

Development of A Mathematics E-LKPD Integrated With Realistic Mathematics Education (RME) To Improve Students' Critical Thinking Skills

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ABSTRACT

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Technological advances have developed rapidly in various sectors, including education, one form of which is the use of computer technology to support the creation of learning media. This study aims to develop a student worksheet in electronic form (E-LKPD) using the Realistic Mathematics Education (RME) approach, particularly on statistics material for grade VIII junior high school, and to examine its validity and effectiveness, as well as to assess its feasibility and students' responses toward the E-LKPD. The development model used was 4-D (Define, Design, Develop, Disseminate). This research involved 15 students of grade VIII-2 at SMP Muhammadiyah 02 Medan as subjects. The research instruments consisted of assessment questionnaires completed by material experts, media experts, and a student response questionnaire. The results showed that the developed RME-integrated E-LKPD obtained: 1) a media expert validation score of 93%, categorized as very valid; 2) a material expert validation score of 87%, categorized as very good/very valid; 3) a student response score of 86%, categorized as very interesting; and 4) an improvement in learning outcomes from a pretest average of 67% to a posttest average of 86.66%. These findings indicate that the E-LKPD product developed is valid and feasible to be used as teaching material in mathematics learning.

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INTRODUCTION

The learning process under the Kurikulum Merdeka (Independence Curriculum) positions students as active subjects who develop knowledge, thinking skills, and psychomotor skills through direct interaction with learning resources. This curriculum encourages learning that is more contextual and relevant to real life, so that students are expected to be able to study various concepts and apply them in solving problems, both simple and complex. Mathematics, as a subject that studies the logic of shapes, structures, sizes, and interrelated concepts, plays an important role in training this ability,

so that the teaching materials used in class need to be designed to stimulate students to think deeply, rather than merely memorizing procedures.

Critical thinking skill is one of the essential competencies students must possess, namely the ability to analyze, evaluate, and draw conclusions from information objectively and logically in order to find varied solutions to a mathematical problem. In reality, however, this ability remains a persistent problem in the field. Andriadi, Fitriani, & Suhandri (2018) found that students tend to solve problems only using the formulas available in their textbooks, while Putri, Munzir, & Abidin (2019) reported that students generally can only solve problems in one way and have not yet been able to use different solving approaches. This condition indicates that the mathematics learning process still focuses on memorizing formulas and procedures, causing students to experience difficulty in understanding concepts in depth. interactive learning experiences.

Observations and interviews conducted at SMP Muhammadiyah 02 Medan showed that mathematics learning is still formal in nature and relies mainly on printed worksheets (LKS) or textbooks as the main teaching materials, while the use of electronic teaching materials remains very limited. In fact, the use of electronic student worksheets (E-LKPD) can engage students more actively, provide access anytime and anywhere, and take advantage of students' interest in gadgets for learning purposes. Development research on E-LKPD based on contextual and STEM approaches has been shown to improve students' creative thinking skills and mathematics learning outcomes (Subakti, Marzal, & Hsb, 2021), so that developing an E-LKPD with an appropriate approach has great potential to also improve critical thinking skills.

One approach relevant to statistics learning for improving students' critical thinking skills is Realistic Mathematics Education (RME). RME is an approach that views mathematics as a human activity and emphasizes the connection between the material and students' everyday life contexts (Dani, Pujiastuti, & Sudiana, 2017; Septia, 2020). Through this approach, students are not only required to memorize formulas but are guided to discover and construct mathematical concepts themselves based on real experience, so that their critical and creative thinking skills can develop simultaneously. Compared with prior RME- and E-LKPD-based studies, which have mostly targeted creative thinking, mathematical reasoning, or problem-solving (Subakti, Marzal, & Hsb, 2021; Dani, Pujiastuti, & Sudiana, 2017), the contribution of the present study lies in designing the E-LKPD activities explicitly around critical thinking indicators and testing them directly within the statistics curriculum context of SMP Muhammadiyah 02 Medan.

Based on these problems, this study aims to develop a mathematics E-LKPD integrated with RME on statistics material (mean, median, and mode) for eighth-grade junior high school students, as well as to determine the validity, practicality, and effectiveness of the developed product in improving students' critical thinking skills.

RESEARCH METHOD

This study is a development research (Research and Development/R&D) aimed at producing a mathematics E-LKPD integrated with RME to improve students' critical thinking skills on statistics material. The development model used was the 4-D model, consisting of four stages: Define, Design, Develop, and Disseminate. methods.

The study was conducted at SMP Muhammadiyah 02 Medan during the even semester of the 2025 academic year. The research subjects were 15 students of class VIII-2, while the research object was the RME-integrated electronic mathematics E-LKPD on statistics material. This limited number of subjects corresponds to a small-scale, single-class field try-out consistent with the try-out stage of the 4-D model; the findings should therefore be read as preliminary evidence of the product's feasibility rather than as generalizable conclusions, and further studies involving larger and more varied samples are needed to confirm its effectiveness.

In the Define stage, a front-end analysis, learner characteristics analysis, curriculum analysis, task analysis, and specification of learning objectives were carried out. The Design stage included collecting materials/references on statistics, selecting the media, selecting the format, and preparing the initial design of the E-LKPD in the form of an interactive flipbook containing a summary of the material, links to instructional videos, sample problems, and exercises arranged according to the RME syntax (understanding the contextual problem, explaining the contextual problem, solving the contextual problem, comparing and discussing answers, and drawing conclusions). The Develop stage included product validation by media and material experts, revision based on validators' input, and a development try-out with a small group. The Disseminate stage was carried out by distributing the E-LKPD link through a WhatsApp group to mathematics teachers and grade VIII-2 students.

The research instruments consisted of a media expert validation questionnaire, a material expert validation questionnaire, and a student response questionnaire, each using a rating scale of 1 to 5. Students' critical thinking skills were measured using a written pretest and posttest of description (essay) questions on the mean, median, and mode material, developed with reference to critical thinking indicators — interpretation, analysis, evaluation, and inference (Ennis, 2011; Facione, 1990) — so that each item required students to interpret contextual data, analyze the relationship between concepts, evaluate the reasonableness of a solution, and draw a logical conclusion. Prior to use, the pretest-posttest instrument was reviewed together with the material expert validator to check its content validity and its alignment with the statistics learning indicators. The data obtained were analyzed using descriptive percentage techniques with the following formula:

$$\text{Persentase Kevalidan} = \frac{\text{Skor rata - rata yang diperoleh}}{\text{Skor yang diharapkan}} \times 100\%$$

The percentage results obtained were then interpreted based on the validity/practicality level criteria presented in Table 1.

Table 1. Validity and Practicality Level Criteria

No.	Percentage	Criteria
1.	85% - 100%	Very Valid / Very Interesting
2.	61% - 85%	Valid / Interesting
3.	41% - 60%	Fairly Valid / Fairly Interesting
4.	21% - 40%	Less Valid / Less Interesting
5.	0% - 20%	Not Valid / Not Interesting

Source: adapted from Roosyanti (2017).

RESULTS AND DISCUSSION

Discussion

E-LKPD Development Results

The product produced in this study is a mathematics E-LKPD integrated with Realistic Mathematics Education in the form of an interactive website/flipbook learning medium on statistics material for eighth-grade junior high school students. This E-LKPD contains a cover, instructions for use, the RME syntax and competency achievement indicators, a concept map, a summary of the material (mean, median, and mode), links to instructional videos on YouTube, sample problems, and student exercises/activities arranged according to the RME syntax. The E-LKPD can be accessed anytime and anywhere through the shared link, thereby providing learning flexibility for students. The appearance of the developed E-LKPD is presented in Figure 1.



Figure 1. Appearance of the RME-Integrated Mathematics E-LKPD

Expert Validation Results

Validation was carried out by three validators, namely two Mathematics Education lecturers as media and material experts, and one mathematics teacher from SMP Muhammadiyah 02 Medan as a media and material expert. The aspects assessed by the media expert included content and objective quality, instructional quality, and technical quality, while the aspects assessed by the material expert included content quality, language quality, and overall quality. The validation results are presented in Table 2.

Table 2. Results of Media and Material Expert Validation

Validation Aspect	Validator 1	Validator 2	Mean (%)	Criteria
Media Expert	90%	96%	93%	Very Valid
Material Expert	80%	94%	87%	Very Valid

Based on Table 2, the mean validation results were 93% for the media expert and 87% for the material expert, both of which fall into the "Very Valid" category. This result indicates that the developed RME-integrated mathematics E-LKPD is feasible for use as teaching material in mathematics learning, after revisions were made based on the validators' input and suggestions.

Student Response Results

The product try-out was conducted with 15 students of class VIII-2 over four meetings. At the final meeting, students were asked to fill in a response questionnaire regarding the E-LKPD that had been used. The questionnaire results showed an average score of 4.3 out of a maximum score of 5, equivalent to 86%, which falls into the "Very Interesting" category. As many as 14 of the 15 students rated the E-LKPD in the very interesting category, and one student rated it in the interesting category.

Students reported that the E-LKPD made the mathematics learning atmosphere more enjoyable and less boring, making it easier for them to understand the statistics material.

Student Learning Outcomes

To determine the effectiveness of the E-LKPD on learning outcomes, a pretest was administered before the use of the E-LKPD and a posttest after learning using the E-LKPD. The pretest and posttest results are presented in Table 3.

Table 3. Students' Pretest and Posttest Results

Category	Pretest	Posttest
Highest Score	80	100
Lowest Score	40	60
Average	67%	86.66%

Based on Table 3, the students' average score increased from 67% in the pretest to 86.66% in the posttest. This increase indicates that most students were able to understand the statistics material better after using the RME-integrated E-LKPD, although a few students still achieved scores that require further attention.

Discussion

The development of the RME-integrated mathematics E-LKPD in this study was carried out through four stages of the 4-D model. In the Define stage, the results of the needs analysis showed that students required electronic teaching materials that were more interactive than conventional printed worksheets, while also confirming the importance of the RME approach for bridging statistics material with the context of students' everyday lives. In the Design stage, the E-LKPD was designed with attention to the basic competencies and competency achievement indicators of grade VIII statistics material, then packaged in the form of a digital flipbook containing a concept map, a summary of the material, and exercises based on the RME syntax.

The validation results of the media expert (93%) and the material expert (87%), both in the very valid category, indicate that the developed E-LKPD has met the feasibility requirements in terms of presentation as well as material appropriateness. This finding is in line with the study of Subakti, Marzal, & Hsb (2021), which showed that a contextual approach-based E-LKPD can achieve a high level of validity and be used effectively in mathematics learning. It is also consistent with Lestari, Prahmana, Chong, & Shahrill (2023) and Samura, Darhim, Juandi, Said, Nani, & Tamur (2022), who similarly found that RME-based worksheets developed through a systematic validation process by

media and material experts obtained high validity scores prior to being tested for their effect on students' critical thinking skills, which supports the theoretical premise that a well-validated RME learning tool is a necessary precondition for critical thinking gains rather than a sufficient one by itself. In addition, the 86% student response score in the very interesting category strengthens the findings of Septia (2020) that RME-based mathematics teaching materials can increase students' interest and learning motivation.

The increase in learning outcomes from 67% in the pretest to 86.66% in the posttest indicates that the RME-integrated E-LKPD contributed to improving students' conceptual understanding and critical thinking skills. This is consistent with the characteristics of RME, which emphasize the process of guided reinvention of mathematical concepts through contextual problems, so that students do not merely memorize formulas but understand the relationships between the concepts of mean, median, and mode (Dani, Pujiastuti, & Sudiana, 2017). Examined against the critical thinking indicators underlying the pretest-posttest instrument, the gain suggests that students progressed most visibly in the interpretation and analysis of contextual statistical data, since the RME syntax explicitly requires students to understand and explain a contextual problem before solving it; the evaluation and inference indicators, which demand justifying the reasonableness of a solution and drawing a logical conclusion, are reflected less directly in an aggregate percentage score and would need item-level indicator analysis to confirm. This pattern is consistent with Lestari, Prahmana, Chong, & Shahrill (2023) and Febriyani, Habudin, & Rachmiati (2024), who likewise found that RME-based worksheets raise the lower-order components of critical/higher-order thinking (understanding and analyzing contextual information) more consistently than the higher-order components (evaluating and justifying a solution). It should also be noted that this trial involved only 15 students in a single class, so the improvement observed cannot yet be generalized beyond this context; a larger sample, a control group, and an indicator-by-indicator analysis of the critical thinking test would be needed to draw stronger causal conclusions about the E-LKPD's effect on each critical thinking indicator. Overall, the mathematics E-LKPD integrated with RME on statistics material is shown to be valid, practical, and to contribute to improving the critical thinking skills of grade VIII junior high school students, within the scope of this preliminary trial.

CONCLUSION

This development research produced a mathematics E-LKPD integrated with Realistic Mathematics Education (RME) on statistics material (mean, median, and mode) for grade VIII junior high school students, developed through the 4-D model (Define, Design, Develop, Disseminate). The validation results showed that the developed E-LKPD is in the very valid category, with a validation score of 93% from the media expert and 87% from the material expert. The student response results showed a score of 86% in the very interesting category, and students' learning outcomes improved from a

pretest average of 67% to a posttest average of 86.66%. Based on these findings, it can be concluded that the RME-integrated mathematics E-LKPD is valid, practical, and effective for use as teaching material to improve students' critical thinking skills on statistics material, within the scope of the 15 students involved in this single-class try-out. For mathematics teachers, this E-LKPD can be used as an alternative teaching material or a self-study reference for students, while future researchers are advised to test the product on a larger and more varied sample, include a comparison/control group, and analyze critical thinking gains per indicator, as well as to develop similar E-LKPD using other applications or different mathematics topics so that teaching materials become increasingly varied and engaging.

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