The Development of Student Worksheet Based on Realistic Mathematics Education

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Abstract. This study is aimed to develop student worksheet based on Realistic Mathematics Education for the topic of circle for the eighth-grade of junior high school. The study type was development research using the ADDIE model comprising analysis, design, development, implementation, and evaluation. The developed product was validated by experts and tested for its practicality by mathematics teachers and students. The product of this study is a set of students worksheets based on RME for the topic of circles. The worksheet has the following characteristics: using real-world context, facilitating mathematization process, facilitating interactivity and integrated learning. The results of validation and try out indicate that the worksheet was valid and practical.

1. Introduction

The circle is one of the compulsory lessons learned in high school. The report states that students mastery of the circle is still less than 60% as shown in Table 1 [1]. In addition, based on observations found that the learning process id not focused on student activities, student worksheet do not facilities students to build their own knowledge, and students only memorize the formula in solving problem.

Table 1. Circle Mastery of Junior High School in 2016/2017.

| Competencies                                      | Province | National |
|---------------------------------------------------|----------|----------|
| Calculating the area of the circle with a given diameter. | 36.91    | 50.23    |
| Recognizing the elements of a circle              | 41.98    | 53.62    |
| Determining the inscribed angle when the central angle is known. | 26.00    | 40.36    |
| Solving mathematics word problem that deals with the area of sector. | 34.54    | 42.51    |

In the process of learning mathematics in school is expected to aim to develop learning outcomes and attitudes of students with the interaction between students. It takes the right approach to realize that expectation. One of the proper approaches is Realistic Mathematics Education (RME). According to Freudenthal realistic mathematical learning is mathematics as a human activity [2]. Mathematics must be related to reality and mathematics should be viewed as a human activity, where math must be close to students and relevant to daily life situations [3]. Characteristics of RME according to Van Reeuwijk include: using real-world context, construction, involving mathematization process, facilitating interactivity, and integrated learning [4]. In this approach, real-world contexts are used as a starting
point for the learning process. On the basis of the real-world contexts, students are given the opportunity
to use their own way in accordance with its ability. Through the process of mathematization, students
will be given the opportunity to recall their knowledge, abilities, and mathematical procedures [5].

Teachers’ reports that contexts and activities such as practices and related discussions attracted
students’ interest plays an important role in learning with RME approaches [6]. Because it comes from
a real-life context that brings it to everyday experience so that math will be a meaningful and students
centered learning. In fact, the TIMSS video analysis also shows that the teaching of mathematics in
Indonesia is dominated by lectures, textbooks, and the involvement of learners in limited learning,
including in the case of asking questions [7]. Of course, the purpose of learning mathematics that are,
1) mathematical communication, 2) mathematical reasoning, 3) mathematical problem solving, 4)
mathematical connections, and 5) mathematical representation [8] has not been achieved. The
realistically approach is effective and contributes to increased mathematical analogical reasoning
because students have a positive mindset in learning mathematics where students are able to find their
own mathematical concepts [9]. RME teaches students to use their mental skills in mathematical
representation [10]. Therefore, this study was focused on developing learning material that is student
worksheet based on Realistic Mathematics Education Approach on Circle.

The student worksheet is one of the printed materials in the form of sheets of paper containing
materials, summaries, and instructions on the implementation of learning tasks that must be done by
students who refer to the basic competencies to be achieved [11,12]. Student worksheets provide clues
or descriptions of the phases to be traversed when students solve problems [13]. A good worksheet can
facilitate teachers in implementing learning and also help students to learn and solve a problems
independently.

Considering the abovementioned background, this study is aimed to develop student worksheet based
on Realistic Mathematics Education on circle and to know the quality of the developed student
worksheet on validity and practicality.

2. Experimental Method

Type of this study is research and development (R & D) to develop student worksheet based on Realistic
Mathematics Education approach for 8th-grade high school. The model of development in this study is
the ADDIE model consisting of 5 stages: analysis, design, development, implementation, and evaluation
[14]. The analysis aims to analyze the development needs intended to provide appropriate information
in developing a product so that the product developed in accordance with the objectives to be achieved.
The design consists of making prototypes of student worksheets, assessment instruments, organizing
materials, and creating student worksheet structures. In addition, several instruments were developed to
assess the quality of student worksheets. Then, the developed student worksheet is validated by the
media expert to know the validity of the student worksheet. Implementation aims to test the student
worksheet that has been validated and revised (valid and feasible). At the end of the implementation of
the teacher fill out a questionnaire as a practicality sheet for the development of student worksheets. The
evaluation aims to revise the development of student worksheets based on suggestions and inputs from
questionnaires on implementation.

The data of this study consist of validity and practicality. The validity data is derived from the average
media expert score. Practical data was obtained from student responses questionnaire and teacher
responses questionnaire score. Instruments are established by considering two aspects of quality that are
validity and practicality. The validity is assessed by three aspect of validity, that are 1) the material
feasibility, 2) the appropriateness of the presentation, and 3) the suitability of the language. Student and
teacher questionnaires are used as instruments to measure the practicality of the products. Practicality is
assessed by the usefulness and easily of developed student worksheet.

Descriptive analysis is used to measure the quality of the developed student worksheet based on validity
and practicality. The validity and practicality of the develop student worksheet can be analyzed by
convert the score into qualitative criteria based on Tabel 2 [15].
Table 2. Data Conversion Criteria Validity and Practicality.

| Interval Score | Criteria       |
|----------------|----------------|
| X > x + 1.8 SDi| Very Good      |
| x + 0.60 SDi < X ≤ x + 1.8 SDi | Good |
| x – 0.60 SDi < X ≤ x + 0.60 SDi | Enough |
| x – 1.80 SDi < X ≤ x – 0.60 SDi | Less Good |
| X ≤ x – 1.80 SDi | Very Less |

with,

x = \frac{1}{2} (\text{maximum score} + \text{minimum score})

SDi = \text{standard of deviation} = \frac{1}{6} (\text{maximum score} – \text{minimum score})

X = \text{actual score}

According to Table 2, it can be determined the interval of evaluation of developed student worksheet as shown in Table 3 and Table 4.

Table 3. The Interval of Validity.

| Interval Score | Criteria       |
|----------------|----------------|
| X > 88.2       | Very Valid     |
| 71.4 < X ≤ 88.2| Valid          |
| 54.6 < X ≤ 71.4| Enough         |
| 37.8 < X ≤ 54.6| Less Valid     |
| X ≤ 37.8       | Very Less Valid|

Table 4. The Interval of Practicality.

| Interval Score | Criteria       |
|----------------|----------------|
| X > 42         | Very Practice  |
| 34 < X ≤ 42    | Practice       |
| 26 < X ≤ 34    | Enough         |
| 18 < X ≤ 26    | Less Practice  |
| X ≤ 18         | Very Less Practice |

The developed student worksheet is categorized as valid and practical if it at least meet the critera of ‘valid’ and ‘practice’.

3. Result and Discussion

The student worksheet was developed by using the ADDIE model that consists of five stages: analysis, design, development, implementation, and evaluation. The analysis comprises a needs analysis and an analysis of student characteristics. The results of the needs analysis identify that 1) the learning process does not focus on the student's activities so that it is still teacher-centered, 2) the student worksheet does not facilitate the students to build their own knowledge, so it only presents the formula instantly and a collection of practice questions. The result of characteristic analysis of student identifies that 1) the student only memorizes the formula in solving the problem, 2) the student is more interested in the learning which is the group discussion. In the next step, student worksheet was designed on basis of the initial draft of the analysis phase, i.e. create prototype student worksheets, assessment instruments, organize the materials, and create a student worksheet structure. In the third step, the initial design of the student worksheet was developed and validated by media and content experts. The student worksheet was revised in accordance with the advice of the validator. Validation results can be seen in Table 4.
Based on the result of validation process, the student worksheet is valid and can be implemented in the school. The validated student worksheet was implemented in eighth-grade high school in Pangkalpinang. In general, the learning process began with an initial activity and students’ preparation to follow the learning process. Then the teacher distributed the student worksheet which contained information about the material, instruction, and student activities. In the core activities, students were formed into several groups and discussed issues on the worksheet. Learning activities used the characteristics of the RME approach that is using real-world context, construction, using mathematization process, the existence of interactivity, and integrated learning. For the characteristics of using real problems, RME learning begins with a mathematical situation derived from real problems/real-life contexts that bring it to the everyday experience so that math becomes meaningful to learners. For the characteristics of using the construction, students are given the opportunity to develop a strategy in the problem solving informally that is in the form of constructivism results and then the students are led to develop the model into a more abstract/general. This construction process is used to reduce the process of transfer of formulas from teacher to learner (using formal mathematics directly). In the process of mathematization, the students developed a mathematical model from the real-world situation in order to reach abstract level. This model served as a bridge for students from informal mathematics to formal mathematics. The existence of student interactivity is a fundamental discussion in the process of mathematization. This interaction serves to train learners in communicating ideas and raising questions in group discussions. The latter is integrated learning integrated learning where inter subjects taught are interrelated between each other. In the discussion of a topic usually contains some related concepts. Integrated learning can make meaningful learning. Examples of problems or activities used in the worksheet are shown in Table 6.
Table 6. Student Activity in Worksheet.

| Characteristic                          | Activity |
|----------------------------------------|----------|
| The use of real-world context          | Ayo Mengasih Meslah! |
| Construction and interactivity         | 5. Apa itu luas lingkaran? |
| The process of mathematization         | Kegihan 3 |
| Integrated learning                    | Ayo Masalah |

In closing activities, the teacher guides the students to reflect on the obstacles and make material conclusions, do the exercises, collect worksheets, and provide information on the next meeting. The lessons were carried out in seven meetings and one meeting for the test. Then the teacher and students fill out a questionnaire to find out the practicality of the developed student worksheet. Practical data
were obtained from the average score of student responses and teacher response scores. The results of practicality are shown in Table 7.

| Teacher Questionnaire | Student Questionnaire | Average | Practicality |
|-----------------------|-----------------------|---------|--------------|
| 38                    | 41.8                  | 39.9    | Practice     |

Based on the results, the student worksheet is practical. The five evaluations aimed at revising the student worksheets based on suggestions and comments obtained from the questionnaire. In summary, student worksheets developed based on RME learning characteristics that use contextual problems, construct, use mathematization process, the existence of interactivity, and integrated learning. In addition, the student worksheet consists of several components such as material, user manual and student activities. The development model of this study is the ADDIE model consisting of five stages: analysis, design, development, implementation, and evaluation. The data of this study consist of valid and practical. Student worksheets developed based on Realistic Mathematics Education approaches on circle for the eighth grade was required validity and practicality.

4. Conclusion
Based on the result, it concluded that student worksheets developed based on Realistic Mathematics Education on the circles which has characteristic using real-world context, construction, the process of mathematization, interactivity and integrated learning was required validity and practicality. It is said to be valid (1) products are developed based on grand theory, and (2) there is internal consistency between components [16]. Practicality refers to the extent to which users consider development products interesting and useful [17]. The practicality of a product is obtained if the teacher and other experts consider the product developed is easy and can be applied by teachers and participants students in accordance with the objectives of development [16]. The developed student worksheets based on Realistic Mathematics Education on the circles was required validity and practicality. Therefore, the student worksheet can be used by students and teachers to support learning in the classroom, and for other researchers to develop this study in terms of material development.

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