Development of POE-Based Student Worksheets (Predict, Observe, And Explain) for Students' Mathematical Representation Abilities

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Article Info

ABSTRACT

Purpose of the study: This research aims to evaluate students' worksheets for building flat-sided spaces based on POE as a learning tool in improving students' mathematical representation abilities. This research also aims to determine student and teacher responses to the use of the student worksheets that were developed.

Methodology: This research uses a 4D device development method which consists of four stages, namely the definition, design, development and dissemination stages. The development stage includes validation by material experts and media experts, revision, and testing of student responses. Data collection uses student response questionnaires using student worksheets to train students' mathematical representation skills. The subjects of this research were students in class VIII of junior high school. Data analysis techniques use descriptive statistics and qualitative analysis using the Miles and Huberman model.

Main Findings: The validation results of material experts and media experts show that the student worksheets developed are quite valid. This research found that the POE-based flat-sided space construction student worksheet is suitable for use in improving students' mathematical representation abilities and getting positive responses from students and teachers. This research contributes to the development of innovative and effective learning tools in the context of mathematics learning.

Novelty/Originality of this study: The novelty of developing a POE-based student worksheet for students' mathematical representation abilities lies in its departure from traditional teaching methods, its emphasis on inquiry-based learning and higher-order thinking, and its adaptability to a variety of mathematical topics all contributing to a more dynamic and engaging educational experience.

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1. INTRODUCTION

Education is a means to advance the nation [1], this is in accordance with the spirit of Law no. 20 of 2003 concerning the National Education System, namely: National education functions to develop abilities and

shape the character and civilization of a dignified nation in order to make the life of the nation intelligent [2], aimed at developing the potential of students to become human beings who believe and are devoted to God Almighty. Almighty, noble, healthy, knowledgeable, creative, independent, and a democratic and responsible citizen [3].

Education is an effort to prepare and improve the quality of human resources. Thus education makes it necessary to advance human differences. Seeking knowledge is very important and obligatory for every human being. Therefore, the Islamic religion really respects people who have knowledge, the same as people who believe in Allah SWT, as Allah SWT says in Surah Al Mujaadilah verse 11: Meaning: Allah will surely exalt those who believe among you and others. who were given some degree of knowledge. and Allah knows best what you do (Q.S Al Mujaadilah: 11) [2]. The knowledge referred to in the paragraph above is knowledge that is useful for oneself or many people and does not harm other people, one of which is mathematics. Mathematics is part of education. So mathematics education is an important aspect of life in efforts to develop and form quality humans [3]. In the process of learning mathematics, the ability to express and represent mathematical ideas is something that people who study mathematics do. Apart from that, the function of mathematics is to develop communication skills using numbers and symbols as well as sharp reasoning which can help clarify and solve problems in everyday life [4].

Likewise, the goals expected in mathematics learning by the National Council of Teachers of Mathematics (NCTM). NCTM (2000) sets five standards for mathematical abilities that students must possess, namely communication abilities, problem solving abilities, reasoning abilities, connection abilities, and representation abilities [5]. Mathematical representation ability is one of the general goals of mathematics learning in schools. This ability is important for students and is related to communication and problem solving skills. To be able to communicate something, someone needs to represent it in the form of pictures, diagrams, graphs or other forms of representation. With representation, problems that initially seem difficult and complicated can become easy and simple, so that the problems presented can be solved more easily [6].

According to Halat and Peker "teachers are tasked with supporting students learning of abstract mathematical concepts. Although most students easily pick up rudimentary knowledge through the use of concrete objects, we ask our students to use symbols and other mathematical notation to represent their understanding" that teachers can provide lessons by teaching abstract mathematical concepts, although basically students easily understand concrete concepts but by using symbols and mathematical notation, students can present their understanding [7]. Hwang et.al, explained that "mathematics representation means the process of modeling concrete things in the real word into abstract concepts or symbols" which means mathematical representation is the process of modeling something in the real world into abstract concepts and symbols [8].

However, the reality in the field shows that students' mathematical representation abilities are still low. This can be seen from the results of research conducted by Misel, Erna Suwangsih entitled "Application of a Realistic Mathematical Approach to Improve Students' Mathematical Representation Ability" that the mathematical representation ability of class IV students at state elementary school 17 Nagri Kaler is still relatively low. This is because the mathematics learning process carried out at the 17th Nagri Kaler state elementary school is still conventional, namely providing material directly at the symbolic stage, providing examples and practicing questions, causing students to tend to memorize the material and work procedurally [9]. Apart from that, Siti Ramziah's research entitled "Improving the Mathematical Representation of Class and students have never been invited to relate the problem everyday life in matrix representation. Apart from being less skilled at representing daily life problems in the form of matrices, students are also not very dominant in communicating opinions, ideas or ideas both in writing and orally [10]. In this regard, learning media is needed that helps students to discover, present and experience for themselves directly, namely learning media in the form of Student Worksheets [11]. Student Worksheets are student guides that are used to carry out investigative or problem solving activities. 10 student worksheets, namely teaching material that has been packaged in such a way that students are expected to be able to study the teaching material independently [12].

Based on the results of interviews with students at the Pesawaran 14 State Junior High School. It is known that many students do not like learning mathematics and say that mathematics is a difficult subject to learn. Apart from that, students also still experience difficulties in understanding mathematical material, both calculations and processing. Apart from that, the teaching materials used cannot help students' abilities in predicting, observing and explaining mathematical problems in real life. Based on the results of an interview with Nur Endang Destyowati, S.Pd, the teacher said that the learning system used so far is using the lecture and question and answer method. Learning using this method has not obtained satisfactory results and has not made students fully active in the learning process. The teaching materials used by teachers so far are textbooks and student worksheets. Teachers have developed their own Student Worksheets, but only Student Worksheets are in the form of questions. The student worksheet developed is not yet based on POE (Predict, Observa, and Explain). This can be seen from the learning results of class VIII students that 57.50% got a score below the KKM, and 42.50% got a score above the KKM. It is said that the mathematics learning results of class VIII

students at SMP Negeri 14 Pesawaran are less than satisfactory. One of the factors that influences learning outcomes is teaching materials that are not yet supportive.

Then another thing was also shown at MTs Nurul Islam. Based on the results of the interview with Ernawati, the MM learning used currently is still teacher-centred, so students are less active in learning. As in the flat-sided geometric material, students have difficulty presenting. The teaching materials used are student worksheets, but they are not very interesting for students in the learning process. The student worksheets used are still practice questions, assignments and material that do not contain interesting images in the student process. Based on the problem, it can be concluded that most students do not like mathematics lessons and they think mathematics is difficult to understand. Likewise, the material on flat-sided geometric figures is considered difficult by students.

The student worksheets used in schools are published by publishers and the student worksheets used only contain material, example questions and questions that are still monotonous and do not suit the needs of students, meaning that the student worksheets do not contain learning activities that involve participants. educate directly in discovering and applying mathematical concepts. These student worksheets cannot provide a learning experience for students and cannot encourage the development of students' representational abilities, so it is necessary to develop supporting student worksheets. One of the student worksheets that can be developed is a student worksheet based on POE (Predict, Observe, and Explain) which can be used as a guide/instruction for activities so that later it can attract students' interest and can train students' independence to discover, apply and represent it in the process. learning.

The POE (Predict, Observe, and Explain) learning model is an alternative that can be used by educators to create a fun and quality learning atmosphere [13]. According to Ozdemir et al, POE can improve students' understanding of science concepts [14]. POE (Predict, Observe, and Explain) learning is a problem solving process carried out by students through three stages, namely, the prediction stage or making initial guesses (predict), observation (observe), and explanation of the results of observations (explain). This model is used to explore students' initial knowledge, provide information to teachers regarding students' thinking abilities, condition students to conduct discussions, motivate students in students to explore the concepts they already have, and stimulate students to carry out investigations [15].

Several studies on the POE (Predict, Observe, and Explain) model include research by Rizky Dezricha Fannie and Rohari entitled "Development of Student Worksheets Based on POE (Predict, Observe, and Explain) in Linear Program Material for Class Linear programs are easier for students to understand because students' way of thinking has been directed towards descriptions of material and examples of questions that are worked on using the steps of the POE (Predict, Observe, Explain) learning model in the POE-based worksheets. This mathematics worksheet is equipped with the competency standards mentioned in the introduction to the worksheet. To evaluate students' abilities who have listened to the material and examples presented in the student worksheet, students can work on evaluation questions for each learning activity which has been assisted by POE (Predict, Observe, Explain) steps [16].

Previous research examining the effectiveness of the POE strategy in overcoming students' misconceptions about the concept of electrical circuits found that the POE-A strategy could overcome students' misconceptions about the concept of electrical circuits. Additionally, this strategy can help students to improve their understanding of these concepts [17]. Apart from that, researcher Ulfanie Wiyatamal, et al entitled "Development of POE-based worksheets (Predict, Observe, and Explain) on the subject of Temperature and Heat in High School Physics for class of 80% with very good interpretation in all aspects of the material.The validation test results of POE-based student worksheets by media experts showed an achievement percentage of 88% with very good interpretation in all aspects of the media [18]. As a generalization of previous research, this research was carried out differently in that this research developed POE-based student worksheets in the mathematics subject of flat-sided geometric shapes to develop students' mathematical representation abilities.

The urgency of developing POE-based student worksheets for students' mathematical representation abilities is rooted in the need for transformative educational practices that encourage critical thinking, problem solving, and active engagement, skills that are essential for success in contemporary and future learning and work environments. The novelty of developing a POE-based student worksheet for students' mathematical representation abilities lies in its departure from traditional teaching methods, its emphasis on inquiry-based learning and higher-order thinking, and its adaptability to a variety of mathematical topics all contributing to a more dynamic and engaging educational experience. Based on the description above, the researcher aims to develop a worksheet for students to build flat-sided spaces based on predict observe explain (POE) for mathematical representation abilities for class VIII middle school.

2. RESEARCH METHOD

The type of research that will be used is research and development (Research and Development or R&D). R&D is a research method used to produce certain products and test the effectiveness of these products

[19]. Research and development of certain products produced for the administrative, educational and other social fields is still low. In fact, there are many certain products in the fields of education and society that need to be produced through research and development. In this research, the 4D device development research method (Four D Model) was used as a research and development procedure [22]. The 4D development model consists of four steps: definition, design, development, and implementation [23].

The definition stage aims to determine the requirements for developing POE-based worksheets (Predict, Observe, and Explain) by analyzing the objectives and limitations of the material [24]. The design stage includes collecting data about POE-based mathematics learning on flat-sided geometry material as well as preparing the structural framework for competency map-based worksheets. The development stage includes validation of student worksheets by material experts and media experts, revisions based on validation results, and testing student responses [25]. The media experts in this research are Zain Hazmi Zain Baharin and Samuel N. Jesse.

The dissemination stage was carried out to disseminate the POE-based student worksheet learning media that had been developed [26]. This research was tested in two stages, namely small group testing and large group testing to determine the attractiveness of the product. The product trial results are categorized as attractive based on the learning media attractiveness scale, if $1.00 < \overline{X} \le 1.76$; Very Less Attractive, if $1.76 < \overline{X} \le 2.51$; Less Attractive, if $2.51 < \overline{X} \le 3.26$; Interesting if $\overline{X} > 3.26$; Very Interesting [27]. The subjects in this research were class VIII middle school students.Data analysis techniques use qualitative analysis and descriptive statistics. Quantitative data analysis uses descriptive statistics in developing this product. Descriptive statistics can be used to analyze feedback or responses from users. Qualitative data analysis using the Miles and Huberman model begins with data collection, data reduction, data presentation, data verification, and drawing conclusions.

3.   RESULTS AND DISCUSSION

This research and development was carried out using the 4D device development research method (Four D Model) from Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel, namely Define, Design, Develop, Disseminate.The define stage is carried out to determine and define development requirements. In other models, this stage is often called needs analysis. At this stage there are four main steps, namely front-end analysis, concept analysis, task analysis, and formulation of learning objectives. Based on the results of interviews conducted, information was obtained that in the learning process teachers have used learning media, namely real learning media such as block and cube frames, Power Point displays and so on. Especially for flat-sided building material, teachers have not used learning media. Apart from that, students' grades for this material tend to be low. In fact, flat-sided building is a material that is very relevant in everyday life. This stage also revealed the fact that the teacher lacked creativity in delivering learning (monotonous), causing students to be less active and bored in the learning process. Therefore, it is necessary to develop mathematics learning media in the chapter on flat-sided geometric shapes for mathematical representation abilities, namely POE-based flat-sided geometric shapes (Predict, Observe and Explain) worksheets.

At this stage of concept analysis, interviews are carried out to identify the main concepts that will be taught, arrange them in a hierarchical form, and detail the concepts that will be taught. The concept analysis that has been carried out is identifying the important and main parts that will be studied and arranging them in a systematic and relevant form that will be included in the learning media based on Front-end analysis, namely prerequisites, instructions for use, Competency Standards, Basic Competencies and success criteria for building flat-sided space worksheet based on POE (Predict, Observe and Explain). In the task analysis, basic competency analysis is carried out and then the learning indicators are described. Task analysis will help determine the form and format of the media that will be developed. Researchers analyze the main tasks that students must master so that students can achieve minimal competence. Based on the results of the analysis, an overview of the tasks required in the learning process is obtained in accordance with basic competencies.

The formulation of learning objectives is to summarize the results of concept analysis and task analysis to determine the behavior of research objects. The set of objects becomes the basis for compiling and designing learning media. Based on this analysis, the learning objectives that will be achieved on students' worksheets for building flat-sided spaces based on POE (Predict, Observe, and Explain) are obtained.

This design aims to design learning media to obtain an initial draft. The media that will be developed is a student worksheet on building flat-sided spaces based on POE (Predict, Observe, and Explain). The steps for preparing this student worksheet product design include adapting the competency standards and basic competencies as well as the syllabus based on the K13 curriculum. Student worksheet using the POE (Predict, Observe, and Explain) model on the subject of flat-sided geometric shapes using A4 paper size; space scale 1.15; 11 pt font; and fonts Times New Roman (Headings CS), Bodoni MT, !Basket of Hammers, Cambria (Headings), Snap ITC, Blackadder ITC, Action Jackson. The student worksheet development product design consists of a front cover and back cover, foreword, student worksheet development team page, concept map, instructions for using student worksheets and table of contents.

Table 1. Results of analysis of assignments for class VIII, even semester, flat-sided spatial construction material

No.	Analysis Section	Analysis Results
1	Basic competencies	1. Identify the properties of a cube, cuboid, prism and pyramid and their parts 2. Make nets of cubes, blocks, prisms and pyramids 3. Calculate the surface area and volume of cubes, blocks, prisms and pyramids.
2	Indicator	1. Name the elements of a cube, cuboid, prism, and pyramid: edges, side planes, and vertices 2. Make a net of cubes, blocks, vertical prisms and pyramids 3. Find the formula for the surface area of a cube, cuboid, pyramid and vertical prism and pyramid 4. Calculate the surface area of a cube, cuboid, prism and pyramid 5. Determine the volume formula for a cube, cuboid, prism, pyramid 6. Calculate the volume of a cube, cuboid, prism, pyramid.
3	Subject matter	Build a Flat Sided Room

The student worksheet consists of Content Standards, preliminary activities, activity instructions, concept maps, history of the discovery of flat shapes, space shapes and volumes, learning activities in the form of story questions that can be experimented with in real life and in the school environment, contains stages - The stages of the POE method (Predict, Observe, and Explain) include Predict, Observe, and Explain (Explain or conclude), and practice questions.

Next, the development stage of the product feasibility assessment, the feasibility of the POE (Predict, Observe, and Explain) based flat side building worksheet development product was assessed by 5 experts consisting of 3 media experts and 2 material experts.

Product feasibility assessments are carried out by material experts and media experts. The results of the experts' assessments are categorized as valid based on the learning media suitability scale, if $1.00 < x \leq 2.51$ then the learning media is less valid (partial revision and review of the material), if $2.51<$). The validation instrument used is a validation instrument prepared with reference to BNSP assessment standards and uses a four-point Likert scale. Complete validation results by experts are as follows.

Table 2. Results of Material Assessment by Stage 1 Material Experts

No	Aspect	Aspect Items	V1	V2	V3
1	Content quality	$\sum score$	10	11	11
		xi	2.5	2.75	2.75
		$\bar{x}$		2.67	
		Criteria		Less valid	
2	Accuracy of coverage	$\sum score$	7	8	11
		xi	2.3	2.7	3.7
		$\bar{x}$		2.9	
		Criteria		less valid	
3	POE (Predict, Observe, Explain)	$\sum score$	10	8	16
		xi	2	1.6	3.2
		$\bar{x}$		2.7	
		Criteria		less valid	
4	Language	$\sum score$	11	11	16
		xi	2.2	2.2	3.2
		$\bar{x}$		2.53	
		Criteria		less valid	

In the first stage of validation, the content quality aspect obtained an average value of 2.67 with quite valid criteria, the coverage accuracy aspect obtained an average value of 2.89 with quite valid criteria, the POE aspect obtained an average value of 2.27 with quite valid criteria and in the presentation feasibility aspect, an average value of 3.53 was obtained with quite valid criteria. After the assessment of each aspect was obtained, the overall average was calculated regarding the suitability of the entire material and obtained an average of 3.11 with quite valid criteria. Thus, the feasibility of student worksheet products for building flat-sided spaces based

on POE (Predict, Observe, and Explain) is still being partially revised based on the results of stage 1 validation by material experts.

Suggestions or input that need to be improved from these four aspects include material, questions, grammatical provisions, the language used is not in accordance with EYD, lack of letters and letter errors. So that the product is improved by improving the material, adding questions, missing letters, grammatical provisions and the language used is in accordance with EYD. After revising the media, in this case, material based on input and suggestions from experts, then stage 2 validation is carried out..

Table 3. Results of Material Assessment by Stage 2 Material Experts

No	Aspect	Aspect Items	V1	V2	V3
1	Content quality	$\sum score$	14	14	11
		xi	3.5	3.5	2.75
		$\bar{x}$		3.25	
		Criteria		less valid	
2	Accuracy of coverage	$\sum score$	10	9	11
		xi	3.3	3	3.7
		$\bar{x}$		3.3	
		Criteria		Valid	
3	POE (Predict, Observe, Explain)	$\sum score$	15	16	16
		xi	3	3.2	3.2
		$\bar{x}$		3.13	
		Criteria		less valid	
4	Language	$\sum score$	16	18	16
		xi	3.2	3.6	3.2
		$\bar{x}$		3.3	
		Criteria		Valid	

Based on table 3 above, the average value obtained for the content quality aspect was obtained, an average value of 3.25 with quite valid criteria, the coverage accuracy aspect obtained an average value of 3.33 with valid criteria, the POE aspect obtained an average value The average value was 3.13 with quite valid criteria and in the language aspect an average value was obtained of 3.33 with valid criteria. After getting a score for each aspect, the overall average was calculated regarding the suitability of the material and obtained a score of 3.2625 with valid criteria (no revisions) and can be used as a mathematics learning medium. By increasing the second stage validation score and obtaining product feasibility results, in this case material with "Valid" criteria, the media is suitable for use (field trials) without revision.

Assessment by media experts prioritizes aspects of media appearance and use. The results of the assessment are in the form of quantitative data on scores for each aspect and descriptions of suggestions. Quantitative data is then converted into the quality of each aspect of the assessment. The following is a table of media validation results:

Table 4. Results of stage 1 media expert validation

No	Aspect	Aspect Items	V1	V2
1	Size of student worksheet	$\sum score$	3	6
		xi	1.5	3
		$\bar{x}$		3.25
		Criteria		less valid
2	Student worksheet cover	$\sum score$	13	16
		xi	2.17	2.7
		$\bar{x}$		2.4
		Criteria		less valid
3	Design the contents of student worksheets	$\sum score$	23	35
		xi	1.92	2.92
		$\bar{x}$		2.41
		Criteria		less valid

Based on table 4, the assessment results were obtained from 2 media expert validators. The results of the validation of the assessment by media experts consist of 3 aspects, namely the size aspect of the student worksheet, the design aspect of the student worksheet skin (Cover) and the content design aspect of the student worksheet. In the aspect of student worksheet size, an average score of 2.25 was obtained with the "less valid" criterion, in the skin design aspect of the student worksheet, an average score was obtained of 2.42 with the "less valid" criterion, and in the content design aspect Student worksheets obtained an average score of 2.41 with the criteria "less valid". Thus, the results of the media expert assessment with an average of 2.36 concluded that the learning media developed was in the range 1.76 < given. Suggestions or input that need to be improved from these two aspects include improving the cover, adjusting images to the material, writing layout, concept map charts, images to determine volume.

After revisions have been made to the media, stage 2 validation testing is carried out. Revisions are carried out based on suggestions and input from media experts. The results of stage 2 validation can be seen in table 5 below:

Table 5. Results of stage 2 media validation expert

No	Aspect	Aspect Items	V1	V2
1	Size of student worksheet	$\sum score$	8	6
		xi	4	3
		$\bar{x}$	3.5	
		Criteria	Valid	
2	Student worksheet cover	$\sum score$	22	18
		xi	3.67	3
		$\bar{x}$	3.3	
		Criteria	Valid	
3	Design the contents of student worksheets	$\sum score$	41	36
		xi	3.42	3
		$\bar{x}$	2.41	
		Criteria	Enough valid	

Based on table 5, the assessment results were obtained from 2 media expert validators. The results of the validation of the assessment by media experts consist of 3 aspects, namely the size aspect of the student worksheet, the cover design aspect of the student worksheet and the design aspect of the content of the student worksheet. In the aspect of student worksheet size, an average score of 3.5 was obtained with "valid" criteria, which means that in this aspect the assessment had increased from stage 1 validation, in the aspect of student worksheet cover design, an average score of 3.33 was obtained with "valid" criteria, so that experienced an increase from the validation assessment stage 1 and in the aspect of student worksheet content design, an average score of 3.20 was obtained with the criteria "fairly valid" and also experienced an increase from the validation assessment stage 1. Thus, the results of the media expert assessment stage 2 were concluded that The learning media developed is in the range $3.26 < x \le 4.00$ so that it is declared as valid criteria and does not need to be revised again for each aspect so that it can be used for field trials.

After the product has gone through the validation stage by material experts and media experts and has been repaired, the product is then tested with a small group trial consisting of 10 class VIII students of Pesawaran 14 State Junior High School who are selected heterogeneously based on gender, large group trial consisting of 30 students. This small group and large group trial was intended to determine the attractiveness of the POE (Predict, Observe, and Explain) based flat-sided building worksheet product.

This research was tested in two stages, namely small group testing and large group testing to find the attractiveness of the product. The results of product trials are categorized as attractive based on the learning media attractiveness scale, if $1.00 < X \le 1.76$; Very Less Attractive, if $1.76 < X \le 2.51$; Less Attractive, if $2.51 < X \le 3.26$; Interesting, if $X > 3.26$; Very Interesting [28]. The average attractiveness results obtained on a small scale which was attended by 10 students obtained an average score of 3.67 based on the results of the response questionnaire completed by the students. These results placed the media in the "Very Interesting" criteria. In the large-scale field trial which was attended by 30 students, the average score of interest obtained was 3.47 in the "Very interesting" criterion. Based on the results of questionnaire data on student responses in the small-scale and large-scale field trials, the mathematical media developed in the criteria for interpreting attractiveness, it is very interesting as a source of learning material and is suitable for use.

In field trials, both small scale and large scale, it was found that students were active in learning, students easily concluded parts of the material by looking at the existing illustrations, students were enthusiastic

about participating in mathematics learning with this media and the daily problems presented in the learning media helped students in the real benefits of the subject matter. In this case, learning media can be an alternative teaching material for students to overcome boredom when learning with textbooks.

After conducting small group trials and field trials, the product was then tested again for teacher trials. This teacher trial was carried out to confirm the data and determine the general appeal of the product. The number of respondents in this teacher test was 1 SMP/MTs class VIII teacher by giving a questionnaire to determine the teacher's response to the attractiveness of the student worksheet. This teacher trial was carried out at SMP Negeri 14 Pesawaran. The results of the field trial obtained a score of 3.15 with the interpretation criteria achieved being "interesting", this means that the worksheet developed by the researcher has very interesting criteria to be used as a tool in teaching and learning activities on flat-sided geometric material for class VIII SMP/MTs.

The advantages of the flat-sided building worksheet based on POE (Predict, Observe, and Explain) which were developed include: (1) as a learning guide for students independently by empowering the potential that exists in school; (2) student worksheet prepared by applying the POE (Predict, Observe, and Explain) based learning model, equipped with exercises to determine the level of mastery of the material and achievement of basic competencies for each material; (3) The worksheet developed contains experimental activities so that it can help teachers guide students in experimental activities to discover concepts and can help students to carry out an investigation or discovery.

In line with previous research, the use of POE-based worksheets in the chemistry learning process is effective in increasing students' conceptual understanding [29]. This previous research shows that student worksheets developed based on POE are effective in increasing students' conceptual understanding, so the current research carried out can provide implications for the learning process, namely POE-based worksheets can Encourage active learning by involving students in the learning process. The interactive nature of predicting, observing, and explaining can increase student engagement, making the learning experience more dynamic and participatory.

Then the introduction of POE-based worksheets can encourage re-evaluation of assessment practices. Teachers can explore alternative assessment methods that align with the interactive and exploratory nature of the POE framework, such as performance assessments or portfolio assessments. Depending on continued use of POE-based worksheets and related teaching practices, there is the potential for long-term impacts on students' mathematical representation abilities.

Long-term research could investigate the durability of the observed positive effects. Research and development of POE-based student worksheets can contribute to the broader field of mathematics education. The findings from this research can inform curriculum development, instructional design, and educational policies aimed at improving students' mathematical representation abilities. The limitation of this development is that the material contained in the POE (Predict, Observe, and Explain) based flat-sided geometric worksheet is still limited to flat-sided geometrical material so it needs to be developed more widely. Then this research is limited by the suitability of the POE framework which can vary between age groups. Younger students, for example, may find certain components of the framework more challenging, requiring careful consideration of age-appropriate modifications.

4. CONCLUSION

Based on the results of validation from material experts and media experts, it can be concluded that students' worksheets for building flat-sided spaces based on POE (Predict, Observe, and Explain) for mathematical representation abilities are worthy of being tested. The students' responses to the students' worksheets obtained an average score with very interesting criteria and the teacher's response to the worksheets obtained an average score with interesting criteria. Recommendations for further research are that students' interest and motivation in learning can be measured using this student worksheet. Recommendations for further research include improving the development and implementation of POE-based student worksheets.

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