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Research paper

Development of Students Worksheet based on Realistic Mathematics Education in Indonesia

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Abstract

A concept of mathematics is one of the essential goals in learning mathematics. Providing an understanding that the material taught to students is not only as a recitation but also as the concept of the subject matter itself. This study aims to develop student worksheet based on realistic mathematical approach. The method used in this study is the stages of 4-D development research which consists of defining, designing, developing, and disseminating. This study employed two data collection instruments. The first is expert validation which was used to measure the validity. Meanwhile the second is questionnaire which was used to measure students' practicality and to get product development assessment from experts and students. The results showed that the developed worksheet is valid with the validity level of 3.67 for the content aspect, 3.60 for the constructed aspect, and 3.50 for the language aspect. The worksheet was tested to 21 students of grade VII in MTs N 2 Gunungkidul Indonesia. The test results stated that the worksheet received a good response from students. Therefore, it can be used in the process of learning mathematics in class.

Keywords: *Development; Student Worksheet; Realistic Mathematics Education.*

1. Introduction

Twenty first century skills demand a person to achieve success professionally and personally through skills in creating and innovating. Those skills will help students to develop in the future, therefore they must have the ability to apply the knowledge they learned to face life's challenges [1]. In education, these students must be able to solve many problems using creative thinking as learning has changed from horizontally to individually [2]. A number of schools begin to develop lessons that can enhance individual innovative and creative thinking skills to meet the requirements of the 21st century [3]. Students who have creative skills will obtain individual success. Hence, 21st century education is expected to prepare the students to master a variety of skills, especially creative thinking skill to become a successful person in life.
Mathematics is learned and developed to equip the students with logical, analytical, systematic, critical, and creative thinking skills [4]. Effective learning strategies are required to support a well-organized mathematics learning process. However, it usually needs too many media or aids in the learning process [5]. One of the possible solutions is to develop teaching material in the form of worksheet which can facilitate students' learning activities so that it will form an active interaction between students and teachers [6].
The researchers obtained the data of mathematics learning in MTs N 2 Gunungkidul Indonesia through interview and observation. In general, teachers there were good at preparing the learning. In the learning process, they had used the student worksheet. However, the worksheet contained only materials and problems which caused the students to have low understanding of mathematical concepts in the learning process. In fact, in learning mathematics, students have to understand the concept so that they will be able to solve various problems and to apply the learning in the real world [7]. The ability to understand mathematical concepts is one of the essential goals in learning mathematics. Providing an understanding that the material taught to students is more than just a recitation. Furthermore, the students are also expected to understand the concept of the material itself.
The learning of mathematics should be done properly by making the appropriate media. Indeed, the teacher should be able to prepare the teaching materials appropriately so that the learning process can improve students' creative thinking. One of them is by providing student worksheet well. Students need the worksheet as the teaching materials that can make them to participate actively and creatively in learning mathematics and can help them to find the concept of learning through daily problem-solving [7]. The developed student worksheet should be made as attractive as possible and made by connecting it with daily life so that students can apply the lessons in real life and understand the benefits of learning mathematics [6].
Realistic Mathematics Education (RME) is regarded as one of the best approaches to teach mathematics based on curriculum objectives that are focused on teaching high-order thinking skills, including building students' knowledge, problem-solving, and critical and creative thinking [8]. Unlike traditional learning, the setting of realistic mathematical classes allows social norms and socio-mathematical norms to arise as students contribute more to the learning [9]. By using this approach, they are given opportunities to learn cooperatively with a pleasant learning environment to improve their mathematical achievement. In this approach, the role of the teachers is to stimulate learning [10]. The RME theory focuses on rediscovery which is guided through mathematizing and considering the problem solving and students' interpretation strategies through real-world context-based issues [11]. The im-

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plementation of RME should be able to provide problematic and interactive based mathematics education [12].
This article proposes the development of student worksheet based on Realistic Mathematics for Grade VII MTs N 2 Gunungkidul Indonesia.

2. Method

This is a developmental research in the field of mathematics education that aims to produce learning tools in the form of worksheet based on appropriate realistic mathematics (valid, practical, and useful) as in research [13] using the stages of the 4-D development research [14]. However, this study is limited to measure the validity and practicality of student worksheet. The stages are shown in Figure 1.

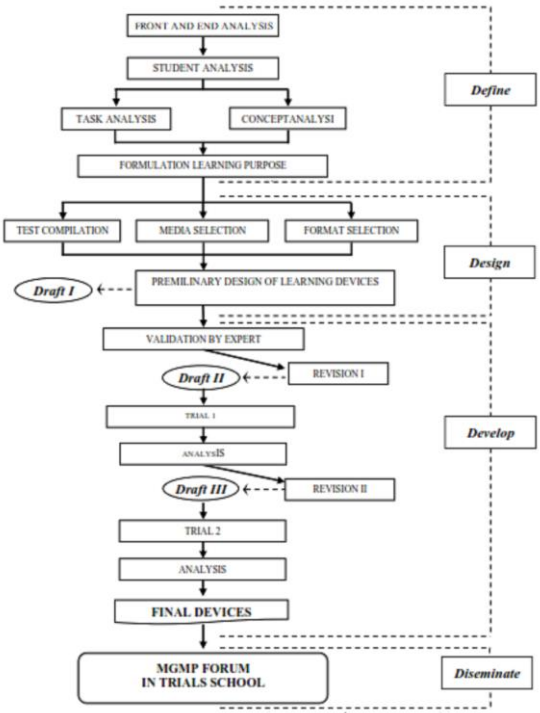


Fig 1: Chart Development of Learning Devices with 4-D Model

This research was conducted in MTs N 2 Gunungkidul Indonesia. The participants were 21 students from VII grade of MTs N 2 Gunungkidul Indonesia. The research instruments of the current study are validation sheet and students' response questionnaire. The student worksheet validation sheet was addressed to an expert (one lecturer) and a practitioner (one mathematics teacher). Then, students' response questionnaire was used to see the practicality level of the worksheet.

2.1. Data Validity

The instruments for validating the student worksheet were prepared and adapted to the curriculum in which the measurement was done by filling the questionnaire in the form of rating and by using the qualitative advice from the expert as the consideration of product revision. The validity level of the learning product is seen through the scores obtained from the device validity questionnaire filled by the expert. Score data given on the validity of the Student worksheet is as follows table 1:

Table 1:

Criteria	Score
Very good	5
Good	4
Enough	3
Less	2
Very Less	1

From the assessment of the scale 1-5, the formula used to measure the average score is:

$$\bar{X} = \frac{\sum_{i=1}^{n} x_i}{}$$

Note:
= average
n = points of assessment
x_i = score on the grading point

Having obtained the average of the scores obtained then the average converted to be a qualitative value with the criteria of scale assessment 5 with the following guidelines in table 2:

Table 2

Score	Criteria
$\bar{X} > \bar{X}_i + 1{,}8 \times sb_i$	Very good
$\bar{X}_i + 0{,}6 \times sb_i < \bar{X} \leq \bar{X}_i + 1{,}8 \times sb_i$	Good
$\bar{X}_i - 0{,}6 \times sb_i < \bar{X} \leq \bar{X}_i + 0{,}6 \times sb_i$	Enough
$\bar{X}_i - 1{,}8 \times sb_i < \bar{X} \leq \bar{X}_i - 0{,}6 \times sb_i$	Less
$\bar{X} \leq \bar{X}_i - 1{,}8 \times sb_i$	Very less

Note:
= The ideal average = (ideal maximum score- ideal manimum score)
= (ideal maximum score - ideal manimum score)
ideal maximum score = assessment item x highest score
ideal manimum score = assessment item x lowest score

Based on the quantitative data conversion table to qualitative above, the researcher determines that for the validity data, only valid and invalid classifications are required table 3:

Table 3

Score	Criteria
$\bar{X} > \bar{X}_i + 0{,}6 \times sb_i$	Valid
$\bar{X} \leq \bar{X}_i + 0{,}6 \times sb_i$	Not Valid

2.2. Data Validity

To measure the worksheet level of practicality, students' response questionnaire was used. The questionnaire was given in the form of rating which was processed quantitatively. Meanwhile the students' comments were used as consideration of the device revision. In the development of this student, a revision would be conducted if the results of validation score and students' questionnaire could be categorized as fair, and also if there were suggestions for the improvement from the validator and students when conducting trials.The analysis of students' questionnaire can be called as practical if the positive response of the students reach up to $\geq$ 70%. The formula used to measure the practicality level is:

$$R_{students} = \frac{A}{B} \times 100\%$$

Note:
= students' response percentage
A = the number of students who response
B =the number of students who give their response

3. Analysis and Result.

3.1. Define

According to the observation results, grade VII students of MTs N 2 Gunungkidul Indonesia need RME-based worksheet as they have to understand the concept of mathematics by self-constructing through previous knowledge related to daily life. This RME-based worksheet is considered necessary as it can train the students in independent learning, creative thinking and can im-

prove their understanding of mathematical concepts so that their learning outcomes will increase.

3.2. Design

The worksheet was developed by observing the aspects of validity and practicality. Besides, appropriate media selection is made so that it can be used in presenting teaching content. The initial design of the worksheet was based on the analysis results done in the define stage. The design of the RME-based worksheet can be seen in the following figure 2.

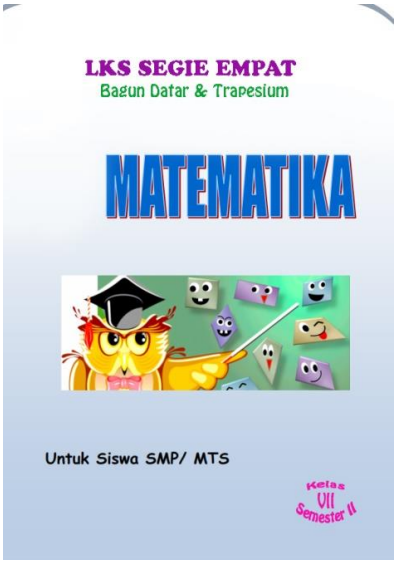


Fig 2: Students work sheet based on RME

The worksheet developed by the researchers is in the form of RME by applying the RME characteristics such as the use of contexts, progressive mathematical model, students' construction results, interactivity and interrelation, and also by using RME principle, for example re-invention and progressive mathematization, didactic phenomenology and self-developed model [15].

In the context, realistic mathematics should enable learners to apply their mathematical understanding and tool / mathematical tools to solve problems. Only in solving problems can students develop mathematical tools and mathematical understanding.The Figure 3 is example part of context.

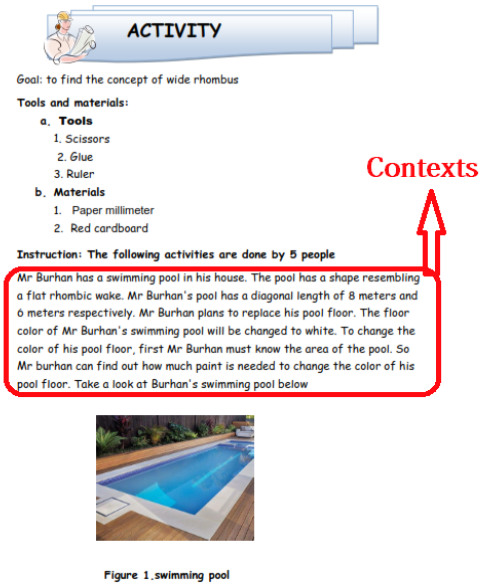


Fig 3: Example part of context

In progressive mathematical model, learning mathematics means that students must go through various stages of understanding, from the ability to find simple solutions that relate to the context, to the creation of multiple stages of direct relationship. Figure 4 is example part of progressive mathematical model.

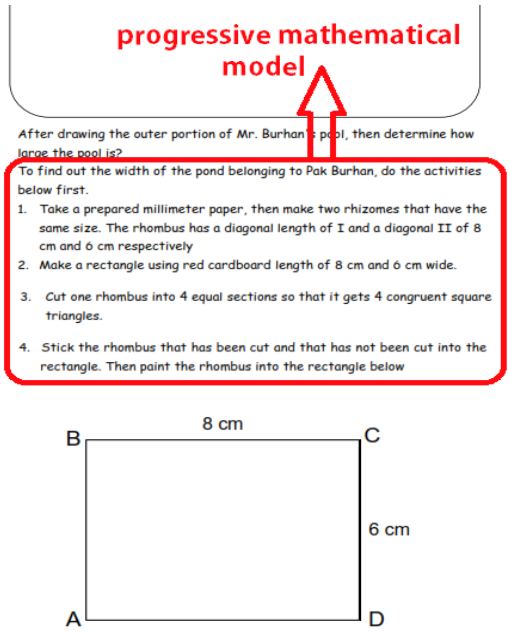


Fig 4: Example part of progressive mathematical model

In students' construction results, students are active participants in the development process of all tooling devices and their mathematical insights. In this case, the problem-solving which allows him to make parts of the problem and develop gradually. In realistic mathematics, learning mathematics is a social activity. Education should be able to provide opportunities for students to share their strategies and discoveries. By listening to what others found and discussing these findings, students got the idea to improve their plan. Figure 5 is example part of students' construction results and interractivity.

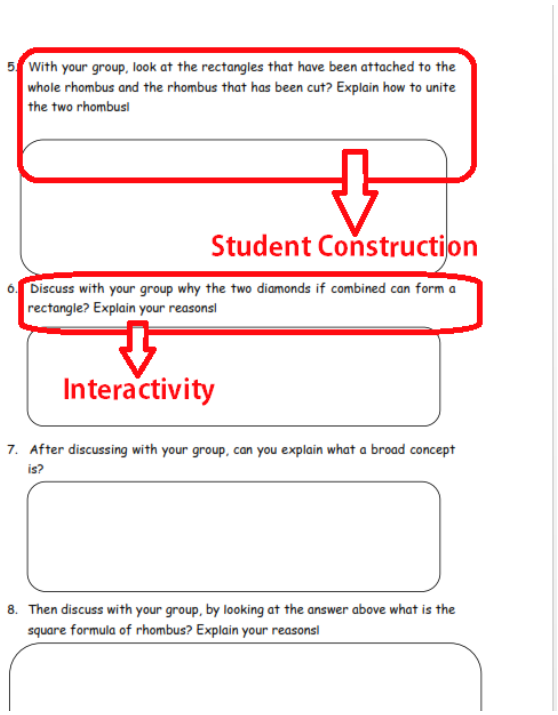


Fig 5: Example part of students' construction results and interactivity

To show interrelation, teacher has the most crucial role in directing learners to gain knowledge. They control a flexible learning process to show what to learn to avoid a false understanding through the process of rote learning. Figure 6 is example part of interrelation.

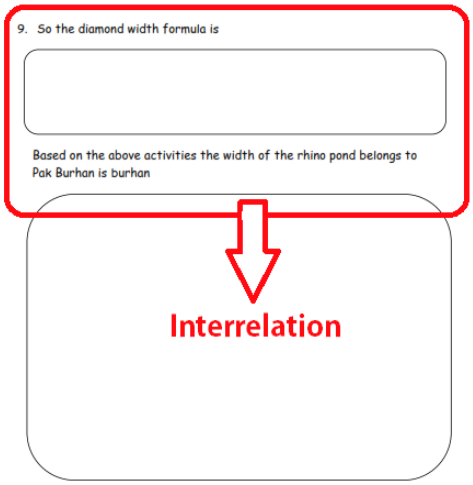


Fig 6: Example part of interrelation

3.3. Develop

3.3.1. Expert Assessment (Validation)

The existence of student worksheet as a student workbook should be useful as a means of learning both regarding appearance, content, and practical [16]. The evaluation results of learning tools by experts are presented in Table 4.

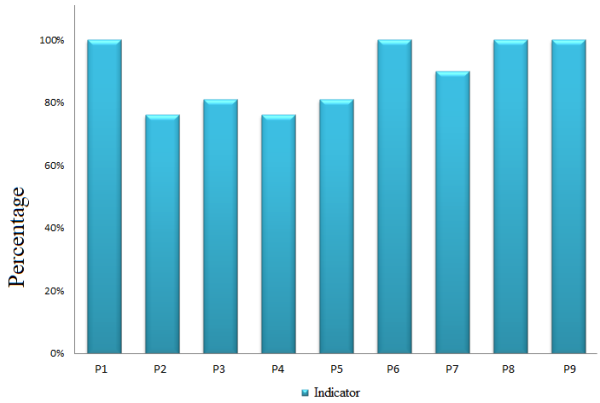
Table 4: The test results of student worksheet validity by expert validators and practitioner validators

No	Aspect	Level of validity	Validity criteria	Description
1	student worksheet contents	3,67	Valid	No revisions needed
2	Construct	3,60	Valid	No revisions needed
3	Language	3,50	Valid	No revisions needed

From the analysis results it can be concluded that the developed student worksheet has met the minimum valid criterion. Therefore, it can be tested at the school to see other eligibility criteria in the learning activity. The validity of learning tools should be reviewed based on the content validity and construct validity. The content validity of a test indicates how far a test measures the level of mastery of specific material content that must be mastered with the purpose of teaching, while the construct validity is to see how far the test can measure the concepts that should be measured [17]. However, some revisions were conducted by researchers based on the expert validators' comments and suggestions and practitioners.

3.3.2. The practicality of Learning Devices

The practicality analysis of learning devices was conducted to see the results of student worksheet practicality test, that is the questionnaire results filled by the students. The questionnaire was filled after a series of worksheet development was completed. Graph 1 presents the results of the students' assessment towards the worksheet.



Graph 1: The test results of student worksheet practicality by students

Based on the results of the questionnaire, 100% of students stated (P1) The RME-based worksheet is easy to understand as it is easy to be observed and the instructions are clear, 76% of them stated (P2) The design of the RME-based worksheet is more interesting than others since the presentation is more straightforward and the layout is interesting, 81% of them stated (P3) The contexts and drawings on the RME-based worksheet attract students' interest as it is related to daily life and it also the use of tools which are available in the surrounding environment, 76% of them stated (P4) The problems and exercises on the RME-based worksheet are close to daily life, hence it is easier to learn because it gives direct benefit to life, then 81% of them stated (P5) Worksheet which was made based on real-world concepts makes the mathematics learning feel more meaningful. Furthermore, 100% of students declared (P6) RME-based worksheet has many learning activities that are able to make the students become more active in learning process, 90% of students stated (P7) RME-based worksheet leads the students to answer the questions, 100 % of them stated (P8) RME-based worksheet is easy to carry, and 100% of them stated (P9) RME-based worksheet is easy to do
The overall practicality criteria of every aspect or indicator of the worksheet is practical, therefore it needs no revision. These results indicate that the developed worksheet is proper to be used in the learning process. It can be used directly by students and they will have the opportunity to study independently according to the exercises and tasks [18]. For the implementation of proper learning approach, RME-based worksheet is needed.

4. Conclusion

This research developed student worksheet based on valid and practical realistic mathematics. The design applied the characteristics and principles of RME. Through the use of contexts, the students are able to be actively involved in exploring problems. The material of RME-based worksheet also emphasizes the students to build a concept in learning. The results of data validation analysis by two validators stated that the validity level is 3.67 for the content aspect, 3.60 for the constructed aspect, and 3.50 for the language aspect. These results indicate that the suitability of the developed worksheet in terms of three aspects of validation is good. After conducting validation, the worksheet was tested to 21 students of grade VII in MTs N 2 Gunungkidul Indonesia. The test results showed that the worksheet received a good response from students. Therefore, it can be used in a mathematic learning process in class.

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