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Development of Mathematics Learning Devices for Students of Borneo Tarakan University

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ABSTRACT
This study aims to produce a feasible, practical, and effective online mathematics learning tool for students at the University of Borneo Tarakan. This research is a development research using the 4-D development model developed by Thiagarajan, Semmel & Semmel which has been modified so that it contains the stages of define, design, and develop. The product developed in this study is a learning tool consisting of a Semester Learning Plan, Student Work Sheet, textbooks and learning outcomes tests. The development of mathematics learning tools starts from the preliminary analysis stage, student / student analysis, material analysis, task analysis, learning objective specifications, media selection, format selection, expert validation, limited trials, field trials, and revisions. The research instruments used in this study were validation sheets, student response questionnaires, and learning implementation sheets. The results showed that based on expert judgment the developed learning tools had very valid criteria with an average total score of 21.5 for Semester Learning Plan and student worksheets obtaining a score of 14.5. Meanwhile, textbooks obtained an average score of 17 and 11 for learning outcomes tests. Based on the results of the student response questionnaire analysis, it can be concluded that the learning tools developed have practical criteria in the learning process with a percentage of 56% in the very good category and 44% in the good category. Meanwhile, based on the analysis of the results of the observation of the implementation of learning and the results of the evaluation of learning outcomes, it can be concluded that the learning tools developed have a very good level of effectiveness with a percentage of learning implementation at 92% and a percentage of student passing 88%.
Keywords: *development, learning tools, mathematics*

1. INTRODUCTION

Education is one of the main needs in human life. Without education, a group of people cannot live according to their respective wishes, which by nature want to always develop and progress like a prosperous and happy life. So that education is an effort of a community group to develop the potential that exists within the individual. Education can also be understood as a human effort that is constructive, generates / creates and understands the meaning of knowledge learned in accordance with one's experiences. An understanding of the meaning of the knowledge learned is able to produce humans who have more dynamic knowledge.

Various efforts have been made by the government to improve the quality of our education in Indonesia. Quality education is meant as education that can produce quality graduates, namely graduates who have academic and non-academic achievements who are able to be the pioneers of reform and change so that they are able to answer various challenges and problems they face, both in the present or in the future. come (hope of the nation). One of the efforts made by the government in improving the quality of education in Indonesia is that educators are required to be able to develop learning tools that can improve the quality of learning. An educator has a very important position and strategy in developing the potential of students by managing classroom learning well. Therefore, an educator can design and produce a learning device that supports the learning process. Professional educators are expected to have the ability to develop learning tools by taking into account the characteristics and social environment of students.[1]

The devices used in the learning process are called learning tools. The tools needed in managing the teaching and learning process can be in the form of: semester learning plans, student worksheets, textbooks / e-books, and learning outcomes tests. According to Permendikbud No. 49/2014 The semester learning plan is determined and developed by lecturers independently or together in a group of expertise in a field of science and / or technology in the study program. Semester Learning Plan is a learning planning document that is prepared as a guide for students in carrying out lecture activities

for one semester to achieve predetermined learning outcomes. The semester learning plan or other terms at least contain; 1) Name of study program, name and code of courses, semesters, credits, names of teaching lecturers; 2) The learning outcomes of graduates imposed on courses; 3) The final ability that is planned at each stage of learning to meet the learning outcomes of graduates; 4) Study materials related to the ability to be achieved; 5) Learning methods; 6) The time provided to achieve the ability at each stage of learning; 7) Student learning experience which is manifested in the description of the assignments that must be done by students for one semester; 8) Criteria, indicators, and weight of assessment; and 9) List of references used.

While student worksheets are teaching materials in the form of sheets of paper containing summary material and instructions for carrying out learning tasks that must be done by students, both theoretical and / or practical which refer to the competencies that students must achieve, and their use depends on the material. teach another [2]. Based on this opinion, the use of student worksheets has several advantages, namely a) activating students in the teaching and learning process, (b) helping students in developing concepts, (c) training students to discover and develop the teaching and learning process, (d) helping lecturers in compiling lessons, (e) as a guide for lecturers and students in carrying out the learning process, (f) helping students obtain notes about the material studied through learning activities, (g) helping students to add information about the concepts learned through systematic learning activities.

Textbooks are books that are used by lecturers as a source of reference in implementing the learning process for their students. Therefore, lecturers should be able to compile the teaching materials that have been done for years into a minimum textbook for the needs of the lecturers themselves and their students. The benefits of textbooks are 1) It can accelerate the discussion of study materials, students do not need to take notes, they just pay attention to important things explained by the lecturer; 2) Students can study the materials to be taught earlier, and add brief notes as deemed necessary; 3) Students have more opportunities to express opinions about a case which is an application of the theory being taught; 4) In textbooks, exercises that must be done by students, which are oriented to contextual problems, can also be inserted. Answers can be collected for daily assignments to add value in addition to formative and summative tests; 5) Lecturers will not be short of teaching time, even though their teaching time may often coincide with national or optional holidays; 6) Questions can be made based on textbooks, so that the assessment is fairer according to the students' abilities; 7) In addition to the above, students have handbooks. With textbooks, theories conveyed by lecturers that cannot be understood in class, students can relearn from the textbook; 8) With textbooks, if there are assignments to be done at home, students already have one of the references to do it.[3]

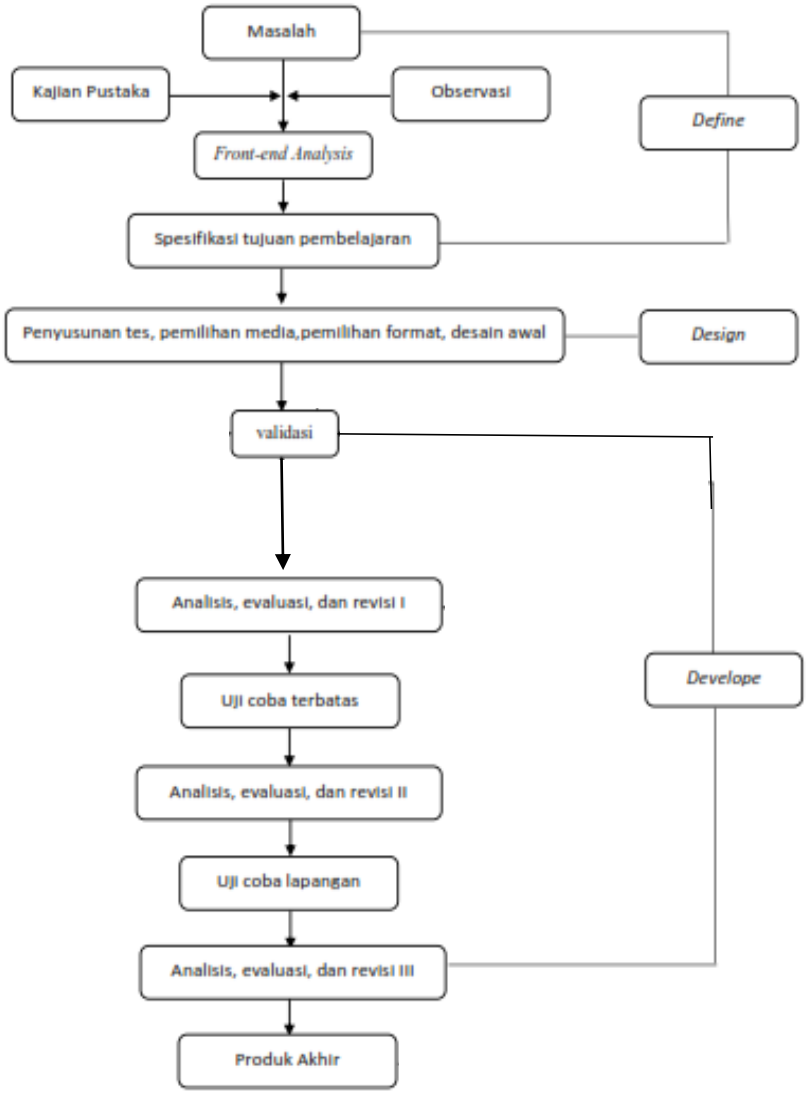
The learning outcome test is a test that is used to measure student mastery of the material that has been taught and can measure the development of student learning progress achieved after taking the learning process within a certain period of time. Trigonometry is one of the compulsory courses in the Mathematics Education Department of the University of Borneo Tarakan. Trigonometry is also one of the materials taught in the high school curriculum. As a lecturer who teaches trigonometry in the first semester, it turns out that there are still many students who do not master trigonometry so that in the course of Calculus 1 the pre-requisite is trigonometry, which is difficult in understanding the material of Calculus 1. So that researchers feel the need to develop mathematics learning tools in trigonometry courses that are valid, effective, and practice.

2. RESEARCH METHODS

The type of research carried out is research and development (Research and Development or R&D). According to [4], R&D research and development is a research method used to produce certain products and test the effectiveness of these products. This mathematical learning device development model refers to the 4-D model developed by Thiagarajan, Semmel & Semmel which contains the Define, Design, Development, and Dissemination processes. However, in this study it was carried out only up to development, this was due to the limited manpower, time and cost that the researcher had to do.[5]. The product developed in this study is a learning tool consisting of a Semester Learning Plan, Student Worksheets, textbooks / e-books and learning outcomes tests. This research was conducted in the Department of Mathematics Education, University of Borneo Tarakan. The subjects in this research and development were students programming trigonometry courses and mathematics education lecturers.

The development procedure in this study was adapted from the development model according to Thiagarajan, Semmel & Semmel, which is known as the 4-D model which has been modified into 3-D.

The development research carried out in this study includes three stages, namely the define stage, the design stage, and the development stage.[6]



Research Instruments

The instruments used in this research and development are validation sheets, learning implementation observation sheets, student response questionnaires and learning outcome test questions. This instrument is used to obtain, manage, and analyze data so that the learning tools developed meet the criteria of validity, practicality, and effectiveness.

Data analysis technique

validity analysis

The instrument used to analyze the validity was the assessment of learning tools for expert validation.

Expert judgment data is measured by the formula according to Arikunto in [7] , as follows :

$$K = \frac{\sum ni}{N} x\ 100\%$$

Information :

K = the percentage of score obtained

∑ni = the number of scores obtained

Nk = the maximum of scores

The calculation results are then entered in the percentage table according to the application

criteria. How to determine the application criteria is to determine the highest and lowest percentages with the formula:

Highest percentage = $\frac{\sum item\ x\ \sum respondents\ x\ \text{highest score}}{\sum item\ x\ \sum respondents\ x\ \text{highest score}} x100\%$

Highest percentage = $\frac{\sum item\ x\ \sum respondents\ x\ \text{highest score}}{\sum item\ x\ \sum respondents\ x\ \text{highest score}} x100\%$

class interval = $\frac{\%\ \text{the highest} - \%\ the\ lowest}{\text{number of classes}} = \frac{100-25}{4} = 18{,}75$

Score 18,75 rounded to 19

Based on this formula, the criteria applied are:

a. very valid = 82% < skor ≤ 100%
b. valid = 63% < skor ≤ 82%
c. quite valid = 44% < skor ≤ 63%
d. invalid = 25% < skor ≤ 44%

Practicality Analysis

The results of the student response questionnaire were calculated in data tabulation then the answers were entered into the scores.

$$K = \frac{\sum ni}{N} x\ 100\%$$

Keterangan:

Information :

K = the percentage of score obtained

percentage (p) = $\frac{\text{lots of answers "}yes\text{"}}{\text{many aspects were observed}} x\ 100\%$

c. Comparing the percentage obtained with the learning implementation assessment

∑ni = the number of scores obtained

Nk = the maximum of scores

After obtaining the lowest and highest percentages then determine the class interval.[8]

class interval = $\frac{\%\ \text{the highest} - \%\ the\ lowest}{\text{number of classes}} = \frac{100-25}{4} = 18{,}75$

Score 18,75 rounded to 19

Based on this formula, the criteria applied are:

a. 82% < skor ≤ 100% = very good
b. 63% < skor ≤ 82% = good
c. 44% < skor ≤ 63% = pretty good
d. 25% < skor ≤ 44% = not good

A product that is developed is said to be practical, if the criteria are at the minimum good category.

Effectiveness Analysis

Observation Analysis of Learning Implementation :

a. Count the number of observers choosing the option "yes" to the aspects observed in learning implementation observation sheet for each meeting.
b. Calculate the percentage of the amount obtained in the previous step using the formula as follows.
criteria. The criteria for assessing the implementation of learning are presented in the following table. [9]

Table 1. Criteria for assessing the implementation of learning

No	Rentang skor	Kriteria
1	$90\% < \bar{x} \leq 100\%$	Very good
2	$80\% < \bar{x} \leq 90\%$	good
3	$65\% < \bar{x} \leq 80\%$	enough
4	$55\% < \bar{x} \leq 65\%$	less
5	$\bar{x} \leq 55\%$	very less

Analysis of Learning Outcomes Evaluation Tests

The instrument used to analyze the effectiveness of the use of this learning device is a learning outcome evaluation test.

a. Tabulating student learning outcomes tests.
b. Calculating the percentage of the evaluation test of student learning outcomes.
c. Then the percentage of completeness of the student learning outcomes test is matched with the criteria interval completeness of the results of the evaluation of student learning outcomes as follows. [9]

Table 2. Criteria for the completeness of the results of the evaluation of learning outcomes

No	Rentang skor	Kriteria
1	$90\% < \bar{x} \leq 100\%$	Very good
2	$80\% < \bar{x} \leq 90\%$	good
3	$65\% < \bar{x} \leq 80\%$	enough
4	$55\% < \bar{x} \leq 65\%$	less
5	$\bar{x} \leq 55\%$	very less

3.RESULTS AND DISCUSSION

Research and development of mathematics learning tools that have been carried out have produced products in the form of mathematics learning tools in trigonometric courses which include Semester Learning Plans, Student Worksheets, notebooks, and student learning outcomes tests developed based on the 4-D development model with the stages of define, design, develop, and disseminate. However, in this research it only reached the develop stage because of the limited manpower, time and cost that the researcher had to do.

Defining Stage

At this stage is the initial stage in the implementation of the development of learning tools which includes five steps, namely: preliminary analysis where this tapa is carried out to find out the fundamental problems in developing learning tools This stage conducts a curriculum analysis of the

UBT Mathematics Education Department which is the basis for the preparation of the Semester Learning Plan, textbooks, student worksheets and student learning outcomes tests. Student analysis, conducted to determine the characteristics of students who are used as research subjects. Material analysis aims to identify, explain and systematically arrange the main parts in the learning process taught to students. Task analysis is carried out to identify what tasks will be carried out by students in the learning process which includes deepening the material and course achievements. The specification of learning objectives is carried out with the aim of formulating course outcomes and indicators of learning outcomes based on material analysis and analysis of previously carried out tasks. The last is the formulation of course achievement indicators which are the basis for knowing the study of what will be presented in the learning tool which ultimately determines how much learning achievement can be achieved.

Design stage

After carrying out the defining stage, the design stage is then carried out. This design stage aims to design mathematics learning that can be used in learning in trigonometry subjects. This design stage includes: media selection which is concerned with determining the appropriate media in presenting material at the material analysis stage, assignment analysis, campus facilities, and student characteristics. Format selection is carried out to design the content of the material, choose strategies, learning approaches and methods used in the learning process. The initial design is to prepare the initial design of SEMESTER LEARNING PLAN, student worksheets, textbooks, and student learning outcomes tests.

Development Stage

This development stage aims to produce revised learning devices based on expert input and trials with students. At this stage, expert validation is carried out by lecturers in the mathematics department to determine whether or not the teaching material products are appropriate. From the results of expert validation, it will be used as material for

improvement for product improvement and determining the feasibility of the resulting product. The data analysis of the results of expert validation for mathematics learning tools is presented in the following table:

Table 3. Data analysis of the results of expert validation for mathematics learning tools

Perangkat pembelajaran	Ahli I	Ahli II
SEMESTER LEARNING PLAN		
1. Formulation of Learning Outcomes	4	4
2. Determination of material / subject matter	4	3
3. Determination of sub learning outcomes	3	3
4. Determination of learning methods	3	4
5. Determining the criteria and form of assessment	4	4
6. Language	3	4
Skor Total	21	22
Student Worksheet		
1. Conformity with learning outcomes	3	4
2. Display	3	4
3. Suitability of material content	4	3
4. language	4	4
Skor Total	14	15
Textbooks		
1. Conformity with learning outcomes	4	4
2. Easy to understand	4	3
3. Suitability of material content	3	3
4. Display	3	4
5. language	3	3
Skor Total	17	17
Study Test		
1. The assessment technique	3	4
2. The suitability of the content with the material	4	4
3. Language	4	3
Skor Total	11	11

Expert I on the development of the Semester Learning Plan gave a total score of 21 with a percentage of 87% (very valid criteria) and validator II a total score of 22 with a percentage of 92% (very valid criteria). Based on the achievement indicators, the Semester Learning Plan product developed is suitable for use in learning. For the development of worksheets, students give a score of 14 with a percentage of 87% for expert I, while expert II gives a total score of 15 with a percentage of 94%. Based on the achievement indicators, it can be said that the student worksheet is feasible to use because it is in the very valid category.

In the development of textbooks, a score of 17 was obtained by expert I and expert II with a percentage of 85% in the very valid category. So that the textbook can be said to be suitable for use in the learning process. In the learning outcome test, it was obtained a total score of 11 for expert I and expert II with a percentage of 92% and were in the feasible category. So, it can be concluded that for all the learning devices developed are suitable for use in the learning process.

The suggestions that have been put forward by the expert are that there are still some autotext sentences that need improvement. In addition, textbooks need to add some sample questions to make it easier for students to understand the material. And other suggestions from experts are that the appearance of the student worksheets is still simple, so that students will feel less interested in seeing the contents of the student worksheets. By looking at the suggestions of experts, improvements are made according to the suggestions so that the learning tools can be used for the limited trial phase.

After expert validation is carried out then a limited product trial is carried out which aims to see if there are weaknesses contained in the learning tools developed. After a limited trial, the product is revised again based on the weaknesses found during the limited trial. After the revision was made on the limited trial, a field trial was conducted on students programming trigonometry courses. This field trial was carried out to see the response of students and the effectiveness in using the learning tools that had been developed. Field trials took place 4 times using the learning tools that have been developed. Data from student responses in the form of questionnaires were analyzed using percentage descriptive techniques. The results of calculating student responses to the application of the developed product can be seen in the following table:

Table 4.students' responses to the application of mathematics learning tools

No	Kriteria	Jumlah Siswa
1	Very good	15
2	good	12
3	pretty good	0
4	Not good	0

Based on the results of the analysis of student response data in the field trial, it was found that as many as 56% stated that the mathematics learning tools were very good. While the remaining 44% of students stated that the mathematics learning tools were good. So it can be concluded that the mathematics learning tools developed are practically used in accordance with the results of the analysis of the trials that have been carried out in the good and very good categories.

During the field trial, an observation sheet for the implementation of the learning process was given which was filled in by one of the lecturers in the mathematics education department. Based on the results of the analysis of the learning implementation observation sheet, it was obtained an average percentage of 74% with good criteria at the first meeting and at the next meeting increased to 92%, thus indicating that the learning tools developed were effective in learning activities.

In addition to observing the implementation of learning during the student learning process, student learning evaluation tests are also given to see the effectiveness of the learning tools that have been developed. Based on the analysis of the learning outcomes test, a passing percentage of 88% is obtained with good criteria. These results indicate that the learning tools developed are effective for use in mathematics learning.

4. CONCLUSION

The results showed that based on expert judgment the developed learning tools had very valid criteria with an average total score of 21.5 for Semester Learning Plan and student worksheets obtaining a score of 14.5. Meanwhile, textbooks obtained an average score of 17 and 11 for learning outcomes tests. Based on the results of the student response questionnaire analysis, it can be concluded that the learning tools developed have practical criteria in the learning process with a percentage of 56% in the very good category and 44% in the good category. Meanwhile, based on the analysis of the results of the observation of the implementation of learning and the results of the evaluation of learning outcomes, it can be concluded that the learning tools developed have a very good level of effectiveness with a percentage of learning implementation at 92% and a percentage of student passing 88%.

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