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Mobile-Based Realistic Mathematics Learning Design to Improve Students' Reasoning Ability and Problem-Solving Ability

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Abstract

Mathematical reasoning and problem-solving skills have become very necessary at this time. Students who do not have mathematical reasoning and problem-solving skills will have difficulty adapting to current technological advances. This study aims to design mobile-based mathematics learning to improve students' mathematical reasoning and problem-solving skills. The subjects of this study were junior high school students. The research method developed was ADDIE (Analysis, Design, Development, Implementation, Evaluation). The results of the study showed that improving students' mathematical reasoning skills had a very positive impact on students' mathematical problem-solving skills. These results provide additional contributions and references for mathematics teachers who want to add knowledge related to improving the quality of mathematics learning in the classroom.

Keywords: Mobile Learning, Mathematical Reasoning, Mathematical Problem Solving

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INTRODUCTION

The rapid development of mobile-based technology has now become an inseparable part of the mathematics learning process in the classroom. Teachers use many mobile-based applications in mathematics learning (Ferdiani et al., 2021; Luluk, 2019). This is a form of effort teachers present to support the creation of higher-quality mathematics learning. Teachers always try to show innovation by integrating mobile-based mathematics learning and the ability to teach students face-to-face at the same time (Alifah & Utami, 2022; Boekaerts et al., 1995). Realistic mobile-based mathematics learning allows students to access all material information and explanations more flexibly and interactively (Anne & Mangulabnan, 2013; Susanti & Hartono, 2019). Therefore, this study has a critical position in understanding how this mobile-based mathematics learning design can positively impact the development of students' abilities. Although mobile technology has been widely discussed, its application in realistic mathematics learning focusing on problem-solving and mathematical reasoning skills of junior high school students has not been widely studied. Facts on the ground show that many junior high school students still have difficulty understanding mathematical concepts more comprehensively and tend to be less skilled in applying their knowledge to solve real problems (Arsyad & Irawati, 2016; Dooren et al., 2013; Hadi & Rulviana, 2018). This shows the need for a more interactive and adaptive realistic mathematics learning method, which can provide opportunities for students to explore mathematical concepts that can be applied to help solve real problems (Barbieri & Booth, 2020; Yi & Na, 2020). The main challenge is how this research can design a practical and fun mobile platform to help students improve their mathematical reasoning and problem-solving skills (Ferdiani et al., 2021; Nyroos et al., 2015). This study aims to design and develop a mobile-based mathematics learning model to improve students' mathematical reasoning and problem-solving abilities (Barbieri & Booth, 2020; Ndiung et al., 2021; Purwanto, 2020). Before the platform design, this study must understand students' needs and obstacles in realistic mathematics learning. A good understanding of the needs of students and teachers will greatly assist researchers in developing this mobile-based mathematics learning. This study also needs to understand the technical obstacles often encountered by students when learning independently or in groups. With an in-depth analysis of the needs and technical obstacles faced, it is hoped that the development of mobile-based realistic mathematics learning can provide many opportunities for students to learn more interactively and independently to understand mathematical concepts more profoundly and applicatively.

METHODS

This study chose a development design with the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model (Mamolo, 2019). The analysis begins with the needs of students, teachers, mathematical problem-solving abilities, and students' mathematical reasoning abilities. The next stage is designing, which describes the stages of developing realistic mathematics learning that will be created. The design is adjusted to the needs analysis and research objectives to improve students' mathematical reasoning and problem-solving abilities. The development stage is carried out by changing the front end of the Figma application that has been created so that it can display something more realistic. The implementation stage is carried out together with teachers in the experimental class using the application that has been developed. The evaluation stage is an essential element in developing realistic mathematics learning, where the use of the application is evaluated in terms of substance and application.

This research was conducted in the odd semester of 2023-2024 in 3 high schools. Each school has six classes, 3 of which are experimental and three control classes. The number of students consists of 214 people, of which there are 45 female students and 157 male students. The research data analysis will be explained in detail in terms of the stages of ADDIE development: analysis, design, development, implementation, and evaluation. The stages of data analysis of mathematical reasoning and problem-solving abilities use a rubric that experts in Mathematics Education and Technology Education have validated. Experts will be asked to give a value ranging between 1 and 5 for each aspect assessed. The combined value between experts will be averaged, including not feasible (average <4.0), feasible (4.0 average value 4.5, and very feasible (average value> 4.5).

Two t-tests were conducted to evaluate the impact on mathematical reasoning and problem-solving abilities. The first test measured students' mathematical reasoning abilities and the second measured students' mathematical problem-solving abilities.

RESULTS & DISCUSSION

Analysis

The analysis stage begins by identifying two aspects, namely, the aspect of student needs and the aspect of the material to be taught. Students' needs start by identifying what they want to make the realistic mathematics learning process more enjoyable and of higher quality (Bintoro et al., 2021; Ferdiani et al., 2021). In collecting this analysis, researchers conducted semi-structured interviews to explore the conditions students want in the learning process. This semi-structured interview makes it easier for researchers to dig up all information from students more comprehensively, making it easier to design learning suitable for students. Based on the interview results, several things were obtained, including students wanting active interaction between teachers and students. The interaction between teachers and students is built through a more conducive learning environment by building students' self-confidence and motivation to learn. In addition, students desire to be motivated to solve different mathematical problems because most students feel that the given issues are not the same as those taught. This reflects the need for students to improve their mathematical reasoning and problem-solving abilities. After identifying the interview results, the researcher compiled the stages he wanted to build to achieve the main objectives of realistic mathematics learning in this context, namely improving mathematical reasoning and problem-solving skills. The researcher started by using indicators of students' mathematical reasoning skills, namely submitting hypotheses, manipulating mathematics, compiling evidence equipped with logical reasons, and concluding problems. Problem-solving skills were compiled using Polya indicators, namely understanding the problem, planning problem-solving, solving problems, and reviewing the results of the work that had been obtained. The researcher tried to elaborate on problem-solving and mathematical reasoning skills by compiling the stages of the learning process. The researcher started by looking for life problems that were very close to students but related to the material to be taught. This problem-collecting stage is fundamental because it is the entry point in compiling the desired learning process (Alim et al., 2016; Pramoda Wardhani & Oktiningrum, 2022). All the problems collected are then modified according to the needs to be achieved while still paying attention to the indicators that have been set. Several teachers and practitioners then read the modified math problems to provide input to be used more effectively and efficiently.

Design

The analysis results are used to design mobile-based learning. The analysis results greatly help the design team translate the learning stages into more real and appropriate ones. In design, the research team has three stages, including the readability of the analysis results, the platform design on Figma, and the revision of the design results. At the readability stage, the analysis results begin by reading carefully and understanding all stages of the learning process that will be included in the platform. The design team is given 1 week to read aspects that need confirmation and those that need further explanation. The readability of the learning design is essential because the design will adjust and improve the quality of interaction through Figma after getting the same understanding between the designer and the research team. The design team begins by determining the plate color used so that all design stages use the appropriate collaboration color. This is very important, considering that color significantly impacts building students' moods to learn. A well-designed application design will positively contribute to the quality of learning and student satisfaction. The design uses Figma to make it easier for developers to implement it in the code. Researchers have prepared various examples of mathematics learning designs to provide a sufficient overview.

Development

The development of a mobile-based platform begins with determining the color of the plate to be used. The Figma design is then converted into codes to be developed into an application. Researchers also integrated short videos and pre-test and post-test value analysis in this development. After this application has functioned well, researchers do not immediately provide it to students and teachers in the mathematics learning process.

Table 1. Media validation results

No	Aspects	Average Values	Criteria
1	Device Engineering	4,66	Very Worthy
2	Visual Display	4,78	Very Worthy

The assessment of media experts illustrates that the development of realistic mathematics learning meets the minimum criteria standards set. This application's ease of the realistic mathematics learning process is expected to meet the research needs to improve students' mathematical reasoning and problem-solving abilities.

Table 2. Validation of mathematicians

No	Aspect	Average Values	Criteria
1	Learning Design	4,31	Worthy
2	Software engineering	4,57	Very Worthy
3	Visual Display	4,58	Very Worthy
4	Functions for mathematical reasoning and mathematical problem-solving abilities	4,55	Very Worthy

Mathematics education experts provide significant input in learning design by changing several learning steps. Experts ask that learning design be given short videos inviting students to improve their mathematical reasoning and problem-solving abilities. Meanwhile, technology learning media experts provide suggestions for the ease of student interaction by adding the joined feature. These experts' advice provides significant input in helping the development of mobile-based mathematics learning.

Implementation

In implementing this research, I received an excellent response from teachers and students. This development invited students to consciously improve their problem-solving and mathematical reasoning skills simultaneously. Learning becomes more active, and many activities encourage students to think deeper so that the existence of teachers in the classroom changes into facilitators who facilitate students in the process of learning mathematics.

In measuring the extent of the impact this development's results can have. Implementation of learning in the classroom is carried out by measuring the extent to which students can improve their mathematical reasoning skills. Many experimental classes increased significantly, as shown in Table 3 below.

Table 3 Results of T-Test Scores for Mathematical Reasoning Ability

Class	Students Number	Average	Sig.	Keterangan
Eksperiment	85	88,56	0,0025	Sig. < 0,05
Control	85	72,25		

The results of mathematics learning on mathematical problem-solving abilities also increased significantly, as seen in the table 4.

Table 4 Results of T-Test Scores for Mathematical Problem-Solving Ability

Class	Students Number	Average	Sig.	Keterangan
Eksperiment	85	88,45	0,0045	Sig. < 0,05
Control	85	73,25		

Teachers' responses in learning that focus on mathematical reasoning and problem-solving skills are very beneficial. Teachers' positive response to the application's ease of use is also constructive.

Evaluation

Evaluating the extent of the positive impact of mathematics learning in the classroom is measured by considering the assessment and survey aspects. The assessment will provide a comprehensive picture of students' mathematical reasoning and problem-solving abilities (Luluk, 2019; Purwanto, 2020; Son et al., 2020). Students in the experimental class were very enthusiastic about undergoing mathematics learning in the classroom. This student enthusiasm is also reflected in the value data obtained by students.

Meanwhile, student satisfaction in mathematics learning will be measured with a standard between very unsatisfactory and very satisfying. The majority of students gave very positive responses to mobile-based mathematics learning. This also aligns with several studies that have positively contributed to the mobile-based learning process. The shift in students' lives, which are very close to cell phones, has changed students' perspectives on learning.

CONCLUSION

Mathematics learning design that is designed and considered in all stages will improve students' mathematical reasoning and problem-solving abilities. This learning design encourages students to be more active in learning in groups to equalize students' reasoning with each other. Students' activeness in group discussions is seen when students make hypotheses supported by students' ability to provide logical reasons for their statements. Each student gives an opinion and strengthens points that have similarities. In the discussion, the entire group concludes the solution to the problem supported by appropriate mathematical concepts. This shows that students' mathematical reasoning abilities have increased. In solving problems, students are seen to be able to manage all information that can be used to solve problems. Students learn to make plans and submit hypotheses through problem-solving. Students freely and actively respond to other students' statements by providing logical and mathematical reasons. The interaction in this learning process illustrates how students can improve their mathematical problem-solving and reasoning abilities. The student's hypothesis, supported by the correct information, reinforces that students' problem-solving and mathematical reasoning have improved—the limitations of time and materials delivered with this learning design challenge future research. Future research must also design this mobile-based mathematics learning in other mathematics materials. The success of this mobile-based learning process allows it to contribute to other materials. Further research also needs to consider using a more comprehensive range of students to test the effectiveness of this mobile-based learning design.

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