Edumatica: Jurnal Pendidikan Matematika
Volume 15 Number 01 April 2025

Submited : 07 January 2025
Revised : 1 Mei 2025
Accepted : 6 Mei 2025

Pengembangan Lembar Kerja RME dengan Konteks Maritim untuk Menguatkan Kemampuan Komunikasi Matematis

Rupita Mina Sari[1], Sujinal Arifin[2*], Komarudin[3]
[1,2,3] Universitas Islam Negeri Raden Fatah Palembang, Sumatera Selatan, Indonesia
E-mail: rupitaminasari022@gmail.com[1] sujinal@radenfatah.ac.id[2] komarudin@radenfatah.ac.id[3]

Abstrak

Tujuan penelitian ini adalah mengembangkan lembar kerja berbasis RME untuk pembelajaran bilangan bulat yang memenuhi standar validitas, kepraktisan, serta memiliki efek potensial terhadap kemampuan komunikasi matematis peserta didik. Penelitian pengembangan ini mengadopsi tahapan ADDIE yang meliputi *analyze*, *design*, *development*, *implementation*, dan *evaluation*. Partisipan penelitian melibatkan 33 peserta didik kelas VII di SMPN 33 Palembang. Pengumpulan data dilakukan melalui lembar validasi dan lembar kepraktisan yang dinilai menggunakan skala Likert 1–5, serta tes kemampuan komunikasi matematis yang dinilai berdasarkan pedoman penskoran. Berdasarkan hasil analisis, lembar kerja yang dikembangkan mencapai tingkat kevalidan dengan skor rata-rata 4,36 (kategori sangat valid). Uji kepraktisan awal melalui *one-to-one* dan *small group* menunjukkan kategori sangat praktis, sehingga produk dinyatakan layak untuk diimplementasikan. Hasil uji kepraktisan pada tahap implementasi juga menunjukkan skor rata-rata 4,60 (kategori sangat praktis). Adapun efek potensial terlihat dari pencapaian rata-rata nilai tes kemampuan komunikasi matematis sebesar 80,30 setelah implementasi lembar kerja (kategori sangat baik). Dengan demikian, dapat disimpulkan bahwa lembar kerja telah memenuhi aspek kevalidan, kepraktisan, dan memberikan efek potensial yang diharapkan.

Kata Kunci: bilangan bulat, kemampuan komunikasi matematis, lembar kerja, RME

Development of RME Worksheets with Maritime Context to Strengthen Mathematical Communication Skills

Abstract

This study aims to develop an RME-based worksheet for integer learning that meets the standards of validity and practicality. It has a potential effect on students' mathematical communication skills. This development research adopts the ADDIE stages, including analysis, design, development, implementation, and evaluation. The research participants involved 33 grade VII students at SMPN 33 Palembang. Data was collected through validation sheets, practicality sheets were assessed using a Likert scale of 1–5, and mathematical communication ability tests were evaluated based on scoring guidelines. Based on the results of the analysis, the worksheets developed reached a level of validity with an average score of 4.36 (very valid category). Initial practicality tests through one-to-one and small groups showed that the category was very practical, so the product was declared feasible for implementation. The results of the practicality test at the implementation stage also showed an average score of 4.60 (very practical category). The potential effect can be seen from the achievement of an average mathematical communication ability test score of 80.30 after the implementation of the worksheet (very good category). Thus, it can be concluded that the worksheet meets the aspects of validity and practicality and provides the expected potential effect.

Keywords*: integers, mathematical communication skills, worksheets, RME*

INTRODUCTION

Mathematics education fosters logical reasoning, analytical skills, systematic thinking, and mathematical communication. However, implementing mathematics learning faces significant challenges, particularly in developing students' ability to communicate mathematical ideas effectively. One fundamental issue is that students often struggle to understand and express abstract mathematical concepts, particularly when these ideas are unrelated to real-life contexts or appropriately represented in various forms (Yudhi & Septiani, 2024). This difficulty in verbal and written mathematical communication is exacerbated by students' struggles with using correct mathematical notation and interpreting mathematical information in diverse formats (Dewantara et al., 2024). Furthermore, the framework for mathematical communication, such as in the KOM and PISA contexts, suggests that fostering students' abilities to express and model mathematics is essential for their academic development (Berget, 2023).

This challenge is reflected in the results of PISA 2022, where Indonesian students scored 365, significantly below the OECD average of 489 (OECD, 2024). This underscores the urgent need to improve students' mathematical communication skills. Effectively communicating mathematical ideas is essential for success in higher-level mathematics, such as algebra and calculus (Siregar et al., 2020; Tong et al., 2021). Research has shown that many students' errors in solving algebraic problems stem from a weak understanding of mathematical operations and an inability to express their thought processes verbally or in writing (Putri et al., 2022). Furthermore, studies have highlighted that enhancing mathematical communication skills directly impacts students' overall performance in mathematics (Lugosi & Uribe, 2022; Tong et al., 2021). Specifically, errors in solving algebraic word problems are often linked to students' limited ability to effectively communicate mathematical reasoning (Kenney & Ntow, 2024).

A strong foundation in integer operations is essential for mastering advanced mathematical topics like functions, equations, and analysis (Benu et al., 2022). Recent studies show a positive relationship between students' comprehension of integers, mathematical communication skills, and problem-solving ability (Rofiq et al., 2023). Students who clearly articulate their reasoning tend to perform better in solving complex problems. Thus, enhancing mathematical communication skills in integer operations strengthens concept understanding and significantly improves problem-solving competence (Alam & Mohanty, 2024; Tadeu, 2024).

Despite being foundational, integer learning still faces significant hurdles. Students often struggle with the concept of negative numbers and their operations, and they find it difficult to express their understanding in precise mathematical language (Baharuddin & Jumarniati, 2021). These difficulties hinder the development of more advanced mathematical understanding, especially in algebra and calculus, where the ability to articulate mathematical reasoning is essential (Malau et al., 2021). Moreover, the lack of contextual learning materials and limited student participation further compound these issues. Existing worksheets often focus on procedural tasks without promoting a conceptual understanding of the development of mathematical communication skills in oral, written, and visual forms (Yuswan & Maat, 2021).

In addition to the challenges revealed in international assessments and literature, a preliminary study conducted by the researcher at SMP Negeri 33 Palembang further illustrates this issue. A test on mathematical communication skills was administered to 33 seventh-grade students, and the results revealed that most students exhibited very low to low levels of mathematical communication ability. Specifically, 20 students (approximately 61%) fell into the very low category, while 10 students (about 30%) were categorized as having low ability. Only two students demonstrated a moderate skill level; only one reached the good category. Notably, no student achieved an excellent level. These findings highlight a significant gap between students' current communication skills and the expected competency levels. This situation is particularly concerning, given that the school's minimum mastery criterion (KKM) for mathematics is 75. The data suggest that students face difficulties understanding integer operations and articulating their reasoning using appropriate mathematical language.

One solution to these challenges is using well-designed worksheets, which can help students build conceptual understanding and develop mathematical communication skills through structured, meaningful activities. These worksheets can facilitate mathematical discussions and enable students to represent their ideas in various formats (Pertiwi et al., 2020). However, current worksheets often lack opportunities for mathematical discussions, do not account for student's individual learning needs, and fail to adequately support students in expressing their mathematical thoughts (Al-Rizal & Trisnawati, 2021). There is a clear need for innovative worksheet designs that address mathematical content and consider the pedagogical and psychological aspects of learning, providing opportunities for students to explain problem-solving strategies, argue mathematically, and use mathematical symbols correctly.

The Realistic Mathematics Education (RME) approach presents a promising solution by integrating students' real-life experiences into learning. RME emphasizes using contextual problems as starting points for learning, making mathematical concepts more meaningful and easier to understand (Nurmasari et al., 2024; Sukasno et al., 2024; Yilmaz, 2020). By enabling students to mathematize real-world situations, RME fosters a more contextual and relevant learning environment (Uyen et al., 2021; Yonathan & Seleky, 2023). Furthermore, RME not only enhances students' conceptual understanding and motivation but also strengthens their mathematical reasoning and communication skills, particularly when applied in various contexts including rural settings (Apriyanti et al., 2023; Chasanah et al., 2020; Palinussa et al., 2021).

In developing effective worksheets, the concepts of validity and practicality are essential. Validity ensures that teaching materials align with curriculum standards, pedagogical principles, and student characteristics while maintaining material accuracy and a systematic learning structure (Alfiyanti & Erita, 2023). Practicality refers to the ease of use, efficiency in implementation, and the readability and appeal of teaching materials for students and teachers (Ardiawan, 2024).

Several previous studies have shown the success of the development of worksheets based on the Realistic Mathematics Education (RME) approach in various mathematics learning contexts. Implementing RME-based worksheets has been proven to improve students' conceptual understanding through realistic contexts that help students construct mathematical knowledge meaningfully (Meika et al., 2023). However, based on the literature analysis conducted, there are still gaps in the development of Worksheets specifically designed for integer learning with the RME approach, particularly in integrating daily life contexts that are relevant to the characteristics and needs of students (Chandra & Hidayati, 2023; Vanesa et al., 2021). While previous studies have highlighted the effectiveness of RME in various contexts, they have not fully addressed how to tailor worksheets to meet the diverse needs of students in specific topics, such as integers. This research introduces novelty by developing RME-based worksheets that more effectively integrate local and relevant real-life contexts, providing students with opportunities to connect mathematical concepts with their daily experiences more meaningfully.

Based on the above discussion, RME-based worksheets represent a promising solution for improving integer learning. This development aims to produce teaching materials that are valid, practical, and effective in helping students understand and communicate the concept of integers. These worksheets will enable students to convey mathematical ideas, use appropriate mathematical representations, and explain problem-solving strategies with logical and systematic language. This research contributes to developing systematic contextual worksheets that cater to students' characteristics, aiming to improve their mathematical communication skills through discussion, presentation, and argumentation activities. This approach is expected to enhance the mathematics learning process in schools, particularly in improving students' ability to communicate mathematical thoughts.

METHOD

This research is a Research and Development (R&D) research that aims to develop Student Worksheets (LKS) based on the Realistic Mathematics Education (RME) approach in integer learning. The resulting learning products are designed to meet standards of validity and practicality in classroom implementation. The development stages follow the ADDIE model framework, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation (Spatioti et al., 2022).

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

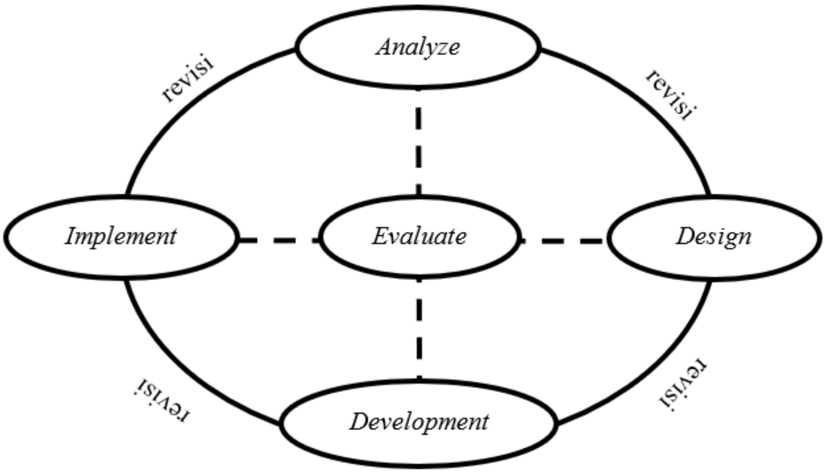


Figure 1. ADDIE Development Model

This research was conducted at SMP Negeri 33 Palembang by involving 33 grade VII students who were selected by considering the diversity of academic achievements through purposive sampling techniques. The selection of this sample aims to ensure a representation of the diversity of student's abilities in the classroom. The research data was collected through three main instruments: (1) Validation instruments to assess the feasibility of the LKS by a team of experts, (2) Student response questionnaires to assess the practicality aspects of the LKS, and (3) Essay test instruments to assess students' mathematical communication skills.

This research was conducted at SMP Negeri 33 Palembang by involving 33 grade VII students who were selected by considering the diversity of academic achievement through purposive sampling techniques. The selection of this sample aims to ensure a representation of the diversity of students' abilities in the classroom. As part of classroom learning activities, the implementation phase is carried out during the odd semester of the 2024/2025 school year, from August to September 2024, to be precise. The research data was collected through three main instruments: (1) a validation instrument to assess the feasibility of the worksheet by a team of experts, (2) a student response questionnaire to assess the practicality aspects of the worksheet, and (3) an essay test instrument to assess students' mathematical communication skills.

The validation process is carried out by a validator team of mathematics education experts who deeply understand the RME approach and the application of integer materials in learning. The validator team provides improvement recommendations that are used to improve the developed LKS. After the revision, the LKS is implemented in learning, and students are asked to provide feedback through a questionnaire. Feedback from students is also used to improve the quality of the worksheet further. The evaluation of learning effectiveness was carried out by giving five descriptive questions to students after using the LKS to measure the improvement of students' mathematical communication skills.

This study's data analysis focuses on three main dimensions: validity, practicality, and potential effectiveness (Daryono et al., 2023). The validity assessment of the LKS uses a 5-level Likert scale, where the number 1 indicates very invalid conditions, and the number 5 indicates very valid conditions (Wang et al., 2024). The LKS admission criteria are determined based on the average score that falls into the "valid" or "very valid" category.

The validity assessment includes the feasibility of content, language, presentation, and suitability with the characteristics of the RME, which include mathematization (the application of mathematical concepts in real-life situations), the use of realistic situations relevant to students' lives, modeling (mathematical representations to solve problems), interactivity between students, and flexibility in exploring various mathematical solutions (Palinussa et al., 2021; Susandi & Widyawati, 2022). These characteristics are designed to foster students' mathematical communication skills, including writing, drawing, and mathematical expressions, which are critical for students to effectively articulate their mathematical thinking (Chasanah et al., 2020; Hughes et al., 2020). For the validity criteria of the worksheet according to the following Table 1:

Table 1. Validity Criteria

Score Interval	Criterion
$4{,}20 < \overline{V} \leq 5{,}00$	Highly Valid
$3{,}40 < \overline{V} \leq 4{,}20$	Valid
$2{,}60 < \overline{V} \leq 3{,}40$	Less Valid
$1{,}80 < \overline{V} \leq 2{,}60$	Invalid
$1{,}00 < \overline{V} \leq 1{,}80$	Highly Invalid

(Indriani et al., 2017)

An evaluation of the practicality of the worksheet was carried out by collecting and analyzing data obtained from the student response questionnaire. This questionnaire was given after students participated in a series of learning using the worksheets developed. The scoring system in the questionnaire adopts a Likert scale consisting of five levels, starting from a score of 1, which indicates a very low level of practicality, to a score of 5, which indicates a very high level of practicality. The selection of this Likert scale aims to get a more measurable and objective picture of the worksheet's practicality level. In evaluating the practicality of worksheets, several key aspects are the focus of the assessment, which include the ease of students in using worksheets, the level of clarity of instructions and the language used, the attractiveness of visual displays, and the effectiveness of worksheets in facilitating understanding of learning materials. The criteria for the practicality of the worksheet are presented in the following Table 2:

Table 2. Practicality Criteria

Score Interval	Criterion
$4{,}20 < \overline{P} \leq 5{,}00$	Very Practical
$3{,}40 < \overline{P} \leq 4{,}20$	Practical
$2{,}60 < \overline{P} \leq 3{,}40$	Less Practical
$1{,}80 < \overline{P} \leq 2{,}60$	Impractical
$1{,}00 < \overline{P} \leq 1{,}80$	Very impractical

(Indriani et al., 2017)

The worksheet's practicality was evaluated by collecting and analyzing data obtained from the student response questionnaire. This questionnaire was given after students participated in a series of learning using the worksheets developed. The scoring system in the questionnaire adopts a Likert scale consisting of five levels, starting from a score of 1, which indicates a very low level of practicality, to a score of 5, which indicates a very high level of practicality. The selection of this Likert scale aims to get a more measurable and objective picture of the worksheet's practicality level (Daryono et al., 2023; Wang et al., 2024). In evaluating the practicality of worksheets, several key aspects are the focus of the assessment, which include the ease of students in using worksheets, the level of clarity of instructions and the language used, the attractiveness of visual displays, and the effectiveness of worksheets in facilitating understanding of learning materials. The criteria for the practicality of the worksheet are presented in the following Table 2:

Table 3. Potential Effects Categories

Interval	Potential Effects Categories
$80 < N \leq 100$	Excellent
$60 < N \leq 80$	Good
$40 < N \leq 60$	Keep
$20 < N \leq 40$	Low
$0 \leq N \leq 20$	Very Low

(Yuliana, 2017)

RESULTS

This study produced a worksheet based on Realistic Mathematics Education (RME) with a maritime context on integer material developed using the ADDIE model. The development of this worksheet begins with an analysis stage that includes four main aspects: needs, curriculum, characteristics of students, and teaching materials used. To ensure alignment with RME principles, the developed worksheet integrates five main characteristics of RME. First, real contexts are applied in a maritime setting, where students interpret situations involving a research ship, helicopter, and submarine about sea level. Second, modelling is supported by visual representations and number line illustrations that help students grasp the concept of integer positions. Third, the worksheet promotes student contributions by providing open-ended questions encouraging students to express their reasoning and personal strategies. Fourth, interactivity is enhanced through group discussions and peer exploration activities. Finally, intertwinement is reflected in how integer operations are connected to meaningful real-life situations, such as altitude changes and temperature differences.

The needs analysis results at SMP Negeri 33 Palembang show that mathematics learning still relies on library package books as the leading learning resource. Curriculum analysis reveals that the school has implemented the Independent Curriculum, with integers as one of the materials learned in grade VII. Based on a preliminary study using test instruments, it was found that students' mathematical communication skills were still at a low level.

The student characteristics were analyzed through in-depth interviews with three students with different mathematical abilities (high, medium, and low). The interviews revealed that the three groups of students showed interest in learning mathematics using the context of daily life and visual materials. High and medium-ability students tend to like the learning approach through practice questions, even though they have difficulties when facing different variations of questions. Meanwhile, low-ability students rely more on memorizing formulas. These three groups have the same preferences in terms of learning methods, namely group discussions.

The analysis of teaching materials revealed limitations in the availability of learning resources. Not all students can package books because of the limited number in the library. Based on the analysis results, the development of RME-based worksheets can accommodate students' needs and characteristics and overcome the limitations of existing learning resources.

The next stage is the design, which is carried out through four systematic steps. The first step is to collect reference materials as a theoretical foundation, followed by the creation of an RME-based worksheet flowchart to visualize the learning flow. The next step is to prepare storyboards in paper-based format as a visual framework for worksheets, and the fourth step is to design research instruments to measure product effectiveness.

After the design stage, the research enters the development stage, which includes three main components. The first component is the realization of the manufacture of worksheets based on the design that has been prepared. The second component includes expert validation to ensure product feasibility before implementation. The third component is the trial implementation, which consists of two stages: one-to-one and small-group trials. In the validation process, the validators provide various suggestions for improvement to improve the quality of the work platform before giving the final assessment. The suggestions provided by the validators are presented in Table 4 below:

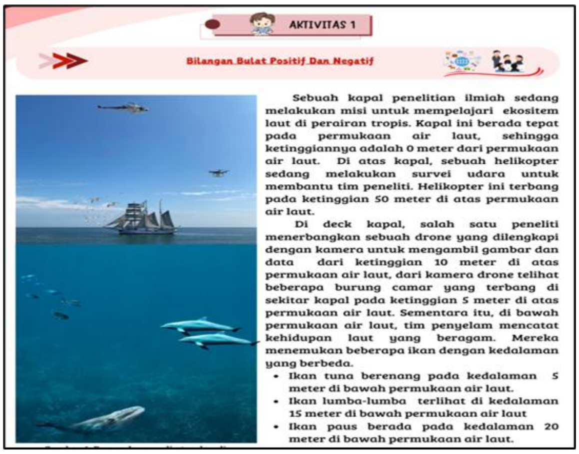
Table 4. Recapitulation of Validators to Worksheets

Validator	Comments & Suggestions
BM	1. The word cover in the content should use the word cover page 2. Fix some writing errors on the worksheet 3. Practice questions should be separated for each activity so that students are more focused when working. 4. In the bibliography, use only the most recent book sources. 5. On the back cover page of the worksheet there is no need to use page numbers.
RZ	1. All activities should use only one problem by using an interrelated context and improve the PMRI approach to each activity. 2. In Activity 1, difficult questions should be used with more real story questions that can be imagined by students.

	3. For the question in problem 2 in activity 3, the word "until" in the question should be replaced with the word "far" so that it becomes an addition operation, use a realistic height and add a picture to the problem. 4. Fix the "Let's Practice on pages 10, 16 and 22" questions, preferably related to the context that has been used in each activity.
LA	The PMRI-based worksheets that were made were good and the appearance and presentation of the pictures were attractive to students. However, it is better to be titled in each activity with the title of the sub-material to be learned so that students are not confused.

Input in the form of comments and suggestions provided by the validator is a crucial consideration for researchers in improving the worksheets designed in the design phase. Improvements are carried out to improve the quality of worksheets to produce more optimal products. Changes made to the worksheet can be observed by comparing the initial and revised versions, as shown in Table 5 and Table 6.

Tabel 5. Activity 1 on Before and After Revision Worksheets

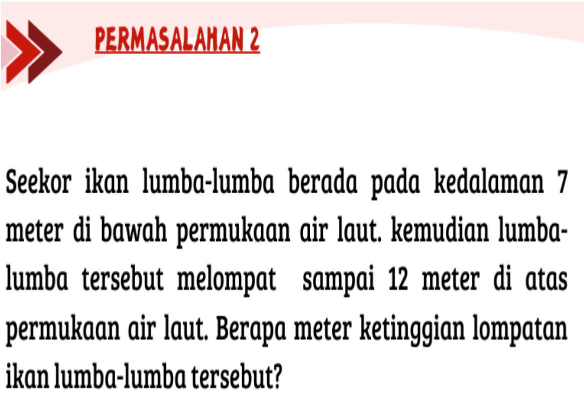
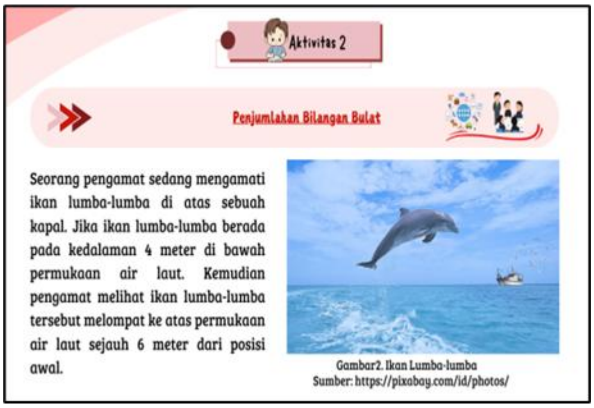
Before	After
 A. MEMAHAMI BILANGAN BULAT 1. Pengertian Bilangan Bulat Kegiatan 1 PERMASALAHAN 1 Penggunaan Konteks Perhatikan gambar di samping! Pak Anton sedang mancing ikan di laut. Ia meletakkan kail pancingnya pada kedalaman 10 meter. Sedangkan panjang tali pancing yang berada di atas permukaan air adalah 10 meter? Bagaimana Pak Anton menentukan posisi kail dan tali pancing pada bilangan bulat? Gambar 1. Memancing di laut Sumber: https://images.app.goo.gl/K1X92VC27afzo4HG6	 AKTIVITAS 1 Bilangan Bulat Positif Dan Negatif Sebuah kapal penelitian ilmiah sedang melakukan misi untuk mempelajari ekositem laut di perairan tropis. Kapal ini berada tepat pada permukaan air laut, sehingga ketinggiannya adalah 0 meter dari permukaan air laut. Di atas kapal, sebuah helikopter sedang melakukan survei udara untuk membantu tim peneliti. Helikopter ini terbang pada ketinggian 50 meter di atas permukaan air laut. Di deck kapal, salah satu peneliti menerbangkan sebuah drone yang dilengkapi dengan kamera untuk mengambil gambar dan data dari ketinggian 10 meter di atas permukaan air laut, dari kamera drone telihat beberapa burung camar yang terbang di sekitar kapal pada ketinggian 5 meter di atas permukaan air laut. Sementara itu, di bawah permukaan air laut, tim penyelam mencatat kehidupan laut yang beragam. Mereka menemukan beberapa ikan dengan kedalaman yang berbeda. • Ikan tuna berenang pada kedalaman 5 meter di bawah permukaan air laut. • Ikan lumba-lumba terlihat di kedalaman 15 meter di bawah permukaan air laut • Ikan paus berada pada kedalaman 20 meter di bawah permukaan air laut.
Translation: A. UNDERSTANDING INTEGERS 1. Definition of integers Activity 1 Problem 1 Use of context Pay attention to the picture on the side! Mr. Anton is fishing in the sea. He placed his fishing hook at a depth of 10 meters. While the fishing line that is above sea level is 10 meters? How does Mr. Anton determine the position of the hook and fishing line on an integer?	**Translation:** A scientific research ship is on a mission to study marine ecosystems in tropical waters. This ship is right at sea level, so its height is 0 meters above sea level. On board, a helicopter is conducting an aerial survey to help the research team. The helicopter flies at an altitude of 50 meters above sea level. On the deck of the ship, one of the researchers flew a droe equipped with a camera to take pictures and data from a height of 10 meters above sea level, from the drone camera you can see several seagulls flying around the ship at an altitude of 5 meters above sea level. Meanwhile, below sea level, the diving team recorded a variety of marine life. They found several fish with different depths. • Tuna fish swim at a depth of 5 meters below sea level • Dolphins are seen at a depth of 15 meters below sea level • Whales are at a depth of 20 meters below sea level

Based on the validator's suggestion, improvements were made in Table 5. The context of fishing, which was previously difficult for students to understand the concepts of positive integers, negative integers, and zeros, was changed to be clearer. The new context used is the activities that

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

occur in the sea, such as the position of fish, the position of ships on the sea surface, and the position of helicopters, birds, and drones in the air.

Tabel 6. Activity 2 Before Revision and After Revision

Before	After
	
Translation: Problem 2 A dolphin is at a depth of 7 meters below sea level. Then the dolphin jumped up to 12 meters above sea level. What is the height of the dolphin's jump?	**Translation:** Activity 1 Summing Integers An observer is observing a dolphin on a boat. If the dolphin is at a height of 4 meters below sea level. Then observers saw the dolphin jumping above sea level as far as 6 meters from the starting position.

Improvements were also made in Table 6, where before the revision, activity two only used story questions without using context-related images. According to the validator's suggestion, the worksheet was revised by adding images related to the activity of dolphins jumping from the sea to the surface as the context of the question.

In the product validation process, three expert validators provide assessments of the developed worksheets. Based on the evaluation results using the validation sheet that has been prepared, the validators recommend several aspects that need revision to improve the quality of the worksheet. The results of the detailed assessment of the three validators have been documented in the following Table 7:

Table 7. Worksheet Validity Level Calculation

No	Assessed aspects	Average	Information
1	Content	4,38	Highly Valid
2	Construction	4,61	Highly Valid
3	Language	4,47	Highly Valid
4	Characteristics of PMRI	4,11	Valid
5	Indicators of Mathematical Communication Skills	4,20	Valid
Rata-rata Keseluruhan		4,36	Highly Valid

Table 7 shows the results of the validation analysis, which shows the achievement of an excellent level of validity in each assessment component. In terms of content, an average score of 4.38 was obtained with the "Very Valid" category, indicating that the substance and material in the worksheet had reached the expected quality standards and were in line with the learning objectives. In terms of construction and language characteristics, it also reached the "Very Valid" category. This confirms that the worksheet's content, presentation flow, and language selection have been organized systematically and communicatively for its users.

The RME approach in the worksheet obtained a status of "Valid", indicating the successful integration of realistic mathematical concepts into the worksheet. Similarly, the aspect of mathematical communication skills that received the title "Valid" proves that the worksheet can support the development of students' mathematical communication skills. Comprehensively, the acquisition of the average score in the "Very Valid" category proves that the worksheets developed have met the eligibility criteria to be applied in mathematics learning. This validation reinforces the belief that the worksheet is a quality and ready-to-use learning instrument.

After going through the validation process, the worksheets were piloted at the one-to-one stage to three students in grade VII.2 with different academic abilities. A questionnaire evaluation of practicality resulted in an average score of 4.65, indicating that the worksheet is included in the very practical category. The worksheet was improved based on student feedback regarding the instructions for working and the layout of the drawings before proceeding to the small group trial stage.

The small group stage test was carried out by forming two heterogeneous groups consisting of six class VII participants. 2. The group composition is designed with ability variation to test the effectiveness of the worksheet in the context of collective learning. The practicality analysis showed very satisfactory results, with a score of 4.54. Positive responses related to use, language, and appearance were obtained. After minor adjustments, including adding visuals and formatting, the worksheet was declared to meet the practical aspect for wider implementation in grade VII mathematics learning.

After the worksheet has gone through a series of development stages, such as the validation stage, limited trials, which include one-to-one and small group stages, and improvements have been made based on the input from each stage, the implementation stage is carried out. At this stage, worksheets are implemented on a broader scale to measure the level of practicality and its potential effect on students' mathematical communication skills. The following results analyse the practicality and potential effects of worksheets developed based on implementation in the real classroom.

Data was collected through a questionnaire after the learning process was completed to assess the practicality of the worksheet from the user's perspective. The practicality questionnaire is designed to measure four main aspects: ease of use, clarity of instructions and language, visual appeal, and the effectiveness of worksheets in facilitating understanding of learning materials. The assessment uses a Likert scale of 1-5, with the results of the score interpretation referring to the practicality criteria presented in the following Figure 2.

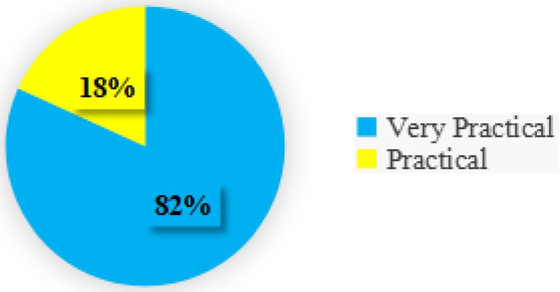


Figure 2. Results of the Practicality of the Implementation Stage Worksheet

Evaluation of the worksheet's practical aspects indicates its users' optimal response. Most assessments lead to the highest level of practicality, demonstrating success in ease of instruction, language clarity, visual appeal, and effectiveness in delivering the material. Achieving an average score in the top range validates fulfilling the practicality criteria. The implementation of the worksheet went smoothly without significant obstacles, which was reflected in the absence of assessments in the category of impractical to very impractical. This confirms that the worksheets have reached the practical standards needed to support learning activities.

The potential effect of worksheets on mathematical communication capacity is measured through tests after the implementation of learning. Evaluation instruments are constructed to assess three main aspects of mathematical communication: the ability to write, draw, and express mathematical concepts. The evaluation results were analysed to determine the extent to which the worksheet contributed to the development of students' mathematical communication competencies. The visualization of the data from the measurement of mathematical communication skills after using the worksheet can be seen in the graphical representation in Figure 3.

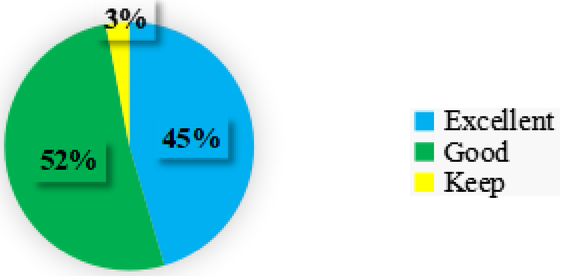


Figure 3. Assess the potential effects of the worksheet based on the test results Tes

The results of measuring mathematical communication proficiency show that worksheets significantly contribute to learning. This indication can be seen from the distribution of student scores, which is dominated by high-level achievements, where almost all students can show good to excellent mathematical communication skills. This achievement indicates that worksheets are effective in facilitating students to develop their ability to communicate mathematical ideas, both in the form of symbols, visual representations, and written explanations. Acquiring a high-grade point average also strengthens the evidence that worksheets successfully help the development of mathematical communication skills. The lack of students at the medium level and the absence of students at the low level show the consistency of the effectiveness of the worksheet in building mathematical communication skills at various skill levels.

A comprehensive understanding of students' mathematical communication skills was obtained by analyzing their written responses using three leading indicators: (1) proficiency in expressing mathematical ideas through written explanations (written text), (2) ability to represent ideas visually using diagrams or images (drawing), and (3) use of appropriate mathematical notation and symbols (mathematical expression). Students' answer sheets were collected during worksheet implementation and then categorized based on these indicators. Examples of student work for each indicator and detailed analysis of their strengths and areas for improvement are displayed and discussed in Table 8.

Table 8. Mathematical Communication Ability Indicator Value

Indikator	**Soal**	**Persoal**	**Perindikator**
Written Text	1	97,7	88,79
	2	100	
	3	92,4	
	4	66,7	
	5	87,1	
Drawing	3	75,0	79,55
	4	84,1	
Mathematical Expression	1	97,0	72,12
	2	90,9	
	3	40,2	
	4	58,3	
	5	74,2	

The achievement patterns in the three indicators of mathematical communication show interesting characteristics in students' mathematics learning processes. The dominance of written text ability indicates that students have developed good verbal and written skills in articulating their mathematical understanding. This reflects the success of learning in building students' ability to explain mathematical concepts and solve problems in clear and structured language.

Drawing skills at the intermediate level indicate that students are quite capable of transforming mathematical concepts into visual representations. However, they still need reinforcement in optimizing the use of images or diagrams to communicate mathematical ideas. This gap between verbal and visual abilities may reflect the need for learning strategies emphasizing visualization aspects in mathematical problem-solving.

Lower achievement in mathematical expression reveals challenges in using mathematical symbolic language. This shows that learners still have difficulty translating their conceptual understanding into proper mathematical notation and expressions. This condition implies the need for further emphasis on mastery of mathematical, symbolic language in the learning process and the importance of building a stronger bridge between conceptual understanding and its symbolic representation.

Evaluation is carried out systematically at each stage of development, starting from the analysis stage, which focuses on finding new solutions and innovations to solve problems related to needs, curriculum, student characteristics, and teaching materials. At the design stage, evaluation is carried out through improvements in the design of the worksheet structure and validation instruments based on the supervisor's input. Furthermore, the development stage involves evaluating and improving worksheets and lesson plans based on validator suggestions and interview results from one-to-one and small-group trials. Meanwhile, at the implementation stage, although the evaluation is planned based on student input, no comments or suggestions require further improvement.

DISCUSSION

Realistic Mathematics Education (RME) based worksheets with a maritime context on integer materials are developed using the structured ADDIE model. The analysis stage involves identifying students' learning difficulties through teacher interviews, classroom observations, and analysis of student characteristics. This stage supports the assertion that identifying learner needs is crucial in instructional design (Al-Rizal & Trisnawati, 2021). The researcher integrates maritime contexts into worksheet content in the design stage while adhering to RME principles. This aligns with the approach proposed by Chandra and Hidayati (2023), who emphasize contextual integration in worksheet design. The development stage comprises media and content validation, revised iteratively following expert suggestions.

The validation process, which includes expert validation, produces highly valid results regarding curriculum alignment, pedagogical soundness, and learner appropriateness. This finding is consistent with Alfiyanti and Erita (2023), and Daryono et al. (2023), who emphasize that expert validation is a crucial step to ensure the quality of instructional materials. Likewise, Chandra and Hidayati (2023) highlight the importance of expert validation in developing effective learning tools, such as student worksheets based on the Realistic Mathematics Education approach. Furthermore, Arifin et al. (2024) demonstrated that incorporating culturally relevant contexts, such as the Palembang wardrobe, into AR-enabled e-modules enhances the expert-validated content quality and fosters students' conceptual understanding and engagement. These findings collectively support that embedding realistic or local contexts into mathematics learning tools significantly contributes to their relevance and effectiveness.

The practicality of the worksheets is demonstrated through classroom implementation and student feedback, which indicate that the materials are user-friendly and efficient. This is reinforced by Ardiawan (2024), who found that media grounded in contextual familiarity increases usability. Additionally, Pertiwi et al. (2020) highlight that well-designed worksheets foster conceptual understanding through structured learning, while Daryono et al. (2023) emphasize practicality as integral to material effectiveness.

In the implementation stage, RME-based worksheets positively impact students' mathematical communication. Students demonstrate an improved ability to express mathematical ideas verbally and visually, consistent with Palinussa et al. (2021), who found that RME enhances mathematical reasoning and communication, particularly in rural contexts. Their visual representation skills also

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

improve, as seen in diagram and model construction, aligning with Benu et al. (2022), who documented an improved understanding of integer operations in students engaged with structured visual tasks.

However, challenges persist in students' formal mathematical notation, mirroring findings from Baharuddin and Jumarniati (2021) and Malau et al. (2021) regarding persistent misconceptions in integer operations. These issues can be addressed by integrating realistic contexts, as supported by Bitu et al. (2024), who emphasize that learning rooted in everyday life fosters stronger conceptual understanding and communication.

The study further confirms that integrating real-life contexts, particularly maritime themes, fosters student motivation and engagement. This is supported by Apriyanti et al. (2023), who demonstrate that RME increases participation and conceptual grasp through realistic scenarios. Moreover, Meika et al. (2023) affirms the effectiveness of RME-based worksheets in improving understanding, especially when aligned with clear learning objectives.

The findings also support the future development of RME-based worksheets across various mathematics topics. Chandra and Hidayati (2023) recommend scaffolding difficulty levels and maintaining a balance between guided learning and independent exploration. Nurmasari et al. (2024) further stress that contextual mathematical engineering improves mathematical literacy and should be prioritized in curriculum development.

In conclusion, the developed worksheets significantly enhance mathematical communication and conceptual understanding of integers through contextualized learning, validating the approach of integrating RME principles with maritime themes.

CONCLUSION

The development of RME-based worksheets using maritime context on integer material has been carried out through a systematic ADDIE model, including the stages of needs analysis, design, development, implementation, and evaluation. The results of the expert validation showed excellent quality in all aspects of the assessment, while the practicality test indicated that the LKPD was easy to use in learning. The implementation of LKPD positively impacts students' mathematical communication skills, especially in verbal and visual representation, although there are still challenges in the use of mathematical symbols. The use of maritime context has been proven to improve students' ability to communicate conceptual understanding and learning activities, with several areas that need improvement, such as simplifying instruction and strengthening scaffolding. Overall, the development of RME-based LKPD with a maritime context on integer material has successfully created mathematics learning that can strengthen students' mathematical communication skills.

Future research should explore the long-term effects of using RME-based worksheets in different mathematical topics and grade levels. In addition, further studies may investigate how digital or interactive versions of the worksheets can enhance students' engagement and mathematical communication, especially in the use of mathematical symbols. It is also valuable to examine the role of teacher facilitation in maximizing the effectiveness of contextual-based learning materials like these worksheets.

ACKNOWLEDGMENTS

The researcher expressed his gratitude to all parties who have contributed to the completion of this research, especially to the big family of SMP Negeri 33 Palembang, which has provided opportunities and support as a place to conduct research. The support and cooperation provided are very meaningful for the success of this research.

REFERENCES

Al-Rizal, A. A., & Trisnawati, N. (2021). Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Berbasis Saintifik pada Mata Pelajaran Teknologi Perkantoran Kelas X OTKP di SMK Ketintang Surabaya. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(1), 186–197. https://doi.org/10.26740/jpap.v9n1.p186-197

Alam, A., & Mohanty, A. (2024). Unveiling the complexities of 'Abstract Algebra' in University Mathematics Education (UME): fostering 'Conceptualization and Understanding' through advanced pedagogical approaches. *Cogent Education*, *11*(1). https://doi.org/10.1080/2331186X.2024.2355400

Alfiyanti, D. G., & Erita, Y. (2023). Validitas Bahan Ajar Dengan Model Problem Based Learning Materi Ips Kurikulum Merdeka Di Sekolah Dasar Penggerak. *Didaktik : Jurnal Ilmiah PGSD STKIP Subang*, *8*(2), 2353–2371. https://doi.org/10.36989/didaktik.v8i2.558

Apriyanti, E., Asrin, A., & Fauzi, A. (2023). Model Pembelajaran Realistic Mathematics Education Dalam Meningkatkan Pemahaman Konsep Matematika Siswa Sekolah Dasar. *Jurnal Educatio FKIP UNMA*, *9*(4), 1978–1986. https://doi.org/10.31949/educatio.v9i4.5940

Ardiawan, I. K. N. (2024). Pengembangan Komik Audio Visual Pendidikan Pancasila Berorientasi Kearifan Lokal. *Jayapangus Press*, *7*(4), 181–194.

Arifin, S., Reihani, M., & Efriani, A. (2024). How Valid is the Development of the E-Module for AR-enabled Cube Surface Area Material in The Context of The Palembang Wardrobe? *INOMATIKA*, *6*(2), 142–154. https://doi.org/10.35438/inomatika.v6i2.467

Baharuddin, M. R., & Jumarniati, J. (2021). Investigasi Kesalahan Siswa Dalam Menyelesaikan Masalah Bilangan Cacah: Kasus Pada Kesalahan Prosedural Dan Kesalahan Konsep. *Proximal: Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *4*(1), 80–86. https://doi.org/10.30605/proximal.v4i1.507

Benu, R. S. M., Jenahut, K. S., & Benu, A. B. N. (2022). Analisis Pemahaman Konsep Operasi Hitung Bilangan Bulat Mahasiswa Pendidikan Guru Sekolah Dasar. *Alpen: Jurnal Pendidikan Dasar*, *6*(1), 1–10.

Berget, I. K. L. (2023). Mathematical modelling in the discourses of the KOM and PISA frameworks and teacher interviews. *Research in Mathematics Education*, *26*(3), 425–442. https://doi.org/10.1080/14794802.2023.2165536

Bitu, Y. S., Setiawi, A. P., Bili, F. G., Iriyani, S. A., & Patty, N. S. (2024). Pembelajaran Interaktif: Meningkatkan Keterlibatan Dan Pemahaman Siswa. *J-KIP (Jurnal Keguruan Dan Ilmu Pendidikan)*, *5*(2), 193–198.

Chandra, A., & Hidayati, A. (2023). Pengembangan LKPD Berbasis Pendekatan Realistic Mathematics Education. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *11*(2), 280. https://doi.org/10.25273/jipm.v11i2.14336

Chasanah, C., Riyadi, & Usodo, B. (2020). The effectiveness of learning models on written mathematical communication skills viewed from students' cognitive styles. *European Journal of Educational Research*, *9*(3), 979–994. https://doi.org/10.12973/EU-JER.9.3.979

Daryono, D., Rayanto, Y. H., & Damayanti, A. M. (2023). Assessing Aspects and Items Validity, Practicality and Effectiveness on Students' Final Project. *EDUTEC : Journal of Education And Technology*, *6*(4), 684–703. https://doi.org/10.29062/edu.v6i4.657

Dewantara, A. H., Istiyono, E., Retnawati, H., & Suyanto, S. (2024). Investigating Pre-Service Primary School Teachers' Difficulties in Solving Context-Based Mathematics Problems: An Error Analysis. *Mathematics Teaching-Research Journal*, *16*(2), 28–47.

 Print ISSN: 2088-2157, Online ISSN: 2580-0779

Hughes, E. M., Riccomini, P. J., & Lee, J. Y. (2020). Investigating written expressions of mathematical reasoning for students with learning disabilities. *Journal of Mathematical Behavior*, *58*(February). https://doi.org/10.1016/j.jmathb.2020.100775

Indriani, M., Niswah, C., & Arifin, S. (2017). Pengembangan lembar kerja peserta didik (lkpd) berbasis inkuiri terbimbing pada materi transformasi geometri. *Jurnal Pendidikan RAFA*, 165–180.

Kenney, S., & Ntow, F. D. (2024). Unveiling the Errors Learners Make When Solving Word Problems Involving Algebraic Task. *SAGE Open*, *14*(4), 1–13. https://doi.org/10.1177/21582440241299245

Lugosi, E., & Uribe, G. (2022). Active learning strategies with positive effects on students' achievements in undergraduate mathematics education. *International Journal of Mathematical Education in Science and Technology*, *53*(2), 403–424. https://doi.org/10.1080/0020739X.2020.1773555

Malau, S., Sugilar, & Yumiati. (2021). Analisis Hambatan Belajar Operasi Bilangan Bulat (Studi Kasus Pada Kelas VII SMP Katolik ST Paulus Palangka Raya) Oleh: *Jurnal Pendidikan*, *22*(2), 116–129. https://doi.org/10.52850/jpn.v22i2.3994

Meika, I., Solikhah, E. F. F., Yunitasari, I., & Sujana, A. (2023). Efektivitas LKPD Berbasis RME terhadap Kemampuan Pemahaman Konsep Ditinjau dari Ketuntasan Belajar. *SJME (Supremum Journal of Mathematics Education)*, *7*(2), 211–221. https://doi.org/10.35706/sjme.v7i2.9314

Nurmasari, L., Budiyono, Nurkamto, J., & Ramli, M. (2024). Realistic Mathematics Engineering for improving elementary school students' mathematical literacy. In *Journal on Mathematics Education* (Vol. 15, Issue 1, pp. 1–26). Sriwijaya University. https://doi.org/10.22342/jme.v15i1.pp1-26

OECD. (2024). PISA 2022 Results (Volume III): Creative Minds, Creative Schools, PISA. In *Factsheets: Vol. I*. OECD. https://www.oecd-ilibrary.org/education/pisa-2022-results-volume-i_53f23881-en%0Ahttps://www.oecd.org/publication/pisa-2022-results/country-notes/germany-1a2cf137/

Palinussa, A. L., Molle, J. S., & Gaspersz, M. (2021). Realistic mathematics education: Mathematical reasoning and communication skills in rural contexts. *International Journal of Evaluation and Research in Education*, *10*(2), 522–534. https://doi.org/10.11591/ijere.v10i2.20640

Pertiwi, P., Handoko, H., & Toheri, T. (2020). Pengaruh penerapan meaningful learning berbantuan LKPD bertema terhadap pemahaman konsep matematika dan kemampuan metakognitif peserta didik. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah Di Bidang Pendidikan Matematika*, *6*(2), 127–137. https://doi.org/10.29407/jmen.v6i2.14464

Putri, N. D., Syahrilfuddin, S., & Guslinda, G. (2022). Analisis Kesalahan Dalam Menyelesaikan Operasi Hitung Campuran Bilangan Bulat Siswa Kelas V Sekolah Dasar. *JURNAL PAJAR (Pendidikan Dan Pengajaran)*, *6*(6), 1930. https://doi.org/10.33578/pjr.v6i6.8634

Rofiq, A., Atmadi, A., Nurazizah, S., & Nuryami, N. (2023). Peningkatan Kemampuan Pemecahan Masalah Matematika Pada Materi Bilangan Bulat Dengan Strategi Problem Based Learning Menggunakan Papan Bilangan. *AL JABAR: Jurnal Pendidikan Dan Pembelajaran Matematika*, *2*, 72–82.

Siregar, N. C., Rosli, R., & Maat, S. M. (2020). The effects of a discovery learning module on geometry for improving students' mathematical reasoning skills, communication and self-confidence. *International Journal of Learning, Teaching and Educational Research*, *19*(3), 214–228. https://doi.org/10.26803/ijlter.19.3.12

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional

Design Model in Distance Education. *Information (Switzerland)*, *13*(9), 1–20. https://doi.org/10.3390/info13090402

Sukasno, Zulkardi, Putri, R. I. I., & Somakim. (2024). The Design of Student Worksheet on Integer Material Using the Context of Musi Rawas Tourism. *Jurnal Math Educator Nusantara*, *10*(2), 210–220.

Susandi, A. D., & Widyawati, S. (2022). Implementation of realistic mathematic education (RME) learning model in improving critical thinking skills. *Al-Jabar : Jurnal Pendidikan Matematika*, *13*(2), 251–260. https://doi.org/10.24042/ajpm.v13i2.14996

Tadeu, P. J. A. (2024). A synopsis of the importance of teaching fractions to children until K-10. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(8). https://doi.org/10.29333/ejmste/14878

Tong, D. H., Uyen, B. P., & Quoc, N. V. A. (2021). The improvement of 10th students' mathematical communication skills through learning ellipse topics. *Heliyon*, *7*(11), e08282. https://doi.org/10.1016/j.heliyon.2021.e08282

Uyen, B. P., Tong, D. H., Loc, N. P., & Thanh, L. N. P. (2021). The effectiveness of applying realistic mathematics education approach in teaching statistics in grade 7 to students' mathematical skills. *Journal of Education and E-Learning Research*, *8*(2), 185–197. https://doi.org/10.20448/JOURNAL.509.2021.82.185.197

Vanesa, Y., Yerizon, Y., Desyandri, D., & Hadiyanto, H. (2021). Validitas Pengembangan LKPD Matematika Menggunakan Pendekatan RME Di Sekolah Dasar. *Jurnal Elementaria Edukasia*, *4*(2), 358–363. https://doi.org/10.31949/jee.v4i2.3320

Wang, J., Wang, Y., & Kashef, S. S. (2024). Pioneering quantitative assessment of questioning competency in elementary pre-service teachers using Likert-scale questions. *International Journal of Science Education*, *December*, 1–24. https://doi.org/10.1080/09500693.2024.2439141

Yilmaz, R. (2020). Prospective mathematics teachers' cognitive competencies on realistic mathematics education. *Journal on Mathematics Education*, *11*(1), 17–44. https://doi.org/10.22342/jme.11.1.8690.17-44

Yonathan, A. B., & Seleky, J. S. (2023). Pendekatan Matematika Realistik Untuk Mengoptimalkan Pemahaman Konsep Matematis Siswa [Realistic Mathematics Education To Optimize Students' Understanding of Mathematical Concepts]. *JOHME: Journal of Holistic Mathematics Education*, *7*(2), 143–155. https://doi.org/10.19166/johme.v7i2.6233

Yudhi, P., & Septiani, F. (2024). Pembelajaran Dengan Etnomatematika Dalam Meningkatkan Pemahaman Konsep Matematika Abstrak. *Inovasi Pendidikan*, *11*(1), 59–64. https://doi.org/10.31869/ip.v11i1.5649

Yuliana, R. (2017). Pengembangan Perangkat Pembelajaran Dengan Pendekatan Pmri Pada Materi Bangun Ruang Sisi Lengkung Untuk Smp Kelas Ix. *Jurnal Pendidikan Matematika*, *6*(1), 60–67.

Yuswan, S. A., & Maat, S. M. (2021). Pengetahuan Konseptual dan Prosedural dalam Matematik: Satu Sorotan Literatur Sistematik. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *6*(12), 94–108. https://doi.org/10.47405/mjssh.v6i12.1178