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Development of Student Worksheet Based on POE (Predict-Observe-Explain) Model to Students Mathematical Problem Solving Skills

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ABSTRACT

This study aims to develop student worksheet products based on the POE (Predict-Observe-Explain) model for student mathematical problem solving skills on quadrilateral topic that are valid, practical, and effective. This study uses the R&D method and the model used ADDIE. Validity is calculated based on the validation sheet. The average percentage obtained from material experts is 80% with a valid category, while the average percentage obtained from media experts is 81.33% with a very valid category. Practically is calculated based on response sheet. The average percentage obtained from students responses is 83.35% with a very practical category, while the average percentage obtained from teacher responses is 75.65% with a practical category, Effectiveness is calculated based on problem solving skills tests. Students who get a score that qualify the minimum completeness criteria is 75 will be considered complete. Amount of students who completed is 24 of 33 and got a completeness percentage 72.73% with an effective category so that the student worksheet can be used as teaching material.

A. INTRODUCTION

Mathematics is a very meaningful subject matter contained in the education system, this makes mathematics provide something that can help us think logically, rationally, critically and broadly (Astuti and Sari, 2017). Mathematics education plays an important role in everyone's life because mathematics cannot be separated from everyday life, because this is why mathematics must be given to all students from elementary school onwards (Widiastuti and Zahari, 2018). Learning mathematics cannot be separated from problems, in learning mathematics students are asked to solve a problem according to mathematical concepts. Problem solving skills is certainly something that is needed by students in studying mathematics at school because it is useful for training students to use their minds and reasoning in making conclusions (Sumartini, 2016).

However, the biggest obstacle for students lies in their inability to solve math problems (Andelinawati et al., 2022). The reason is that mathematics material is relatively abstract, making students ability to solve problems in mathematics also relatively low. The facts are proven through the results of Indonesia's PISA (Program for International Student Assessment where in 2018, Indonesia's mathematics ability category obtained an average score of 379 which resulted in Indonesia being ranked 73rd out of 79 countries (Schleicher, 2019). That is why it is important to improve students mathematical abilities, because the advantage is that students master this ability so that students can grow their ability to analyze problems related to math problems (Falenti, 2019). But of course this requires extra effort so that students learning activities achieve the best condition. Teaching activities require tools to convey the material being studied, it can be in the form of textbooks, student worksheet and other media that assist teachers in conveying material, of course teaching materials need to be in line with knowledge (Mawadah, 2021).

Student worksheet are considered part of the learning component and are often used in teaching and learning activities in schools. Abdul Majid in (Mariyana et al., 2018) revealed that in fact the student worksheet which is usually given to students so far has not supported the formation of understanding for the students themselves. Therefore, in carrying out teaching activities, an appropriate learning model is needed, which is not only suitable, but can also provide interesting learning. Therefore, the use of learning models must also be considered. Of the many models of learning mathematics, there is a model that is fairly well implemented,

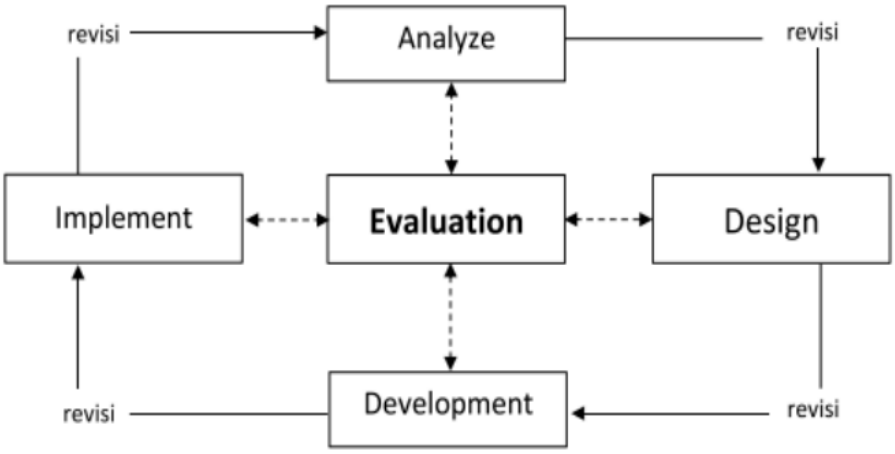
namely learning POE (Predict-Observe-Explain). The reason is because the POE learning model contains efficient steps to create student participation in exploring mathematics (Budiono et al., 2018).

The explanation of the problems mentioned above became something that made authors interested in developing student worksheet based on POE (Predict-Observe-Explain) model to students mathematical problem solving skills. The aim of this research is to find out the feasibility of student worksheet by testing the validity, practicality and effectiveness of student worksheet.

B. RESEARCH METHODS

Research and Development (R&D) is the choice for authors as a method for developing products. Sugiyono in (Abdillah and Astuti, 2020) stated that R&D itself is a method that is intended to produce a kind of product and then the results are first tested for the effectiveness of the product. As well as the five stage ADDIE model being the model used in this research. The research was held at Junior High School 7 Serang City. The research time starts on October 7 2022 until October 14 2022 with a total of 3 meetings. Class VIII at Junior High School 7 Serang City who have accepted the quadrilateral topic will be selected as research subjects

Next, in the development model, ADDIE is the model of choice used by authors. Sugiyono in (Noviyanti and Gamaputra, 2020) argues that the ADDIE development model stands for Analyze, Design, Development, Implementation, Evaluation which refers to the main process or technique of developing a learning system. The choice of the ADDIE model is inseparable from the main reason because the development process with the ADDIE stages is carried out with several expert team tests and revisions, the aim is to make the final product more perfect even though in the end of development procedure the proper product standards, also tested empirically and there is no return error (Cahyadi, 2019). The ADDIE stages are schematized by Branch in (Hidayat et al., 2021) as a learning system design is contained in Picture 1 below.



Picture 1. ADDIE's Development Model Stages

There are 3 kinds of instruments that will be used as research material, namely validation sheet, response sheet, and problem solving skills test sheet. Acquisition of data and results from each instrument will be calculated and analyzed to determine the results of the scores and criteria obtained from each instrument sheet.

1. Validity Analysis

Student worksheet validity analysis was carried out based on the results of the expert validation sheet, in this research there were two validation sheet used, namely for material experts and media experts. The validity calculation will refer to the Likert scale with a scale of 1-5, while the formula and criteria for calculating validity are:

$$r = \frac{\sum x}{\sum X} \times 100\%$$

Information:

r = results of validity percentage

$\sum x$ = total score obtained

$\sum X$ = maximum total score

There are also criteria for calculating validity with the above formula listed in table 1 below:

Table 1. Criteria for Validity Test Results of Student Worksheet

Intervals	Category
$80\% < r \leq 100\%$	Very Valid
$60\% < r \leq 80\%$	Valid
$40\% < r \leq 60\%$	Quite Valid
$20\% < r \leq 40\%$	Less Valid
$0\% < r \leq 20\%$	Not Valid

2. Practicality Analysis

Student worksheet practicality analysis was carried out based on the results of the response sheet, there were two response sheet used, namely the teachers response sheet and the students response sheet. Practicality analysis calculations also refer to the Likert scale with a scale of 1-5, the formula used is listed below:

$$p = \frac{\sum x}{\sum X} \times 100\%$$

Information:

p = results of practicality percentage
$\sum x$ = total score obtained
$\sum X$ = maximum total score

There are also criteria for calculating practicality with the above formula listed in table 2 below:

Table 2. Criteria for Practicality Test Results of Student Worksheet

Intervals	Kategori
$80\% < p \leq 100\%$	Very Practical
$60\% < p \leq 80\%$	Practical
$40\% < p \leq 60\%$	Quite Practical
$20\% < p \leq 40\%$	Less Practical
$0\% < p \leq 20\%$	Not Practical

3. Effectiveness Analysis

Student worksheet effectiveness analysis is carried out based on the results of the problem solving skills tests that students work on. The scores obtained will then be processed based on the guidelines for scoring mathematical problem solving skills (Astutiani et al., 2019). The guidelines are listed in table 3 below:

Table 3. Guidelines for Scoring Mathematical Problem Solving Skills

No	Indicators	Student Activity	Score
1	Understand the problem	Students write down thins that are known from the problem	
		Students not write down things that are known	0
		Students write down things that are known, but wrong	1
		Students write down things that are known correctly but incomplete	2
		Students write down things that are known completely and correctly	3
		Students write down the things that are asked of the problem	
		Students not write down the things that are asked	0
		Students write down the things that are asked, but wrong	1
		Students write down the things that are asked correctly but incomplete	2
		Students write down the things that are asked completely and correctly	3
2	Planning settlement	Students not make a settlement plan	0
		Students make plan for completion but lead to wrong answers	1
		Students make plan that leads to correct answers but is incomplete	2
		Students make plan completely and leads to correct answers	3
3	Solving problems	Students not write down the completion	0
		Students write completion but the procedure is not clear	1

	according to plan	Students write completion that lead to correct answers but wrong in solving	2
		Students write the correct procedures and get the correct results	3
4	Recheck answers	Students not write the conclusions	0
		Students can write conclusions but are not precise	1
		Students can write conclusions but are almost complete	2
		Students can write conclusions completely and correctly	3

Then the formula for calculating the problem solving skills test score is contained below:

$$t = \frac{\sum x}{\sum X} \times 100\%$$

Information:
t = results of problem solving skills score
$\sum x$ = total score obtained
$\sum X$ = maximum total score

There is also a formula for calculating the level of effectiveness contained below:

$$e = \frac{e_1}{e_2} \times 100\%$$

Information:
e = results of effectiveness percentage
e_1 = number of students who completed
e_2 = total students

The formula above is intended to identify the category of effectiveness obtained from student worksheet, in which category determines the level of effectiveness of student worksheet, for the categories listed in table 4 below:

Table 4. Criteria for Efectiveness Test Results of Student Worksheet

Intervals	Category
$80\% < e \leq 100\%$	Very Effective
$60\% < e \leq 80\%$	Effective
$40\% < e \leq 60\%$	Quite Effective
$20\% < e \leq 40\%$	Less Effective
$0\% < e \leq 20\%$	Not Effective

C. RESULT AND DISCUSSION

1. Analyze

The first stage is the analyze stage. The results of the analyze stage are obtained from interviews with mathematics teachers. In this research, the analyze stage contains two parts, namely curriculum analysis and needs analysis. From the results of the interviews, information regarding the curriculum used and the needs of student at Junior High School 7 Serang City could be obtained. From the results of observations through interviews with mathematics teachers, Junior High School 7 Serang City has implemented the 2013 curriculum in the learning process. In the curriculum analysis section, authors identified basic competencies and competency achievement indicators in quadrilateral material needed to develop student worksheet. basic competencies and competency achievement indicators that have been identified are listed in table 5 below:

Table 5. Basic Competency and Competency Achievement Indicator Quadrilateral Material

Basic Competency	Competency Achievement Indicator
1. Relate the formulas for perimeter and area for various types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite) and triangles	1.1. Explain the definition of quadrilateral 1.2. Identify the types and properties of quadrilateral 1.3. Determine the area and perimeter of the quadrilateral
2. Solving contextual problems related to the area and perimeter of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite) and triangles	2.1 Solving contextual problems related to the area and perimeter of quadrilaterals

As for the needs based on what was expressed by the mathematics teacher at Junior High School 7 Serang City, it requires learning media such as student worksheet which can support students mathematical skills, previously the use of student worksheet actually existed, but the implemented in schools did not fully support mathematical problem solving skills students, plus the student worksheet presented is limited to student worksheet in the form of ordinary questions and does not use any model. Because this makes student worksheet based on the POE model needed, the reason is because this developed student worksheet can provide a different learning experience, coupled with the POE model certainly supports students mathematical problem solving skills.

2. Design

The drafting of the students worksheet that will be developed is what is done at this design stage. This stage includes the preparation of references that will be a source for the selected topic of discussion, namely the quadrilateral topic of discussion, the references taken are also adjusted to the core competency, basic competency, and competency achievement indicators that have been prepared at the analyze stage. Furthermore, authors also develop product designs, The designed student worksheet includes the students worksheet includes the student worksheet cover, preface, table of contents, instructions for using worksheet, supporting informations, core competency, basic competency, and competency achievement indicators, learning objectives, materials, questions and student activities, conclussions, researcher biodata, and references. This design is made in the form of a storyboard to facilitate the development that will be carried out at a later stage.

3. Development

This stage contains steps for student worksheet development and validation. Student worksheet development is carried out by following the design in the form of a storyboard which made in the previous stage, then from the storyboard it is developed in such a way that a POE model based student worksheet is formed which will then go through validation steps before being implemented.

The validation in this study consisted of material expert validation and media expert validation, each expert consisting of one lecturer and one mathematics teacher. The following are the results of the validation of material experts and media experts listed in the table 6 and 7 below:

Table 6. Material Expert Validation Results

No	Assessment Aspects	Validators	
		1	2
1	Didactic	19	18
2	POE (Predict-Observe-Explain) Model	17	15
3	Mathematical Problem Solving Skills	16	16
4	Construction	20	23
	Total Score	72	72
	Validity Percentage	80%	80%
	Validity Category	Valid	Valid
	Average Percentage	80%	
	Overall Category	Valid	

Table 7. Media Expert Validation Results

No	Assessment Aspects	Validators	
		1	2
1	Worksheet Design	27	30
2	Technical	30	35
	Total Score	57	65
	Validity Percentage	76%	86.67%
	Validity Category	Valid	Very Valid
	Average Percentage	81.33%	
	Overall Category	Very Valid	

After the validity category is determined, suggestions for improvement and comments based on the provision of the validator are also considered by the researcher.

4. Implementation

The implementation stage is to try out the student worksheet that has been developed and validated in the research destination school. Class VIII F is the selected class with a total of 33 students and the implementation stage is carried out to determine the level of practicality and level of effectiveness of the developed student worksheet.

The implementation of the student worksheet will be carried out for 3 meetings, the 3 meeting will be divided into the first and second meetings, namely the student worksheet trials, as well as providing student response sheet and teacher response sheet aimed to knowing the practicality level of student worksheet. Meanwhile for the third meeting, namely giving test sheet for mathematical problem solving skills on quadrilateral material which is intended to determine the level of effectiveness of student worksheet.

5. Evaluation

Assessment of the results of student responses and teacher responses, then assessment of the results of tests of mathematical problem solving skills are things that are done at this stage. Student response sheet were given to 33 class VIII F students of Junior High School 7 Serang City, while teacher response sheet were given to two mathematics teachers at Junior High School 7 Serang City.

Practicality of student worksheet gets very practical category after going through calculations using the practicality calculation formula, as evidenced by the results obtained, with average percentage 83.35%. Referring to table 2 in the form of practicality criteria, this percentage clearly proves that student worksheet is very practical based on student responses.

Another response that is also very important from the teacher, the aspects that are used as a reference for student worksheet assessments are the benchmark for this assessment. The results are listed in table 8 below:

Table 8. Results of Teachers Response Sheet

No	Aspects Assessments	Teachers		Information	Teachers	
		1	2		1	2
1	Didactic	23	24	Total Score	87	87
2	POE Model	16	16	Practicality Percentage	75.65%	75.65%
3	Construction	16	16	Practicality Category	Practical	Practical
4	Worksheet Design	12	11	Average Percentage	75.65%	
5	Technical	20	20	Overall Category	Practical	

Next, the mathematical problem solving skills test sheet was given to 33 students with total of 3 questions and the maximum score is 100. Students must get a score ≥ 75 to be considered complete because that is minimum completeness criteria at Junior High School 7 Serang City in mathematics subject. To recap the results of the assessment of the mathematical problem solving skills test listed in table 9 below:

Table 9. Results of Students Effectiveness

Total students who complete	24
Total students	33
Students Completeness Percentage	72.73%
Effectiveness Category	Effective

Referring to the research results, the feasibility of developing student worksheet has been tested with the help of validators, teachers, and also students. Each has its own role in this research. The validator helps in terms of validity teachers and students help in terms of practicality and effectiveness. The revision provided by the validator, the responses from teachers and students and the results of problem solving skills tests had a huge impact on achieving the objectives of this researches. Moreover, the five stages of ADDIE greatly facilitate authors in conducting this research, which means that the ADDIE model is very good for making some product that is suitable for use.

D. CONCLUSSION AND SUGGESTIONS

Student worksheet based on POE (Predict-Observe-Explain) model to students mathematical problem solving skills in the quadrilateral material has been developed with the ADDIE model. Sourced from the validation results of material experts, the average percentage obtained is 80%, which means it is categorized as valid from material perspective, while the validation results from media experts, the average percentage obtained is 81.33%, which means it is categorized as very valid from a media perspective. Then based on the results of student responses, the average percentage obtained was 83.35%, which means it was categorized as very practical, while the results of teachers response, the practical category was obtained with an average percentage of 75.65%. Next for the final is the results of effectiveness, the percentage of completeness obtained was 72.73%, which means it was categorized as effective. With these results it can be concluded that the student worksheet that been developed is valid, practical, and effective. Thus the use of student worksheet for learning activities can be applied by teachers, and students can make this student worksheet a learning resource on the topic of quadrilateral discussion.

For suggestions of this research, the authors hopes that this research will be a source for the further development of student worksheet based on POE, not only quadrilateral material or on mathematical problem solving skills, but can be developed on other math material or other subjects and on other mathematical skills.

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