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DEVELOPMENT OF A REALISTIC MATHEMATICS EDUCATION MODULE BASED ON COASTAL CULTURE TO IMPROVE NUMERATION LITERACY

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Abstract

Despite high cognitive potential from fish consumption, coastal students face boring traditional modules; thus, a culture-based RME-AI module was developed to enhance numeracy skills. This study aims to analyze the level of validity, practicality, and effectiveness of the Realistic Mathematics Education (RME) learning module based on coastal culture with the Gemini application and how the module can improve the numeracy literacy skills of fifth grade students. The RME module development leverages students' environmental reality to facilitate mathematical learning, effectively bridging pedagogical gaps to achieve superior educational goals through contextual experiences and meaningful conceptual mastery. So that with this module it can help students in improving numeracy literacy skills. The RME-based module is said to be suitable for use if it meets three criteria: valid, practical, and effective. Based on the results of the research analysis, 1) the module was declared very valid after being revised with a percentage of 89.00%, 2) the module was declared practical with an average student response questionnaire result of 84.00% in the field test. Furthermore, 3) the normalized gain test was used to determine how effective the RME learning module was in improving students' numeracy literacy skills. The gain test results showed a value of 0.35 which indicates moderate. This means that the RME learning module based on coastal culture is effective in improving students' numeracy literacy skills. The implications suggest integrating local wisdom bridges abstract-reality gaps, while Gemini AI offers scalable, culturally-responsive models that significantly enhance student engagement and long-term retention of numeracy skills.

Keywords: coastal culture; learning modules; mathematical literacy; RME

Abstrak

Meskipun memiliki potensi kognitif tinggi dari konsumsi ikan, siswa di daerah pesisir menghadapi modul tradisional yang membosankan; Oleh karena itu, dikembangkan modul RME-AI berbasis budaya untuk meningkatkan kemampuan berhitung. Penelitian ini bertujuan untuk menganalisis tingkat validitas, kepraktisan, dan efektivitas modul pembelajaran Pendidikan Matematika Realistis (RME) berbasis budaya pesisir dengan aplikasi Gemini dan bagaimana modul tersebut dapat meningkatkan kemampuan literasi berhitung siswa kelas lima. Pengembangan modul RME memanfaatkan realitas lingkungan siswa untuk memfasilitasi pembelajaran matematika, secara efektif menjembatani kesenjangan pedagogis untuk mencapai tujuan pendidikan yang unggul melalui pengalaman kontekstual dan penguasaan konsep yang bermakna. Modul ini bertujuan meningkatkan literasi numerasi siswa melalui pendekatan RME yang memenuhi kriteria kelayakan: valid, praktis, dan efektif. Hasil penelitian menunjukkan modul sangat valid dengan persentase 89,00% setelah revisi. Pada uji lapangan, tingkat praktis mencapai 84,00% berdasarkan respons siswa. Terakhir, efektivitas modul dalam meningkatkan keterampilan literasi numerasi diukur menggunakan uji normalized gain (N-Gain). Implementasi ini membuktikan bahwa perangkat pembelajaran berbasis RME layak digunakan untuk mendukung kemampuan literasi numerasi siswa secara signifikan. Hasil uji peningkatan menunjukkan nilai 0,35 yang menunjukkan tingkat sedang. Ini berarti bahwa modul pembelajaran RME yang berbasis budaya pesisir efektif dalam meningkatkan keterampilan literasi numerasi siswa. Implikasinya menunjukkan bahwa integrasi kearifan lokal menjembatani mengganggu abstrak-realitas, sementara Gemini AI menawarkan model yang terukur dan responsif secara budaya yang secara signifikan meningkatkan keterlibatan siswa dan retensi jangka panjang keterampilan numerasi.

Kata kunci: *budaya pesisir; literasi matematika; modul pembelajaran; RME*

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INTRODUCTION

Mathematics is a vital tool for developing individuals who can think critically, solve problems, and apply knowledge effectively in real-life situations (Ministry of National Education [MoNE], 2018). However, traditional mathematics education, often abstract and disconnected from daily life, contributes to students' difficulty in recognizing the relevance of mathematics in the real world (Alyanak & Özkaya, 2026). Students experience difficulties when they are not accustomed to being confronted with realistic problems, especially students in disadvantaged schools.

Telaga Tujuh Elementary School is located on the coast of a small island in Langsa City. The majority of the residents work as fishermen, so students in the area should have good academic abilities, supported by their daily consumption of fish. Fish oil contains omega-3 (n-3) long-chain polyunsaturated fatty acids (LC-PUFA). Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) are required for brain formation and function (von Schacky, 2021). DHA and EPA are especially critical in the developing brain and retina. This creates a demand for DHA and EPA and increases the risk of health issues, especially cognitive and visual deficits (Sittiprapaporn et al., 2022).

Low numeracy literacy among Indonesian students is evident in PISA 2015 and 2018 results, which consistently fall below international benchmarks (OECD, 2018a; (Afgani & Paradesa, 2021). Numeracy literacy includes the knowledge, skills, behaviors, and character that students need to use mathematics in a broader context (Gal et al., 2020). This deficiency is exacerbated by conventional teaching and textbook over-reliance, leading to student disengagement (Beatty et al., 2021). Given that numeracy is vital for practical problem-solving (Stecey, K., & Turner, 2015) updating teacher competencies is essential. Adopting diverse instructional strategies is crucial to enhancing student engagement and addressing the persistent challenges in mathematical literacy (Zhang et al., 2024).

Despite the coastal environment's potential, numeracy literacy among Telaga Tujuh students remains low. The reliance on conventional, monotonous textbooks has led to student disengagement and a decline in learning interest (Beatty et al., 2021). Furthermore, while students have access to technology (gadgets), their usage is limited to entertainment rather than educational purposes. Limited student technology use, primarily for gaming, necessitates optimizing digital literacy through Artificial Intelligence. Integrating AI, specifically Google Deepmind's Gemini (Masalkhi et al., 2024), fosters interactive learning. Gemini enhances mathematics education through advanced image analysis, allowing students to process visual texts effectively. This transition from passive consumption to active digital inquiry is crucial for modernizing pedagogical engagement in learning. This indicates an urgent need for varied learning methods that prevent boredom and capitalize on the students' lived experiences.

Therefore, special attention is needed from the government because coastal students also have a great opportunity to participate in regional, national, and international competitions related to numeracy skills that stimulate students' thinking character. Teachers, as the frontline facilitators of learning, hold invaluable insights into the

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educational processes and challenges faced by students (Wijaya et al., 2024). Their view points and recommendations are crucial in understanding the complexities behind the declining scores and in formulating effective strategies to enhance mathematics literacy (Attard & Busuttil, 2020). One solution is to implement learning methods that can improve numeracy skills through coastal culture-based learning.

The development of Realistic Mathematics Education (RME) modules by utilizing reality and the environment that students understand to facilitate the mathematics learning process, thereby achieving better mathematics education goals. RME is a more contextual and relevant approach for students, allowing them to connect mathematical concepts to real-world situations. Implicitly, it is student-focused (Listyaningrum et al., 2025).

To navigate the aforementioned pedagogical hurdles, the Realistic Mathematics Education (RME) framework, initiated by Freudenthal, presents a viable solution (Murni et al., 2026). This approach prioritizes mathematical instruction rooted in authentic contexts, facilitating a systematic transition from tangible experiences to formal symbolic notation (Murni et al., 2026). By embedding mathematical principles within routine activities such as commerce, measurement, or object categorization RME empowers learners to derive genuine meaning and apply theoretical concepts to real-world scenarios. Empirical evidence underscores RME's capacity to bolster conceptual mastery and heuristic skills across various learner profiles, particularly benefiting those who struggle with conventional methods (Van den Heuvel-Panhuizen, M., & Drijvers, 2014). Previous RME research by (Murni et al., 2026) utilized eco-based activities and recycled objects to integrate environmental awareness with mathematics.

In the specific context of schools in Telaga Tujuh, this coastal culture-based RME is adapted by transforming local daily activities such as calculating fish yields, measuring net areas, and understanding tidal patterns into structured mathematical problems. While RME and AI tools like Gemini have been studied independently, there is a distinct lack of research focusing on their integration within specific coastal cultural contexts. Most existing RME modules use general urban or market scenarios. The novelty of this study lies in the development of a Coastal Culture-Based RME module specifically designed for island communities. This research bridges the gap between traditional coastal life (e.g., calculating fish yields and tidal patterns) and modern digital literacy by utilizing the Gemini AI application to transform local reality into structured mathematical problems.

This research develops a Coastal Culture-Based Realistic Mathematics Education (RME) module integrated with the Gemini AI application to enhance numeracy and character skills at Telaga Tujuh Elementary School. The study aims to evaluate the module's validity, practicality, and effectiveness. By aligning mathematical concepts with familiar coastal realities, this study provides a pedagogical framework that transforms daily contexts into meaningful learning. AI tools optimize culturally responsive materials, strategically addressing students' stagnant numeracy skills.

METHODS

The research used is research on the development of a Learning Management System using the ADDIE model

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with the (Dick & Carey, 2006). Implementation is carried out in five stages, namely: Analysis, Design, Development, Implementation, and Evaluation (Alfianto et al., 2019). The ADDIE development research flowchart can be seen in Figure 1.

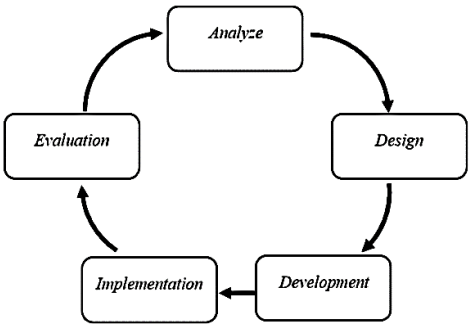

Figure 1. ADDIE Research and Development Cycle

1) Analysis Stages

The analysis stages carried out are divided into three stages: needs analysis, curriculum analysis, and student characteristics analysis. Needs analysis is conducted to examine the learning modules available and used by schools, as well as the conditions in the classroom and the problems faced by teachers in delivering the mate-rial. Material analysis is conducted to determine which material has been difficult for teachers to convey to students, to then be used as material in this study. Student characteristics analysis is conducted to examine how students' behavior and abilities in learning activities are by conducting direct interviews with students or asking them to the teacher.

2) Design Stage

The second stage is design. The design phase is divided into two stages: research instrument design and learning module design. The instrument design is divided into several parts, including the initial and final tests for students' mathe-matical creativity abilities, interview guidelines, media expert validity questionnaires, and education expert validity questionnaires, as well as student response questionnaires.

3) Development Stage

The third stage is development. The design of the learning module created in the second stage will be realized in this stage. The result of this stage is an alpha version of the learning module. This alpha version of the learning module will then be reviewed for validity by three experts: a material expert, a media expert, and a practitioner to determine whether the alpha version of the learning module is valid or not. If the learning media is declared valid by the experts, then the implementation will proceed with the alpha version. However, if the alpha version of the learning module is not valid, improvements will be made first until all improvements are completed and it becomes a beta version of the learning module that will be used for the next stage.

4) Implementation Stage

The fourth stage is imple-mentation. At this stage, the learning module that has been declared valid is tested on test subjects, namely students in the class. First, a pre-test is given to determine the students' initial digital literacy and mathematical creativity skills. After the pre-test, the learning module is then used in learning activities for three meetings. After the final lesson is completed, students are given a post-test to determine their digital literacy and mathematical creativity skills after using the learning module. In addition to the test, students are also given a questionnaire regarding their responses to the learning module they have used. Practicality data is also obtained from the results of the

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practicality questionnaire given to teachers after the learning activities are completed.

5) Evaluation Stage

The fifth stage in this research is evaluation. This stage assesses the effectiveness of the developed learning module in improving students' digital literacy and mathematical creativity. It also assesses the practicality of the learning media. This stage not only provides evaluation but also provides suggestions for future development of this learning module.

This research was conducted at Teulaga Tujuh Elementary School, West Langsa District, Langsa City, during the even semester of the 2024/2025 academic year. The study period was three months. Data collection techniques were observation and interviews. The instruments used in this study were: 1) a validity questionnaire, 2) a student response questionnaire, and 3) a test. A module is considered suitable for use if it meets the criteria of validity, practicality, and effectiveness.

To analyze the feasibility of RME-based learning modules, this can be done by looking at the results of the feasibility test through the following categories:

1) Validity Analysis of RME-Based Modules.

This analysis is used to measure the validity level of RME-based modules, which will be carried out by expert validators. The formula is as follows:

$$V_a = \frac{TS_e}{TS_h} \; x \; 100\% \qquad \text{... (1)}$$

Where :

V_a : Validation from experts
TS_e : Total empirical score (results from validator)
TS_h : Total maximum expected score

Table 1. RME-Based Module Validity Level Indicator

No	Validity Criteria	Validity Level
1	81,26% - 100%	Very valid
2	62,51% – 81,25%	Valid
3	43,76% - 62,50%	Quite Valid
4	25,01% - 43,75%	Invalid
5	0,00% - 25,00%	Very Invalid

2) Module Practicality Analysis

Student practicality analysis can be calculated using a Likert scale. The Likert scale is used to measure a person's attitudes, opinions, and perceptions. The questionnaire will contain statements about the module's practicality, which will then be scored according to the answers. The total of the student assessment results will then be calculated as a percentage to determine the level of practicality of the RME-based teaching module using the following formula (Sugiyono, 2014).

$$P = \frac{A}{B} \; x \; 100\% \qquad \text{... (2)}$$

Where :

P : Percentage of Student Responses
A : Total score obtained
B: Total maximum expected score

Table 2. Practicality Level Indicator of RME-Based Modules

Validity Criteria	Validity Level
5	Strongly agree
4	Agree
3	Neutral
2	Don't agree
1	Strongly Disagree

An RME-based learning module can meet the criteria for media practicality if it meets the criteria of ≥ 70% of students providing a positive response as a class (Putri et al., 2020). If it is less than 70%, the researcher must make improvements according to the suggestions.

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3) Effectiveness Analysis

The effectiveness of the coastal culture-based RME learning module using the Gemini application was tested by administering a numeracy literacy test to fifth-grade students as research subjects on geometry. To see if there was an increase in students' numeracy literacy skills, a Gain Termonalization test was used. The formula for the Gain test is as follows (Hake, 1999):

$$\text{NGain} = \frac{\text{Postest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}} \ldots (3)$$

Tabel 3. Normalized gain test indicator

Validity Criteria	Validity Level
$-1 \leq g \leq 0{,}00$	There was a decline
$g = 0{,}00$	constant
$0{,}00 < g < 0{,}30$	Low
$0{,}30 \leq g < 0{,}70$	Currently
$0{,}70 \leq g \leq 1{,}00$	High

In this study, the researchers set the range $0.00 < g < 0.30$ as the minimum limit for the thermalization gain test.

RESULTS AND DISCUSSION

The development of a coastal culture-based RME module using the Gemini application is aimed at fifth-grade elementary school students. It is hoped that this module will help students improve their numeracy literacy skills. The following steps need to be taken by researchers in developing this RME-based module:

1) Analisis Curriculum analysis was used to determine the curriculum currently being used at the school. The analysis revealed that the curriculum used at Teulaga Tujuh Public Elementary School is the independent curriculum, with the intended competency being to improve students' knowledge and skills.

2) Student character analysis was conducted to determine students' numeracy literacy skills, attitudes toward mathematics learning, and interest in mathematics. The results showed that students' numeracy literacy skills were still low. This hampered students' cognitive development, particularly in mathematics. Furthermore, students were less interested in the modules because the material was not connected to their surrounding culture. This resulted in students feeling bored and lacking interest in mathematics.

3) Analisis Analysis of the RME approach, based on the analysis of the problem background outlined above, concluded that students' mathematical literacy skills were low. Therefore, the researcher concluded that using a coastal culture-based RME approach would help students understand mathematics material, particularly in training them to improve their numeracy skills.

4) Module selection: A good and appropriate module will help students understand the material during the learning process, preventing boredom. Therefore, a possible solution is to develop the existing module into a coastal culture-based RME learning module using the Gemini application.

5) Material analysis: In developing this RME module, the researcher will select material with a geometry theme. This material is often considered difficult by students, especially those with low numeracy skills.

In the cover design section, the researcher designed a display of coastal culture related to geometry and still used some of the displays from the previous module.

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Figure 2. RME Module Design

For a developed learning module to be usable, it must first be certified as suitable by validators, both media experts and content experts. A learning module can be deemed suitable if it meets three criteria: validity, practicality, and effectiveness. The following explains the analysis results of these three criteria in more detail:

1) Validity of Coastal Culture-Based RME Learning Modules

The learning module was validated by 3 expert validators. The results of the validation analysis were calculated using the Validity (Va) formula. Judging from the validity results, the RME-based module obtained a percentage of 82.00% with minor revisions. After the revision, the module obtained a percentage of 89.00%, which can be said to be very valid so that the RME learning module based on coastal culture with the Gemini application can be used as teaching material in mathematics learning, especially in geometry material in grade V of Teulaga Tujuh State Elementary School.

Table 4. RME Module Revision Results

Before Revision	After Revision
There needs to be images related to coastal culture in the questions and in the module content so that the module looks more interesting and does not look monotonous.	There are additional images on the questions and cover
There is material related to the Pythagorean theorem that has not been taught at elementary school level.	Revise questions that require solutions using the Pythagorean theorem by adding some information to the questions.
There are many typing errors	Typing correction
The systematics of typing rules are not neat	Tidy up the systematics of typing rules
In addition to mathematical problems in real life, it is necessary to add formal mathematical forms to the material.	Addition of formal mathematics material

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Based on Table 4, it can be concluded that to make the module more engaging and easier for students to understand, several revisions are needed, including adding images related to coastal culture, revising material deemed inappropriate for elementary school, revising the layout to improve its clarity, and adding formal mathematics content.

This module development research also aligns with (Wahyudi et al., 2017), who stated that RME-based module achieved a success rate of 81.00% before and 93.00% after revision. After the revision, the module was deemed highly valid, making the RME-based learning module suitable for use as teaching material in mathematics.

2) Practicality of RME Learning Module

A learning module is considered practical if it can be used in learning without or with revision, and can also be seen from how practical students are in using the module during learning. The one-to-one evaluation phase produced an average score of 74 out of 75 its practicality. Furthermore, the second stage of the field test revealed a positive effect on critical reasoning (Palinussa et al., 2025). The positive responses from students indicate that students are happy with the RME learning module based on coastal culture. This is because this module has never existed before. In the field trial, an average percentage of 84.00% was obtained, indicating a high level of practicality. Based on the results obtained, it can be said that the RME-based learning module is practical to use in the learning process at school. In line with the results of research conducted by (Putri et al., 2020) which stated that the RME module obtained an average percentage of 77.67%, indicating a high level of practicality.

3) Effectiveness of RME-Based Learning Modules

A learning module is said to be effective if the module receives a positive response from the majority of students because it means that students like the development of RME-based learning modules (Putri et al., 2020). From the analysis of the results of the limited trial, it was found that the results of the gain test showed an increase in students' mathematical literacy skills which were indicated by an increase in the ability to work on learning achievement test questions. The Gain test results obtained a result of 0.35 in the moderate category. Therefore, the RME learning module based on coastal culture with the Gemini application is also said to be able to improve students' numerical literacy skills. In line with the results of data analysis conducted by (Dhayanti et al., 2018) showed that the application of RME can improve students' critical and creative thinking skills and student learning achievements meet the minimum completeness criteria.

The development of the RME module based on coastal culture with the Gemini application in improving the numeracy literacy of Teulaga State Elementary School students meets the criteria of being valid, practical and effective. So it can be used in learning at school. The development of the RME module with the results of the research analysis: Empirical evidence demonstrates that the RME-based module is a viable instructional tool. It achieved a high validity index of 89.00% and demonstrated practical utility, evidenced by a positive student

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response rate of 84.00%. The application of the Gain Test resulted in a value of 0.35, indicating a moderate yet significant improvement in numeracy skills. Consequently, the module is proven effective in fostering students' mathematical literacy through the Realistic Mathematics Education approach. In line with (Pujiastuti et al., 2025) who stated that the Ethno-RME based module in improving students' critical reasoning skills is in accordance with the Pancasila Student Profile. The results of research conducted (Putri et al., 2020) on the development of the RME module meeting the criteria of being valid, practical, and effective in improving students' mathematical literacy skills.

The research findings demonstrate several significant strengths, primarily rooted in the successful integration of the Realistic Mathematics Education (RME) framework with local coastal culture and modern AI technology. By utilizing familiar environmental contexts, such as fish yield calculations and tidal patterns, the module effectively bridges the gap between abstract geometric concepts and the students' lived experiences, thereby reducing disengagement. The inclusion of the Gemini AI application marks a notable technological advancement, transforming traditional instruction into an interactive, multimodal learning experience. Methodologically, the study maintains high rigor, as evidenced by the validation from experts resulting in a very high validity score (89%) and a strong practicality rating (84%). Furthermore, the increase in numeracy literacy, confirmed by a normalized gain score of 0.35, proves that the module is a viable pedagogical tool for improving student performance in specific local contexts.

Despite these advantages, the study exhibits certain limitations that warrant further consideration. Although the module is categorized as effective, the N-gain score of 0.35 remains in the "moderate" range, indicating that while the intervention is superior to conventional methods, there is still substantial room for optimization to achieve high-level effectiveness. Additionally, the initial development phase revealed challenges in content alignment, specifically regarding the inclusion of the Pythagorean theorem which was deemed cognitively inappropriate for fifth-grade students. This suggests a need for more precise material mapping during the design phase. Furthermore, the module's heavy reliance on the Gemini application introduces a dependency on digital infrastructure and internet stability, which may pose challenges for scalability in remote coastal areas. Finally, since the current module focuses exclusively on geometry, its broader impact on other mathematical domains remains to be explored.

CONCLUSIONS

Based on the research findings, it can be concluded that the development of the Realistic Mathematics Education (RME) module based on coastal culture, integrated with the Gemini application, has successfully met the established criteria for high-quality learning materials. The module is declared valid for use in the educational process, having undergone rigorous validation and refinement to ensure its theoretical and pedagogical soundess. Furthermore, the module demonstrates high practicality, as evidenced by the positive engagement and seamless implementation during field trials with students. Most importantly, the research confirms the module's effectiveness in enhancing

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students' numeracy literacy, particularly within the domain of geometry. The integration of familiar coastal contexts through an AI-supported development process proved capable of bridging the gap between abstract mathematical concepts and students' daily lives, thereby fostering a more meaningful and impactful learning experience. These results indicate that the module serves as a viable and effective tool for improving the academic performance and numeracy character of students in coastal educational settings.

This research has not examined all subjects related to numeracy literacy in elementary schools. It is hoped that future researchers can develop literacy-based RME modules for other subjects.

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