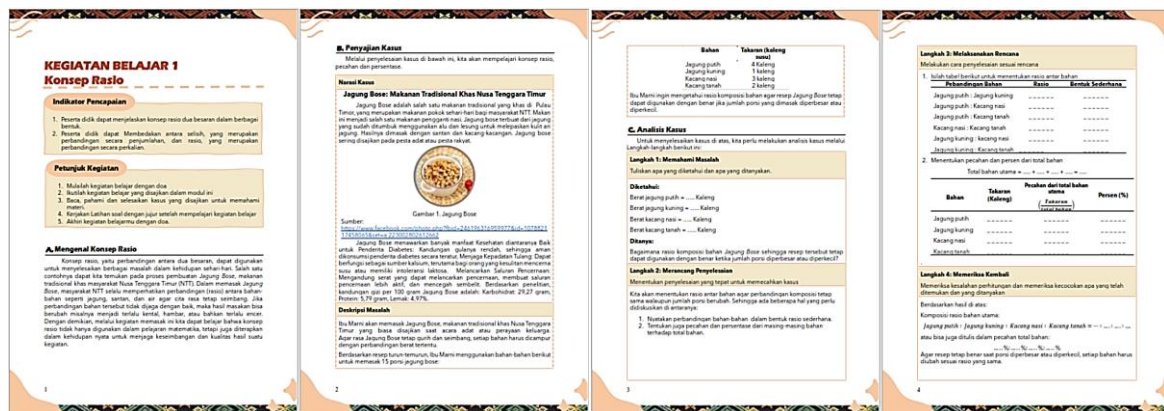


Figure 1. Example of Learning Activities in the Module

Module Validity Result

The learning module was validated during the development stage through expert judgment involving subject-matter and media experts to assess content feasibility and visual quality. As presented in Table 7, the case method-based module integrating

East Nusa Tenggara ethnomathematics achieved average validation scores above 4.0 across all assessed aspects, including content material, ethno-mathematics integration, instructional strategy, visual design, layout, and usability, indicating a high level of validity.

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

Table 7. Results of Module Validation by Subject Matter Experts and Media Experts

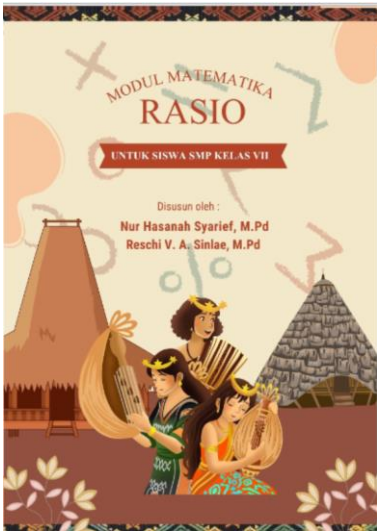
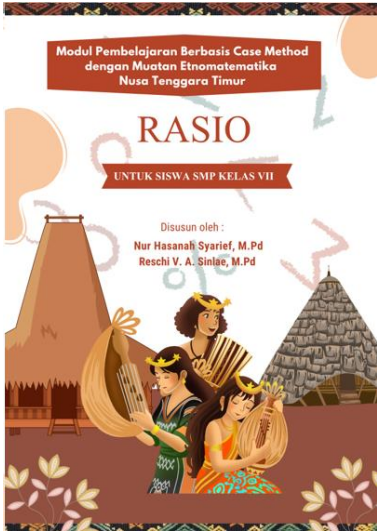
Assessment Aspect		Validation Results			Validation Criteria
		Validator 1	Validator 2	Average	
Subject-matter experts	Content Accuracy	4,4	4,8	4,6	Very valid
	Ethnomathematics Content	5	4,6	4,8	Very valid
	Delivery Strategy	4,8	4,6	4,7	Very valid
	Language	4	3,8	3,9	Valid
Media Expert	Visual Design	4,8	4	4,4	Very valid
	Layout Design	4	4,6	4,3	Very valid
	Usability	4,8	5	4,9	Very valid

These results confirm that the module is systematically developed, aligned with the intended learning objectives, and consistent with the principles of the case method, which emphasizes active student engagement in analyzing and solving authentic problems (Fimansyah et al., 2023; Puri, 2020). Expert feedback further suggested minor revisions, such as adding module identity on the cover, providing titles for all figures, and

including a glossary of local terms, which were implemented to enhance clarity and instructional quality.

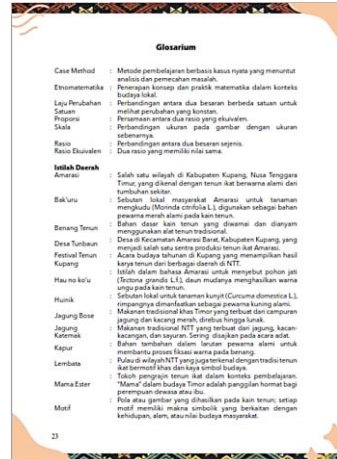
Based on feedback from both media and content experts, several revisions were made to improve the module’s quality, including: adding the module’s identity as a case method–based ethnomathematics learning resource on the cover, inserting titles for each figure, and including a glossary containing local terminology.

Table 8. Product Revision

Before Revision	After Revision
Adding the module identity as a case method–based learning resource with ethno-mathematical content on the cover.	
	

Before Revision	After Revision
Inserting titles for each figure,	
	

Including a glossary containing local terminology



Module Practicality

During the implementation stage, the validated and revised module was piloted with 20 seventh-grade students at SMP Negeri 5 Kupang and implemented by a mathematics teacher

using a case method-based approach integrating ethnomathematics. After the learning activities, both students and the teacher completed response questionnaires to evaluate the module's practicality.

Table 9. Practicality of the Learning Module

Assessment Aspect	Scores (%)		Average	Criteria Practicality
	Student Response	Teacher Response		
Attractiveness	85,3	92	89	Highly practical
Ease of Use	79,8	92	86	Highly practical
Module Quality	83,3	92	88	Highly practical
User Guidance	79,8	96	88	Highly practical

As shown in Table 7, the module was rated as highly practical across all aspects, with average practicality scores

ranging from 86% to 89%, the highest being learning attractiveness (89%) and the lowest ease of use (86%). These

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

results indicate that the module is easy to use, engaging, and of high quality for classroom implementation. The positive evaluation of the attractiveness aspect suggests that the visual design, cultural context, and case presentation effectively enhanced students' learning motivation, which is consistent with previous studies highlighting the role of ethnomathematics-based modules in increasing student engagement and learning interest (Supriyadi et al., 2024; Widiantari et al., 2022). Furthermore, the integration of ethnomathematics supports deeper conceptual understanding while fostering appreciation of local cultural values and the development of students' critical and creative thinking skills (Mahendra & Panglipur, 2025).

Module Effectiveness

The effectiveness of the case method-based mathematics module integrating East Nusa Tenggara

ethnomathematics was examined at the evaluation stage using a pre-test–post-test design. Students' numeracy literacy skills were measured before and after the implementation of the module. Prior to hypothesis testing, the normality of the pre-test and post-test score differences was assessed using the Shapiro–Wilk test due to the sample size being fewer than 50.

Table 10. Normality Test Result with Shapiro-Wilk

	Statistic	df	Sig.
Diference pre – post test	0.976	20	0.872

The results indicated that the score differences were normally distributed (Sig. = 0.872 > 0.05), justifying the use of parametric analysis. Accordingly, a paired sample t-test was conducted to determine the effectiveness of the developed module.

Table 11. Effectiveness Test Result with Paired Sample t test

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre_Test-Post_Test	-15,6250	22,8824	5,1166	-26,3343	-4,9157	-3,054	19	,007

As presented in Table 10, the paired sample *t*-test revealed a statistically significant improvement in students' numeracy literacy skills after using the developed module (Sig. (2-tailed) = 0.007 < 0.05). The mean score increased from 69.63 in the pre-test to 85.25 in the post-test, indicating that the developed module effectively improved

students' numeracy literacy skills. Furthermore, the effect size analysis yielded a Cohen's *d* value of 0.683, indicating a medium effect according to (Cohen, 1988) criteria. This finding suggests that the improvement was not only statistically significant but also educationally meaningful.

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

Table 12. Mean Scores of Numeracy Literacy Indicators Before and After Module Implementation

Numeracy Literacy Indicator	Pre-Test	Post-Test	Mean Gain
Communicating understanding	2,85	3,40	0,55
Representing mathematical	2,83	3,60	0,78
Applying problem-solving strategies	2,65	3,70	1,05
Reasoning and justification	2,80	2,90	0,10
Making mathematical connections	2,80	3,45	0,65

To provide a more comprehensive description of students' numeracy literacy development, the pre-test and post-test scores were further analyzed for each numeracy literacy indicator. As shown in Table 11, improvements were observed across all five indicators. The largest improvement occurred in solution strategies, with a mean gain of 1.05, followed by mathematical representation (0.78), mathematical connections (0.65), and mathematical communication (0.55). The mathematical reasoning indicator showed the smallest improvement, with a mean gain of 0.10.

These findings indicate that the developed module contributed to improvements across multiple dimensions of students' numeracy literacy, with the greatest gains observed in students' ability to formulate and apply solution strategies when solving contextual mathematical problem

The improvement across all numeracy literacy indicators suggests that the effectiveness of the developed module was not merely reflected in students' overall achievement but also in their ability to solve contextual mathematical problems using different cognitive processes. Among the five indicators, applying problem-solving strategies demonstrated the highest gain. This result is closely associated with the characteristics of the case method, which engages students in analysing authentic situations, identifying relevant information,

evaluating alternative solutions, and selecting appropriate mathematical strategies before reaching conclusions. Such learning activities encourage students to actively construct knowledge through discussion and reflection rather than relying on memorization. Puri (2020) explained that the case method bridges theoretical knowledge with real-world situations by promoting preparation, analysis, discussion, and reflection, while Fimansyah et al. (2023) also reported that case method-based e-modules effectively improve higher-order thinking skills because students are required to analyse authentic cases and formulate solutions independently. These characteristics likely contributed to the substantial improvement in students' problem-solving strategy skills observed in this study.

The improvement in students' numeracy literacy was also influenced by the integration of East Nusa Tenggara ethnomathematics into the learning activities. Presenting ratio, scale, and rate-of-change concepts through familiar cultural contexts enabled students to connect abstract mathematical ideas with everyday experiences, thereby facilitating conceptual understanding and mathematical representation. This finding supports Astuti et al. (2024), who emphasized that ethnomathematics-based learning contributes to students' numeracy development by providing meaningful cultural contexts for mathematical

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

thinking. Likewise, Supriyadi et al. (2024) found that ethnomathematics-based e-modules enhance conceptual understanding, learning engagement, and cultural awareness. Consequently, the combination of culturally relevant contexts and case-based learning in the present study appears to have created meaningful learning experiences that supported students in applying mathematics to contextual situations.

Although improvements occurred across all indicators, reasoning and justification exhibited the smallest gain. This finding indicates that developing mathematical reasoning requires longer and more sustained learning experiences than improving procedural or strategic competencies. Reasoning involves constructing logical arguments, providing mathematical justification, and evaluating relationships among concepts, which generally develop through repeated opportunities for explanation and reflection. From an ethnoconstructivist perspective, meaningful learning occurs when students actively construct new mathematical knowledge based on their cultural experiences rather than passively receiving information. Therefore, while the developed module successfully improved students' numeracy literacy, future implementations should incorporate more activities requiring mathematical justification, argumentation, and reflective discussion to further strengthen reasoning skills (Syahrial et al., 2020).

CONCLUSIONS

This study successfully developed a case method-based mathematics learning module integrating East Nusa Tenggara ethnomathematics for junior secondary students. The developed module was demonstrated to be valid, highly practical, and effective in

improving students' numeracy literacy. By integrating local cultural contexts into ratio, scale, and rate-of-change topics, the module provided meaningful learning experiences that enabled students to construct mathematical understanding through authentic situations while fostering appreciation of local cultural values. These findings indicate that combining the case method with ethnomathematics offers an effective instructional approach for promoting contextual and culturally responsive mathematics learning.

From a theoretical perspective, this study contributes to the growing body of research supporting constructivist and contextual learning by demonstrating that culturally grounded case-based learning can enhance students' numeracy literacy. Practically, the developed module provides an alternative instructional resource for mathematics teachers seeking to implement meaningful, student-centered, and culturally responsive learning activities in the classroom.

Despite these promising findings, several limitations should be acknowledged. The field trial involved only 20 seventh-grade students from a single junior high school in Kupang, East Nusa Tenggara, which limits the generalizability of the findings to broader educational contexts. In addition, the effectiveness evaluation employed a one-group pre-test–post-test design without a comparison group; therefore, the observed learning gains cannot be attributed exclusively to the developed module. Future studies are recommended to involve larger and more diverse samples across different regions and to adopt quasi-experimental or experimental designs with control groups. Such studies would provide stronger evidence regarding the

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

effectiveness of case method-based ethnomathematics modules and further examine their impact on students' numeracy literacy and other higher-order mathematical competencies.

REFERENCES

- Afgani, M. W., & Paradesa, R. (2021). PISA-Like Problems Using Islamic Ethnomathematics Approach. *Infinity Journal of Mathematics Education*, 10(2), 203–216.
<https://doi.org/10.22460/infinity.v10i2.p203-216>
- Astuti, E. P., Wijaya, A., & Hanum, F. (2024). Characteristics of junior high school teachers' beliefs in developing students' numeracy skills through ethnomathematics-based numeracy learning. *Journal of Pedagogical Research*, 8(1), 244–268.
<https://doi.org/10.33902/JPR.202423405>
- Botha, H., & van Putten, S. (2018). How Mathematical Literacy Teachers Facilitate Mathematization in Modelling Situations. *African Journal of Research in Mathematics, Science and Technology Education*, 22(1), 93–102.
<https://doi.org/10.1080/18117295.2018.1437337>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (Second). Lawrence Erlbaum Associates.
- Dhiki, Y. Y., & Bantas, M. G. D. (2021). Eksplorasi Etnomatematika Sebagai Sumber Belajar Matematika di Kabupaten Ende. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(4), 2698–2709.
<https://doi.org/10.24127/ajpm.v10i4.4254>
- Fauzan, A., Harisman, Y., Yerizon, Suherman, Tasman, F., Nisa, S., Sumarwati, Hafizatunnisa, & Syaputra, H. (2024). Realistic mathematics education (RME) to Improve Literacy and Numeracy Skills of Elementary School Students Based on Teachers' Experience. *Infinity Journal of Mathematics Education*, 13(2).
<https://doi.org/10.22460/infinity.v13i2.p301-316>
- Fimansyah, F., Irnandi, I., Siregar, N. N., & Simamora, E. W. (2023). Development of an interactive e-module based on a case method to improve higher-order thinking skills. *Journal of Research in Instructional*, 3(2), 296–306.
<https://doi.org/10.30862/jri.v3i2.254>
- Gesty, H. A. (2025). Development Of Mathematics E-Module Based On Ethnomathematics. *JKTP: Jurnal Kajian Teknologi Pendidikan*, 8(2), 94–106.
<https://doi.org/10.17977/um038v8i22025p094>
- Iswara, H. S., Ahmadi, F., & Ary, D. Da. (2022). Numeracy Literacy Skills of Elementary School Students through Ethnomathematics-Based Problem Solving. *Interdisciplinary Social Studies*, 2(2), 1604–1616.
<https://doi.org/10.55324/iss.v2i2.316>
- Juhaevah, F. (2022). Developing mathematics problems using local wisdom context of Maluku to improve students' numeracy. *Jurnal Elemen*, 8(1), 323–339.
<https://doi.org/10.29408/jel.v8i1.4524>
- Kusumantoro, Jaenudin, A., & Melati, I.

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

- S. (2022). Case-Based Interactive E-Module: an Alternative Supplement to Increase Student Learning Motivation. *Journal of Education Tecnology*, 6(4), 674–684.
<https://doi.org/10.23887/jet.v6i4.47254>
- Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t -tests and ANOVAs. *Frontiers in Psychology*, 4(November), 1–12.
<https://doi.org/10.3389/fpsyg.2013.00863>
- Mahendra, I. W. E., & Panglipur, I. R. (2025). *Etnomatematika dalam Pembelajaran Strategi dan Teknik Evaluasi*. Deepublish.
- Mairing, J. P., & Nini. (2023). Ethnomathematics Learning Model Based on Motifs of Dayak Ngaju Central Kalimantan. *Mathematics Teaching Research Journal Fall*, 15(5), 30–48.
<https://eric.ed.gov/?id=EJ1412234>
- Masruroh, M., & Amir, M. F. (2024). Innovative Learning Media : Ethnomathematics-based Modules for Third-Grade of Elementary School Students. *Journal for Lesson and Learning Studies*, 7(1), 81–93.
<https://doi.org/10.23887/jlls.v7i1.68306> Innovative
- OECD. (2016). PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic and Financial Literacy,. In *OECD Publishing*.
<https://doi.org/10.1787/9789264255425-en>
- OECD. (2023). *PISA 2022 Results*.
[https://www.oecd.org/publication/pisa-2022-](https://www.oecd.org/publication/pisa-2022-results/webbooks/dynamic/pisa-country-notes/c2e1ae0e/pdf/indonesia.pdf)
- country-
notes/c2e1ae0e/pdf/indonesia.pdf
- Peterson, C. (2003). Bringing ADDIE to Life : Instructional Design at Its Best. *Journal of Educational Multimedia and Hypermedia*, 12(3), 227–241.
<https://www.learntechlib.org/primary/p/2074/>
- Prahmana, R. C. I., & Istiandaru, A. (2021). Learning Sets Theory Using Shadow Puppet : A Study of Javanese Ethnomathematics. *Mathematics*, 9.
<https://doi.org/10.3390/math9222938>
- Puri, S. (2020). Effective learning through the case method. *Innovations in Education and Teaching International*, 00(00), 1–11.
<https://doi.org/10.1080/14703297.2020.1811133>
- Putri, M. A. K., Pambudi, D. S., & Kurniati, D. (2022). Pengembangan Perangkat Pembelajaran Berbasis Lesson Study for Learning Community Bernilai Budaya Using Untuk Meningkatkan Numerasi. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(4), 2567.
<https://doi.org/10.24127/ajpm.v11i4.6164>
- Putri, S. A. M., Putra, Z. H., & Alpusari, M. (2023). Pengembangan Modul Materi Bangun Datar Berbasis Etnomatematika Melayu Kuansing di Sekolah dasar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 12(3), 3309–3329.
<https://doi.org/10.24127/ajpm.v12i3.6139>
- Rahmadeni, F., Septiana, A., &

DOI: <https://doi.org/10.24127/ajpm.v15i2.15708>

- Syaripah, S. (2023). Numeracy Literacy Module Based on Local Culture: Effort to Improve Numeracy Literacy Skill. *Al Khawarizmi: Jurnal Pendidikan Dan Pembelajaran Matematika*, 7(1), 10. <https://doi.org/10.22373/jppm.v7i1.17115>
- Ryazanova, N., Semak, A., & Kazakova, E. (2021). ADDIE educational technology for coursework design in environmental education for sustainable development in Russia. *E3S Web of Conferences*, 265, 1–7. <https://doi.org/10.1051/e3sconf/202126507001>
- Supriyadi, E., Turmudi, T., Dahlan, J. A., Juandi, D., & Indonesia, U. P. (2024). Development of Sundanese Gamelan Ethnomathematics E-Module for Junior High School Mathematics Learning. *Malaysian Journal Of Learning and Instruction*, 21(2), 139–178. <https://doi.org/https://doi.org/10.32890/mjli2024.21.2.6>
- Syahrial, Asrial, Maison, Mukminin, A., & Kurniawan, D. A. (2020). Ethnoconstructivism analysis : Study of pedagogic mathematics competence of primary school teachers. *International Journal of Evaluation and Research in Education (IJERE)*, 9(3), 614–624. <https://doi.org/10.11591/ijere.v9i3.20256>
- Wahyuni, A., Saputra, M. A., & Kurniawanti, M. R. (2025). Case Method Based E- Module : History Learning Innovation to Improve Students's Higher Order Thinking Skills. *HISTORIA: Jurnal Program Studi Pendidikan Sejarah Volume*, 13(1). <https://doi.org/10.24127/hj.v13i1.10171>
- Widiantari, N. K. K., Suparta, I. N., & Sariyasa. (2022). Meningkatkan Literasi Numerasi dan Pendidikan Karakter dengan E-Modul Bermuatan Etnomatematika. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, 10(2), 331–343. <https://doi.org/10.25273/jipm.v10i2.10218>
- Wijaya, T. T., Hidayat, W., Hermita, N., Alim, J. A., & Talib, C. A. (2024). Exploring Contributing Factors to PISA 2022 Mathematics Achievement: Insights From Indonesian Teachers. *Infinity Journal of Mathematics Education*, 13(1), 139–156. <https://doi.org/10.22460/infinity.v13i1.p139-156>
- World Economic Forum. (2016). *New Vision for Education: Fostering Social and Emotional Learning through Technology*. https://www3.weforum.org/docs/WEF_New_Vision_for_Education.pdf
- Yanuarni, R., Yuanita, P., & Maimunah. (2021). Pengembangan Perangkat Pembelajaran Model Problem Based Learning Terintegrasi Keterampilan Abad 21. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(2), 536–549. <https://doi.org/https://doi.org/10.24127/ajpm.v10i2.3331>