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The Development of Students' Worksheet Based on RME For the Topic Circle in Junior High

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a r t i c l e i n f o

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a b s t r a c t

The purpose of this research was to produce a students' worksheet based on Realistic Mathematics Education for the topic circle in 8th grade at SMPN 01 Kota Bengkulu which was valid and practical. The type of this research was Research & Development using 3 steps of 4D model namely define, design, and develop. The instrument of this research consisted of validity sheets and practically sheets. Vallidity was done by two validators. Practicallity has been tested to 35 students in class VIII.2 at SMPN 1 Kota Bengkulu for the odd semester of academic year 2019/2020. From the research that has been done, it showed the development of students' worksheet based on Realistic Mathematics Education for the topic circle in 8th included in the category: (1) valid based on 40 items which consisted of 12 material items, 20 contruction items, and 8 language items with the avarage score 4,11 and it was known from: (a) students' worksheet showed the correctness and suitability according to the sequences of Realistic Mathematics Education syntax on material validation, (b) on the construction validity it showed that the studens' worksheet was containing good font type and interesting images which made the students' worksheet easy to read, (c) the sentences were simple, clear, easy to understand, and suit the rule of indonesioan language on languange validation. (2) very practical with the avarage score 4,51 which was known by instruction, steps, images, and the problem in students' worksheet that were understandable and easy to use by students.

Keywords:
Realistic Mathematics Education; Research and Development; Students' Worksheet

INTRODUCTION

The demands in learning mathematics are not only memorizing and applying formulas, but also students' ability to utilize the knowledge they already have to construct new knowledge. In Permendikbud No. 58 it was stated that the goals to be achieved through learning mathematics are understanding mathematical concepts, using patterns as conjectures in solving problems and being able to analyze the components that exist in solving problems in the context of mathematics and outside mathematics (real life, science, and technology), and respect the usefulness of mathematics in life and confidence in problem solving (Kemdikbud, 2014: 325). Badan Standar, Kurikulum, dan Asesmen Pendidikan (2022) also shared the similar statements that to be competent in mathematics, every learner needs to have skills in responding, solving problems, and taking steps towards real issues happening in the world. Thus, learning mathematics needs more than memorizing formulas and applying them. The students need to know what they are learning, what is the purpose of learning that matter, how to use the knowledge they have learned in several situation arise from the problem.

Unfortunately, many students in Indonesia still have a lower problem-solving ability (Mulyati, 2016). Many of them also have lower mathematical concept understanding (Fajar et al., 2019) and lower mathematical reasoning ability (Putri et al., 2019). Most of the students in the classroom tend to memorize the formula and imitate the solution from the example given by the teacher so that they are unable to solve mathematical problem. It is supported by the findings that stated many difficulties and errors of students in solving functional material problem (Ramadhani & Hakim, 2021).

One of the factors that causes students to have difficulty in solving math problems is due to the inability to acquire math skills (Tambychik & Meerah, 2010). In addition, mistakes made by students when working on problem solving questions math is a mistake because carelessness in calculation (Sumartini, 2016; Suraji et al., 2018), skill error process, and transform error information, misunderstood about the problem (Sumartini, 2016). Sometimes, the procedures carried out by students were completely wrong so that the final conclusions obtained were wrong and students did not carry out the completion process and strategies (Lukman et al., 2019; Ratnasari & Abadi, 2018).

Based on the results of an interview with a class VIII mathematics teacher at SMPN 01 Bengkulu City, it is known that students also have a lower problem-solving ability. Besides, the learning objectives and achievement of student learning outcomes are still not optimal. One of the factors that causes this to happen was the lack of use of students' worksheet which can help students be active in learning in class and can help students understand mathematics learning material.

According to Suyitno (2011) students' worksheet is sheets containing assignments that must be done by students. In the Ministry of National Education (2008) the meaning of students' worksheet (LKPD) is also explained as sheets containing assignments that must be done by students which are usually in the form of instructions, steps to complete a task. The content of students' worksheet will easier to help students in constructing their conceptual understanding if it is related to real world context. One of the lessons that can be used using problems related to everyday life is RME (Realistic Mathematics Education).

Gravemeijer (1994) stated that realistic mathematics learning was based on Hans Freudenthal's assumptions about mathematics that was “mathematics as a human activity”. Realistic mathematics education is relevance oriented between mathematical concepts and context of real-world problems and also student oriented (Lestari & Yudhanegara, 2017; Wardono & Mariani, 2018; Warsito et al., 2019). Lesnussa (2019) believed that realistic mathematics education is the best and the most effective way to learn and teach mathematics. The use of realistic mathematics education in mathematics learning has a positive effect on understanding of students' mathematical concepts (Jeheman et al., 2019). The traditional approach of learning there were more emphases on the mechanistic and memorize solutions and operations of mathematics (Riyanto et al., 2018). From the traditional approach, students solve without understanding the problem (Reusser & Stebler, 1997). Besides, some previous research shows that PMR is effective in improve mathematical ability student (Ahmad & Asmaidah, 2017; Alamiah & Afriansyah, 2017; Muhtadi & Sukirwan, 2017).

Based on the explanation above, it can be concluded that the students’ worksheet based on RME is a worksheet which contains realistic problems and must be solved by students as a source of emerging understanding of mathematical concepts. By using realistic problems, students can imagine mathematical problems in accordance with conditions that can be understood by students. In addition, Hidayat & Iksan (2015) stated that RME worksheet is the main factor in increasing students' conceptual understanding. Based on the background above, the researcher was encouraged to conduct research entitled the development of students’ worksheet based on RME for the topic circle in class VIII SMPN 01 Kota Bengkulu.

METHODS

Population and Sample

The population was the student class VIII at SMPN 01 Kota Bengkulu. The subject of this research was 35 students from class VIII.2 of SMPN 01 Kota Bengkulu academic year 2019/2020. Students at class VIII SMPN 01 Kota Bengkulu have intellectual abilities evenly and educators at this school were not optimal yet in using students’ worksheet in the learning process.

Reseach Design

Use The type of research used in this study was research and development (research and development). This study uses a modification of the Thiagrajan, Semmel and Semmel models. Thiagrajan, Semmel and Semmel in the development of learning which consists of stages namely define, design, and develop.

The stages of definition begin with (1) an initial analysis of the end, followed by (2) student analysis, (3) concept analysis, (4) task analysis, and finally, (5) the formulation of objectives. Moving on to the design stage, it encompasses (1) test preparation, (2) media selection, (3) format selection, and culminates in (4) the preliminary design (Draft 1). Finally, the development stage involves conducting both (1) a validity test and (2) a practicality test to ensure the robustness and applicability of the design.

Frame Work Flow

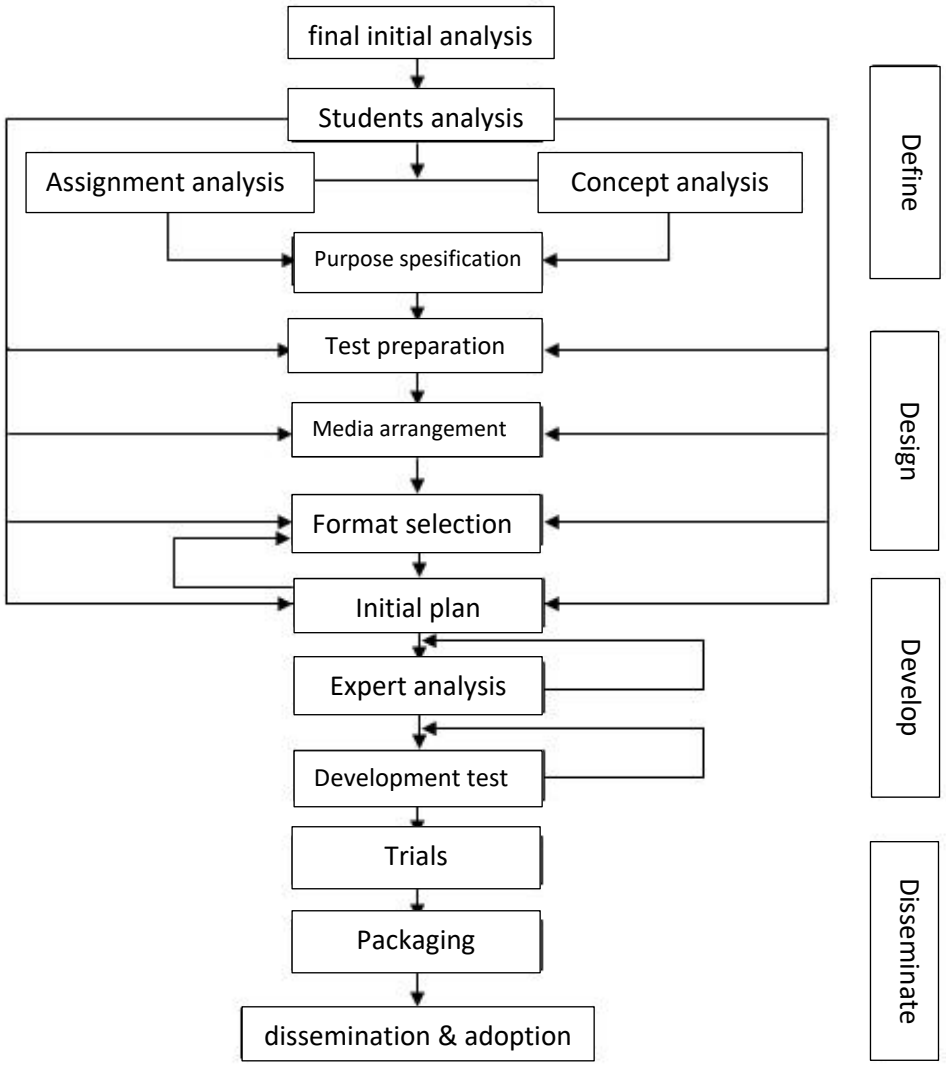


Figure 1
4-D Learning Development Model (Thiagaajan, Semmel, and Semmel in Trianto, 2011)

Data Collection and Analysis

The instruments used in this research was validity sheets and practicality sheets. These research instruments served as an assessment tool for the implementation of learning devices as well as criteria for validation and practicality so that the data generated from these research instruments can be used to revise the resulting learning media.

Validity data was obtained from the students' worksheet validity sheets which were filled in by 2 validators who gave an assessment of the validity of the material, 1 validator for construction and 1 validator for language of the students' worksheet. These data then were analyzed descriptively by taking into account the results of the validator's assessment.

The average score then was being matched to the validation average (V) with the validity criteria.

Table 1
Students' worksheet validity categorization criteria

Score Intervals	Category of Calidity
$\bar{V} > 4{,}2$	Very Valid
$3{,}4 < \bar{V} \leq 4{,}2$	Valid
$2{,}6 < \bar{V} \leq 3{,}4$	Valid Enough
$1{,}8 < \overline{V \leq} 2{,}6$	Less Valid
$\bar{V} \leq 1{,}8$	Invalid

(Adapted from Widoyoko, 2009)

Students' worksheet can be used without revision if it meets minimum at the valid criteria. If it does not meet the minimum criteria, the students' worksheet must still be revised so that it becomes valid.

The practicality analysis of students' worksheet will be carried out using practicality sheets that are assessed by mathematics educators and students. The average score then was matched to the practicality average (P) with the practical criteria of students' worksheet.

Table 2
Practicality categorization criteria

Score Intervals	Category of Practicality
$\bar{P} > 4{,}2$	Very Practical
$3{,}4 < \bar{P} \leq 4{,}2$	Practical
$2{,}6 < \bar{P} \leq 3{,}4$	Practical Enough
$1{,}8 < \bar{P} \leq 2{,}6$	Less Practical
$\bar{P} \leq 1{,}8$	Impractical

(Adapted from Widoyoko, 2009)

Students' worksheet can be used without revision if it meets minimum at the practical criteria. If it does not meet the minimum criteria, the students' worksheet must still be revised so that it becomes practical.

RESULT AND DISCUSSION

Description of test result

The validity of Students' worksheet based on realistic mathematics for the topic circle in junior high school is seen from three aspects, namely material or content aspects, construction aspects and language aspects. This material validation test was carried out by one Mathematics Teacher at SMPN 1 Bengkulu City and one Mathematics Education Lecturer at FKIP University of Bengkulu. The results of the general material validator assessment of each students' worksheet are shown in the table 3 below.

Table 3
Material Validation Score

Student' worksheet	Average Score	Category
1	4,12	Valid
2	4,37	Very Valid
3	4,41	Very Valid
4	4,335	Very Valid
Average	4,312	Very Valid

General construction validator assessment of each students' worksheet can be seen in Table 4 below.

Table 4
Construction Validation Score

Students' Worksheet	Average Score	Category
1	4,055	Valid
2	4	Valid
3	4	Valid
4	4	Valid
Average	4,014	Valid

General language validator assessment of each students' worksheet can be seen in Table 5 below.

Table 5
Language Validation Score

Students' Worksheet	Average Score	Category
1	4	Valid
2	4	Valid
3	4	Valid
4	4	Valid
Average	4	Valid

Based on the validity that has been carried out on two material validators, one construction validator and one language validator, it is found that the validated students' worksheet is declared valid with an average validation score of 4.11. The product of this stage called as draft II students' worksheet.

After the validity test was carried, the other stage of development is called as practicality test. Practicality test is a test carried out on a number of students with heterogeneous abilities on draft II students' worksheet to produce draft III students' worksheet. The practicality test was carried out on 35 students from class VIII.2 SMPN 1 Bengkulu City. Tests were conducted to see whether the designed students' worksheet was easy and practical to use. The overall average results on the practicality aspect are in Table 6 below.

Table 6
Practicality Test Score

Students' Worksheet	Practicality Data			Average	Criteria
	Observer	Teacher	Student		
1	4,57	4,28	4,52	4,46	Very Practical
2	4,57	4,36	4,55	4,49	Very Practical
3	4,78	4,36	4,50	4,54	Very Practical
4	4,78	4,43	4,51	4,57	Very Practical
Average	4,67	4,36	4,52	4,51	Very Practical

Based on Table 6 it was obtained that the average practicality score for the four students' worksheets is 4.51 including in the criteria of very practical. The results of this assessment indicate that the draft II students' worksheet is appropriate and can be used properly.

Data Analyze

The validity test was conducted using draft I students' worksheet to produce draft II students' worksheet. The material presented in the four students' worksheets was declared appropriate by the validator. The basic competency used is 3.6 Identifying the elements, circumference and area of a circle; 3.7 Identify the central angle, arc length, and sector area and their relationship; and 4.6 Resolving real problems related to the application of the relationship between the central angle, arc length, and area of the circular section. In each LKPD there are problems related to the daily life of students

Changes and improvements were made based on the results of examinations carried out by the validator. The followings were some of the improvements and changes in the students' worksheet that were not appropriate. The underlined sentence in Figure 2 was the sentence that must be revised

Apakah panjang ruas garis dari titik pusat O ke titik pada lingkaran (F, C, D, E) semuanya adalah sama? - Jawab: ..... Apakah panjang ruas garis dari titik pusat P ke titik A, G, I dan H adalah sama? - Jawab: ..... Apakah perbedaan antara lingkaran dan bukan lingkaran? - Jawab:	Do the line segments from center O to points on the circle (F, C, D, E) have the same length? Answer: Do the line segments from center point P to points A, G, I and H have the same length? Answer: What is the difference between a circle and a non-circle? Answer:

Figure 2
Questions to Find the Definition of a Circle Before Revision

According to the validator, the questions in the stage understanding the problem to find the definition of a circle through the examples and non-examples was still not accurate to guide students. Thus, the question was revised to be like the sentence in Figure 3.

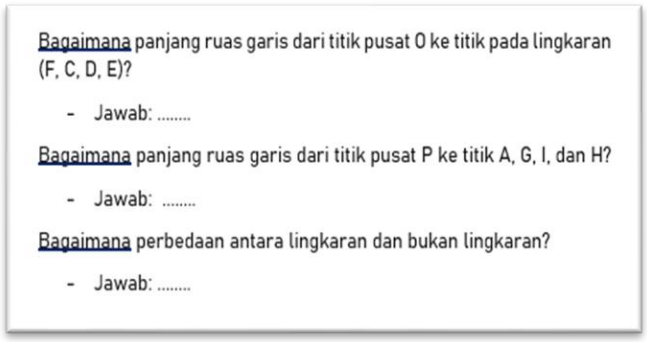
	What is the length of the line segment from the center point O to the point on the circle (F, C, D, E)? Answer: What is the length of the line segment from center point P to points A, G, I and H? Answer: How is the difference between a circle and a non-circle? Answer:

Figure 3
Questions to guide learners to find the definitions of a circle after being revised

According to the validator the question above made students become more critical in thinking, so as to develop students' ability to construct their own understanding of the definition of a circle. For this purpose, the questions in students' worksheet 1 which was guiding students to find the definition of a circle were changed to a question of how.

The next validation was for the construction part. Validation and improvement in terms of construction were carried out at a time from students' worksheet 1 to students' worksheet 4 because the construction of the four worksheets are the same. From the construction validation stages it was obtained that students' worksheet contained clear titles, basic competency, learning indicators, instructions for using students' worksheet are clear, completion time allocation for each step was appropriate, students' worksheet usage was complete, its paper size was not too big and not too small, its each page was not too dense with writing, used a clear numbering system, contained material clearly, used letters that were clearly legible, used clear frames, and it had a good combination of pictures, colors, and writing.

One of the changes happened in the cross-sectional image of a circle at the stage of understanding the problem in students' worksheet 2 shown in the Figure 4.

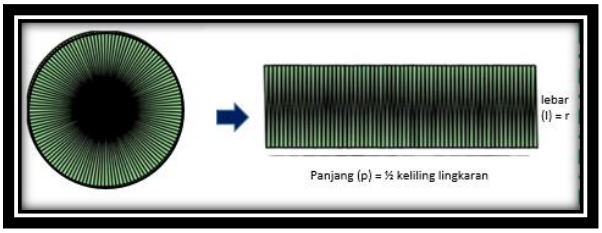


Figure 4
Cut of Circle Sector before Revision

According to the validator, the color in the image shown in Figure 4 made students lost focus and it was quite confusing so that it was necessary to change the color. Based on that suggestion, the circle sector was changed as shown in Figure 5 below.

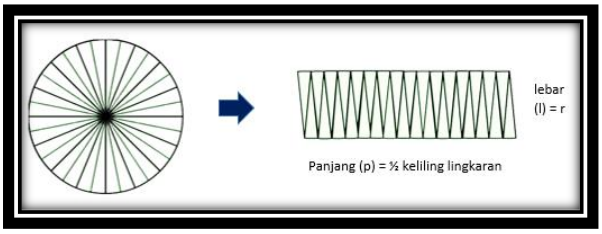


Figure 5
Cut of Circle Sector after Revision

The change was to change the wedges to white color as shown in Figure 5. In addition, the sectional pieces presented in the students' worksheet before the revision were too small so that it would confuse students, therefore a picture was replaced by using a slightly larger wedge.

Besides the material and construction validation tests, the developed students' worksheet also went through the language validation test stage. One of the changes happened in the procedure of numbering on the students' worksheet cover. Figure 6 below was a display of the numbering in the group name column before revision.

Figure 6
Group member list numbering before revision

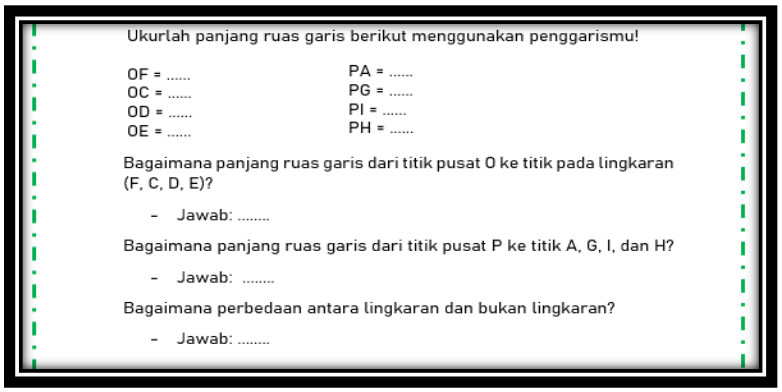
From the Figure 6 above it was known that the numbering was not in accordance with PUEBI. Each number must end with a dot sign (.). So that the numbering group members list was changed to as shown in Figure 7 below.

Figure 7
Group member list numbering after revision

The change shown in Figure 7 was in accordance with PUEBI that the dot (.) was used after numbers or letters in a chart, overview, or list. Thus, every number in the form of a list must be followed by a sign (.). The other changes were about writing the preposition "in-". Writing the preposition "di-" in students' worksheet which was not in accordance with PUEBI. It also happened to the use of words that cause sentences becoming ineffective, such as the use of the word "then" in a sentence.

From the validation stage, the validated students' worksheet was declared valid with an average validation score 4.11. The product of this stage called as draft II students' worksheet.

The next stage after validity test was called as the practicality test. From the results of observations on the learning process using students' worksheet Draft II and the results of discussions with educators, it was considered that there were some parts that needed to be corrected and got revised. The several parts of the students' worksheet that must be revised were described as follows. In the learning process using Students' worksheet 1, students were still difficult to determine the definition of a circle which was shown in Figure 8.


Ukurlah panjang ruas garis berikut menggunakan penggarismu!

OF = ...
OC = ...
OD = ...
OE = ...

PA = ...
PG = ...
PI = ...
PH = ...

Bagaimana panjang ruas garis dari titik pusat O ke titik pada lingkaran (F, C, D, E)?

- Jawab: .....

Bagaimana panjang ruas garis dari titik pusat P ke titik A, G, I, dan H?

- Jawab: .....

Bagaimana perbedaan antara lingkaran dan bukan lingkaran?

- Jawab: .....

Figure 8
Questions on Understanding the Problems of Students' Worksheet 1 before Revision

Because of the difficulty student faced in determining definition of a circle and elements of a circle based on their own understanding, the question in Figure 8 was revised as Figure 9.

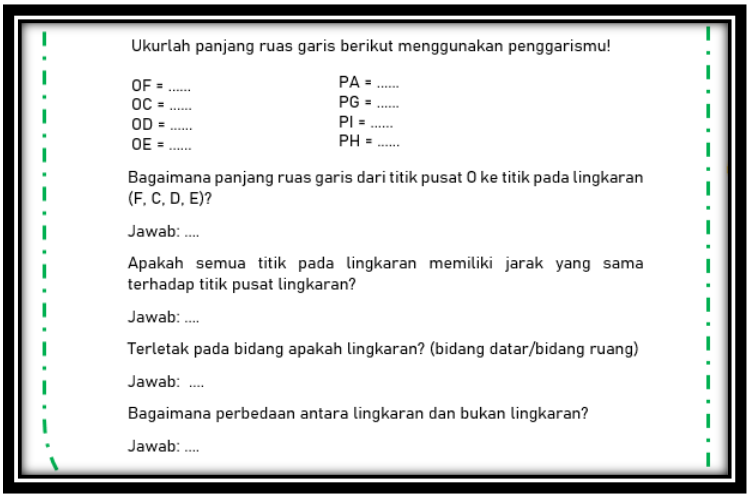


Figure 9
Questions in the Stage of Understanding Problems of Students Worksheet 1 after Revision

The changes as Figure 9 was done to make students easier to construct their own understanding about the circle and its elements definition. Another change also happened to the line of a radius in a circle shown in Figure 10.

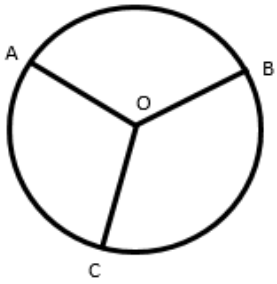


Figure 10
Thickness of Circles Radius Before Revision

Many students questioning what was the actual central angle because the thickness of the radius line in Figure 10 made students doubtful in determining the actual size of the angle. This was due to the shift and lack of precision in measuring the central angle. The change was made as Figure 11 below.

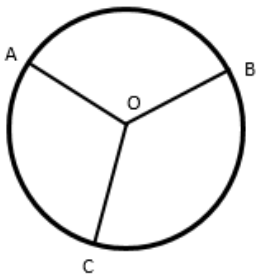


Figure 11
Thickness of the Circle Radius after Revision

The change in the thickness of the line in Figure 11 was intended so that the measurements made by students became more thorough and accurate.

From the practicality test, it is obtained that the average practicality score for the four students' worksheets is 4.51 which is included in the criteria of very practical that indicates that the draft II LKPD is appropriate and can be used properly.

CONCLUSION AND IMPLICATION

Conclusion

Students' worksheet based on realistic mathematics for the topic circle in junior high school is included in the valid category with an average score of 4.11. The validity of its students' worksheet consists of 40 aspects of assessment consisting of 12 aspects of material assessment, 20 aspects of construction assessment, and 8 aspects of language assessment. The descriptions of the validated students' worksheet are as follows: (1) This students' worksheet is in accordance with the realistic mathematics education learning stages. (2) This students' worksheet contains questions based on definitions and contains examples/non-examples to guide students in finding definitions or formulas. In addition, the students' worksheet also contains pictures that support the steps to find and construct the concept. (3) This students' worksheet contains text in an easy-to-read font, has attractive color combinations and pictures and is in accordance with the context of the students' worksheet. (4) This students' worksheet uses simple sentences, is effective, easy to understand, and is in accordance with PUEBI.

Students' worksheet based on realistic mathematics for the topic circle in junior high school is included in the very practical category with an average score of 4.51. This is known through practicality tests which show that the students' worksheet is easy to use because the problems in the worksheet are easy to understand to find concepts, use letters and text that are easy to read, effective sentences, use language that is easy to understand and does not cause double interpretations, and uses pictures/illustrations that are clear and in context on students' worksheet. Therefore, the developed students' worksheet is easy to understand and does not make students experience difficulties when using the worksheet.

Implication

Based on the results of the development research of students' worksheet based on RME on circle material in class VIII SMPN 01 Bengkulu City, the following suggestions are suggested.

1. Students' worksheet for the junior high school level and equivalent should contain illustrations of various activities that are often encountered in everyday life so that it can students easier to work in the process of understanding and discovering concepts.
2. The tools that will be used by students during learning activities should be delivered by the teacher the day before the learning activities take place and the teacher should bring backup tools. This is done to anticipate the possibility that there will be groups that do not bring aids.
3. Numbers used in students' worksheet to help students find the concepts should be numbers that are easy to process and calculate, so that students do not need a lot of time to count existing numbers.

Disclosure statement

No potential conflict of interest was reported by the authors.

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