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# Development of Realistic Mathematics Education Based Mathematics Learning Tools to Improve Problem Solving Skills

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**ABSTRACT**

**Purpose of the study:** This study aims to develop mathematics learning tools based on the Realistic Mathematics Education approach for comparison material in Grade VII junior high school.

**Methodology:** The development process followed the 4-D model, consisting of the define, design, and develop stages. The research subjects were students of class VII-B at Al-Hidayah Junior High School Medan. To evaluate the quality of the developed learning tools, expert validation sheets were used to measure validity, while student response questionnaires were employed to assess practicality.

**Main Findings:** The findings indicate that all developed learning tools met the established validity criteria with very good classifications. The Learning Implementation Plan achieved an average score of 4.50 out of 5.00, while the Teaching Materials obtained an average score of 4.60. The Student Worksheets reached an average score of 4.52, and the Learning Media recorded an average score of 4.50, all categorized as very good. In addition, the Learning Outcome Tests achieved an average score of 4.53 out of 5.00, confirming their strong validity. The practicality of the learning tools was also highly supported by students, as reflected in the student response questionnaire, which yielded an average score of 4.88 out of 5.00 with very good criteria.

**Novelty/Originality of this study:** This research offers a new contribution by combining RME principles and adaptive learning tool design, to create relevant and contextual learning experiences to support students' critical thinking skills.



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## 1. INTRODUCTION

Education plays a strategic role in determining the progress of a nation. Education is not only a means of transferring knowledge, but also shaping the character, skills, and critical thinking abilities of the younger generation [1], [2]. George F. Kneller stated that education includes processes that influence the development of the soul, character, and physical abilities of individuals [3], [4]. In Indonesia, education aims to produce a generation that is faithful, has noble character, is intelligent, and creative, as mandated in Law Number 20 of 2003 concerning the National Education System [5], [6]. This shows the importance of the role of education in building superior and competitive human resources.

The curriculum is the main reference in organizing formal education in schools [7], [8]. The implementation of the Merdeka Curriculum replaces the previous curriculum with the aim of providing more freedom to teachers and students in organizing the learning process [9], [10]. This curriculum is designed to build a profile of Pancasila students who are characterful, creative, and adaptive to the challenges of the times [11], [12]. The learning approach used in the Merdeka Curriculum emphasizes the development of student potential holistically through project-based learning, problem solving, and independent exploration [13], [14]. Thus, this curriculum aims to produce a generation that is able to face global change creatively and innovatively.

Problem-solving ability is one of the main competencies emphasized in mathematics learning [15], [16]. This competency not only helps students solve mathematical problems, but also trains them to think logically, analytically, and critically [17], [18]. Based on observations at Al-Hidayah Middle School Medan, it was found that mathematics learning is still dominated by lecture methods with teaching materials in the form of standard textbooks. This causes students to be less actively involved in the learning process and hinders the development of problem-solving skills [19], [20]. Therefore, a more innovative learning strategy is needed that is relevant to students' needs.

One solution to improve the quality of mathematics learning is the development of learning tools that are in accordance with student characteristics [21], [22]. Learning tools such as Lesson Implementation Plans, Student Worksheets, teaching materials, and learning media based on Realistic Mathematics Education can be an effective alternative [23], [24]. The Realistic Mathematics Education approach emphasizes the importance of linking mathematics to reality, so that students can rediscover mathematical concepts through meaningful learning experiences [25], [26]. With learning tools designed using this approach, students can more easily understand mathematical concepts and improve their problem-solving skills [27], [28]. This is in line with the principles of the Independent Curriculum learning which supports active student exploration.

The Realistic Mathematics Education approach is based on Freudenthal's theory that mathematics is a human activity that must be linked to real life [29], [30]. In this approach, students are given the opportunity to rediscover mathematical concepts through problems that are relevant to their lives [31], [32]. This approach also emphasizes the importance of using models or visual representations to help students understand abstract concepts. By linking mathematics learning to reality, students are expected to be able to develop logical and critical thinking in solving problems [33], [34]. Therefore, this approach is very relevant to the objectives of the Independent Curriculum in encouraging meaningful learning.

The development of Realistic Mathematics Education -based learning devices requires a systematic and structured model. One suitable model is the 4-D model (Define, Design, Develop, Disseminate) because of its clear and detailed stages [35], [36]. This model allows the development of effective learning devices that are in accordance with students' needs [37], [38]. In this study, the learning devices developed include the Learning Implementation Plan, teaching materials, Student Worksheets, learning media, and assessment systems. With these devices, mathematics learning is expected to be more effective, contextual, and relevant to students' needs [39], [40].

Despite numerous studies reporting the effectiveness of the Realistic Mathematics Education approach in improving students' mathematical understanding and problem-solving skills, most existing research still focuses on the implementation of Realistic Mathematics Education in isolated classroom activities or specific learning strategies, rather than on the systematic development of complete and integrated learning tools [41], [42]. In addition, several studies emphasize learning outcomes without thoroughly addressing the alignment between lesson plans, teaching materials, student worksheets, learning media, and assessment instruments within the context of the Merdeka Curriculum [43], [44]. This condition indicates a research gap related to the need for comprehensive Realistic Mathematics Education -based learning tools that are specifically designed according to student characteristics and curriculum demands, particularly at the junior high school level. Therefore, the novelty of this study lies in the development of a set of integrated and validated mathematics learning tools based on Realistic Mathematics Education that explicitly support students' problem-solving abilities through contextual learning experiences. The urgency of this research is strengthened by the ongoing implementation of the Merdeka Curriculum, which requires innovative, student-centered, and meaningful learning designs to improve the quality of mathematics education and equip students with essential higher-order thinking skills needed to face real-life challenges.

Based on the identified mathematics learning problems, this study focuses on the development of learning tools based on Realistic Mathematic Education to improve the problem-solving abilities of grade VII students of Junior High School. This study not only aims to overcome learning problems, but also to support the optimal implementation of the Independent Curriculum. It is hoped that this study can contribute to improving the quality of mathematics learning and help teachers develop innovative learning tools. In addition, this study also aims to provide meaningful learning experiences for students in understanding and applying mathematical concepts. Thus, this study can be a reference in developing learning that is relevant to the needs and challenges of the times.

## 2. RESEARCH METHOD

### 2.1. Types of research

This study uses the Research and Development method. Research and Development is a research method used to produce certain products and test the effectiveness of the product [45], [46]. Research and Development emphasizes products that are useful or beneficial in various forms as an extension, addition, and innovation of existing forms. The products produced from this study are learning tools in the form of Learning Implementation Plans and Student Worksheets based on Realistic Mathematical Education on comparison and scale materials that are oriented towards problem-solving abilities [47], [48].

### 2.2. Research Design

The Research and Development model that will be used in this study is 4-D developed by Thiagarajan and Semmel [49], [50]. The 4-D model consists of 4 stages, namely: Define, Design, Develop, and Disseminate [51], [52]. In the cycle above, the dissemination stage is not carried out, because at that stage it takes quite a long time, so this stage only goes up to packaging.

### 2.3. Research Subject

Development of Learning Devices Based on Realistic Mathematical Education on Comparison and Scale Material to Improve Problem Solving Ability. The subjects of this development are students of Al-Hidayah Junior High School Medan on Jalan Letda Sujono, namely class VII-B. This research was conducted in a small class of 10 students.

### 2.4. Data Collection Instruments

Measuring instruments in research are usually called research instruments. Instruments in research are used to produce learning devices that meet valid and effective criteria. The instruments used are expert validation sheets, Tests and Questionnaires. Expert validation sheets are used to meet validity criteria [53], [54]. Learning Outcome Test Instruments are used to meet the criteria for the effectiveness of the developed learning devices. Questionnaires are used to determine students' responses to learning devices developed with the Realistic Mathematical Education approach.

### 2.5. Data Analysis Techniques

The data analysis technique used in this study is descriptive qualitative. This model has 4 components, namely: data collection, data reduction, data presentation, and drawing conclusions [55], [56]. Data analysis is the process of organizing and sorting data into patterns, categories, and basic description units so that themes can be found and places to formulate working hypotheses as suggested by the data.

## 3. RESULTS AND DISCUSSION

### 3.1. Development Results

#### 3.1.1. Lesson plan

The Learning Implementation Plan is prepared as a guide for teachers in implementing learning in the classroom [57], [58]. The composition of the Learning Implementation Plan uses the Realistic Mathematical Education approach, which contains the identity of the Learning Implementation Plan, time allocation, competency standards, basic competencies, indicators, learning objectives, main materials, learning models and methods, learning scenarios, learning resources, media/tools and materials, and assessments. Learning activities consist of initial activities, core activities, and final activities.

The learning activities that will be carried out in general refer to the steps of the Realistic Mathematical Education approach which include students' understanding of contextual problems, students are expected to be able to explain contextual problems, students are expected to be able to solve contextual problems, students compare and discuss their answers, students conclude the answers. The preparation of the Learning Implementation Plan is carried out with 4 learning meetings.

#### 3.1.2. Teaching materials

The teaching materials developed in this study are based on Realistic Mathematic Education and are designed to facilitate effective and contextual learning [23], [59]. The main components of the teaching materials include several important elements. First, learning objectives, which explain the learning outcomes expected to be achieved during the learning process, making it easier for teachers to direct teaching and learning activities. Second, concept maps, which are presented in visual form to map learning materials so that the concepts learned are clearly visible and structured. Third, initial narratives, which aim to provide students with an initial overview of the material to be learned, thus stimulating them to think more deeply. Furthermore, the teaching materials also explain the Realistic Mathematic Education approach, including the steps that must be taken during the learning

process to create a relevant learning experience. The last component is the learning process, which describes the learning model that will be used with reference to the Realistic Mathematic Education approach.

The design of the content section of the teaching materials also includes several learning activities designed to actively engage students. The first activity is Let's Observe, which directs students to prepare themselves by observing the problems that have been provided. Then it is continued with Let's Ask, where students are invited to ask questions based on the problems that were previously observed. Next, students will carry out the Let's Observe Information activity, where they look for other sources or additional information related to the problems that have been presented. The next activity is Let's Reason, which encourages students to understand and analyze problems logically. Finally, in the Let's Share activity, students present their work to their friends, as well as answer questions related to the learning material. This approach is expected to be able to improve students' understanding of mathematical concepts and encourage them to be actively involved in the learning process.

#### 3.1.3. Student Worksheet

The Student Worksheet developed in this study is designed to actively engage students in the learning process through various systematic activities [60], [61]. The first activity is Let's Observe, which aims to direct students to prepare themselves in facing the problems that have been compiled in the practice questions, so that they are better prepared to analyze them. Next, there is the Let's Ask activity, which encourages students to ask questions related to the problems contained in the practice questions, in order to stimulate their curiosity and critical thinking skills.

The next activity is Ayo Informasikan, where students are encouraged to look for additional information or other sources that are relevant to the problems that have been presented previously, so that they can broaden their horizons and deepen their understanding. After that, students will carry out the Ayo Berbagi activity, which involves discussion and delivery of understanding through examples of questions designed to help students understand the concepts needed before moving on to the next step. Finally, there is Ayo Berlatih, which is an activity of answering practice questions that are equipped with a solution sheet, so that students can record their processes and solutions systematically. This Student Worksheet is expected to be able to support active, in-depth learning, and in accordance with the Realistic Mathematic Education approach.

#### 3.1.4. Instructional Media

The creation of learning media is adjusted to the Realistic Mathematical Education approach. In addition, the media developed can facilitate students in the learning process. The media developed in this study are miniature houses and fruit maps.

#### 3.1.5. Learning Outcome Test

The compilation of learning outcome tests is based on more specific learning outcome indicators. The test is compiled in the form of a descriptive test consisting of 10 questions. The time provided to complete all of these questions is 90 minutes.

### 3.2. Expert validation results (Lecturers and Mathematics Teachers)

#### 3.2.1. Lesson plan

Draft A produced is validated by experts. Expert validation is conducted to see the validity of learning that covers all developed devices that focus on format, language and content. The results of expert validation are used as a basis for revising and improving the learning devices. Learning devices that have been declared valid are called Draft-B. The assessment given by experts is in the form of quantitative and qualitative assessments. Quantitative assessment is in the form of scores and qualitative assessment is in the form of comments and suggestions on the developed device. The average results of qualitative assessment are converted into categories according to the five-scale converter rules. After being converted, the categories of the developed learning devices are obtained, whether they are included in the very good, good enough, lacking, or very lacking categories. Quantitative assessment data by experts (Lecturers and Mathematics Teachers) are presented as follows:

Table 1. Assessment of Learning Implementation Plans by Lecturers and Mathematics Teachers

| No. | Aspects | Average | Criteria |
|---|---|---|---|
| 1. | Suitability between basic competencies Kl1, Kl2, Kl3, Kl4 | 4.60 | Very Good |
| 2. | Suitability of achievement indicator formulation with basic competencies (from Kl1, Kl2, Kl3, Kl4) | 4.60 | Very Good |
| 3. | Suitability of learning materials with competency achievement indicators | 4.80 | Very Good |
| 4. | Suitability of learning materials with indicators of competencies to be achieved | 4.20 | Good |
| 5. | Clarity and sequence of teaching materials | 3.80 | Less Good |

| | | | |
|---|---|---|---|
| 6. | Suitability of learning strategies (methods and approaches) with learning objectives and teaching materials | 4..60 | Very Good |
| 7. | Suitability of learning strategies with student characteristics | 4.60 | Very Good |
| 8. | Clarity of learning scenarios (steps of learning activities) with the objectives to be achieved | 4.20 | Good |
| 9. | Learning scenarios (steps of learning activities) describe active learning and reflect scientific learning | 4.80 | Very Good |
| 10. | Determination of closing activities in learning | 4.60 | Very Good |
| 11. | Assessment includes aspects of basic competencies Kl1, Kl2, Kl3, Kl4 | 4.80 | Very Good |
| 12. | Suitability of assessment techniques with indicators/competencies to be achieved | 4.60 | Very Good |
| 13. | Completeness of assessment learning tools (questions, answer keys, assessment rubrics) | 3.80 | Less Good |
| 14. | Integration and synchronization between components in the Learning Implementation Plan | 5.00 | Very Good |
| | Total | 63 | Very Good |
| | Average score | 4.5 | Very Good |
| | Precentage | 90.00% | Very Valid |

Based on the data in the table above, it can be seen that the quality of the Learning Implementation Plan based on the assessment by Experts (Deans and Mathematics Teachers) shows very good criteria with an average score of 4.5 from a maximum average score of 5.00.

**3.2.2. Teaching materials**

Quantitative assessment data by experts (lecturers and mathematics teachers) are presented as follows:

Table 2. Assessment of Teaching Materials by Experts

| No. | Components Assessed | Aspect | Average | Criteria |
|---|---|---|---|---|
| A. | Teaching Material Components | | | |
| 1. | Title | There is an interesting title according to the content | 4.80 | Very Good |
| 2. | Core Competencies-Basic Competencies | Includes Core Competencies and Basic Competencies | 4.20 | Good |
| 3. | Indicators | Suitability between indicators and Basic Competencies | 4.60 | Very Good |
| 4. | Learning Objectives | Learning objectives according to Core Competencies-Basic Competencies | 4.40 | Very Good |
| | | Shows the benefits obtained by participants | 4.40 | Good |
| 5. | Materials | According to learning objectives | 4.40 | Good |
| | | There is appreciation and enrichment of material | 3.60 | Not Good |
| 6. | Example Questions | There are sample questions according to learning objectives | 4.60 | Very Good |
| | | Stimulates students to develop | 4.80 | Good |
| 7. | Exercise/Test/Simulation | There are exercises/tests/simulations that are in accordance with learning objectives that allow students to master the expected basic competencies | 4.40 | Very Good |
| 8. | References | There is a list of actual references from books, print/electronic media, scientific journals | 4.60 | Very Good |
| | | Compliance with the rules for writing references | 4.20 | Good |
| B. | Substance of Material | | | |
| 9. | Truth | In accordance with scientific principles | 4.40 | Good |
| | | Testable / tested | 4.60 | Very Good |
| | | Factualization (based on facts) | 4.40 | Very Good |
| | | Logical / Rational | 4.80 | Very Good |

| | | | | |
|---|---|---|---|---|
| | | Completeness of Material | 4.80 | Good |
| | | Exploration / Development | 4.20 | Good |
| 10. | Coverage of Material | Collaboration with other materials / subjects | 4.40 | Very Good |
| | | Descriptive / imaginative | 4.40 | Very Good |
| | | Topicality (seen in terms of material) | 4.60 | Very Good |
| 11. | Current | Up to date (Using examples of applications / implementations based on current real conditions) | 4.40 | Very Good |
| | | Innovative (bringing up new things) | 4.60 | Good |
| 12. | Readability | Standard language and understandable | 4.20 | Good |
| 13. | Letter | Readable, Proportional and Good composition | 4.40 | Good |
| 14. | Lay Cut | Proportional and attractive design layout | 4.00 | Good |
| | | Total | 115.2 | |
| | | Average score | 4.43 | Good |
| | | Precentage | 88.6-% | Very Valid |

Based on the data in the table above, it can be seen that the quality of Teaching Materials based on the assessment by Experts (Lecturers and Mathematics Teachers) shows good criteria with an average score of 4.43 from a maximum average score of 5.00. Qualitative data in the form of suggestions and comments from Experts (Lecturers and Mathematics Teachers) are presented as follows:

Table 3. Data from Qualitative Assessment Results of Teaching Materials by Experts

| Validators | Revision | Before | After |
|---|---|---|---|
| 1 | Writing Improvements | When going to school, Aldi and his friends received a brochure distributed by someone, the brochure showed the prices of various books available at the HAPPY STORE | When going to school, Aldi and his friends got a brochure that was distributed by someone, the brochure showed the prices of various books available at the HAPPY STORE |
| 2 | Language Improvements | For example, someone riding a bicycle, riding a car, when we are shopping and others. | For example, someone riding a bicycle, driving a car, when we are shopping and others. |
| 3 | - | There is none | There is none |
| 4 | - | There is none | There is none |
| 5 | - | There is none | There is none |

### 3.2.3. Student Worksheet

Quantitative assessment data by experts (lecturers and mathematics teachers) are presented as follows:

Table 4. Assessment of Student Worksheets by Experts

| No. | Aspects | Average | Criteria |
|---|---|---|---|
| 1. | The material practiced on the Student Worksheet encourages students to interact more with the subject matter being taught | 4.80 | Very Good |
| 2. | The material practiced on the Student Worksheet encourages students to explore more material related to the lesson being taught | 4.20 | Good |
| 3. | The material practiced on the Student Worksheet is able to provide reinforcement for students that they have truly mastered | 4.60 | Very Good |
| 4. | The material practiced in the Student Worksheet and how to practice it can increase students' retention (long-lasting in memory) of the subject matter being taught | 4.40 | Very Good |
| 5. | The practice material and training methods provide students with the opportunity to work on the exercises independently | 4.80 | Very Good |
| 6. | The practice material and training methods in the Student Worksheet are challenging and interesting for students so that they are happy to complete the exercises without getting bored | 4.40 | Very Good |

| | | | |
|---|---|---|---|
| 7. | The Student Worksheet provides answers and explanations about getting answers to each exercise that can be easily understood | 4.20 | Good |
| 8. | The Student Worksheet provides clear and easy-to-understand instructions on what to do in completing the exercise | 4.60 | Very Good |
| 9. | The Student Worksheet displays various sub-topics as representatives of the material being taught so that the Student Worksheet functions as a means of review (study) effective re-test | 4.60 | Very Good |
| 10. | The Student Worksheet provides a comment space at the end of each exercise section for student self-evaluation regarding which parts have been understood well and which parts have failed as well as other information related to the exercise activity. | 4.60 | Very Good |
| | Total | 45.2 | Very Good |
| | Average score | 4.52 | Very Good |
| | Precentage | 90.40% | Very Valid |

Based on the data in the table above, it can be seen that the quality of the Teaching Materials based on the assessment by Experts (Lecturers and Mathematics Teachers) shows very good criteria with an average score of 4.52 from a maximum average score of 5.00. Qualitative data in the form of suggestions and comments from Experts (Lecturers and Mathematics Teachers) are presented as follows:

Table 5. Qualitative Data Results of Student Worksheets by Experts

| Validators | Revision | Before | After |
|---|---|---|---|
| 1 | Change text color |  |  |
| 2 | Language Fix | Doni has 15 marbles, while Ali Doni has 10 marbles. What is their ratio? | Doni has 15 marbles, while Ali has 10 marbles. What is their marble ratio? |
| 3 | - | There isn't any | There isn't any |
| 4 | - | There isn't any | There isn't any |
| 5 | - | There isn't any | There isn't any |

### 3.2.4. Instructional Media

Quantitative assessment data by experts (lecturers and mathematics teachers) are presented as follows:

Table 6. Learning Media Assessment by Experts

| No. | Aspects | Average | Criteria |
|---|---|---|---|
| 1. | The media used is able to make abstract information more real/concrete | 4.40 | Good |
| 2. | The media used will be able to make students' minds more focused on the information/concepts/principles taught or learned | 4.80 | Very Good |
| 3. | The media used will be able to divert students' attention from other things to the information/concepts/principles taught or learned | 4.20 | Good |
| 4. | The media used is in accordance with the learning objectives planned to be achieved by students | 4.60 | Very Good |
| 5. | The media used is in accordance with the characteristics of most students being taught (mental development level, knowledge level, learning experience, etc.) | 4.40 | Very Good |
| 6. | The media used is adaptive or can change flexibly and spontaneously to provide feedback on students' responses/reactions or answers during the learning process | 4.60 | Very Good |
| 7. | The media used encourages students to be more active/more physically/psychomotorically involved | 4.60 | Good |

| | | | |
|---|---|---|---|
| 8. | The media used encourages students to be more emotionally involved (involving the heart and feelings) | 4.40 | Very Good |
| 9. | The media used involves various uses of the five senses as information channels simultaneously (sight, hearing, smell, and feeling) | 4.60 | Good |
| 10. | The media used is able to encourage students to be more involved in high-level cognitive activities (problem solving, creative thinking, creative creation, innovation, etc.) in accordance with the stages of children's psychological development. | 4.40 | Very Good |
| | Total | 45 | Very Good |
| | Average score | 4.50 | Very Good |
| | Precentage | 90.00% | Very Valid |

Based on the data in the table above, it can be seen that the quality of the Teaching Materials based on the assessment by Experts (Designers and Mathematics Teachers) shows very good criteria with an average score of 4.50 from a maximum average score of 5.00.

### 3.2.5. Learning Outcome Test

Quantitative assessment data by experts (lecturers and mathematics teachers) are presented as follows:

Table 7. Assessment of Learning Results Tests by Experts

| No. | Aspects | Average | Criteria |
|---|---|---|---|
| 1. | Suitability of test items with established basic competency indicators | 4.60 | Very Good |
| 2. | Suitability of test materials with measurement objectives | 4.40 | Good |
| 3. | Formulation of each test item uses words/statements/commands according to student answers | 4.40 | Good |
| 4. | Formulation of each test item uses simple, communicative, and easy-to-understand language | 4.80 | Good |
| 5. | Formulation of each test item uses good and correct Indonesian language rules | 4.80 | Very Good |
| 6. | Formulation of each test item does not use words/sentences that give rise to multiple interpretations | 4.60 | Very Good |
| 7. | Clarity of instructions for using learning devices | 4.80 | Very Good |
| 8. | Clarity of assessment criteria described in the assessment device | 4.60 | Very Good |
| 9. | Clarity of the purpose of using the assessment device | 4.20 | Good |
| 10. | Suitability of indicators assessed for each aspect of assessment in the assessment device with measurement objectives | 4.60 | Very Good |
| 11. | The categories contained in the assessment device already cover all student and teacher activities that may occur in learning | 4.20 | Good |
| 12. | Suitability of time allocated for the implementation of the entire assessment device | 4.40 | Good |
| | Total | 54.40 | Very Good |
| | Average score | 4.53 | Very Good |
| | Precentage | 90.60% | Very Valid |

Based on the data in the table above, it can be seen that the quality of the Teaching Materials based on the assessment by the Experts (Desen and Mathematics Teachers) shows very good criteria with an average score of 4.53 from a maximum average score of 5.00.

Classification of the Learning Implementation Plan that meets the criteria is very good, classification of Teaching Materials that meets the criteria is very good, classification of Student Worksheets that meets the criteria is very good, classification of Learning Media that meets the criteria is very good, classification of THB that meets the criteria is very good. Shows that the Learning Implementation Plan, Teaching Materials, Student Worksheets, Learning Media, and Learning Outcome Tests meet valid qualifications so that the Learning Implementation Plan, Teaching Materials, Student Worksheets, Learning Media and Learning Outcome Tests that have been developed are suitable for use in learning at school.

### 3.3. Product Trial

The product trial was conducted at Al-Hidayah Junior High School, Medan, class VII B. The product trial process was attended by 10 students. At this stage, the examiner tested all the activities on the Student Worksheet.

The activities designed were to explain the objectives of the lesson that would take place. At this stage, there were observation activities. Where at this stage students were asked to observe existing problems where the problems would be discussed at the end of the lesson. This activity was carried out independently by each student, where students worked on all the activities in the Student Worksheet, after finishing each student presented the results they obtained in front of the class and drew a conclusion about which answer was correct from the results of each student's presentation.

### 3.4. Questionnaire Response Analysis

The student response questionnaire was used to assess the practicality of the Teaching Materials and Student Worksheets. The following are the results of the student questionnaire presented as follows:

Table 8. Student Response Questionnaire

| No. | Aspect | Average | Criteria |
|---|---|---|---|
| I. | What do you think about | | |
| 1. | Student books (teaching materials) | 5 | Very Good |
| 2. | Student Worksheets | 5 | Very Good |
| 3. | Exercises/Practices | 4.8 | Very Good |
| 4. | Teacher's teaching methods | 5 | Very Good |
| II. | What do you think about | | |
| 1. | Student books (teaching materials) | 5 | Very Good |
| 2. | Student Worksheets | 5 | Very Good |
| 3. | Exercises/Practices | 4.9 | Very Good |
| 4. | Teacher's teaching methods | 5 | Very Good |
| III. | What do you think about the student book (study guide)? | | |
| 1. | Readability | 4.7 | Very Good |
| 2. | Language | 4.9 | Very Good |
| 3. | Appearance of the study guide | 4.8 | Very Good |
| 4. | Content/lesson material | 4.7 | Very Good |
| 5. | Images/Illustrations in the study guide | 5 | Very Good |
| | Average Score | 63.8 | Very Good |
| | Amount | 4.91 | Very Good |

Based on the data in the table above, it can be seen that the quality of the student response questionnaire shows very good criteria, namely with an average score of 4.91 from a maximum average score of 5.00.

### 3.5. Analysis of Student Learning Outcome Tests

Student learning outcome tests are used to see whether students' problem-solving abilities have improved after the development of learning devices on the Comparison material. The following are the test results given to students:

Table 9. Student learning outcome test

| Amount | Average | Criteria |
|---|---|---|
| 96.4 | 9.64 | Complete |

Based on the learning outcome test data in the table above, it can be seen that students' problem-solving abilities increased after the development of learning tools on comparative material.

The findings of this study are consistent with previous research indicating that the Realistic Mathematics Education approach effectively enhances students' problem-solving abilities by connecting mathematical concepts to real-life contexts [62], [63]. Several prior studies have reported that Realistic Mathematics Education -based learning encourages students to actively construct knowledge, engage in meaningful reasoning, and develop deeper conceptual understanding, which ultimately supports problem-solving skills [64], [65]. The high validity and practicality scores obtained for the lesson plans, teaching materials, student worksheets, learning media, and learning outcome tests in this study reinforce earlier findings that systematically designed Realistic Mathematics Education -based learning tools can create more interactive and student-centered learning environments. Furthermore, the positive student responses observed during the product trials align with previous research emphasizing that contextual problems and guided discovery activities increase student motivation and engagement in mathematics learning. Thus, this study strengthens existing evidence that Realistic Mathematics Education is not only effective as an instructional approach but also highly suitable as a foundation for developing integrated mathematics learning tools in junior high school settings.

This research has several important impacts on mathematics education practice. First, the developed Realistic Mathematics Education-based learning tools provide teachers with practical and validated instructional resources that support the implementation of the Merdeka Curriculum and promote students' problem-solving abilities through contextual learning. Second, the learning tools contribute to more meaningful learning experiences by encouraging active participation, critical thinking, and collaborative discussion among students. However, this study also has certain limitations. The research was conducted on a limited scale involving a small number of students from a single school, which may restrict the generalizability of the findings. In addition, the development process was only carried out up to the develop stage of the 4-D model, without broader dissemination or large-scale effectiveness testing. Therefore, future studies are recommended to implement the developed learning tools in larger and more diverse samples, as well as to examine their long-term impact on students' mathematical abilities and learning outcomes.

## 4. CONCLUSION

Based on the research results, it was concluded that the development of learning devices based on Realistic Mathematic Education on comparative material produced products in the form of Lesson Plans, Teaching Materials, Student Worksheets, Learning Media, and Learning Outcome Tests developed using the 4-D model (Define, Design, Develop, Disseminate). This research only reached the Develop stage which included instrument validation, product validation, and field trials. The validation results by experts showed that all learning devices, namely Lesson Plans, Teaching Materials, Student Worksheets, Learning Media, and Learning Outcome Tests, received an average score above 4.50 out of a maximum of 5.00 with a very good classification. The assessment of the student response questionnaire also showed an average score of 4.88 with a very good classification. Thus, the developed learning devices were declared suitable for use in learning in schools. Future research is recommended to implement the developed Realistic Mathematic Education -based learning tools on a larger scale involving diverse school contexts to examine their effectiveness and generalizability. In addition, further studies may explore the integration of technology-assisted media within the Realistic Mathematic Education framework to enhance students' problem-solving skills and higher-order thinking abilities.

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## REFERENCES

[1] M. I. S. Ahmad, M. I. Idrus, and S. Rijal, "The Role of Education in Fostering Entrepreneurial Spirit in the Young Generation," *J. Contemp. Adm. Manag. (ADMAN*, vol. 1, no. 2, pp. 93–100, 2023, doi: 10.4995/HEAd23.2023.16159.

[2] J. Southworth, "Bridging critical thinking and transformative learning: The role of perspective-taking," *Theory Res. Educ.*, vol. 20, no. 1, pp. 44–63, 2022, doi: 10.1177/14778785221090853.

[3] P. C. H. Runtunuwu, "An analysis of employee welfare levels study at trimega bangun persada company," *Indones. Audit. Res. J.*, vol. 11, no. 3, pp. 107–113, 2022, doi: 10.35335/arj.v11i3.20.

[4] M. S. I. Waqfin, "Values of Character Education According to KH. Hasyim Asy'ari and Its Relevance," *Sch. Soc. Lit. Study Educ.*, vol. 3, no. 3, pp. 284–288, 2024, doi: 10.32764/schoolar.v3i3.4493.

[5] M. Arif, "Character Education Innovation in Forming Millennial generation Personality," *Didakt. Relig. J. Islam. Educ.*, vol. 10, no. 1, pp. 75–99, 2022.

[6] I. Wulansari, M. Yanto, and D. Wanto, "Merdeka Curriculum Management Based on Character Education in The Millennial Generation," *J. Qual. Assur. Islam. Educ.*, vol. 2, no. 2, pp. 74–86, 2022, doi: 10.47945/jqaie.v2i2.702.

[7] H. Helda and S. Syahrani, "National Standards of Education in Contents Standards and Education Process Standards in Indonesia," *Indones. J. Educ.*, vol. 3, no. 2, pp. 257–269, 2022, doi: 10.54443/injoe.v3i2.32.

[8] Z. Deng, "Powerful knowledge, educational potential and knowledge-rich curriculum: pushing the boundaries," *J. Curric. Stud.*, vol. 54, no. 5, pp. 599–617, 2022, doi: 10.1080/00220272.2022.2089538.

[9] W. Ndari, Suyatno, Sukirman, and F. N. Mahmudah, "Implementation of the Merdeka Curriculum and Its Challenges," *Eur. J. Educ. Pedagog.*, vol. 4, no. 3, pp. 111–116, 2023, doi: 10.24018/ejedu.2023.4.3.648.

[10] F. Fauzan, R. A. M. Ansori, M. Dannur, A. Pratama, and A. Hairit, "The Implementation of the Merdeka Curriculum (Independent Curriculum) in Strengthening Students' Character in Indonesia," *Aqlamuna J. Educ. Stud.*, vol. 1, no. 1, pp. 136–155, 2023, doi: 10.58223/aqlamuna.v1i1.237.

[11] M. N. Hakim, K. Z. Solihah, F. Ismail, A. Salim, and N. T. Prasetiyo, "Optimizing the Merdeka Curriculum for Developing the Pancasila Student Profile through Project-Based Learning," *Munaddhomah*, vol. 5, no. 4, pp. 395–408, 2024, doi: 10.31538/munaddhomah.v5i4.1396.

[12] Z. Zainuddin, A. Nafisah, and M. Muttaqin, "Transforming Character Education through the Implementation of the Independent Curriculum in Indonesia," *Int. J. Educ. Humanit.*, vol. 5, no. 3, pp. 560–572, 2025, doi: 10.58557/(ijeh).v5i3.346.

[13] F. A. Halim, "Project-Based Learning in the Independent Curriculum : Improving Secondary Students ' Mathematical Problem -Solving Skills," *EDUKASIA J. Pendidik. dan Pembelajaran*, vol. 6, no. 2, pp. 1027–1038, 2025, doi: 10.62775/edukasia.v6i2.1676.
[14] H. Hunaepi and I. G. P. Suharta, "Transforming Education in Indonesia: The Impact and Challenges of the Merdeka Belajar Curriculum," *Path Sci.*, vol. 10, no. 6, pp. 5026–5039, 2024, doi: 10.22178/pos.105-31.
[15] P. Malangtupthong, W. Nurittamont, and B. Phayaphrom, "Factors Influencing Mathematical Problem-Solving Competency: A Case Study on High School Students," *SSRN Electron. J.*, vol. 11, no. April, pp. 1–18, 2023, doi: 10.2139/ssrn.4522267.
[16] D. Olivares, J. L. Lupiáñez, and I. Segovia, "Roles and characteristics of problem solving in the mathematics curriculum: a review," *Int. J. Math. Educ. Sci. Technol.*, vol. 52, no. 7, pp. 1079–1096, 2021, doi: 10.1080/0020739X.2020.1738579.
[17] S. Sachdeva and P.-O. Eggen, "Learners' Critical Thinking About Learning Mathematics," *Int. Electron. J. Math. Educ.*, vol. 16, no. 3, p. em0644, 2021, doi: 10.29333/iejme/11003.
[18] Marzuki, Wahyudin, E. Cahya, and D. Juandi, "Students' critical thinking skills in solving mathematical problems; a systematic procedure of grounded theory study," *Int. J. Instr.*, vol. 14, no. 4, pp. 529–548, 2021, doi: 10.29333/iji.2021.14431a.
[19] B. Dixit, M. Bedekar, A. Jahagirdar, and N. Sathe, "Role of active learning techniques in development of problem solving skills," *J. Eng. Educ. Transform.*, vol. 34, no. Special Issue, pp. 670–674, 2021, doi: 10.16920/jeet/2021/v34i0/157241.
[20] E. Karan and L. Brown, "Enhancing Student's Problem-solving Skills through Project-based Learning," *J. Probl. Based Learn. High. Educ.*, vol. 10, no. 1, pp. 74–87, 2022, doi: 10.54337/ojs.jpblhe.v10i1.6887.
[21] E. V. Soboleva, K. K. Zhumakulov, K. P. Umurkulov, G. I. Ibragimov, L. V. Kochneva, and M. O. Timofeeva, "Developing a Personalised Learning Model Based on Interactive Novels to Improve the Quality of Mathematics Education," *Eurasia J. Math. Sci. Technol. Educ.*, vol. 18, no. 2, pp. 1–17, 2022, doi: 10.29333/EJMSTE/11590.
[22] M. Sabilah and F. Yolanda, "Development of mathematics learning devices with a problem based learning model oriented on the mathematics problem solving ability," *Int. J. Trends Math. Educ. Res.*, vol. 5, no. 2, pp. 180–190, 2022, doi: 10.33122/ijtmer.v5i2.136.
[23] S. Sutarni, S. Sutama, H. joko Prayitno, A. Sutopo, and P. A. Laksmiwati, "The Development of Realistic Mathematics Education-Based Student Worksheets to Enhance Higher-Order Thinking Skills and Mathematical Ability," *Infin. J. Math. Educ.*, vol. 13, no. 2, pp. 285–300, 2024.
[24] W. R. Tumangger, I. A. Khalil, and R. C. I. Prahmana, "The Impact of Realistic Mathematics Education-based Student Worksheet for Improving Students' Mathematical Problem-Solving Skills," *IndoMath Indones. Math. Educ.*, vol. 7, no. 2, pp. 196–215, 2024, doi: 10.30738/indomath.v7i2.122.
[25] K. Koerunnisa *et al.*, "The Influence of a Realistic Mathematical Approach on Student Learning in Elementary Schools," *J. Math. Instr. Soc. Res. Opin.*, vol. 4, no. 1, pp. 105–114, 2024, doi: 10.58421/misro.v4i1.282.
[26] N. T. Da, "Realistic mathematics education and authentic learning: A combination of teaching mathematics in high schools," *J. Math. Sci. Teach.*, vol. 3, no. 1, p. em029, 2023, doi: 10.29333/mathsciteacher/13061.
[27] L. Amalia, M. Makmuri, and L. El Hakim, "Learning Design: To Improve Mathematical Problem-Solving Skills Using a Contextual Approach," *JIIP - J. Ilm. Ilmu Pendidik.*, vol. 7, no. 3, pp. 2353–2366, 2024, doi: 10.54371/jiip.v7i3.3455.
[28] K. A. Harahap, B. Sinaga, and P. Siagian, "Development of Geogebra-Assisted Problem Based Learning (PBL) Learning Tools to Improve Visual Thinking Skills in Mathematical Problem Solving Students of SMA Negeri 1 Samudera," *Budapest Int. Res. Critics Linguist. Educ. J.*, vol. 4, no. 1, pp. 239–251, 2021, doi: 10.33258/birle.v4i1.1581.
[29] E. P. S. Bayu, A. Fauzan, and A. Armiati, "Realistic mathematics education approach," 2023, p. 030005. doi: 10.1063/5.0148141.
[30] N. Bal and M. Seckin Kapucu, "The Effect of Realistic Mathematics Education Activities Applied in Secondary School 7th Grade Mathematics Education on the Development of Life Skills," *Eurasia Proc. Educ. Soc. Sci.*, vol. 25, no. 2014, pp. 113–122, 2022, doi: 10.55549/epess.1218207.
[31] P. Üredi and A. Doğanay, "Developing the Skill of Associating Mathematics with Real Life Through Realistic Mathematics Education: An Action Research * Gerçekçi Matematik Eğitimi Yoluyla Matematiği Gerçek Yaşamla İlişkilendirme Becerisinin Geliştirilmesi: Bir Eylem Araştırması," *J. Theor. Educ. Sci.*, vol. 16, no. April, pp. 394–422, 2023.
[32] L. P. Nugraheni and M. Marsigit, "Realistic mathematics education: An approach to improve problem solving ability in primary school," *J. Educ. Learn.*, vol. 15, no. 4, pp. 511–518, 2021, doi: 10.11591/edulearn.v15i4.19354.
[33] D. S. Setiana, R. Y. Purwoko, and Sugiman, "The application of mathematics learning model to stimulate mathematical critical thinking skills of senior high school students," *Eur. J. Educ. Res.*, vol. 10, no. 1, pp. 509–523, 2021, doi: 10.12973/EU-JER.10.1.509.
[34] A. L. Palinussa, J. S. Lakusa, and L. Moma, "Comparison of Problem-Based Learning and Discovery Learning To Improve Students' Mathematical Critical Thinking Skills," *Form. J. Ilm. Pendidik. MIPA*, vol. 13, no. 1, pp. 109–122, 2023, doi: 10.30998/formatif.v13i1.15205.
[35] N. I. H. L, N. Nasruddin, A. E. Sejati, and A. Sugiarto, "Developing Teaching Material of Research Methodology and Learning with 4D Model in Facilitating Learning During the Covid-19 Pandemic to Improve Critical Thinking Skill," *J. Kependidikan J. Has. Penelit. dan Kaji. Kepustakaan di Bid. Pendidikan, Pengajaran dan Pembelajaran*, vol. 9, no. 2, pp. 541–554, 2023.
[36] T. Widodo, L. N. Rachmawati, and S. N. Hasanah, "Development of Digital-based LKPD on Ecosystem Material," *Edutechnium J. Educ. Technol.*, vol. 1, no. 2, pp. 66–76, 2023, doi: 10.71365/edujet.v1i2.29.
[37] A. T. Syam and D. Furwana, "The 4-D Model on the Development of English Learning Materials for Islamic Education Learners," *Din. Ilmu*, vol. 22, no. 1, pp. 17–39, 2022, doi: 10.21093/di.v22i1.4235.
[38] G. Guslinda, O. Kurniaman, L. N. Firdaus, and H. Hadriana, "Developing Local Wisdom-Based Teaching Materials on "Family Addressing Terms" for Elementary School Students: Validation Analysis Using the 4D Model," *Multidiscip. J.*

*Sch. Educ.*, vol. 13, no. 1 (25), pp. 295–315, 2024, doi: 10.35765/mjse.2024.1325.15.
[39] L. Misqa, W. Oviana, Z. Hayati, and M. Jannah, "Improving Student Learning Outcomes in Mathematics Learning through a Contextual Teaching and Learning Approach in Elementary Schools," *J. Indones. Prim. Sch.*, vol. 1, no. 2, pp. 19–26, 2024.
[40] D. Harefa and Fatolosa Hulu, "Mathematics Learning Strategies That Support Pancasila Moral Education: Practical Approaches for Teachers," *Afore J. Pendidik. Mat.*, vol. 3, no. 2, pp. 51–60, 2024, doi: 10.57094/afore.v3i2.2299.
[41] S. Samritin, S. R. Natsir, A. Manaf, and E. R. Sari, "The Effect of Realistic Mathematics Education Implementation in Mathematics Learning in Elementary School," *Form. J. Ilm. Pendidik. MIPA*, vol. 13, no. 1, pp. 81–88, 2023, doi: 10.30998/formatif.v13i1.16522.
[42] E. Susanti, "Enhancing Problem-Solving Skills in Elemtary Students Through Realistic mathematics Education," *Sci. J. Inov. Pendidik. Mat. dan IPA*, vol. 5, no. 1, pp. 48–59, 2025.
[43] Meidawati and E. Kusdarini, "Implementation of the Merdeka Curriculum in the Planning, Implementation, and Assessment of Pancasila Education Learning in Senior High Schools," *J. Penelit. Pendidik. IPA*, vol. 11, no. 2, pp. 508–515, 2025, doi: 10.29303/jppipa.v11i2.10202.
[44] M. Mila and M. Zuhdi, "Curriculum Development and Educational Practices for Islamic Education: An Analysis of the Merdeka Curriculum at Integrated Islamic Junior High School in Indonesia," *BIIS Bull. Indones. Islam. Stud.*, vol. 4, no. 2, pp. 719–737, 2025.
[45] U. Umar, M. B. Purwanto, and M. M. Al Firdaus, "Research and Development: As the Primary Alternative To Educational Research Design Frameworks," *JELL (Journal English Lang. Lit. STIBA-IEC Jakarta*, vol. 8, no. 01, pp. 73–82, 2023, doi: 10.37110/jell.v8i01.172.
[46] H. Nopiyanti, I. Tabroni, U. Barroso, and A. Intes, "Product Development of Unique Clothing Learning Media to Stimulate Fine Motor Skills of 4-5 Years Old Children," *J. Comput. Sci. Adv.*, vol. 1, no. 1, pp. 48–61, 2023, doi: 10.55849/jsca.v1i1.452.
[47] A. Manggarrani, N. H. Marhaeni, and A. Triyono, "Design of Realistic Mathematics Education-Based Student Worksheets to Improve Students' Mathematical Problem-Solving Skills," *EDUTREND J. Emerg. Issues Trends Educ.*, vol. 1, no. 2, pp. 121–128, 2024, doi: 10.59110/edutrend.340.
[48] F. F. Putri, Y. Yerizon, and I. M. Arnawa, "Development of Learning Tools Based on Realistic Mathematics Education to Improve the Mathematical Problem-Solving Ability of Students in Class VII Middle School," *J. Soc. Res.*, vol. 2, no. 10, pp. 3404–3410, 2023, doi: 10.55324/josr.v2i10.1436.
[49] I. Aimmah and M. Amin, "Thiagarajan's 4-D Learning Model: A Theoretical Study and Its Application in Learning Device Development," *J. Educ. Policy Anal.*, vol. 1, no. 1, pp. 17–24, 2025, [Online]. Available: https://businessandfinanceanalyst.com
[50] T. A. Siagian, D. Armanto, and P. Siagian, "Development of learning device oriented problem based learning to improve student's mathematical problem solving skill," in *Journal of Physics: Conference Series*, 2021, pp. 1–8. doi: 10.1088/1742-6596/1731/1/012056.
[51] I. Mulyati, I. Astuti, and E. Ernawaty, "Development of Canva Application Assisted Learning Media in Class XII Advanced Study Materials with 4-D Models," *JTP - J. Teknol. Pendidik.*, vol. 24, no. 3, pp. 322–329, 2022, doi: 10.21009/jtp.v24i3.30483.
[52] E. Erdisna, M. Ridwan, and H. Syahputra, "Developing Digital Entrepreneurship Learning Model: 4-D Competencies-Based for Millennial Generation in Higher Education," *Utamax J. Ultim. Res. Trends Educ.*, vol. 4, no. 2, pp. 84–100, 2022, doi: 10.31849/utamax.v4i2.10081.
[53] N. Elangovan and E. Sundaravel, "Method of preparing a document for survey instrument validation by experts," *MethodsX*, vol. 8, no. July 2020, pp. 1–9, 2021, doi: 10.1016/j.mex.2021.101326.
[54] R. Lestari, R. C. I. Prahmana, M. S. F. Chong, and M. Shahrill, "Developing Realistic Mathematics Education-Based Worksheets for Improving Students' Critical Thinking Skills," *Infin. J.*, vol. 12, no. 1, pp. 69–84, 2023, doi: 10.22460/infinity.v12i1.p69-84.
[55] M. A. Talukder *et al.*, "Machine learning-based network intrusion detection for big and imbalanced data using oversampling, stacking feature embedding and feature extraction," *J. Big Data*, vol. 11, no. 1, pp. 1–44, 2024, doi: 10.1186/s40537-024-00886-w.
[56] F. Muttaqiean, R. Cahyaningati, and R. Meilan, "Implementation of Management Strategies to Improve Employee Performance at Rural Banks in East Java," *Wiga J. Penelit. Ilmu Ekon.*, vol. 13, no. 2, pp. 257–271, 2023, doi: 10.30741/wiga.v13i2.1105.
[57] C. Amelia, A. Aprilianto, D. Supriatna, I. Rusydi, and N. E. Zahari, "The Principal's Role as Education Supervisor in Improving Teacher Professionalism," *Nidhomul Haq J. Manaj. Pendidik. Islam*, vol. 7, no. 1, pp. 144–155, 2022, doi: 10.31538/ndh.v7i1.2075.
[58] D. Suryana, A. Husna, and N. Mahyuddin, "CIPP Evaluation Model: Analysis of Education Implementation in PAUD Based on Government Policy on Implementation of Learning During the Covid-19 Pandemic," *J. Obs. J. Pendidik. Anak Usia Dini*, vol. 7, no. 4, pp. 4386–4396, 2023, doi: 10.31004/obsesi.v7i4.3722.
[59] R. Purwitaningrum and R. C. I. Prahmana, "Developing instructional materials on mathematics logical thinking through the Indonesian realistic mathematics education approach," *Int. J. Educ. Learn.*, vol. 3, no. 1, pp. 13–19, 2021, doi: 10.31763/ijele.v3i1.178.
[60] M. A. Fadillah, U. Usmeldi, F. Festiyed, L. Lufri, and M. Mawardi, "Assessment of Teaching Strategies, Utilization of Student Worksheets, and Student Engagement in Science Education," *Int. J. Educ. Inf. Technol. Others*, vol. 8, no. 1, pp. 198–207, 2025.
[61] R. O. Khastini, W. S. Rohmah, and A. N. Sahida, "The Effectiveness of the e-Student Worksheets to Improve Students' Learning Outcomes and Critical Thinking Skills on Digestive System Concepts," *Int. J. Biol. Educ. Towar. Sustain. Dev.*, vol. 3, no. 1, pp. 52–61, 2023, doi: 10.53889/ijbetsd.v3i1.160.

[62] J. K. L. Dinglasan, D. R. C. Caraan, and D. A. Ching, "Effectiveness of Realistic Mathematics Education Approach on Problem-Solving Skills of Students," *Int. J. Educ. Manag. Dev. Stud.*, vol. 4, no. 2, pp. 64–87, Jun. 2023, doi: 10.53378/352980.

[63] I. N. Rohmah and A. Jupri, "The Effectiveness Of Mathematics Learning Through A Realistic Mathematics Education Approach Elementary Schools," *J. Cakrawala Pendas*, vol. 10, no. 3, pp. 500–511, 2024.

[64] M. O. Fokuo *et al.*, "The use of visualization tools in teaching mathematics in college of education: A systematic review," *Online J. Math. Sci. Technol. Educ.*, vol. 4, no. 1, pp. 65–75, 2023, doi: 10.53022/oarjst.2023.9.1.0057.

[65] D. M. L. D. Rasteiro *et al.*, "Integrals Applications: A STEAM Activity to Teach/Learn Mathematics in Higher Education," in *2024 5th International Conference in Electronic Engineering, Information Technology & Education (EEITE)*, IEEE, May 2024, pp. 1–5. doi: 10.1109/EEITE61750.2024.10654423.