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The development of calculus teaching materials using geogebra

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ABSTRACT

Calculus is one of the fields of mathematics that is the basis of mathematical thinking. Problems related to differential calculus experienced by students are visual ability in drawing graphics. Focus material on graphs of equations and functions. Therefore, researchers make innovations in learning by making teaching materials using GeoGebra. The research method used is research and development. The research subjects were 40 students in the Mathematics Education Study Program at Universitas Suryakancana. The results of the validation of media experts using the Kendall test, sig. = 0,020> 0.05 (Ho accepted) means that the calculus teaching material using GeoGebra is feasible to use. The results of the validation of the material using the Kendall test, sig. = 0,025 (Ho accepted) means that the material content is appropriate. The results of tests on 40 mathematics education study program students, an average percentage of 78% of students answered strongly agree and 15% answered agreed, meaning that calculus teaching material using GeoGebra is effectively used.
Keywords: Development, Calculus, Geogebra

INTRODUCTION

Calculus is one of the fields of mathematics that is the basis of mathematical thinking. Problems related to differential calculus experienced by students are visual ability in drawing graphics. Focus material on graphs of equations and functions. Functions and equations are important and fundamental mathematical concepts in differential calculus.

Mathematical concepts that are introduced to students or students more directly use formal definitions without regard to the concept of image / visual. Some students are still weak in their ability to illustrate images. Visual abilities rely more on memory/memorization abilities so that they are low in algebraic and graphical representations and their effects on analytic abilities. This is a serious problem in solving problems. Weaknesses in solving problems due to obstacles drawing graphics in calculus. There are some similar difficulties in differential calculus, namely drawing graphs of incorrect functions/difficulties.

In the 4.0 industrial revolution era, the development of the technological world is growing rapidly[8]. Some applications in the world of education have been widely used by lecturers [9]. Also, the ability of lecturers in teaching is required to master technology, so that in the end it will adjust to the conditions of the times. The challenge in the future is how an educator can master technological literacy in the industrial revolution 4.0 era. Current technological developments are needed according to the times. Educators must utilize technology in their learning, so they can adjust to their needs.

Many technology-based tools are widely used in mathematics learning. One of the computer software that can be utilized in learning mathematics is GeoGebra software. This software should be introduced to Mathematics educators so that students can explore the world of Mathematics in a wider and make the students able to think critically and creatively. According to Hohenwarter, the GeoGebra program is very beneficial for teachers and students. Unlike the use of commercial software that usually can only be used at school, GeoGebra can be installed on a personal computer and used anytime and anywhere by students and teachers. For teachers, GeoGebra offers an effective opportunity to create an interactive online learning environment that allows students to explore various mathematical concepts.

The need for the development of teaching materials related to differential calculus courses adjusted to the ability of students to be a way for lecturers to overcome problems that occur. Learning calculus with Geogebra could make students give more attention on the material. Therefore, it needs to be made and developed teaching materials using GeoGebra.

Based on the description above, the researchers aimed to find out the calculus teaching material using GeoGebra, knowing the results of expert validation in terms of multimedia and material, and knowing the effectiveness of using calculus teaching material using GeoGebra.

RESEARCH METHOD

The method used in this research is Research and Development (R&D) with a development model that is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The resulting product is a calculus teaching material in the form of a GeoGebra file. The subjects in this study were lecturers of calculus and multimedia experts at Universitas Suryakancana. In addition, the target users were 40 students in the Mathematics Education Study Program at Universitas Suryakancana in the academic year 2019-2020.

The instruments used in this study were multimedia expert validation sheets, calculus material validation sheets, and student response questionnaires. The multimedia expert validation sheet contains aspects of the assessment of ease and technical quality. Multimedia validation was carried out by 5 multimedia experts from 2 multimedia teaching lecturers, 2 multimedia expert lecturers from informatics engineering lecturers, and 1 technology application lecturer in mathematics learning.

The calculus material validation sheet contains aspects of learning assessment and lecture material. Material validation was conducted by 5 material experts from 2 lecturers in differential calculus, 2 lecturers in integral calculus, and 1 lecturer in basic mathematics. Student questionnaire includes convenience, motivation, attractiveness, and benefits.

The data analysis techniques of multimedia expert validation sheets and calculus material validation sheets used the alignment/compatibility test with the Kendall Test. Data analysis techniques in the student response questionnaire used the percentage of student answers.

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RESULTS AND DISCUSSION

The calculus teaching material using GeoGebra

The development of calculus teaching materials using Geogebra is carried out with several stages by the development model, namely ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The resulting product is a calculus teaching material in the form of a GeoGebra file.

In the analysis phase, before using teaching materials, a needs analysis must first be done by observing or reviewing the relevant literature. Next, in the second stage, the design stage includes learning design and multimedia design. The learning design phase includes identity, learning objectives, subject matter, learning strategies, evaluation design, and source of material. While the product design stage includes the elements of image and navigation.

In the third stage, the development stage, at this stage the production of teaching materials in the form of GeoGebra with planned designs. The fourth stage is implementation, at this stage the product has been designed, designed, and ready for use and then tested on the target product users. The final stage is the evaluation stage, at this stage, an evaluation is carried out using validation by multimedia experts and material experts. Besides, trials were conducted on students as targets for product users.

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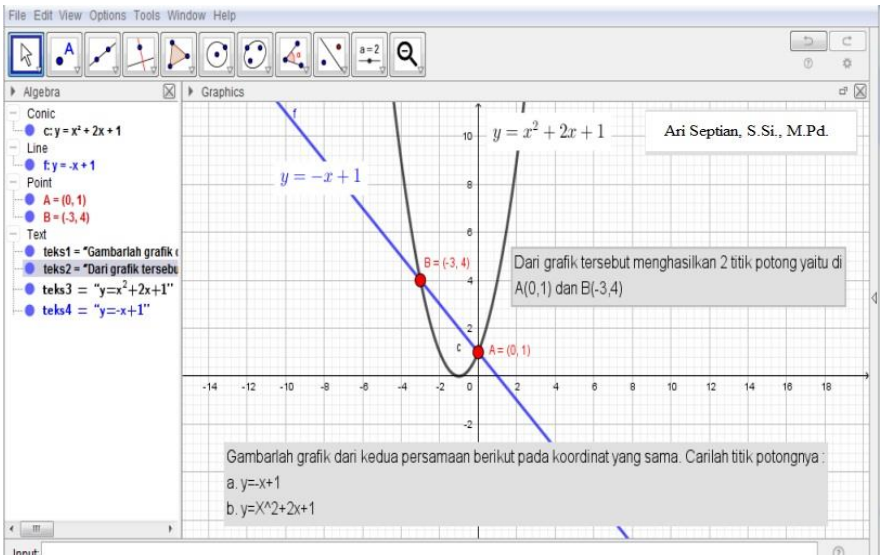

Figure 1. Display calculus teaching material using GeoGebra on the material functions and equations

Expert validation in terms of multimedia and material

Multimedia validation was carried out by 5 multimedia experts from 2 multimedia teaching lecturers, 2 multimedia expert lecturers from informatics engineering lecturers, and 1 technology application lecturer in mathematics learning.

The aspects assessed by multimedia experts are instructional quality and technical quality. There are 26 assessment indicators with 6 instructional quality indicators and 20 technical quality indicators. Tests carried out using the Kendall test. Kendall test is done to find out whether there is harmony among the weighers in making an assessment. The hypothesis for this case is, H_0: There is alignment among weighers in evaluating, H_1: There is no harmony among weighers in valuing. Decision making: If Sig. > 0,05, H_0 is accepted and if Sig. < 0,05, H_0 is rejected. Following are the results of data processing with SPSS 24.

Table 1. Kendal Test Results for Assessment of Multimedia Experts

Validator	Kendall W	Sig.	Df	Conclusion
5	0,332	0,020	25	Ho accepted

From Table 1 it can be seen that Sig. = 0,020. This means that Ho is accepted, thus it can be concluded that there is harmony among the weighers in providing an assessment. the majority of multimedia experts rate it in the good category (4), so it can be concluded that calculus teaching material using GeoGebra is appropriate to use.

Material validation was conducted by 5 material experts from 2 lecturers in differential calculus, 2 lecturers in integral calculus, and 1 lecturer in basic mathematics. The aspects assessed by material experts are instructional quality and quality of content and objectives. There are 21 assessment indicators with a composition of 9 instructional quality indicators and 12 indicators of content quality and objectives.

Tests carried out using the Kendall test. Kendall test is done to find out whether there is harmony among the weighers in making an assessment. The hypothesis for this case is, H_0: There is alignment among weighers in evaluating, H_1: There is no harmony among weighers in valuing. Decision making: If Sig. > 0,05, H0 is accepted and if Sig. < 0,05, H_0 is rejected. Following are the results of data processing with SPSS 24.

Table 2. Kendall Test Results for Assessment of Material Experts

Validator	Kendall W	Sig.	df	Conclusion
5	0,342	0,025	20	Ho accepted

From Table 2 it can be seen that Sig. = 0,025. This means that Ho is accepted, thus it can be concluded that there is harmony among the weighers in providing an assessment. The majority of material experts judge in the good category (4), so it can be concluded that the content of the material is appropriate.

The effectiveness of using calculus teaching materials using GeoGebra

The effectiveness of the use of calculus teaching material using GeoGebra was measured by using an assessment of 40 students in the form of a questionnaire with 21 statements divided into 4 aspects namely ease, motivation, attractiveness, and usefulness. The following results from filling out the effectiveness questionnaire using calculus teaching material using GeoGebra.

Table 3. Student responses to the use of GeoGebra in learning

Aspects	Indicator	Student Response			
		Strongly Agree	Agree	Disagree	Strongly Disagree
Ease	Ease of Use	83%	13%	1%	4%
	Ease of navigation	80%	16%	3%	1%
	Ease of understanding material	74%	16%	3%	8%
Motivation	Interest Motivation	82%	15%	1%	3%
	Attention	78%	15%	3%	4%
Interest	Display quality	79%	15%	3%	3%
	Attractive	74%	16%	3%	8%
Usefulness	Give a positive impact on students	73%	20%	5%	3%
	Providing learning assistance	70%	20%	3%	8%
	Overall Indicator Average	78%	15%	2%	4%

The results of tests on 40 mathematics education study program students, an average percentage of 78% of students answered strongly agree and 15% answered agreed, meaning that calculus teaching material using GeoGebra is effectively used. .

CONCLUSIONS

Based on the results and discussion, researchers can conclude that calculus teaching material using GeoGebra is feasible to use, the content of the material is appropriate, and calculus teaching material using GeoGebra is effectively used.

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