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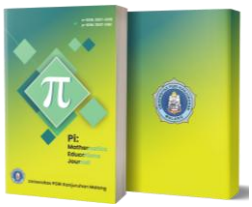

Development Realistic LKPD on Exponential Material to Improve Grade X Students' Ability to Think Critically

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ABSTRACT
The aim of this study is to produce realistic mathematics education (RME)-based learner worksheets (LKPD) on exponent material to improve critical thinking skills of grade X students that are valid, practical and effective. The method used is Research and Development (R&D) with the ADDIE model, which includes the stages of analysis, design, development, implementation and evaluation. The results showed that the realistic based LKPD on exponent material was very valid based on the results of expert validation with a score of 87.5%, the practicality of realistic-based LKPD learning media was considered practical based on teacher and student responses with a score of 79.7%. In addition, its effectiveness can be seen from the increase in student learning outcomes with an average post-test score of 85.38%. The statistical test results show a significance value of 0.001 (two-tailed), indicating a significant difference between the pre-test and post-test results. Therefore, it can be concluded that the development of realistic-based worksheets improves students' critical thinking skills. The Realistic Mathematics Education approach links mathematical concepts to real-life situations, motivating students and helping them to understand exponential material more deeply. This study makes a valuable contribution to mathematics education by improving students' analytical and reasoning skills and facilitating a more meaningful, contextualised learning of exponents.

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1. Introduction

According to Ki Hajar Dewantara, education is an effort to guide and direct the potential of children's nature. This means seeing children as individuals with their own unique abilities and characteristics. According to [1], Article 3, Paragraph 1 of the 2009 Minister of Education Regulation No. 70 stipulates that every student has the right to inclusive education tailored to their individual needs and abilities. As [2] argues, education should not be an activity that limits or forces children to submit to certain rules; rather, it should act as a companion that respects the natural process of their growth and development. This principle establishes education as a flexible process that adapts to the developmental stages of children in accordance with their nature. Education is defined as a conscious and planned effort to create an atmosphere and process of learning that allows

students to actively develop their potential [3]. The intention is for children to develop mental strength, self-control, intelligence, noble character and beneficial abilities for themselves, others, society and the state. This aligns with [4] view that the purpose of education is to enable children to develop into well-rounded individuals who can contribute to society and achieve the highest degree of security and happiness.

Education consists of several levels, all of which incorporate mathematics learning. Mathematics is one of the disciplines that has always developed alongside human demands for technology. Mathematics needs to be taught from elementary school through to high school in order to develop group cooperation skills and the ability to think logically, analytically, methodically, critically and creatively[5], [6]. [7]lso state that, even at kindergarten or early childhood education level, students are guided in their approach to mathematics through the learning process at school, equipping them with the ability to think critically, objectively, logically and carefully. One of mathematics' characteristics is its relationship with abstract objects [8]. Therefore, mathematics always relies on reasoning in the educational process. Furthermore, the benefits of learning mathematics continue to be utilised in various aspects of everyday life.

Critical thinking ability is defined as a person's skill in solving problems effectively through the use of reasoning, and it also aids the processes of analysis, evaluation and decision-making regarding beliefs or actions [9]. According to Facione, critical thinking involves four main abilities: interpretation, analysis, judgement and inference. These include the capacity to understand the significance and reliability of data, analyse relationships between concepts, and reach logical conclusions. Critical thinking is a higher-order thinking ability that is important to develop when studying mathematics. This is in accordance with [10] assertion that critical thinking is one of the crucial abilities that children must have to deal with various problems, especially when studying mathematics. However, critical thinking skills among Indonesian students are still low. According to [11] one of the problems that often arises in the Indonesian education system is students' low critical thinking skills. [12] found that low student scores indicate the need for studies related to improving learning outcomes, one way being through developing critical thinking skills. This is because an increase in critical thinking skills is expected to lead to better learning outcomes.

It is very important to utilise learning media in order to overcome low critical thinking skills in learning. According to [13] one way to help students quickly understand the material is to use learning media. Media serve to convey messages that can stimulate students' attention, interest, thoughts and feelings, thereby supporting the achievement of learning objectives. [14] expressed the opinion that learning media are one of the external factors that play a role in supporting critical thinking. Using learning media can help teachers deliver material in the classroom more effectively. In line with [15] opinion, the use of learning media can increase students' motivation to participate in discussions and complete assignments, making the learning process more effective and efficient. It also helps teachers deliver material in a more focused manner. Students also benefit from learning media because it increases their understanding of the material taught and encourages optimal learning outcomes. One type of learning media that can be used is LKPD.

The Learner Worksheet (LKPD) method is expected to increase students' interest in mathematics and help them understand the subject matter and solve practice problems [16]. Planned, organised and careful learning activities using LKPD can help students develop a deeper understanding of the concepts they are learning, making it an effective learning alternative. LKPDs often consist of worksheets with tasks for students to complete. These

tasks should explicitly explain the basic competencies to be achieved, and the activity sheets usually take the form of instructions or stages for completing the tasks [17]. The goal of incorporating LKPD into the learning process is to improve and support the achievement of curriculum indicators and competencies. The LKPD is also expected to support teachers in conveying knowledge and encouraging active student participation in the learning process [8].

Based on interviews with mathematics teachers at MA Al Khoirot, it was found that around 80% of students had not achieved the minimum passing grade (KKM) for exponents, this is due to some students perceiving mathematics as a difficult and confusing subject. In line with the views of [16] many students find mathematics meaningless because they feel it involves too many calculations and complicated formulas, requiring high analytical skills. Observations revealed that students relied solely on LKS and teacher explanations. The content of the LKS on exponents was limited, making it difficult for teachers to provide in-depth explanations of the concepts. Additionally, the absence of contextual examples in the form of pictures rendered the learning process less effective. Many students found the concepts difficult to understand because they were presented only in numbers, without being related to everyday situations. Real problems faced by students include difficulty in applying exponential concepts to solve story problems, an inability to understand the meaning of exponents and roots in real contexts, and a tendency to memorise formulas without understanding their meaning. Meanwhile, only a small number of students were able to understand the material well. The exercises are still abstract and monotonous, causing students to lose interest quickly and struggle to answer questions correctly.

As stated by [18] exponent material is one of the most important topics in mathematics because it is a prerequisite for learning various other mathematical topics, such as algebra, calculus, and trigonometry. However, given that the subject matter is explained in the form of numbers, some students may find it difficult to understand.

According to [19], ealistic mathematics is a technique that uses situations which students can imagine because they are related to everyday life. This means that mathematics learning should always involve everyday problems. Realistic Mathematics Education (RME) is a learning strategy that emphasises the importance of active student participation in the learning process, enabling students to discover the topics they are studying for themselves. The active participation of students in the learning process is one of the basic principles of RME. Students should have the opportunity to develop their own knowledge and understanding [20]. Therefore, it can be said that RME learning materials utilise real-world problems to motivate students to engage in active learning.

Research by [3] into the development of LKPD using a realistic mathematics approach states that RME can be used to create useful worksheets to assist the learning process. RME-based LKPD development concretely connects material concepts with real life [8] By incorporating everyday life factors, this approach motivates students and increases their engagement in learning. It also facilitates an understanding of the material, helping students to truly grasp the lesson rather than just a formula. Students can also see how mathematics is used in everyday life, which makes it more relevant and relatable.

The development of a realistic, mathematics-based LKPD was previously carried out by [8] under the title 'Development of LKPD through the Realistic Mathematics Education Model on Fraction Material for Grade IV Elementary School Students'. This research differs from previous studies in that it focuses on the development of realistic mathematics-based LKPD on exponent material to improve the critical thinking of grade X students.

Against this background, researchers are interested in developing a Realistic Mathematics Education (RME)-based mathematics LKPD on exponent material to improve the critical thinking skills of Grade X students. This study aims to create valid, practical and effective RME-based student worksheets on exponents to help students understand the concept contextually and develop their mathematical critical thinking skills.

2. Methods

This research, conducted at MA Al Khoirot on 12 December 2024, aimed to create Student Worksheets (LKPD) for Year 10 students based on a realistic approach to exponential material. A total of 23 students participated in the study. Convenience sampling was used for this research. Convenience sampling, a technique based on ease of access to research subjects, was used to select the sample. This method was chosen because it enabled the researcher to contact participants more easily according to their availability. This aligns with Alsya Salwa [21] view that convenience sampling is based on considerations of convenience, whereby individuals are selected as research respondents because they are available at the time and place of the study. The research used an R&D approach, incorporating ADDIE. According to research by [22] and [23] the R&D method is a research approach used to design a particular product and evaluate its usefulness and productivity in education. The ADDIE model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The end result is teaching materials in the form of LKPD on exponential material for mathematics lessons. The following are the ADDIE models:

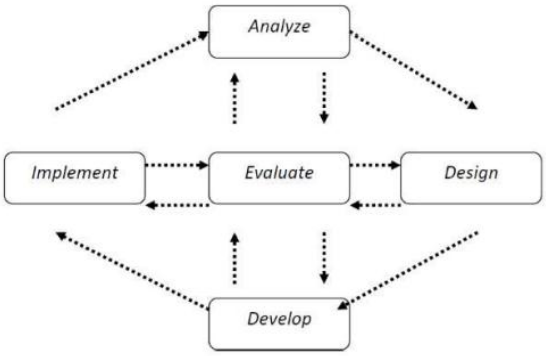


Figure 1: ADDIE Model
(Jurnal Cendekia : Jurnal Pendidikan Matematika [24])

Data was collected using expert validation, teacher and student questionnaires, and student initial and final tests. The feasibility of LKPD in terms of both theory and media is evaluated through expert validation. Following the declaration of the LKPD's feasibility based on the validation results, it was tested on students. This was carried out by mathematics lecturers at Al Qolam University in Malang, who are experts in mathematics and learning media. After conducting the validation assessment, the results were analysed by calculating the percentage of assessment scores using a specific formula to determine the level of product validity. The percentage of assessment results is calculated using the following formula:

$$\text{Percentage Score} = \frac{Total\ Score\ Obtained}{Maximum\ Score} \times 100\%$$

Table 1. Validity percentage criteria [17]

No	Percentage	Category
1	$75\% < Score \leq 100\%$	Very valid
2	$50\% < Score \leq 75\%$	Valid
3	$25\% < Score \leq 50\%$	Not Valid
4	$0\% \leq Score \leq 25\%$	Very Invalid

Teacher and student questionnaires were used to assess the practicality of the LKPDs in supporting mathematics learning.

Table 2. Practicality Indicators

No	Practicality Aspects	Indicator
1.	Kemudahan Penggunaan	1. Used by individuals and groups. 2. Clear instructions 3. Useful.
2.	Efisiensi Waktu Daya Tarik	1. In accordance with the allocated time. 2. Contextual problems 3. Attractive design and ease of understanding.
3.	Ekivalensi LKPD	1. Relevant material for learning resources. 2. Can be used as an alternative teaching material.
4.	Kemudahan Dipahami	1. Leading to contextual problems. Not difficult, not easy. 2. Simple language
5.	Manfaat LKPD	1. Helping to solve problems. 2. Understanding the material. 3. Getting used to thinking, asking questions and engaging in discussion.

All questionnaires were categorised according to the following four assessment criteria: 1) Disagree, 2) Disagree Less, 3) Agree, and 4) Strongly Agree. Questionnaire data were calculated to obtain the percentage of assessment results, using the following formula:

$$\text{Percentage Score} = \frac{Total\ Score\ Obtained}{Maximum\ Score} \times 100\%$$

Table 3. Practical Percentage Criteria [17]

No	Percentage	Category
1	$85\% < Score \leq 100\%$	Very Practical
2	$75\% < Score \leq 85\%$	Practical
3	$59\% < Score \leq 75\%$	Quite Practical
4	$54 < Score \leq 59\%$	Less Practical
5	$0 \leq Score \leq 54$	Very Less Practical

To evaluate the effectiveness of the teaching materials for realistic, mathematics-based LKPD in the classroom, students complete pre- and post-test questions validated by expert lecturers. The Paired Samples T-test is a statistical technique that can be used to evaluate the effectiveness of the LKPD development process. This technique compares two measurement values from the same individual. It is used to ascertain whether the observed difference is significant or the result of chance. After applying the LKPD approach, a paired samples t-test can be used to examine whether there has been a statistically significant improvement in students' critical thinking skills [25].

1. If Sig. (2-tailed) < 0.05, then the pre-test and post-test data are significantly different.

2. If Sig. (2-tailed) > 0.05, then the pre-test and post-test data are not significantly different.

3. Result And Discussion

3.1 Research Results

The main objective of this development is to create LKPD (Learning Knowledge and Problem-Solving Development) material on exponents, a type of mathematics learning resource based on a realistic mathematics approach. The final result of this research is a realistic mathematics-based LKPD for Class X, with an emphasis on exponent content, created using the ADDIE approach. The following are specific details about the results of each stage of the research and development.

1. Analysis

The analysis stage was conducted to identify fundamental problems in mathematics learning, particularly with regard to exponents. Interviews with mathematics teachers at MA Al-Khoirot revealed that many students found mathematics difficult to understand. This was due to some students assuming that mathematics was a difficult subject. This aligns with the view of [16] who stated that some students find mathematics difficult and meaningless due to its reliance on complicated calculations and formulas that require significant memory and analytical abilities.

One of the most challenging topics is exponents, which covers not only the concept of multiplication, but also root forms, equations and exponential inequalities. Based on observations, it was found that most students relied solely on workbooks and teachers' explanations. However, the exponent material in the workbooks was limited, which made it difficult for teachers to explain the concepts in depth. Additionally, the lack of illustrations or visual representations rendered the delivery of the material less effective. Many students find it difficult to understand concepts presented only in numerical form, although a small number are able to do so. The available practice questions also tend to be monotonous and lack variety, causing students to quickly lose interest in learning.

Based on semi-structured interviews with mathematics teachers, the following statement was obtained: “Most students are still confused about the difference between exponents and roots. They often memorise formulas without understanding how to apply them to real-life situations.” Field observations also revealed that approximately 80% of students did not achieve the minimum passing grade (KKM) for exponents. In addition, interviews with students reinforced these findings. One student said, 'If I just look at the numbers in the book, I find it hard to understand what they mean. But if there are examples or problems related to everyday life, it's easier to understand.' This situation highlights the need for more contextualised, interactive learning materials. In terms of facilities, MA Al-Khoirot already has a projector, internet access and a basic computer laboratory. However, these facilities have not yet been utilised to their full potential for mathematics learning.

Based on these findings, it can be concluded that mathematics learning at MA Al-Khoirot remains abstract and lacks context. Therefore, developing student worksheets based on Realistic Mathematics Education (RME), supported by digital elements, would help students to understand exponential concepts through real, interesting and interactive learning experiences.

2. Design

The design stage involved designing the structure and content of the LKPD based on the Realistic Mathematics Education (RME) approach to exponential material, in accordance with the needs of students and the learning objectives. At this stage, the researcher compiled the components of the LKPD, consisting of six main parts: (1) a cover page and

student details, (2) learning objectives and competencies to be achieved, (3) a summary of the exponent material covered, (4) contextual, problem-based learning activities, (5) exercises to reinforce concepts, and (6) reflection sheets for students. Each section is designed to integrate with the others and guide students in their understanding of the concept of exponents through real and meaningful learning experiences.

The application of the principles of Realistic Mathematics Education in the design of student worksheets is based on Gravemeijer's (1994) theory, which sets out three key principles [26]:

a. Guided Reinvention: Students are given the opportunity to discover concepts, definitions or solutions for themselves by solving contextualised problems using various strategies.
b. Didactical phenomenology: teachers emphasise real-world contexts or situations that students can relate to in order to introduce new mathematical concepts.
c. Self-developed models: Students are encouraged to develop models of representation according to their own way of thinking when solving problems.

In addition, at this design stage, the researchers also referred to the critical thinking indicators proposed by Facione: interpretation, analysis, evaluation and inference[27]. These four indicators were chosen because they are the most relevant to mathematics learning at senior high school level, and can be observed through problem-solving activities.

a. 'Interpretation' helps students to understand the information and context of exponential problems accurately.
b. Analysis helps students to describe the relationships between the concepts of exponents, roots and the properties of exponents.
c. Evaluation emphasises the ability to assess the accuracy of problem-solving strategies and results.
d. Inference trains students to draw logical conclusions from the results of their analysis and calculations.

These four indicators were chosen because they directly support the study's main objective: to develop an RME-based LKPD that is valid, practical and effective and capable of improving students' critical thinking skills. Thus, this design stage ensures that each element of the LKPD functions as both a learning guide and a means of building students' conceptual understanding and higher-order thinking skills through realistic and interesting contexts.

3. Development

The development stage involves compiling and refining the LKPD based on the initial design and Realistic Mathematics Education (RME). At this stage, researchers begin developing the LKPD according to the results of previous analyses and designs. The initial LKPD product is then validated by experts to ensure the suitability of the content, language and appearance, and conformity with learning objectives.

In this study, the validator was Mrs Ucik Fitri Handayani, a lecturer in mathematics education and learning media at Al-Qolam University in Malang. She assessed the suitability of the LKPD content with respect to realistic learning principles, the accuracy of the exponent material and whether activities aligned with the critical thinking indicators to be developed.

The aspects and indicators of the validation instrument are presented in the following table. This study uses four assessment criteria: content completeness, language, materials and E-LKPD design. Each aspect has achievement indicators that are used to evaluate the product's overall quality.

Table 4. validation indicators [28]

No	Validation Aspects	Indicator
1.	Completeness of LKPD	1. Reporting material clarity 2. Layout arrangement
2.	Laguage	1. The appropriateness of the language used in accordance with the EYD. 2. Sentence structure should be simple. 3. The clarity of instructions and directions. 4. Sentences do not have double meanings.
3.	Content	1. The suitability of e-LKPD for students' needs. 2. Its effectiveness as a learning tool.
4.	Design	1. The layout of the LKPD cover is harmonious. 2. The attractive font is easy to read. 3. The layout of the title and illustrations on each page is consistent. 4. There are not too many font types used.

The realistic LKPD media resulting from this process are included in the 'very valid' category, based on the validation results which obtained a percentage score of 87.5%. The following table shows the validation results and recommendations from the validators:

Table 5. Validator Results

No	Validation Aspects	Total score
1.	Completeness of LKPD	4
2.	Content	45
3.	language	11
4.	Design	24
Score		84
Presentase Score		87,5%

Table 6. Validator Suggestions

No	Expert Recommendations Validation
1	Cognitive assessment rubric only, no need for attitudes. Focus the rubric on how to assess students' responses.
2	For the assessment rubric, since the focus is on critical thinking, there is no need to add other skills.

The table below displays the learning media's end outcomes:

Table 7. Learning media of realistic LKPD

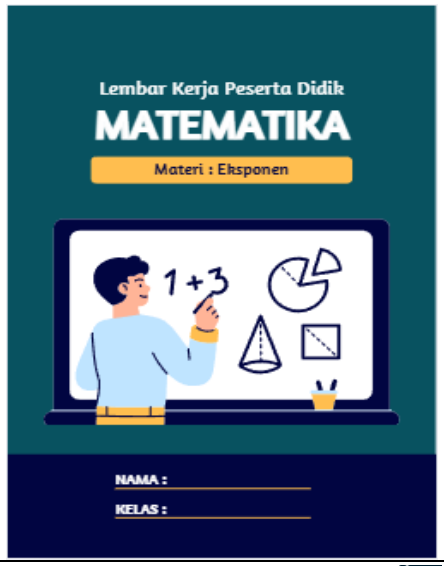
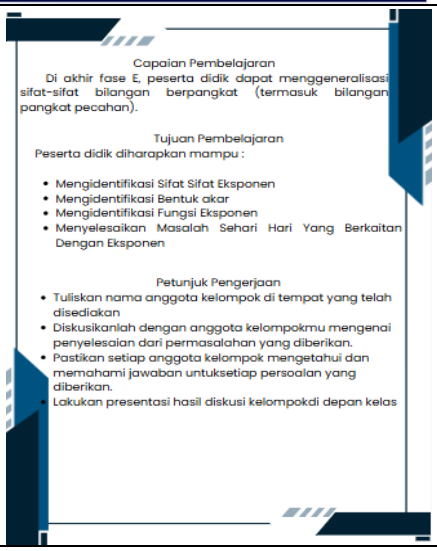
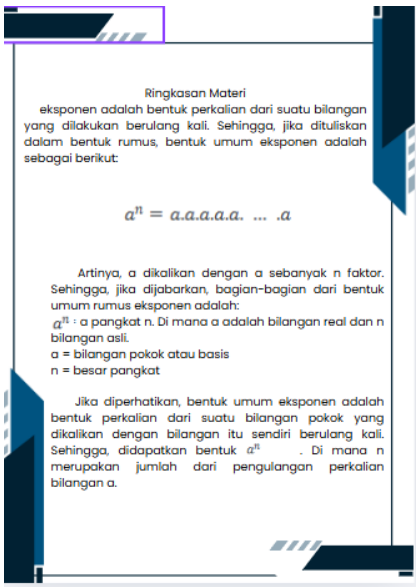
No	Image	Description
		**Figure 2. The Cover of The Realistic Based Maths LKPD**
		**Figure 3. Learning Outcomes, Learning Objectives and Instructions For Working on The Realistic Mathematics LKPD**
		**Figure 4. Grade X Exponent Material Summary**

Figure 5. Illustration of Realistic Maths Learning and Examples of Realistic Maths Problems

4. Implementation

The implementation stage involved the application of RME-based LKPD to assess its feasibility and practicality. The trial was conducted at MA Al Khoirot, Karangsuko, Pagelaran, Malang, on 12 December 2024, involving 13 Grade X students in two learning sessions (2 x 45 minutes) on the topic of exponents. The teacher began the lesson by explaining the learning objectives and emphasising the importance of understanding exponents in everyday life. Acting as a facilitator, the teacher guided group activities and ensured that students understood the worksheet instructions. The lesson consisted of three main stages: introduction, core activities, and reflection. Based on classroom observations and interviews, students showed increased enthusiasm and active participation. One student stated, 'Learning feels easier because the questions are related to real-life situations, so they are easier to understand.' Teachers also provided positive feedback, stating that the worksheets encouraged collaborative learning and helped students connect abstract mathematical concepts to real-world contexts. Despite some minor challenges, such as limited time to complete all activities and limited digital devices, RME-based LKPD is effective in encouraging active learning, conceptual understanding, and critical thinking about exponents.

After completing the worksheet questions prepared by the researcher, students were asked to assess the effectiveness of the teaching materials. Students were also asked to complete a questionnaire to assess the product developed. The researcher then analysed the obtained data to determine the level of effectiveness and practicality of the LKPD. The practicality scores are presented in the following table.

Table 8. Practicality Score

No	Questionnaire	Assessment	Score	Description
1	Student Response Questionnaire	Practicality	80,19 %	Practical
2	Teacher Response Questionnaire		78,5 %	Practical
Average			79,7 %	Practical

Based on the results of the response questionnaire filled by students and mathematics teachers of class X MA Al Khoirot, the learning media of realistic mathematics based LKPD is considered practical and can be used in the learning process with a score of 79.7%. Meanwhile, to see the effectiveness of realistic mathematics-based LKPD learning media seen from the students' pretest and posttest scores.

The pretest and posttest results are described in the data distribution table below:

Table 9. Deployment

	Pretest	***Protest***
Mean	61,92	85,38
Nilai Max	70	100
Nilai Min	50	75

The average pretest score is 61.92, and the average posttest score is 85.38, according to Table 7 of the pretest and posttest data above. The learning media for realistic mathematics based LKPD is considered effective in teaching mathematics because the data above shows that the difference in student learning outcomes using this approach is that there is an increase in learning, which is evident in the difference in the average pretest and posttest scores.

Additionally, the following figure shows the association between pretest and posttest scores following learning with realistic LKPD.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	61.92	13	6.934	1.923
	Post Test	85.38	13	9.233	2.561

Figure 6. Paired Sample Statistics SPSS

The statistical results of the pretest and posttest are displayed to us based on the output in Figure 5. There were 13 responders, and the average scores for the pretest and posttest were 61.92 and 85.38, respectively, for the standard. The posttest deviation is 9.233 and the standard deviation is 6.934 on the pretest. Error The pretest mean is 1.923, and the posttest mean is 2.561. There is an average difference between the pretest and posttest findings because the pretest mean value of 61.92 < posttest mean of 85.38.

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Pre Test - Post Test	-23.462	7.742	2.147	-28.140	-18.783	-10.927	12	<,001	<,001

Figure 7. SPSS Paired Samples Test Results

There is a difference between the pretest and posttest scores, according to the paired sample T-test findings, which show that the Sig. (2-tailed) value of the first significance of 0.001 and the second significance of 0.001 < 0.05. Therefore, it can be said that the realistic LKPD that was produced for the exponent material is effective

5. Evaluation

The evaluation stage involved a thorough reflection on each step taken in developing a realistic, mathematics-based LKPD framework. During the analysis stage, it was found that most students struggled to understand the exponent material because it tended to be presented numerically, without illustrations or real-life examples. This finding was important for designing more contextualised learning materials.

Furthermore, the LKPD framework is designed at the planning stage with the needs of students and teachers in mind, from the cover and learning outcomes to the objectives and contextual problem-based questions. The design aims to improve students' understanding of abstract material by taking a more realistic approach.

During the development stage, the designed media is developed and validated by experts. Based on the validators' feedback, several aspects were improved, including the completeness of the material, the presentation of illustrations and the language used. The development process runs in stages until the media meets the criteria for excellent validity.

Implementation was carried out through trials in Class X at MA Al Khoirot, where the LKPD approach was used in the learning process. The results of the trial showed a significant improvement in student learning outcomes, as evidenced by the difference in pre- and post-test scores. Additionally, the results of the student and teacher response questionnaires showed that LKPD was considered a practical approach.

A final evaluation of all stages shows that the development of realistic, mathematics-based LKPD using the ADDIE model went according to plan, producing valid, practical and effective learning media. Each stage, from the initial needs analysis to the final field trials, contributed positively to improving the final product.

3.2 Discussion

The development of mathematics learning media in the form of realistic mathematics-based LKPD for grade X students with exponent material was carried out at MA Al Khoirot with 13 students. The development of RME-based LKPD is learning that concretely connects material concepts with real life [8]. The five stages of the ADDIE model analysis, design, development, implementation, and evaluation—are followed in the process of creating the RME-based LKPD under study [29] stated that the ADDIE model, which comprises the following steps: 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation, is followed by the development stages.

LKPD is a task sheet to be completed by students, usually containing instructions or steps to complete the task [19]. In mathematics learning, the application of LKPD is expected to support students in developing their understanding independently or in groups by utilizing the knowledge they have gained from previously learned material, this is in line with his opinion [30] that realistic LKPD can also develop students' understanding because the realistic approach to mathematics education in LKPD starts with understanding contextual problems, namely problems related to everyday life. The teacher gives this problem to the students and encourages them to solve it by providing motivation. Students are then asked to discuss and compare their answers with their friends. At the end of the lesson, the students and the teacher jointly conclude the learning outcomes. This approach is favored by students because it not only actively involves them, but can also enhance their creativity.

In addition, the outcomes of the students' validation of realistic LKPD revealed a percentage score of 87.5%, indicating that the created realistic LKPD media falls into the very valid category. The validation results show that the graphic design aspect received the highest score, as the LKPD layout was considered attractive, proportional and easy for students to understand. This demonstrates that an appealing visual presentation can stimulate interest in learning and facilitate students' comprehension of the LKPD content.

Meanwhile, the language aspect received a lower score because some sentences needed to be simplified for greater clarity. In terms of practicality, a score of 79.7% was obtained from the teacher response survey responses, putting it in the area of practical. This is consistent with research on the usefulness and practicality of learning materials using Adobe Flash Player by [31] which found that practicality is linked to how easy it is for students and teachers to utilize educational resources, which can foster a meaningful, engaging, enjoyable learning process and foster creativity, is consistent with the study carried out by [32] wherein the LKPD for mathematics based on Realistic Mathematics Education (RME) is claimed to be practical in a number of ways, including ease of use, time efficiency, advantages experienced while using the program, and compatibility with other instructional resources. LKPD uses contextual problems such as compound interest calculations and population growth analysis to encourage students to think critically in real-life contexts.

On the other hand, the average posttest score of students for the effectiveness component was 85.38%, indicating an increase in learning through the application of realistic mathematics-based LKPD teaching materials. This shows the effectiveness of the media in the educational process. Based on the Paired Sample T-Test findings, it is known that the scores on the pretest and posttest vary based on the Sig. (2-tailed) value, the first significance is 0.001 and the second significance is 0.001 <0.05. Thus, it can be said that the realistic LKPD on the resulting exponent material is effective. This opinion is consistent with the research conducted by [33] on the creation of learning materials to enhance student learning outcomes, which claims that learning materials can enhance students' comprehension and facilitate the more effective and efficient attainment of educational objectives. However, this study has several limitations. The sample size was small, comprising just 13 students from MA Al Khoirot, meaning the results cannot be generalised to a wider population. Additionally, the study only covered exponential material. Future research should involve a larger number of participants and develop digital RME-based worksheets to make learning more interactive and applicable to other materials.

3. Conclussion

This study used the ADDIE development process, consisting of the stages of analysis, design, development, implementation and evaluation, to create an effective Learner Workbook (LKPD) on exponent material based on Realistic Mathematics Education (RME). With a practicality score of 79.7%, based on responses from students and teachers, the results of the implementation show that this resource is effective in improving students' understanding of the topic. Expert validation shows that this LKPD is highly feasible for learning, with a score of 87.5%. Additionally, the LKPD obtained an average post-test score of 85.38, indicating its effectiveness. Based on pre- and post-test assessments, and with a Sig. (2-tailed) value of 0.001< 0,05 for both the first and second significance, it can be concluded that this media is effective and can improve students' critical thinking skills. By incorporating real-life contexts, students are able to understand mathematical concepts more deeply and apply their knowledge to solve contextual problems. Furthermore, this LKPD contributes to training students' critical thinking skills, which are important in 21st-century education. Similar RME-based LKPD could be developed for other mathematical topics or educational levels in future research. Long-term studies could also be conducted to examine the long-lasting impact of RME-based LKPD on students' critical thinking skills and motivation to learn.

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