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Research Paper

Development of Mathematics Learning Devices Oriented on Problem-Based Learning Model to Improve Critical Thinking Ability of Students in Across of Sma Kuala Nagan Raya Aceh

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ABSTRACT

This study aims to produce mathematics learning devices which are valid, practical and effective through the Problem-Based Learning model to improve critical thinking in across of high school students in Kuala Nagan Raya Aceh. Specific objectives in this study are 1). Producing mathematics learning devices which are valid, practical and effective for being used in teaching and learning process; 2) Knowing the improvement of students' critical thinking by using learning devices which is developed oriented on problem-based learning models. This research was developed with a 4-D model, namely: define, plan (design), develop, and disseminate (disseminate). Learning devices developed in this study are: Lesson plan and Student Worksheets. While the learning model used in this study is a Problem-Based Learning model. In this study there are validation team, they are two lecturers of mathematics study program and one mathematics teacher in the research class. The effectiveness of learning devices can be seen from student test scores in the class during try out. The practicality of learning devices also can be seen from the results of interviews with teachers and scores on the observation sheet.

Keywords: Development of Learning Devices, Problem-based learning model, Critical thinking ability

INTRODUCTION

Learning activities which are taking place in schools are formal, intentional, planned, with the help of teachers and other educators. The learning process in the classroom is inseparable from the role of a teacher who is a professional educator. Learning devices are devices used in the learning process (Trianto, 2011: 201). Some learning tools needed include Lesson Plan Syllabus, student work sheets, books and evaluation devices. Preparation of devices is the initial stage in learning. Therefore, the quality of the devices used also determines the quality of learning. To produce a good quality device, the learning device must be carefully arranged.

To produce a good learning device, a certain procedure needs to be taken, which is by referring to one model of development of a particular learning device. The development model that will be used in this study is *the Thiagarajan et al model* known as *4-D Models (4D Model).* The 4D model

was chosen because it was systematic and suitable for developing learning devices.

Johnson (2007: 87) defines critical thinking as a directed and clear process used in mental activities such as solving problems, making decisions, persuading, analyzing assumptions, and conducting scientific research. Thinking is important for humans to be able to face the development of the world (Nababan. S.A. 2017). Therefore critical thinking is an active process that does not take for granted information and ideas from others.

This problem-based learning model has been known since the time of John Dewey. This learning model began to be applied because in general this learning begins with the presentation of authentic and meaningful problem situations to students in order for students can carry out the process of investigation and inquiry easily. Problems given at the beginning of learning are used as a trigger for the learning process.

MATERIALS & METHODS

This research is development research. It was developed a research about a statistical learning devices oriented on problem-based learning model to improve critical thinking ability of students. This research was conducted at Kuala Nagan Raya 1 High School in statistic material. The subject of this research is class X students.

To measure the validity of mathematics learning devices, then the research instruments were developed. The instrument used in this study is the learning device validation sheet. The validation sheet aims to measure the validity of the learning device will be developed. This validity is determined based on the opinions of experts (validators) on learning devices arranged in draft I. As for the validators in this study were 2 lectures of mathematics study program and 2 teachers. Furthermore, this opinion is used as a reference or guideline in revising the learning device. The validation sheet used are: (a) validation sheet of the lesson Plan(b) student work sheets validation ; and (c) validation sheet for tests of critical thinking ability.

RESULT

The main objective of this study is to describe the results of the development of learning devices oriented on problem-based learning models. In addition, the results of students' critical thinking ability will also be described to develop a valid and effective learning devices oriented on Problem-based model. The development process uses a 4-D model as described in advance. The results of the development in the form of Lesson Plan, student worksheets and tests of critical thinking ability of students. The process and results of the development of learning devices are described as follows:

The results of the development of learning devices from each activity at the development stage are described as follows:

a. Expert validation results

The first draft which produced in the initial design was validated by the expert. The expert validation was focused on format, content, illustrations and language that include all the learning devices developed. The results of expert validation in the form of corrections, criticisms and suggestions are used as a basis for making revisions and improvements to the learning device. The revised learning device based on input from the validators is a learning device that has met the valid criteria called Draft II.

1) Results of Validation and Revision of Lesson Plan

The assessment carried out by the validator includes indicators: format, language, and contents of the Lesson plan. In making revisions, the researcher refers to the results of the discussion by following the suggestions and instructions of five validators. The results of expert validation of the Lesson Plan include format, language and content.

Based on the assessment, it was found that the mean validation for the

format aspects was 4.35, the contents aspect was 4.64 and the language aspect was 4.35. Thus the average total results of RPP validation is 4.45. With a mean of 4.45,Thus, the Lesson Plan designed is in the valid category.

b. Results of Validation and Revision of Student Worksheets

The evaluation carried out by the validation team on the student worksheet includes format, language and content. The results of expert validation of the student worksheet show that each validator gives a score of 4 or 5 on each indicator. The average validation for the format aspect is 4.53; language aspects 4.37; and aspects of content 4.57. The average aspect of the format is obtained from the division of numbers. Average format aspect indicators with many indicators (in this case 6). From the average value of the validation of each aspect obtained the average total validation of the average number distribution of the three aspects with many aspects (in this case 3). The distribution results obtained are 4.49. This average value is in the range 4-5, so it can be concluded that the Student worksheet is in the valid category.

From the results of the validator assessment, obtained corrections, criticisms, and suggestions were used as considerations in revising the Student worksheet. Improvements made to the worksheets include giving instructions / instructions on how to work on the worksheet, selecting the color of the illustrations used, completing the components such as the place of student identity and selecting many questions / problems with time allocation.

c. Results of Validation and Revision of the Critical Thinking Ability Test

The assessment carried out by the validator includes aspects of clarity of instructions, content and language. In making revisions, the researcher refers to the results of the discussion by following the suggestions and instructions of the validator. The five validators provide an assessment of the components in the test with valid or fairly both in terms of content, can be understood or very understandable in terms of language and question writing as well as minor revisions or without revisions in terms of recommendations. This shows that the questions can be used in the field trial after making improvements from the validator's suggestions. Improvements done to the test include the suitability of time allocation with many questions, softer selection of color diagrams, errors in calculations on alternative answers and writing format.

DISCUSSION

The test of the critical thinking ability test aims to obtain data that is used as a reference for determining the validity and reliability of the test. These two indicators will determine whether the test developed can be used or not in measuring critical thinking ability and whether there are things that need to be revised or not. This trial was conducted by giving this test to 30 students, then the score obtained will be used as data in the analysis of validation and reliability of the test. The results of the validity and reliability tests are as follows.

1) Validity

Validity was analyzed using the product moment correlation formula. The analysis was carried out using SPSS 20.

Based on the data, all the questions in the valid category and the validity level of each test item are in the sufficient and high category. Thus, all the items of the test are appropriate to be used to measure students' critical thinking ability. Nevertheless, researchers only chose 6 items of the questions, namely questions number 1, 2, 4, 7, 8 and 9.

2) Reliability

Test reliability was analyzed using *the Cronbach alpha* formula. Calculations are performed using SPSS 20. The results of the calculation of reliability are presented in appendix 8. Based on the results of

calculations, the reliability coefficient obtained for the test of critical thinking ability is 0.815. . This means that the reliability of the critical thinking ability test instruments developed is included in the high category. Thus, this test can be said to be reliable to measure students' critical thinking ability on statistical topics.

1) Critical Thinking Ability Test Results

The results of tests of students' critical thinking ability in trials I and II can be seen in the appendix. A summary of the results obtained is shown in table 1.

Table 1 Summary of Results of Critical Thinking Ability Test

Information	Trial I	Trial II
Average	2,73	3,05
Percentage of students who completed(%)	64,7	86,1
Percentage of students who did not complete (%)	35,3	13,9

On the table 1 it can be seen that the average critical thinking ability of students in the first trial was 2.73, while in the second trial was 3.05. The percentage of students completing in the first trial was 64.7% and the non-completion was 35.3%. If referred to Chapter III, the percentage of completeness was 64.7%, it did not meet the specified classical completeness, which was appointed≥85%. While in the second trial, the percentage of students who completed was 86.1% and those that did not complete 13.9%. The percentage of completeness was 86.1%. It has fulfilled the classical completeness which was appointed.

1. Results of the Dissemination Stage

Since a field trial, the final learning device is obtained. This final device consists of student books. The next step is to conduct socialization to the MGMP forum in the High School 1 Kuala. The socialization is carried out by providing learning devices to the MGMP forum and it is expected that the mathematics teachers who are members of the forum can implement these learning devices to further learning in accordance with the subject matter contained within.

Based on the average of the two trials, there was an increase in this ability of 0.32 points and a 21.4% increase the learning completeness. From the results of this study it can be said that the use of Problem-Based Learning model can improve students' critical thinking ability.

CONCLUSION

Referring to the finding of the research in the previous discussion, the following points can be concluded.

1. Based on the development of learning devices using the 4- D model, it is produced a valid learning devices oriented on Problem-Based Learning model. The learning devices consist of: (1) Lesson Plan (2) Student worksheet; and (3) Critical Thinking Ability.
2. Learning Devices that are developed oriented towards Problem-Based Learning model meet the effective criteria. This is indicated by:
    a. Completeness of learning of individual and classical students is fulfilled
    b. Students' responses to learning are in a good category
3. The average of increasing in critical thinking ability of students from trial I to trial II was 0.32 points with an increase in completeness of learning in a classical manner of 21.4%.

Suggestion

Based on the finding of this study, the author presents several suggestions as follows.

1. The learning devices produced still need to be tested in other schools with various conditions to obtain truly quality learning devices.

2. Development of learning devices like this should also be conducted on other topics to make students interested, happy and active in learning mathematics.

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