

Validity of Mathematics Learning Devices Based on M-APOS Theory to Improve The Problem Solving Ability of Students Class VII Junior High School

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Abstract—This study aims to produce a valid mathematics learning devices for class VII junior high school. The developed devices are learning plan and student’s worksheets based on M-APOS approach. The development model used in this research is a Plomp model consisting of 3 phases, that is preliminary research, prototyping stage, and assessment stage. But the focus of this research is prototype development stage that is in stage of validity by expert. Aspects assessed at the validation stage are aspects of language, aspects of presentation/didactic, content aspects, and aspects of graffiti. The final result of this research is to produce a valid mathematics learning device based on M-APOS.

Keywords—Validation, Learning Devices, M-APOS Theory

I. INTRODUCTION

Mathematics is a subject that has important roles and functions for students in every level of education ranging from elementary school (SD) even up to university for some majors. There are many reasons why mathematics has an important role or function for students. As stated by Cornelius that there are five reasons for the need to learn mathematics because mathematics is (1) a clear and logical means of thinking, (2) the means to solve problems of everyday life, (3) Patterns of relationship and generalization of experience, (4) means to develop creativity, and (5) means to raise awareness of cultural development [1].

Furthermore, Cockroft argues that mathematics needs to be taught to students because (1) Mathematics is regarded by most people as being essential, (2) Mathematics is only one of many subjects which are included in the school curriculum, (3) Mathematics provides a means of communication which is powerful, concise and unambiguous, (4) Mathematics can be used to present information in many ways, (5) Develop powers of logical thinking, accuracy, and spatial awareness, and (6) Give satisfaction to attempt to solve challenging problems [2].

From some of the opinion above, we can know that one of the learning mathematics function is as a tool to train the problem solving skills of learners. To perform the mathematical functions as a tools to train the problem solving skills of learners, then the ability to solve

mathematical problems must also be one of the goals of learning mathematics itself. As stated in Permendikbud RI No.58 year 2014 at point 2 is one of the objectives of learning mathematics is that learners can use the pattern as a conjecture in problem solving and able to make generalizations based on phenomena or existing data. This means that the ability to solve mathematical problems is a goal of mathematical learning according to Permendikbud (government regulations).

Although problem-solving skills are very important in mathematics learning activities, the reality of student’s problem-solving ability is still low. The low ability of mathematical problem solving of these learners can be seen from the results of literacy conducted by Fauzan and Tasman at junior/MTs level in West Sumatra. From the literacy results, it is found that 40.957% of students have low problem solving abilities, 34.574% have medium problem solving skills, and 24.468% have high problem solving abilities. It’s mean that the ability to solve mathematical problems of learners at junior/MTs level in West Sumatra Tend to Low [3].

The low ability of problem solving mathematical learners can also be seen from the results of observations that have been done in several junior high school / MTs in Kab. Pasaman Barat. Observation is done by giving a problem-solving test. The test was given to the students of SMP N 2 Pasaman in class VII-5 followed by 22 students and in MTsS Darussalam in class VII-Pi followed by 31 students. Table 1 below shows the results of mathematical problem solving test of learners in SMP N 2 Pasaman and MTsS Darussalam Pinagar.

TABLE 1. OBSERVATION RESULTS OF MATHEMATICAL PROBLEM SOLVING TEST

School	Qualification Values (Percentage)				
	Excel lent	Good	Satisfac tory	Less than Satisfactory	More Less than Satisfactory
SMP N 2 Pasaman	13,63	9,09	-	13,63	63,64
MTs S Darussalam	16,13	9,67	6,45	9,67	58,064

From Table 1 we are able to know that the early ability to solve mathematical problems of students both in SMP N 2 Pasaman and MTs S Darussalam is still relatively low.

From the observations that have been done by the researchers, the low ability of problem solving learners caused by several factors, including: (1) the lack of learning resources used in the learning process, (2) Student's Worksheets used so far does not contain adequate activities for learners to construct his understanding to find a mathematical concept, (3) the problems that exist in Student's Worksheets used so far do not contain the contextual or story problem so that learners are not accustomed to solving the story problem, while for the present era learners are expected to be able to do the HOTS one of the criteria of the problem is contextual, and (4) the activities in the Learning plan do not show the activities that lead the learners to be active and to be able find the mathematical concepts learned

From the problem above, it can be concluded that Learning plan and Student's Worksheets used so far is not optimal. Where learning plan and student's worksheets used so far has not been supporting the learning activities of learners to be able to improve problem-solving skills. It is very unfortunate that the learning plan and student's worksheets used in schools so far has not been fully able to meet the needs of learners. Learning plan is a tool that can assist teachers in managing the stages to be done in the classroom and student's worksheets can facilitate teachers and learners in implementing learning in the classroom. Student's worksheets can improve the problem solving ability of learners, because in student's worksheets loaded questions that will guide learners to train problem-solving skills. So, learning plan and student's worksheets are two things that help teachers and learners in learning.

Along with the need for learning plan and student's worksheets that can support the problem solving ability of learners, it is also necessary to have approach that can be used as a foundation in developing learning plan and student's worksheets. Learning plan and the developed student's worksheets will be more optimal in improving the problem solving ability of learners, if learning plan and student's worksheets is based on one learning approach that also has a goal to improve the problem solving ability of learners and teaches students how to solve a problem. One of the learning approaches used to achieve that goal is through the M-APOS theory approach.

The M-APOS theory is a modification of the theory of APOS (action, process, object, and schema). As stated by Lestari that the theory of M-APOS is a modification of the theory of APOS (action-process-object-scheme). Modifications are made to the activity phase, where the activities in the computer labs on the APOS model are replaced by the assignment of the recitation assignment given before the learning is carried out. Recitation tasks are presented in the form of a learner's activity sheet that guides and assists learners in studying concepts or solving mathematical problems [4]. M-APOS theory is a theory that is considered capable of improving the problem solving skills of learners, because in solving a problem will certainly

involve a high-level thinking process. In this process of thinking, an idea cannot suddenly come to mind. Ideas occur after various symbols are processed so that it can be said that in the process of thinking it will pass through several mental reconstruction stages as follows: (1) action, at this stage the transformation of objects perceived by the individual as necessary, and instructions step by step (2) the process, which is a mental construct that occurs internally when a person has been able to perform the level of action repeatedly, (3) object, can be interpreted as something that resulted from mental done at the stage of the process, and (4) schema, which is a collection of actions, processes, and objects summarized into a scheme. The learning that has the characteristics above is the M-APOS learning model.

Based on the problems that have been described above, the researcher develops an M-APOS basis learning device. The development model used in this research is the Plomp model which has three stages, namely the introduction stage, the development stage or the prototype making, and the assessment stage [5]. The purpose of this development is to acquire learning tools that are valid, practical, and effective. This means that learning devices that will be used in schools must be valid, practical, and effective first. But in this study focused on the validity of developed learning devices. So the research question in this research is "How is validity of mathematics learning devices based on M-APOS theory to improve the problem solving ability of students class VII junior high school?"

II. THE RESEARCH METHOD

This research is a research development with development of Plomp model. The author uses this model because it is more systematic, directed, analytical, and suitable for developing learning tools. The Plomp model consists of three phases, namely the preliminary research phase, the prototype development or prototyping phase, and the assessment phase (5). The validation stage is at the stage of development or manufacture of prototypes. Validation is done by 5 experts consisting of 3 mathematics experts, 1 Indonesian language expert, and 1 person from education technology experts. Mathematicians will review the device from content and didactic aspects, language experts will review from the language aspect, and educational technology experts will review from the aspect of graffiti. The instruments used to collect data are the learning plan and student's worksheets validation sheets that have been validated by 2 mathematicians and 1 language expert. In this study, the average score (r) of expert assessment results is adjusted according to the criteria of device assessment based on the criteria of device validity according to Mulyardi which can be seen in Table 2 [6]

TABLE 2. CRITERIA OF LEARNING DEVICED VALIDITY

Interpretation	Criteria
$R \leq 0,08$	Invalid
$0,08 < R \leq 1,60$	Less valid
$1,60 < R \leq 2,40$	Quite valid
$2,40 < R \leq 3,20$	Valid
$R > 3,20$	Very valid

The device is valid if it has a average experts / validator score > 2.40 .

III. RESULT AND DISCUSSION

learning devices that developed in the research are learning plan and student’s worksheets. Learning device development process refers to the plomp model. Next will be explained and discussed briefly the results of learning plan and student’s worksheets validation based on M-APOS.

1. Learning Plan

The learning implementation plan developed in this research is based on the m-apos approach, in which the core activities of better learning are on the steps of the m-apos approach (action, process, object, and scheme). Learning plan designed for math materials class VII SMP/MTs semester 2. In the validation phase, learning learning plan implemented by 4 experts consisting of 3 mathematicians and 1 person from the indonesian language. Aspects of learning plan are validated by the expert is linguistic, didactic / presentation, and content aspects. The validation result of m-apos-based learning plan by 4 people can be seen based on table 3 below.

TABLE 3. RESULTS OF THE VALIDATION OF THE IMPLEMENTATION PLAN OF LEARNING BY EXPERTS

Rated Aspect	Average score from validator				Average	Kriteria
	V1	V2	V3	V4		
Linguistic	3	4	3	4	3,5	Very Valid
Didactic	3,25	4,00	3,50	3,88	3,66	Very Valid
Content	3,03	4,00	3,34	3,94	3,58	Very Valid
Average	3,09	4,00	3,37	3,93	3,60	Very Valid

From Table 3 we can see that the learning implementation plan (learning plan) that has been designed by the researcher is valid for every aspect of the assessment (language, dictication, and content). This is because the compilation of learning plan in accordance with the provision of learning plan according to permendikbud number 81a year 2013. In addition, the learning plan that is compiled is valid because the aspects of presentation, language, and content have been in accordance or meet the criteria of good [7]. However, linguistic aspects get the lowest average compared to other aspects, this is because there are still many mistakes in typing and punctuation, then this needs to be corrected by the author.

In terms of the average rating each aspect is on very valid criteria. Nevertheless, there are still some things that need to be improved from the learning plan that has been designed by researchers. The following Table 4 shows sereval things

that need to be revised on the learning plan based on the suggestion of the validator.

TABLE 4. REVISED VALIDATION RESULTS OF LEARNING PLAN

Before revision	After revision
Lesson objectives are incomplete, learning objectives adjust to abcd (audience, behavior, conditioning, degree).	Complete learning objectives and tailored to abcd (audience, behavior, conditioning, degree).
Learning resources are less clear (word "etc" remove, mention all learning resources in detail)	All learning resources are written clearly
Motivation on preliminary activities is not real	Motivation on preliminary activities is changed into something real or real for learners, for example with things that are close to the learner
At the introduction stage there is no teacher explanation of the lesson steps to be taken	Add a teacher's explanation of the steps of the learning activities at the introduction stage
Do not write down what student's worksheets statement is used	write down information for each student's worksheets used for each meeting
Attitudes observed in learning activities are too numerous	Minimize attitudes to be assessed in the learning process, attitudes assessed only that deemed necessary and can be assessed during learning alone
Not to mention the number of questions that the learner will do as an exercise in closing activities	Mention the number of questions a learner should do as an exercise in closing activities
Not all the problems presented in student's worksheets are written in the learning plan	Any problems given in the learning activities should be written in the learning plan

Based on some validator’s suggestions above, researchers revise the developed learning plan, so that learning plan can be used to assist in the process of learning activities of mathematics.

2. Student’s Worksheets

Student's worksheets is designed based on the results of preliminary analysis conducted by researchers to: (1) analysis of learners, (2) analysis of learning problems, and (3) concept analysis. From the preliminary analysis result, it is designed student's worksheets based on M-APOS on the material ofclass VII SMP/MTs semester 2. Students worksheets which has been designed validated by 5 experts consisting of 3 mathematicians, 1 language expert and 1 expert education technology. The didactic and content aspects were validated by 3 mathematicians, the language aspect validated by language experts and the aspect of graffituality validated by educational technology experts. The average of student's worksheets validation results by experts can be seen in Table 5 below.

TABLE 5. RESULTS OF VALIDATION OF STUDENT’S WORKSHEET BY EXPERTS

Rated aspect	Average Score from Validator					Average	Kriteria
	V1	V2	V3	V4	V5		
Linguistic	-	-	-	3,71	-	3,71	Very Valid
Didactic	3,14	4,00	3,57	-	-	3,57	Very Valid
Content	3,20	4,00	3,67	-	-	3,63	Very Valid
Graffiti	-	-	-	-	3,86	3,86	Very Valid
Rata-rata keseluruhan						3,69	Very Valid

Adjective : V1, V2 dan V3 : expert of Mathematic
 V4 : expert of Indoensian Language
 V5 : expert of education technology

From Table 5 we can see that all aspects assessed in student's worksheets are at very valid criteria. This means that student's worksheets has been developed feasible and can be used as one of the learning devices in the process of teaching and learning activities. The developed student's worksheets eligible for use because in the design process student's worksheets refers to the steps of making student's worksheets according to mone [8] and on matters contained in student's worksheets refer to prajitno's opinion [9].

Based on the average scoring score, all aspects of the assessment are at a very valid category. Nevertheless, there are still some things in the student's worksheets that researchers need to improve in order to make the student's worksheets better. The suggestion of student's worksheets improvement from the validators can be seen in Table 6 below

TABLE 6. REVISED VALIDATION RESULTS OF STUDENT WORKSHEET

Before Revision	After Revision
Cover is less attractive and the image on the cover is too small	Fix the cover of student's worksheets, and display the images that represent the contents of student's worksheets
The title student's worksheets do not use the word "activity 1, activity 2, etc."	Replacing "activity 1, activity 2, etc." to student's worksheets 1, student's worksheets 2, etc. "
Every problem on student's worksheets has no number	Numbering for each problem on lkdp makes it easier to direct learners in learning
There are still some sentences in the student's worksheets that are not yet complete	Complete the sentence on student's worksheets so as not to create double meaning and learners more easily understand the problem on student's worksheets

Based on some of the validator's suggestions above, student's worksheets that has revised used in learning process.

IV. CONCLUSION AND SUGGESTION

Based on the results and discussion of the research found that learning tools developed by researchers have been valid and can be used in learning mathematics SMP/MTs class VII semester 2. The suggestions for the next researchers who develop learning tools to pay more attention to the accuracy of typing, sentences effective and in accordance with

cognitive level of learners, and refer to the development procedures of clear learning plan and student's worksheets.

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