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### RESEARCH ARTICLE

#### THE DEVELOPMENT OF STUDENT WORKSHEETS BASED ON REALISTIC MATHEMATICS EDUCATION TO IMPROVE THE SIXTH GRADE STUDENTS' CRITICAL THINKING ABILITY ON THE MATERIAL OF COUNTING FRACTION OPERATIONS

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#### Abstract

Mathematics has an important role at every level of education and is a means of solving problems in life. Mathematics will increasingly provide benefits with the support of the ability to think logically-reflective to make rational decisions that are believed to be true. Student worksheets as a learning medium can combine mathematics and critical thinking skills in learning. This study was aimed to produce student worksheets based on realistic mathematics education to improve students' critical thinking skills that are valid, practical and effective. The research was conducted by using Borg & Gall's R&D design, but only eight steps were taken, in the form of preliminary research, development planning, initial product design development, initial product validation, initial product revision, trial use, product development revision and effectiveness testing product. The research subjects were 58 grade VI students of SDN Sumberagung 01 Jember. The data were collected by using documentation, interview, product validation, and test learning outcomes. After the data were collected, the data were analyzed by using the following techniques: product validation, t-test, and relative effectiveness test. The results of the study stated that the validity of the student worksheet development product showed 93.96% (very worthy), the productivity of the student worksheet product showed 74.71% (practical), the field test results showed that the worksheet product from this study was more effective than with the previous product, and the relative effectiveness level obtained was 62.57% (high effectiveness). Thus, it can be concluded that the product of developing student worksheets based on realistic mathematics education can improve students' critical thinking skills on the fraction counting operation material.

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#### Introduction:-

Mathematics is one of the basic subjects that has an important role at every level of formal education. Mathematics is used and needed in every movement of human life. Mathematics is needed as a tool that can clarify and simplify a situation through abstraction, idealization, and / or generalization to solve various problems that arise in life.

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Mathematics learning in elementary school is the foundation for basic concepts for continuing learning at the next level. Early mastery of mathematics will greatly influence the mastery and creation of technology in the future. Proving the function and benefit of mathematics directly is a little more difficult, but we all agree that mathematics is used in all aspects of life.

In fact, the ideal situation conveyed above is not yet fully occurred in SD Negeri Sumberagung 01, Sumberbaru, Jember Regency. According to observations and brief interview with teachers, it shows that there has not been a maximum fulfillment of education services. Many teachers are still not maximal in presenting learning, in terms of planning, implementation, and the assessment stage. In addition, learning resources are still not varied and do not really accommodate the characteristics of students and material characteristics. This situation is one of the reasons why students' critical thinking skills have not developed optimally. Furthermore, student enthusiasm and motivation to learn is reduced which affects student learning outcomes.

Based on that fact, researchers desired to improve it. Thus, the researchers compiled a learning instrument in the form of student worksheets. The researchers consider to use student worksheets based on realistic mathematics education because students will get closer to the material. Therefore, the absorption both in the process and learning outcomes will be better, and it will increase.

The concept of realistic mathematics education emphasizes that mathematics is a human activity and mathematics must be connected significantly to the context of students' daily lives. Realistic mathematics education is implemented by placing students' realities and experiences as the starting point for learning. Realistic mathematics education requires students to be more sensitive in the application of mathematics in solving problems. The habit of finding solution to a learning problem using realistic mathematics education is expected to be carried out by students when they solve the problems in their lives.

The ability to think critically is very important in learning and in life because it can help students solve problems both in mathematics and in everyday life. Ennis (as quoted in Suatini, 2019: 42), "Critical thinking is logical and reflective thinking that aims to make decisions that are rational and are believed to be true". With the ability to think critically in mathematics, it can lead students to achieve learning goals optimally, and be able to solve problems through understanding after carrying out learning. Snyder (Haryani, 2019), "Critical thinking will improve students' ability to solve math problems in a deeper way". There are three important reasons for critical thinking, as stated by Jannah, Isrok'atun, and Sunaengsih (2017). Second, every individual must be faced with a problem and choice, the problem requires individuals to think critically in solving problems and determining solutions. And third, critical thinking is an aspect of solving the individual problems in order to compete fairly, and to create nuances of good and fair cooperation.

Based on the description above, the problem formulations in this study are as follows: (1) how do teachers develop student worksheets based on realistic mathematics education to improve students' critical thinking skills? (2) How do the validity, practicality, and effectiveness of student worksheets based on realistic mathematics education improve students' critical thinking skills?

From the formulation of the problems mentioned above, the research objectives are as follows: (1) Producing student worksheets based on realistic mathematics education to improve students' critical thinking skills, (2) Proving the validity, practicality, and effectiveness of students' worksheets based on realistic mathematics education to improve students' critical thinking skills.

The benefits of research are: (1) able to provide an illustration that students' critical thinking skills can be improved by using realistic mathematics education-based worksheets, (2) Increasing learning outcomes and students' critical thinking skills regarding a problem through realistic mathematics education-based student worksheets, (3) able to provide benefits for teachers related to the use of realistic mathematics education based student worksheet development in increasing students' critical thinking skills, (4) As input for school principals to motivate teachers in developing student worksheets to be more effective and efficient, so that the quality of learning, student learning outcomes, and higher-order thinking skills can be increased, (5) the results of this study can be used as a reference for consideration in increasing positive motivation in educational, (6) As a learning instrument for researchers to integrate knowledge and skills directly, so that they can see, feel, and appreciate whether the learning practices carried out effectively and efficiently, and (7) as a source of information and reference for other researchers in

developing research and fostering a culture of research, so that learning innovations occur, especially related to student worksheets.

### Research Method:-

The used research design in this research was the development research of Borg & Gall. Masyhud (2016: 227) reveals 10 steps of Borg & Gall's development research, namely (1) preliminary research, (2) product development planning, (3) development of initial product design, (4) product design validation, (5) design revision of initial product, (6) usage trial, (7) product design revision, (8) effectiveness trial, (9) final product and mass product, and (10) product dissemination and implementation. However, in this research, only eight steps were carried out, or it was accurately called the modification of the Borg & Gall development research steps. The design was administered because the last two steps require collaboration from stakeholders with other parties who are not the authority of the research. In addition, achieving the last two steps requires a relatively long period of time and the funding in this study also could not be accommodated.

The research subjects were students in class VIA and class VIB at Sumberagung 01 public elementary school, Sumberbaru sub-district, Jember district, in 2020/2021 academic year. The members of the VIA class were 35 students, while the VIB class members were 23 students.

According to Sugiyono (2014), a research instrument is a tool used to measure observed natural and social phenomena. Therefore, in this research, a research instrument was needed for collecting research data. The instruments used were (1) preliminary research instrument, (2) validity instrument, (3) accessibility instrument, (4) effectiveness instrument, and (5) critical thinking skills instrument. The research data collection technique was carried out by several techniques, namely observation, interview, filling out questionnaire, and learning outcome test.

The data analysis methods used were: (1) product validity analysis, (2) t-test analysis, and (3) relative effectiveness analysis. The data analysis technique formulas are as follows.

### Analysis formula of product validity (Valpro):

The analysis formula of product validity was used to determine whether the initial product from the development research results was eligible to be tested or not. The product analysis formula is as follows:

$$Valpro = \frac{srt}{smt} \times 100$$

Where

Valpro = Product validity

srt = Achieved real score

smt = Achieved maximal score

The decision on the product validity calculation result was based on the criteria in table number 1 as follows

**TableNo. 1:-** Criteria table of validity comparison.

| Percentage | Category    |
|------------|-------------|
| 81 – 100   | Very worthy |
| 61 – 80    | Worthy      |
| 41 – 60    | Enough      |
| 21 – 40    | Less worthy |
| 0 - 20     | Not worthy  |

(Masyhud, 2016:243)

### t-test formula

The t-test formula was used to determine whether the results of developing the final product were more effective than the previous product. It was done through trial with 2 groups. The t-test formula used is as follows:

$$t = \frac{M_2 - M_1}{\sqrt{\frac{\sum x_1^2 + \sum x_2^2}{N(N-1)}}}$$

Where::

- M-1 = Mean score of group X<sub>1</sub> (experimental group)  
 M-2 = Mean score of group X<sub>2</sub> (control group)  
 x-1 = Deviation of each X<sub>1</sub> score from the mean of X<sub>1</sub>  
 x-2 = Deviation of each X<sub>2</sub> score from the mean of X<sub>2</sub>  
 N = Number of research subject/sample

(Masyhud, 2015)

### 1. Relative effectiveness analysis

The relative effectiveness formula was used to determine how much the relative effectiveness of this research product which was compared to the previous product's effectiveness.

$$ER = \frac{MX1-MX2}{\left(\frac{MX1+MX2}{2}\right)} \times 100\%$$

Masyhud, 2016

Where:

- ER = Relative effectiveness of an action compared to another action  
 MX1 = The mean in the class with the new revised product of LKPD  
 MX2 = The mean in the class with the initial product of LKPD

The decision on the results of calculating the relative effectiveness is based on table Number 2 as follows:

**TableNo. 2:-** Criteria table of effectiveness comparison.

| Percentage | Category                |
|------------|-------------------------|
| 81% – 100% | Very high effectiveness |
| 61% – 80%  | High effectiveness      |
| 41% – 60%  | Enough                  |
| 21% – 40%  | Low effectiveness       |
| 0% – 20%   | Very low effectiveness  |

(Masyhud, 2016:254)

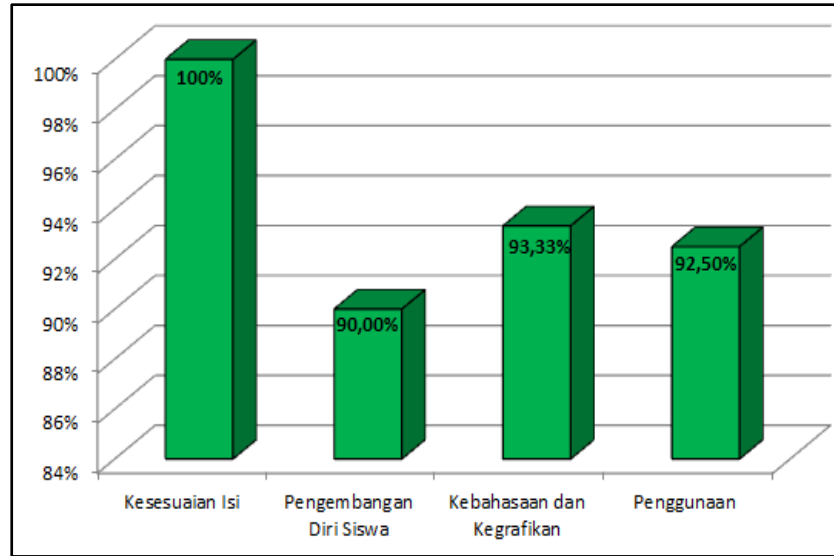
## Results And Discussion:-

### Product design validity

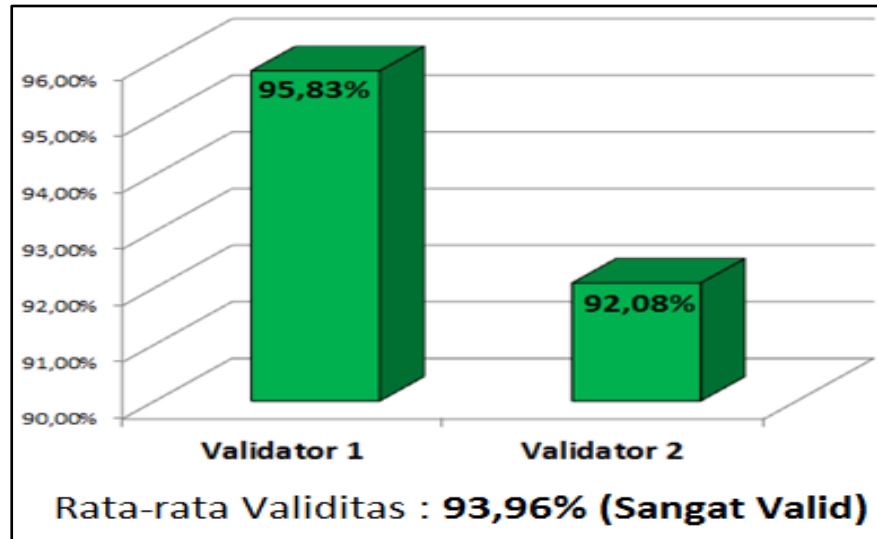
Validation carried out by the validator included several aspects of the worksheet validity. These aspects are content suitability, suitability with student self-development, linguistic and graphic, as well as appropriateness of use. In these aspects of validation, each aspect contains indicators aimed at exploring whether or not the initial product of the resulting student worksheet is valid.

**Table No .3:-** The validity recap of the student worksheet development product.

| No                   | Validity aspect                           | Percentage    |               | Average       | Description |
|----------------------|---|---------------|---------------|---------------|-------------|
|                      |   | V1            | V2            |               |             |
| 1                    | content suitability                       | 100,00%       | 100,00%       | 100,00%       | Very valid  |
| 2                    | suitability with student self-development | 93,33%        | 86,67%        | 90,00%        | Very valid  |
| 3                    | linguistic and graphic                    | 100,00%       | 86,67%        | 93,33%        | Very valid  |
| 4                    | appropriateness of use                    | 90,00%        | 95,00%        | 92,50%        | Very valid  |
| <b>Total average</b> |   | <b>95,83%</b> | <b>92,08%</b> | <b>93,96%</b> | Very valid  |



Picture1:- Recap of the initial product validation of students' worksheets.



Picture 2:- Recap of the initial product validation of students' worksheets by two validators.

Based on the research results of the above calculation, the validity of the development of student worksheets based on realistic mathematics education that can improve students' critical thinking skills is in the Very Valid or Very Worthy categories.

**Practicality of product design**

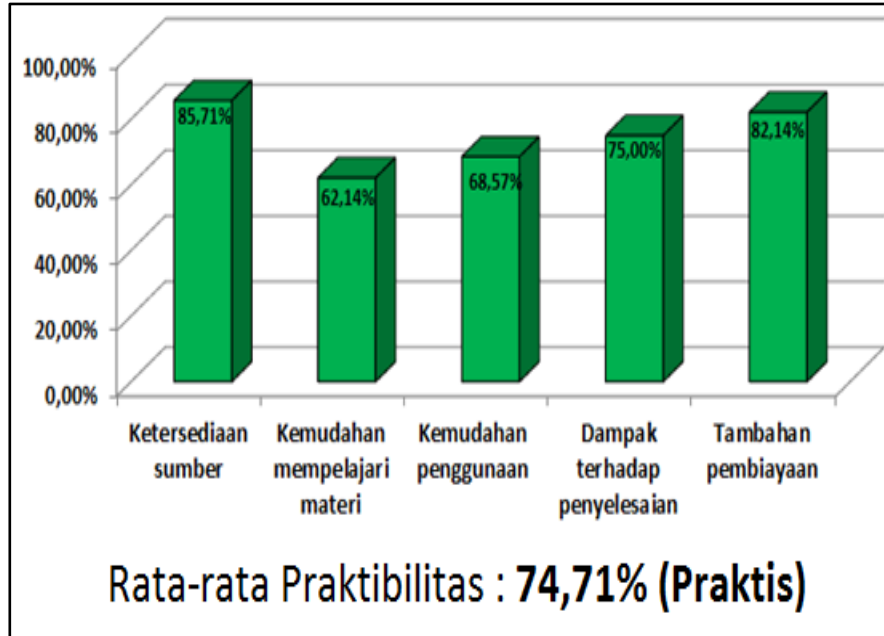
The following table is the result of filling in the practicability questionnaire sheet that has been carried out by students.

Table 4:- The practicality recap of student worksheet development product.

| No | Practicality Aspect                            | Percentage | Description    |
|----|--|------------|----------------|
| 1  | Availability of sources in a worksheet         | 85,71%     | Very practical |
| 2  | Ease of studying the material in the worksheet | 62,14%     | Practical      |
| 3  | Ease of use of worksheets                      | 68,57%     | Practical      |
| 4  | The impact of the worksheet on problem solving | 75,00%     | Practical      |

|                      |  |               |                  |
|----------------------|--|---------------|------------------|
| 5                    | Additional financing to support worksheets | 82,14%        | Very practical   |
| <b>Total average</b> |  | <b>74,71%</b> | <b>Practical</b> |

The following is a bar chart presentation of product practicality for the development of student worksheets based on realistic mathematics education that can improve students' critical thinking skills.



Picture 4:- The practicality recap of student worksheet development product.

Thus, it can be concluded that the students'worksheets based on realistic mathematics education which can improve students' critical thinking skills have fulfilled the elements of practicality.

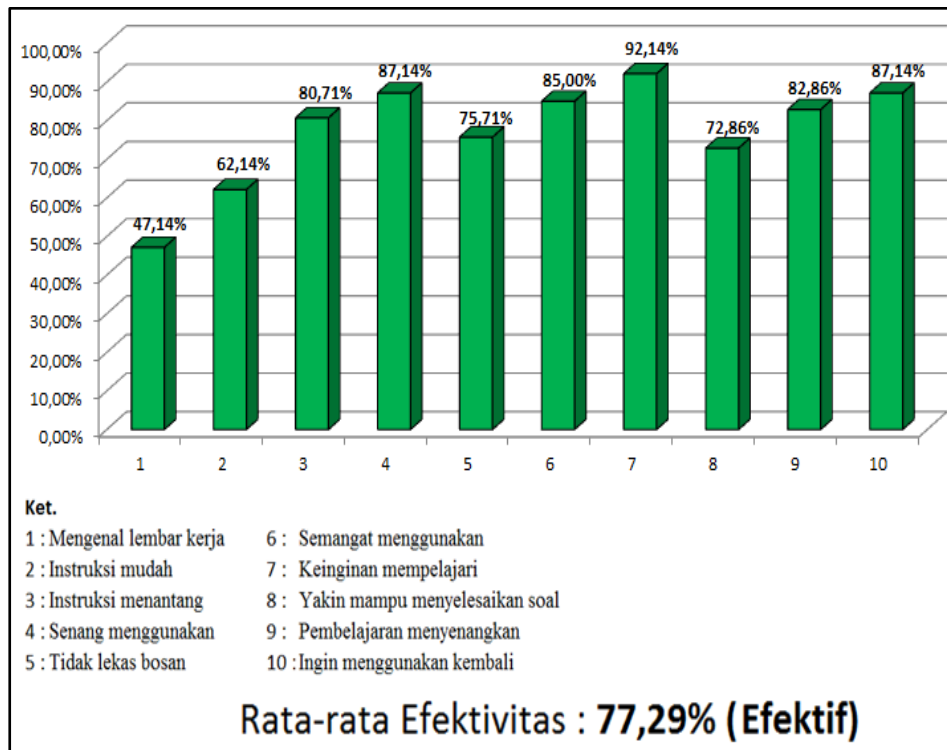
#### Effectiveness of product design

The following table is the result of filling out the effectiveness questionnaire sheet that has been filled in by students.

Table 5:- The effectiveness recap of product development worksheets for students.

| No                   | Effectiveness Aspect  | Percentage    | Description |
|----------------------|---|---------------|-------------|
| 1                    | Introduction of student worksheets                                      | 47,14%        | Fair        |
| 2                    | Feel easy when executing worksheet instructions                         | 62,14%        | High        |
| 3                    | Feel challenged when carrying out worksheet instructions                | 80,71%        | High        |
| 4                    | Have fun using worksheets   | 87,14%        | Very high   |
| 5                    | Feel bored easily when using worksheets                                 | 75,71%        | High        |
| 6                    | Feel excited when using worksheets                                      | 85,00%        | Very high   |
| 7                    | Strong desire to study more material                                    | 92,14%        | Very high   |
| 8                    | Feel confident that you can solve the problem after using the worksheet | 72,86%        | High        |
| 9                    | Find the learning more enjoyable with worksheets                        | 82,86%        | Very high   |
| 10                   | Feel like using the worksheet in the next lesson                        | 87,14%        | Very high   |
| <b>Total average</b> |   | <b>77,29%</b> | <b>High</b> |

The average of these ten aspects becomes the effectiveness level of student worksheet development product based on realistic mathematics education after being compared with the comparison table. With the following diagram presentation, it will further explain the effectiveness of the worksheet development product.



Picture 5:- The effectiveness recap of student worksheet development products.

The formula for the relative effectiveness level which is used to calculate the relative effectiveness is using the formula from M. SulthonMasyhud. The calculation result shows the percentage of 62.57%. Based on the results that have been shown, then if it is compared with the table of effectiveness comparison, it shows that it is in the category of "High Effectiveness". Based on the research results and calculation results, it can be concluded that the student worksheets based on realistic mathematics education which can improve the critical thinking skills of these students have high effectiveness.

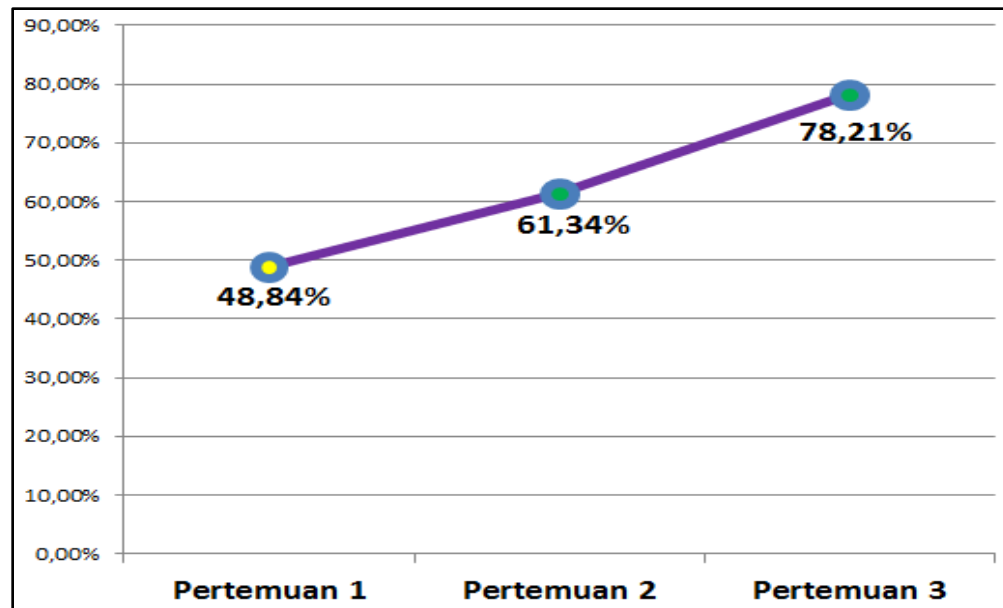
$$ER = \frac{MX1 - MX2}{\left(\frac{MX1 + MX2}{2}\right)} \times 100\% = \frac{87,34 - 45,71}{\left(\frac{87,34 + 45,71}{2}\right)} \times 100\% = \frac{41,63}{66,53} \times 100\% = 62,57\%$$

Increasing students' critical thinking skills is the impact of the use of student worksheet development product based on realistic education methods that are presented together in the form of table and graph.

Table 6:- The enhancement of students' critical thinking skills.

| No | Observed Aspect                         | Meeting |        |        |
|----|---|---------|--------|--------|
|    |   | 1       | 2      | 3      |
| 1  | Analyzing the problem                   | 52,86%  | 63,57% | 87,86% |
| 2  | Focusing the problem                    | 60,00%  | 67,14% | 83,57% |
| 3  | Looking for troubleshooting information | 60,71%  | 71,43% | 82,14% |
| 4  | Communicating problems                  | 35,71%  | 42,14% | 68,57% |
| 5  | Giving an opinion on a problem topic    | 32,14%  | 52,14% | 64,29% |
| 6  | Appreciating different opinions         | 64,29%  | 76,43% | 85,71% |
| 7  | Providing alternative solutions         | 35,00%  | 42,14% | 63,57% |
| 8  | Choosing the right solution             | 50,00%  | 75,71% | 90,00% |

|               |        |        |        |
|---------------|--------|--------|--------|
| Total average | 48,84% | 61,34% | 78,21% |
| Ability Level | Fair   | High   | High   |



Picture 6:- Graph of enhancement of students' critical thinking skills.

Thus, it can be concluded that the product of developing student worksheets based on realistic methods of education can improve students' critical thinking skills.

### Conclusion And Suggestion:-

Based on the research results as described in the previous section, the following conclusions can be made: (1) The validity of student worksheet development based on realistic mathematics education to improve critical thinking skills showed a percentage of 93.96% (very worthy). The practicality of developing student worksheets based on realistic mathematics education to improve critical thinking skills showed a percentage of 74.71% (practical). The effectiveness of student worksheet development products based on realistic mathematics education to improve critical thinking skills showed a percentage of 62.57% (high effectiveness)., and (2) The product of developing student worksheets based on realistic mathematics education was proven to be able to improve students' critical thinking skills.

Based on the results of the research above, some suggestions can be made as follows: (1) In connection with the results of the development of student worksheets that have met the elements of validity, practicality and effectiveness, it is advisable to consider the policy of accommodating mass production and wider implementation, (2) The product development of student worksheets can be carried out by accommodating various basic approaches in accordance with the characteristics of the material and the characteristics of students, and (3) Based on the discussion on the advantages and disadvantages of the product, it is suggested for further studies to pay more attention to aspects that become weaknesses in the elements of validity, practice, and effectiveness.

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