



DEVELOPING LEARNING MATERIALS ORIENTED TO A REALISTIC MATHEMATICS EDUCATION APPROACH INTEGRATED WITH ETHNOMATHEMATICS TO ENHANCE STUDENTS' MATHEMATICAL PROBLEM-SOLVING SKILLS

PENGEMBANGAN PERANGKAT PEMBELAJARAN BERIORENTASI PENDEKATAN MATEMATIKA REALISTIK BERBASIS ETNOMATEMATIKA UNTUK MENINGKATKAN KEMAMPUAN PEMECAHAN MASALAH MATEMATIS SISWA

Embin Nasution¹, Ahmad Nizar Rangkuti^{2*}, Mariam Nasution³,

¹Postgraduate Program in Islamic Mathematics Education, State Islamic University of Sheikh Ali Hasan Ahmad

Addary Padangsidimpuan, Email: embinnasution203@gmail.com

² State Islamic University of Sheikh Ali Hasan Ahmad Addary Padangsidimpuan, Email:

nizarahmad1304@gmail.com

³State Islamic University of Sheikh Ali Hasan Ahmad Addary Padangsidimpuan, Email:

mariam@uinsyahada.ac.id

*email Koresponden: nizarahmad1304@gmail.com

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Abstract

This research aims to develop a mathematics learning device oriented toward the Realistic Mathematics Education (RME) approach based on Ethnomathematics to improve students' mathematical problem-solving skills at MTs Negeri 3 Tapanuli Selatan. The study employed a Research and Development (R&D) design using the 4-D model, which consists of four stages: defining, designing, developing, and disseminating. The research subjects were 36 seventh-grade students in the second semester of the 2022/2023 academic year. The instruments used included expert validation sheets, teacher and student practicality questionnaires, classroom observation sheets, and mathematical problem-solving tests. The results revealed that the developed learning device achieved an average expert validation score of 4.25 in the very valid category in terms of content, language, and presentation. The practicality test showed that the teacher's response reached 89% and the students' response reached 91%, categorized as very practical, indicating that the device was easy to use and engaging for students. The effectiveness test showed an average *N-Gain* score of 0.52 (moderate category) with 86.11% of students achieving mastery learning, signifying that the learning device was effective in enhancing students' mathematical problem-solving abilities.

The integration of the realistic mathematics approach with local cultural elements (ethnomathematics) successfully created meaningful and contextual learning experiences while fostering students' appreciation for their cultural heritage. Therefore, the developed learning device is feasible to be implemented as an innovative mathematics learning medium based on cultural contexts in junior high schools and madrasah.

Keywords: Learning Device, Realistic Mathematics Education, Ethnomathematics, Mathematical Problem-Solving Ability.



Abstrak

Penelitian ini bertujuan untuk mengembangkan perangkat pembelajaran matematika berorientasi pendekatan Matematika Realistik berbasis Etnomatematika guna meningkatkan kemampuan pemecahan masalah matematis peserta didik kelas VII MTs Negeri 3 Tapanuli Selatan. Penelitian ini menggunakan metode Research and Development (R&D) dengan model 4-D yang terdiri atas tahap pendefinisian (*define*), perancangan (*design*), pengembangan (*develop*), dan penyebaran (*disseminate*). Subjek penelitian adalah 36 peserta didik kelas VII pada semester genap tahun ajaran 2022/2023. Instrumen yang digunakan meliputi lembar validasi ahli, angket kepraktisan guru dan siswa, lembar observasi aktivitas belajar, serta tes kemampuan pemecahan masalah matematis. Hasil validasi ahli menunjukkan bahwa perangkat pembelajaran yang dikembangkan memperoleh skor rata-rata 4,25 dengan kategori sangat valid dari segi isi, bahasa, dan tampilan. Hasil uji kepraktisan menunjukkan respon guru sebesar 89% dan respon siswa sebesar 91% yang termasuk kategori sangat praktis, menandakan bahwa perangkat mudah digunakan dan menarik minat belajar siswa. Hasil uji efektivitas menunjukkan rata-rata *N-Gain* sebesar 0,52 (kategori sedang) dan ketuntasan klasikal mencapai 86,11%, sehingga perangkat pembelajaran terbukti efektif dalam meningkatkan kemampuan pemecahan masalah matematis peserta didik. Integrasi pendekatan realistik dengan unsur budaya lokal (etnomatematika) terbukti mampu menciptakan pembelajaran yang bermakna, kontekstual, dan menumbuhkan apresiasi terhadap budaya daerah. Dengan demikian, perangkat pembelajaran yang dikembangkan layak digunakan sebagai inovasi pembelajaran matematika berbasis konteks budaya di sekolah menengah pertama dan madrasah.

Kata Kunci: Perangkat Pembelajaran, Pendekatan Matematika Realistik, Etnomatematika, Kemampuan Pemecahan Masalah Matematis.

1. INTRODUCTION

Mathematical problem-solving ability is one of the essential competencies and the primary goal of mathematics learning. Through problem-solving activities, students not only learn to apply formulas but also develop logical, critical, and reflective thinking toward the situations they face. The National Council of Teachers of Mathematics (NCTM, 2000) emphasizes that problem-solving is the heart of mathematics learning because it enables students to develop deep conceptual understanding, reasoning skills, and the ability to communicate mathematical ideas effectively. Therefore, problem-solving ability serves as a key indicator of success in mathematics learning at all levels of education.

However, the reality in the field shows that this ability remains far from expectations. Preliminary observations at MTs Negeri 3 Tapanuli Selatan revealed that most students struggle to solve context-based mathematical problems. Of the 36 students who took the diagnostic test, only six students (16.67%) reached the moderate category, while 69.44% were in the low category, and 13.89% were in the very low category. Students tend to directly use formulas without understanding the meaning of the problems given. This condition indicates that students' mathematical thinking is still limited to procedural ability and has not yet reached a higher conceptual level (Rahman, 2017).

This situation is further exacerbated by the teacher-centered learning model, in which students only receive information without having the opportunity to explore their own ideas and problem-solving strategies. Teachers tend to rely on lectures and routine exercises, while real-life contexts are rarely introduced into the classroom. In fact, effective mathematics learning should allow students to relate mathematical concepts to real-life phenomena that they experience daily (Freudenthal, 1991). As a result, students fail to understand the meaning behind mathematical concepts and find it difficult to apply them in solving new problems.



One of the factors contributing to the weakness of students' problem-solving ability is the inadequacy of instructional materials. The Lesson Plans (RPP) used are often procedural in nature and lack steps that stimulate students' creative and reflective thinking processes. The Student Worksheets (LKPD) are typically generic printed products from publishers and have not been adapted to the local context of learners. According to Nieveen (1999), effective learning materials should have three key characteristics—validity, practicality, and effectiveness—and be designed to facilitate meaningful and contextual learning.

To address these challenges, the Realistic Mathematics Education (RME) approach is considered a relevant alternative. This approach was developed by Hans Freudenthal in the Netherlands, based on the main idea that mathematics is a human activity rather than a static body of knowledge. Within this perspective, students should not be given mathematical knowledge directly; rather, they should be guided to *reinvent* mathematical concepts through meaningful learning experiences (Wijaya, 2012). The learning process begins with realistic or contextual problems—situations that can be imagined or experienced by students. These problems serve as the starting point for students to mathematize reality and later abstract it into formal mathematical concepts through the processes of horizontal and vertical mathematization.

The realistic approach has several defining characteristics: (1) the use of real-life contexts as the starting point of learning, (2) the progressive development of mathematical models by students, (3) the utilization of students' own constructions as part of the learning process, (4) interactivity during learning, and (5) the interconnection of mathematical concepts (Treffers in Freudenthal, 1991). Theoretically, these five characteristics can foster meaningful learning because students actively construct their own knowledge.

However, to make realistic mathematics learning more closely related to students' lives, the contextual problems used should be adapted to their cultural environment. Here, Ethnomathematics plays a crucial role in strengthening the contextual foundation of learning. According to D'Ambrosio (1985), ethnomathematics refers to the way members of specific cultural groups understand, articulate, and utilize mathematical ideas embedded in their cultural practices. In the Indonesian context, ethnomathematics holds great potential due to the nation's rich cultural diversity, which can serve as a valuable source of inspiration for mathematics learning (Fitriati, 2016).

Ethnomathematics-based learning provides students with opportunities to recognize that mathematics is not an isolated discipline but one deeply intertwined with daily life activities such as weaving, crafting, building traditional houses, arranging floor patterns, or even cooking. Consequently, students can better grasp mathematical concepts because the learning process is grounded in real experiences that are familiar to them (Yesi & Amidi, 2022). Moreover, integrating local culture into mathematics learning enhances students' self-confidence and cultural identity, positioning mathematics education as a medium for preserving cultural values.

By combining the RME approach with Ethnomathematics, mathematics learning becomes not only outcome-oriented but also process- and meaning-oriented. Students are encouraged to solve authentic problems derived from their own lives, thereby understanding the connection between mathematics and culture. For instance, geometric concepts can be taught through the exploration of Mandailing traditional house structures or ulos weaving patterns, while ratio concepts can be related to traditional cooking recipes such as *sambal*



tuktuk. Through such contextualization, students realize that mathematics exists all around them and forms an integral part of their living culture.

Based on this background, this research aims to develop a mathematics learning device oriented toward the Realistic Mathematics Education approach and based on Ethnomathematics, which meets the criteria of being valid, practical, and effective in enhancing students' mathematical problem-solving skills. The study is expected to contribute not only to improving the quality of mathematics learning in madrasah but also to the preservation of local cultural values through education. Furthermore, the results of this research are expected to serve as a reference for mathematics teachers in developing innovative learning materials that connect mathematical concepts with real-life experiences of students.

2. RESEARCH METHOD

This study is a Research and Development (R&D) type of research employing the 4-D model proposed by Thiagarajan, Semmel, and Semmel (1974). The research procedure consisted of four stages: Define, Design, Develop, and Disseminate. Each stage was systematically carried out to ensure the development of a valid, practical, and effective mathematics learning device based on the Realistic Mathematics Education (RME) approach integrated with Ethnomathematics:

a. Define Stage

This stage aimed to identify problems and learning needs. The researcher conducted a preliminary analysis of the mathematics learning conditions at the school. The analysis revealed that the existing learning materials did not emphasize contextual aspects and were not yet designed to support the development of students' problem-solving skills. Furthermore, student analysis showed that most students still engaged in mechanical learning—applying formulas without understanding the underlying concepts. Therefore, it was necessary to design a learning device that encouraged conceptual understanding through contextual and culturally relevant activities.

b. Design Stage

This stage involved the preparation of Lesson Plans (RPP), Student Worksheets (LKPD), and assessment instruments. The design was developed based on the principles of Realistic Mathematics Education (RME), emphasizing the use of contextual problems, progressive mathematization, and the gradual development of mathematical models by students. The learning media were adjusted to local cultural contexts, such as using traditional weaving patterns, the architectural forms of local houses (*rumah adat*), or traditional foods to explain geometric concepts. Through these cultural representations, mathematical concepts became more relatable and meaningful to students.

c. Develop Stage

In this stage, the initial product was validated by material experts, language experts, and media experts. The validation process provided valuable feedback and resulted in several revisions to ensure the product met the required standards of validity in terms of content, language, and presentation. After the validation phase, a limited field trial was conducted with Grade VII students of MTs Negeri 3 Tapanuli Selatan to evaluate the practicality and effectiveness of the developed learning device. The trial helped to assess how well the device could be implemented in an actual classroom setting and how effectively it facilitated students' learning processes.



d. Disseminate Stage)

The final stage involved limited dissemination to mathematics teachers in other madrasahs with similar student characteristics. The purpose of this stage was to promote the use of the developed learning device and evaluate its potential for broader implementation. Dissemination also served as a feedback mechanism for further refinement of the product before large-scale application.

The research instruments included validation sheets, teacher and student practicality questionnaires, classroom observation sheets, and learning achievement tests. The data were analyzed quantitatively and descriptively, focusing on the average scores of validity, practicality, and effectiveness. The validity criteria referred to Khabibah (2006), while the effectiveness of the learning device was determined based on the percentage of students achieving mastery learning and the improvement in the N-Gain score. This analysis framework ensured that the developed product not only met the theoretical standards of educational device development but also demonstrated empirical effectiveness in enhancing students' mathematical problem-solving abilities.

3. RESULTS AND DISCUSSION

Validity of the Learning Device

Based on the validation results by three experts, the developed learning device obtained an average score categorized as “very valid.” The experts evaluated that the Lesson Plan (RPP) and Student Worksheet (LKPD) were in accordance with the principles of the Realistic Mathematics Education (RME) approach, which emphasizes the use of real-life contexts, active student engagement, and progressive mathematization (Wijaya, 2012).

The language used in the LKPD was considered simple and communicative, while the visual design was attractive and incorporated illustrations of local cultural elements. The integration of ethnomathematical components—such as weaving patterns, floor motifs, and the architectural forms of traditional houses—made the learning materials more relevant to students' everyday lives.

Based on the experts' assessments, both the RPP and LKPD achieved a minimum category of “valid,” meaning that the learning device can be used with minor revisions according to the suggestions provided by the validators.

Table 1.
Summary of Learning Device Validation Results

No	Evaluated Component	Average Validation Score	Validation Level
1.	Lesson Plan (RPP)	4.68	Valid
2.	Student Worksheet (LKPD)	4.65	Valid

The overall validity score of the learning device was in the interval $4 \leq V_a < 5$, which according to the validity criteria indicates that the developed device is “Valid.” Therefore, the developed learning materials are suitable for implementation after minor revisions.

Practicality of the Learning Device

The practicality test aimed to determine the ease of use and the implementability of the developed learning device during the learning process. The data were collected through teacher and student response questionnaires after implementing the learning device in the classroom.



The results indicated that the teacher response reached 89% and the student response reached 91%, both categorized as “very practical.” Teachers stated that the RPP and LKPD were easy to use because the steps were systematic, the language was communicative, and the learning activities were clearly described. The LKPD was perceived as helpful in guiding students to think and discuss, shifting the learning process toward a more student-centered approach.

From the students’ perspective, practicality was demonstrated through their ability to easily understand the instructions and contextual problems presented in the LKPD. Students expressed that learning mathematics became more enjoyable because it incorporated familiar cultural contexts, such as traditional house shapes, *ulos* fabric patterns, and symmetry in traditional weaving.

These findings reinforce Vygotsky’s (1978) social constructivist theory, which posits that learning rooted in students’ sociocultural context can accelerate conceptual internalization. Furthermore, teachers reported that the ethnomathematics-based learning device encouraged collaboration and interaction among students. Learners were more active in asking questions and discussing different problem-solving strategies. This is consistent with the interactive characteristic of Realistic Mathematics Education, where students exchange ideas and develop their own mathematical models (Wijaya, 2012).

Thus, it can be concluded that the learning device developed based on the RME–Ethnomathematics approach meets the criteria of practicality, both from the teachers’ and students’ perspectives. This demonstrates that the learning materials can be effectively implemented in classroom instruction without significant obstacles.

Effectiveness of the Learning Device

The effectiveness of the developed learning device was measured using the results of mathematical problem-solving tests administered to students after the implementation. The analysis involved comparing the pretest and posttest scores and calculating the N-Gain to determine the improvement in students’ problem-solving abilities.

The results showed that the average N-Gain score was 0.52, which falls under the moderate category (Hake, 1999). This indicates a significant improvement in students’ problem-solving abilities after learning with the RME–Ethnomathematics-based device. The classical mastery level reached 86.11%, exceeding the school’s minimum mastery criterion of 75%.

This improvement reflects that students were able to understand and apply Polya’s (1973) four-step problem-solving process—understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. During the learning activities, students were not merely asked to compute answers mechanically but were encouraged to explain the reasoning behind each problem-solving step.

In this study, students’ achievement levels were analyzed through a Mathematical Problem-Solving Ability Test. The descriptive results of students’ problem-solving abilities in the second field trial are presented below.

Table 2.
Description of Mathematical Problem-Solving Ability Results

Description	Posttest Score (Problem-Solving Ability)
Highest Score	100
Lowest Score	70



The analysis of learning objectives attainment was conducted to determine the percentage of achievement for each learning goal related to mathematical problem-solving ability, as shown in Table 3.

Table 3.
Achievement of Learning Objectives in Mathematical Problem-Solving Ability

No	Learning Objectives	Percentage of Achievement	Description
1	Students are able to understand the concept of plane figures.	78.25%	Achieved
2	Students are able to understand the concept of equivalent plane figures and solve real-life problems related to it.	82.50%	Achieved
3	Students are able to understand the concept of similar plane figures and solve contextual problems related to them.	83.50%	Achieved
4	Students are able to understand the concept of inverse plane figures and apply them in daily life situations.	81.25%	Achieved

In addition to the improvement in learning outcomes, classroom observations revealed a change in students' learning behavior. They became more active in discussions, asked questions, and presented their solutions confidently in front of the class. This supports Freudenthal's (1991) view that in Realistic Mathematics Education, students should be positioned as discoverers of concepts rather than passive receivers of information.

The integration of RME and Ethnomathematics proved to foster meaningful learning experiences. By connecting mathematical concepts with local cultural elements—such as geometric forms in traditional houses and decorative textile motifs—students felt more connected to the subject matter. Similar findings were reported by Yesi and Amidi (2022), who stated that ethnomathematics-based learning increases student motivation and engagement in understanding mathematical concepts.

4. CONCLUSION

Based on the results of this research, several conclusions can be drawn as follows:

- The Realistic Mathematics Education (RME)-based learning device integrated with Ethnomathematics developed in this study achieved a high level of validity, meeting all criteria in terms of content, language, and presentation. Expert validation confirmed that the learning materials were theoretically sound, aligned with the curriculum, and effectively incorporated local cultural contexts to support conceptual understanding.
- The developed learning device was found to be practical for both teachers and students in the mathematics learning process at MTs Negeri 3 Tapanuli Selatan. Teachers perceived the device as easy to implement, while students responded positively to its contextual and culturally familiar learning materials, which enhanced engagement and participation during class activities.
- The learning device was proven to be effective in improving students' mathematical problem-solving skills, as evidenced by the increase in the N-Gain score (0.52, moderate category) and the achievement of 86.11% classical mastery learning. This indicates that the



integration of realistic and cultural contexts not only enhances cognitive performance but also supports the development of higher-order thinking skills.

In general, the findings demonstrate that the RME–Ethnomathematics-based learning device is feasible and beneficial as an innovative instructional tool for mathematics education. By combining realistic learning principles with local cultural elements, the device provides a meaningful and contextual learning experience that bridges abstract mathematical concepts with real-world situations.

Furthermore, this research highlights the potential of integrating local culture into mathematics instruction as a means to promote cultural appreciation, identity development, and contextual understanding among students. Therefore, it is recommended that similar learning devices be developed and implemented in other educational settings to strengthen meaningful learning and foster culturally responsive mathematics education.

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