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Research Article

Design of Realistic Mathematics Education Based Student Worksheets to Improve Students' Mathematical Problem-Solving Skills

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ABSTRACT
This study focuses on the design and development of student worksheets based on Realistic Mathematics Education (RME) principles aimed at enhancing students' mathematical problem-solving skills. The research adopts a design-based research methodology, involving iterative cycles of design, implementation, analysis, and refinement. The RME approach emphasizes the use of real-world contexts to facilitate meaningful learning and engagement with mathematical concepts. The designed worksheets integrate realistic scenarios, encouraging students to apply mathematical reasoning in practical situations. Preliminary testing with a sample group of middle school students indicates significant improvements in their problem-solving abilities, as evidenced by increased performance in solving complex mathematical tasks. The results suggest that RME-based worksheets are effective tools for promoting deeper understanding and practical application of mathematics. Future work will involve larger-scale testing and further refinement of the worksheets to ensure their efficacy and adaptability across diverse educational settings.

Keywords: *Mathematical Problem Solving; Realistic Mathematics Education; Student Worksheets.*

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1. Introduction

Mathematics education plays a crucial role in improving human quality. This is one of the factors why mathematics is a compulsory subject at every level of education, from primary school to university. In the learning process, mathematics is often considered difficult by students (Aditya, 2018). This is because learning mathematics is not just about remembering formulas, but also students are required to understand the theory to think critically in finding answers to solving mathematical problems. In the process of learning mathematics, there are various skills that need to be achieved by students, one of which is the ability to solve problems (Mujahidah, 2020).

Often, learning mathematics in school is not enough to provide opportunities for students to develop their problem-solving skills effectively (Alba, 2014). According to Subhan (2018) in (Yokri & Saltifa, 2020), the reality in the field shows that not all mathematics learning in schools, especially in secondary schools, supports the development of this problem-solving ability so that students' problem-solving skills are still not optimal. Uhti (2011) revealed that low problem-solving ability is due to students having thoughts that are only fixated on one step of the answer so that when given another problem, students will feel confused (Nuri, 2021).

In this context, Realistic Mathematics Education (RME) emerged as a learning approach that emphasizes the application of mathematics in real-life situations. This approach not only helps students understand mathematical concepts in more depth, but

also allows them to see the relevance of mathematics in everyday life (Suryaningsih & Yarmi, 2023).

Realistic Mathematics Education (RME) was chosen as a promising alternative, bringing an approach that focuses on real-world experiences and contextual problem solving (Artika et al., 2019). Students' involvement in real mathematical situations can motivate them to develop a deeper and more relevant understanding of the subject matter (Kamarudin et al., 2023). In the RME approach, learning begins with contextual problems (real or everyday life), so that learners can directly use their previous experiences (Agustina et al., 2018).

To support quality learning, the use of teaching media such as Learner Worksheets (LKPD) is relevant. LKPD as a learning tool provides a systematic structure for the process of receiving information and learning activities of students. RME-based LKPD can improve problem-solving skills by presenting real-world contexts in mathematics problems. Based on the background description above, the researcher aims to describe the design of Realistic Mathematics Education-based LKPD to improve the problem-solving ability of mathematics class X SMA.

2. Method

This type of research is research and development with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This research aims to analyse students' needs for teaching materials that can facilitate students to find and construct aspects of problem solving skills in Statistics material and determine the validity of the product. The data sources of this research are students of class X E-2 SMA Negeri 4 Yogyakarta, two material expert validators, and two media expert validators. This research was conducted in July 2023 - April 2024. Data collection techniques used interviews, observations, questionnaires, problem solving ability tests, media expert validation questionnaires, and material expert validation questionnaires. Observations were conducted in the classroom during the learning process, while interviews were conducted with mathematics teachers of grade X SMA Negeri 4 Yogyakarta regarding the curriculum, learning methods, student characteristics, obstacles during mathematics learning, and also the need for mathematics teaching materials. For tests, tests were conducted to determine students' problem solving skills. As well as for the questionnaire is done to find out what kind of learning media are of interest to students. While the validation questionnaire is used to determine the validity score of the product developed. Where if the total score is in the good category then the product is declared valid. The research will still continue at the implementation and evaluation stages.

3. Result and Discussion

In this study, the development method applied was the ADDIE model, a systematic framework used in the instructional development process. The choice to use this model is based on the consideration that the ADDIE model has been developed in a structured manner with a strong theoretical foundation in learning design. The ADDIE development stages consisting of analysis, design, and development are the focus of this research.

a. Analysis

This analysis stage was conducted by the researcher through evaluating the curriculum implemented during the learning process, the learning methods used, learning resources, and the characteristics of students in class X E-2 SMA Negeri 4 Yogyakarta. To collect the data needed to deepen this analysis stage, the researcher

conducted a series of approaches, including observations, interviews, distributing questionnaires, and conducting initial tests to evaluate the level of problem solving skills. During the observation stage, the researcher observed the ongoing mathematics learning process. Interviews with mathematics teachers were conducted to get a better picture of the curriculum used, student characteristics, and obstacles encountered in the learning process. Questionnaires were administered to assess students' ability to solve mathematical problems as well as their preference for learning media. Then, an initial test was given by giving a number of questions that tested students' problem solving skills in the context of statistics material.

1) Analysis of Competencies to be Achieved by Learners

The curriculum used at SMA Negeri 4 Yogyakarta is the Merdeka Curriculum. Furthermore, the researcher examines the statistics material in the Merdeka Curriculum and the extent to which the material is taught in class X or Phase E in accordance with the Learning Outcomes (CP) set out in the curriculum. Based on the curriculum, the CP for statistics material is: At the end of phase E, learners can represent and interpret data by determining quartile and interquartile range. They can create and interpret box plots (box-and-whisker plots) and use them to compare data sets. They can use box plots, histograms and dot plots according to the nature of the data and needs. They can use scatter diagrams to investigate and explain the relationship between two numerical variables (including one independent variable of time). They can evaluate statistical reports in the media based on appearance, statistics and data representation. The flow of learning objectives (ATP) contained in the curriculum are:

a) Distinguish between different types of data and create appropriate graphs that represent the data, and analyse the data to draw conclusions.

b) Draw and interpret histograms and bar charts

c) Determine the measures of centrality of a data set: mode and median through line plots

d) Determine the measures of centrality from a data set (mean, mode and median) of single data and group data.

e) Compare the results of mean, mode, and median, on single data and group data

f) Determine the measures of placement of a data set: quartiles and percentiles of single data and group data.

g) Compare two groups of data using measures of concentration and dispersion.

Based on the results of interviews with teachers, researchers obtained information related to the time allocation per week in learning mathematics at SMA Negeri 4 Yogyakarta, which is carried out as many as 2 meetings per week with the number of lesson hours (JP) per week which is 4 JP (4 × 45 minutes).

2) Material Analysis

Based on the CP and ATP that have been prepared at the stage of analysing the competencies that must be achieved by students, researchers analyse the material that will be included in the LKPD through collecting references related to material that is in accordance with the scope of CP. The results of the analysis have concluded that statistical material has the main materials, namely: (1) Histogram; (2) Frekuensi Relatif; (3) Ukuran Pemusatan; (4) Ukuran Penempatan; (5) Ukuran Penyebaran.

3) Student Character Analysis

Before the product was used by students, researchers gave a pre-test containing problem solving questions on statistics material to students in class X E-2 which was the experimental class and X E-3 which was the control class on 20 and 22 March 2024. Based on the results of the pre-test, it is known that students' mathematical problem-solving skills are still low. One of the factors that cause the low problem solving ability of students is the media that teachers use. Teachers use learning media. The material and practice problems presented in the media do not contain aspects of the problem and the lack of interactivity in the media. This situation provides encouragement for researchers to develop media with material and practice problems that emphasise the development of problem solving skills, with the aim of improving students' ability to solve problems.

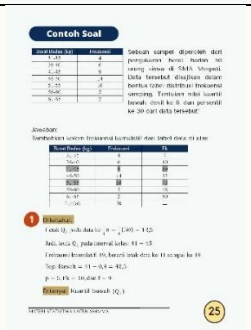
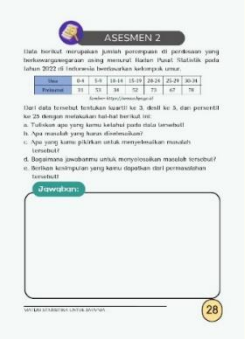
4) Analysis of Students' Needs for Learning Media

This analysis activity aims to find out what kind of learning media students want to use. On 13 September 2023, the researcher gave a preliminary study instrument questionnaire regarding the use of learning media in mathematics learning. This questionnaire involved 36 students of class X E-2 and it was found that 56% of students were interested in student worksheets based on realistic mathematics education.

b. Design

In the design stage, researchers developed a product description framework based on the analysis of previous research results. In this context, the researcher decided to design a Learner Worksheet (LKPD) that focused on statistics material. The researcher developed the structure and content of the LKPD by referring to the learning outcomes that had been determined. This LKPD includes indicators of mathematical problem solving skills that involve the use of example problems in the context of solving everyday problems, analysing data (graphs, tables, etc.), and drawing conclusions from the results of calculations. The following are the initial results of the design process.

Table 1. Preliminary Results of The Design Process

No.	Design	Desciption
1		Cover The title on the cover is Realistic Mathematics Education Based Learner Worksheet for Statistics. This LKPD is designed based on indicators of mathematical problem solving skills in statistics material for class X SMA / MA. The cover image can be seen in the picture below.
2		Learning Outcomes and Flow of Learning Objectives Learning outcomes and learning objectives should be aligned with the results of the curriculum analysis.
3		Material This student worksheet contains statistics material based on Realistic Mathematics Education.
4		Sample Question Examples of problems used in LKPD contain problems related to the context of everyday life
5		Assesment The assessment questions on the LKPD contain indicators of problem solving

c. Development

In the development stage, researchers implemented the design that had been made at the design stage into physical form, producing a prototype of LKPD that aims to improve students' mathematical problem solving skills. In addition, researchers compiled validation instruments, including validation sheets for media experts and material experts, as well as student response questionnaires, pretests, and posttests of mathematical problem solving skills. After the instruments were validated by media experts and material experts, the results showed that the instruments were valid and could be used. The responses, recommendations, and views from experts summarized in Table 2 below.

Table 2. Material Expert Validation

No.	Suggestions and Inputs	Follow-up
1	Replacing questions with current issues or contextual sols with actual data	Questions have been changed according to the validator's suggestion
2	Provide answer columns that are tailored to Polya indicators	An answer column is provided according to the Polya indicator
3	Provide some pictures or illustrations related to the problem	Pictures or illustrations as required
4	Provide a preliminary narrative before presenting data and problems	A narrative is given at the beginning of the question

The results of the assessment of students' work in design validation were obtained through the process of validating the design of learning media using the Likert Scale. Likert scale is a measurement tool used to assess the level of agreement or opinion on a statement. After the validation stage, the results obtained are compared with the ideal criteria listed in the following Tables 3 and 4.

Table 3. Material Expert Validation

No.	Score	Criteria
1	$\bar{X} > 67,2$	Very Valid
2	$54,4 < \bar{X} \leq 67,2$	Valid
3	$41,6 < \bar{X} \leq 54,4$	Valid Enough
4	$28,8 < \bar{X} \leq 41,6$	Less Valid
5	$\bar{X} \leq 28,8$	Very Less Valid

Table 4. Media Expert Validation

No.	Score	Criteria
1	$\bar{X} > 58,8$	Very Valid
2	$47,6 < \bar{X} \leq 58,8$	Valid
3	$36,4 < \bar{X} \leq 47,6$	Valid Enough
4	$25,2 < \bar{X} \leq 36,4$	Less Valid
5	$\bar{X} \leq 25,2$	Very Less valid

The results of student worksheet validation are as follows.

Table 5. Student Worksheet Material Expert Validation Score Data

Validator	Position	Score	Criteria
Naela Faza Fariha, S.Si., M.Sc.	Lecturer in Mathematics Education, Universitas Mercu Buana Yogyakarta	76	Very Valid
Dra. Sri Yekti Marhaeningsih	Maths teacher at SMA Negeri 4 Yogyakarta	69	Very Valid
Total score of validators 1 and 2			145
Average			72,5
Final Criteria			Very Valid

Table 6. Student Worksheet Media Expert Validation Score Data

Validator	Position	Score	Criteria
Dr. Suharno, M.Pd.	Lecturers and Practitioners in the Field of Teaching Media Development	63	Very Valid
Ardhika Fajar Ramadhan, S.Pd.	Learning Media Developer	56	Valid
Total scores of validators 1 and 2			119
Average			59,5
Final Criteria			Very Valid

The purpose of this study is to develop a learning media for student worksheets based on Realistic Mathematics Education that is declared valid for use by material experts and media experts. In the design stage, the researcher considers the input from students regarding the media that is interesting according to the students and can improve mathematical problem-solving skills. So that the material developed contains examples and practice questions that are suitable for problems in daily life. At the development stage, the researcher asked for opinions from two material expert validators and two media expert validators. From this opinion, the researcher has improved and discussed it again with the validator so that the product is declared valid for use. It has also been improved and revised by researchers. So, from the validator aspect, the product has been declared valid to use. The things that researchers consider in designing realistic Mathematics Education-based LKPD learning media to improve mathematical problem-solving skills are because there has been similar research, namely the results of research conducted by (Kustantina et al., 2021) entitled Mathematical Comic Design to Improve Ability Numerical Literacy and Student Learning Motivation. The results of the study show that the validity of the media developed is very valid with a total score of 142 from material experts and a total score of 118 from media experts. This study concludes that the product developed can be used to improve students' numeracy literacy skills and learning motivation. Literacy Ability and Student Learning Motivation

4. Conclusion

The results of this study confirm that (1) students‘ mathematical problem solving skills show a low trend, demanding the design of appropriate teaching materials to improve these skills; (2) the teaching material products developed in this study are in the form of learner worksheets produced using Canva; (3) the worksheet design consists of 3 volumes with an emphasis on aspects of basic competencies, the framework of exercise questions tailored to the indicators of problem solving skills, and the use of

attractive visual aesthetics to improve students' mathematical problem solving skills; (4) The results of the evaluation by material experts and media experts showed a good assessment, with an average score of 72.5 from material experts and 59.5 from media experts, indicating the validity of the use of the teaching materials. This research will continue to the implementation stage and further evaluation.

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