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Development of Geogebra Applets of Equation and Square Functions for Class Ix Students of Junior High School

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Abstract: The purpose of this research is to make learning media that meet the quality requirements of learning media. There are three objectives targeted in this study, namely, Knowing the characteristics of the media, knowing the practicality, and knowing the effectiveness of the media. This type of research is research and development using a 4-D development model. The stages of developing the 4-D model used include the definition stage, the design stage, and the development stage. These stages produce GeoGebra applet learning media which consists of 3 applet media that have been tested for feasibility with an average of 4.48 in the Very Eligible criteria. The learning media produced have been tested for their practicality, seen from the results of the analysis of the average teacher response questionnaire scores and student responses, which are 5.0 and 4.5 which have a very good practicality level. And this media has been proven effective in learning. This can be seen from the classical completeness with the percentage of classical completeness 84.37%. The conclusion is that the GeoGebra applet learning media is practical and effective to train students' conceptual understanding IX grade junior high school on equations and quadratic functions

Keywords: GeoGebra applet, 4-D development model, quadratic equations and functions.

Abstrak: *Tujuan penelitian yakni membuat media pembelajaran yang memenuhi persyaratan kualitas media pembelajaran, Ada tiga tujuan yang disasar dalam penelitian ini yakni, Mengetahui karakteristik media, mengetahui kepraktisan, dan mengetahui keefektifan media. Jenis penelitian ini adalah penelitian dan pengembangan menggunakan model pengembangan 4-D. Tahapan pengembangan model 4-D yang digunakan meliputi tahap pendefinisian, tahap desain, dan tahap pengembangan. Tahapan tersebut menghasilkan media pembelajaran applet GeoGebra yang terdiri dari 3 media applet yang sudah diuji kelayakannya dengan rata-rata sebesar 4,48 dalam kriteria Sangat Layak. Media pembelajaran yang dihasilkan telah teruji kepraktisannya dilihat dari hasil analisis rata-rata skor angket respon guru dan respon siswa adalah 5,0 dan 4,5 yang memiliki tingkat kepraktisan sangat baik. Serta media ini telah teruji efektif dalam pembelajaran. Hal ini dapat dilihat dari ketuntasan klasikal dengan persentase ketuntasan klasikal 84,37%. Kesimpulannya bahwa media pembelajaran applet GeoGebra praktis dan efektif untuk melatih pemahaman konsep siswa SMP kelas IX pada materi persamaan dan fungsi kuadrat.*

Kata kunci: *applet GeoGebra, model pengembangan 4-D, persamaan dan fungsi kuadrat.*

▪ INTRODUCTION

The development of education cannot be separated from the development of technology. In 21st century education, technology plays an important role in education. Learning is no longer teacher-centered, but student-centered where the teacher's role is as a student facilitator in their efforts to carry out the learning process, by preparing learning resources and media (Surani, 2019). Correspondingly, Damopolii, et al. (2020) and Rafianti, et al. (2018) revealed that in the learning process in the 21st century today, the learning process should be adapted to the progress and demands of the times in the

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21st century, technological advances that demand new innovations to improve the quality of education, one of which is in terms of learning media.

Rusmana & Isnaningrum, (2015) reveal that learning media in the era of globalization requires learning media based on Information Communication and Technology or often known as ICT. Learning media is a tool that can be used to convey messages to students so that learning objectives can be achieved (Widodo, 2018). The learning media that are most often used by teachers in the learning process in the classroom are blackboards, textbooks and limited teaching aids, but media such as computer applications are still rarely used in classroom learning (Agung, 2018). Students master the material well, if students understand the concept. If students understand the concept, various kinds of questions and problems will be easy to solve (Lestari, 2018) . In line with that according to Putra, et al. (2019) explained that there is a need for various creative innovations in making a media that can later be used as an innovative and exploratory learning medium. Teachers face the challenge of choosing appropriate learning technologies, teaching models and strategies that stimulate students' attention and inspire active participation in learning (Radović et al., 2020).

Mathematics is an abstract subject that requires media in the learning process. One of the learning materials that is still difficult for students to understand is the quadratic function (Fatahillah et al., 2020). In line with research conducted by (Anggraini, 2020) it shows that students have difficulty in working on questions related to quadratic equations, student errors in working on questions are caused by because students' understanding ability is low in mastering concepts. In line with that, the research conducted by (Sarlina & Alyani, 2021) showed that students had difficulties in learning mathematics, especially in quadratic equations.

Dynamic geometry software is the best tool that allows students to understand the concepts and features of GeoGebra it is also very simple and easy to use (Khalil et al., 2018). In line with that, Nisiyatussani et al., (2017) stated that the GeoGebra software is very flexible in the sense that it can be downloaded for free on personal computers, Android devices, and can be used directly on the web without installing the application. This software can be used to create worksheets and can be used or shared on the GeoGebra web server (Kalaphath, 2021). Misrom et al., (2020) revealed that making mathematical concepts moreinteresting and easy to understand through visualization because there are interesting and colorful text and graphics in GeoGebra. GeoGebra can be used to introduce or construct new concepts (Nur, 2016). Pakpahan, et al. (2020) revealed that in improving students' creative thinking skills, they are better in the learning process assisted by GeoGebra. In line with that, Septian and Monariska (2021) revealed that the improvement of students' mathematical understanding skills using GeoGebra-based educational games was better than students who received ordinary learning. The independence of student learning in conducting exploration in the learning process will later affect student learning outcomes, because students who are independent in learning will be happy to work on questions independently (Yunitasari, et al. 2019).

Based on this brief background, the author makes GeoGebra Applet learning media in the material of equations and quadratic functions for grade IX junior high school students. The purpose of using the GeoGebra Applet is to improve students'

understanding of mathematical concepts, especially in the matter of equations and quadratic functions.

▪ METHOD

In this research, the development of the GeoGebra Applet uses a 4D model. In the 4D model there are 4 stages of development consisting of Define, Design, Develop, Disseminate. In this case the researcher develops the media to the develop stage. The development procedure in this study is in accordance with the stages of the 4D development model as follows.

The definition stage is the first step in the 4D model development model. At this stage, it is done to find out and analyze the information that is needed in the media to be developed. The definition stage includes five phases, including; front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives.

The design stage at this stage is carried out with the aim of designing a prototype of the developed learning media and its evaluation tools. The steps taken are compiling the design of the product to be developed in the form of a storyboard which will facilitate the process of making learning media. Once implemented, the initial product design will be generated. The design stage consists of four stages, namely: Preparation of benchmark reference tests, Selection of appropriate media objectives, Format Selection, Initial design. The development stage at this stage is to realize the product design that has been made so as to produce the final product GeoGebra Applet the subject of quadratic equations and functions. In the development of this media, 3 GeoGebra Applets were created. In the GeoGebra 1 Applet, it presents learning material about quadratic equations. In the GeoGebra 2 Applet, it presents learning material about quadratic functions. In the GeoGebra 3 Applet, presenting about games related to contextual issues.

Trial Subject

Research on the development of the GeoGebra applet was carried out in SMP Negeri 8 Singaraja. The test subjects in this study were students of class IX SMP Negeri 8 Singaraja, totaling 32 students.

Instrument data

Data collection techniques in research on the development of the GeoGebra applet are using interviews, questionnaires and tests. The interview method is used as a guide in knowing the problems that occur in learning at school. The results of the interviews are used as a basis in the development of learning media that will be designed. The questionnaire instrument for material experts and media experts was made based on the LORI (Learning Object Review Instrument) with a scale of 1 to 5, in the media expert assessment instrument, the aspects assessed included: presentation design, user interaction, accessibility, reuse. For the material expert assessment instrument, the aspects assessed include: quality of content/material, learning objectives, feedback and adaptation, and motivation.

The questionnaire instrument for teacher and student responses was made based on the content of the material and learning media developed in accordance with the National Education Standards Agency. The questionnaire used has a value range from 1 to 5. The aspects assessed include: interest, material, and language.

The evaluation test instrument was carried out to students who had participated in learning using the GeoGebra applet. The evaluation test indicator is to determine students' conceptual understanding of the research on the development of the GeoGebra applet of equations and quadratic functions and tests are used to determine the effectiveness of the developed media.

Data Analysis

The data analysis technique used in this study is qualitative and descriptive quantitative data analysis techniques, which will later be used to determine the feasibility of the GeoGebra applet media, the practicality, and effectiveness of the GeoGebra applet media. The assessment of the GeoGebra applet learning media can be seen from the questionnaire data that has been filled out by media experts and material experts as well as the practicality of the GeoGebra applet media seen from the teacher's response and student responses. The effectiveness of the GeoGebra applet media can be seen from the results of the learning mastery test after participating in learning using the GeoGebra applet media. Students can be said to be complete if the test score obtained is more than the KKM (Minimum Completeness Criteria) where the value is 70.

▪ RESULT AND DISSCUSSION

This development research aims to produce learning media GeoGebra applets with material equations and quadratic functions of junior high school class IX. The development model used in this study is the Four-D (4-D) model which is limited only to the develop stage. After going through the process of the develop stage, a GeoGebra applet learning media is produced which has been evaluated and is ready to be tested. In the development of this media, 3 GeoGebra applets were created. In the GeoGebra 1 Applet, presenting material on quadratic equations. In the GeoGebra 2 applet, presenting material on quadratic functions. In the GeoGebra 3 Applet, presenting a game in which it contains practice questions for contextual problems.

Defining Stage

The definition stage includes five phases, including; front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. In the Front-end Analysis phase. Researchers made observations to find out the problems of learning mathematics in SMP Negeri 4 Sukasada and SMP Negeri 8 Singaraja. Based on the results of interviews from the two schools, information was obtained that when learning online, teachers only used WhatsApp media by giving assignments. This certainly makes learning feel monotonous and the media used is less diverse and the problems faced by students are related to understanding concepts. Students find it difficult to accept and understand the material on equations and quadratic functions in class IX. So it can be concluded that the problems faced are related to the media used by the teacher is less diverse, students' interest in learning decreases, students have difficulty understanding the material, one of which is equations and quadratic functions in class IX.

At the Learner Analysis stage, it is carried out to analyze the characteristics of the targeted students regarding the learning media that will be developed. This process is carried out by means of interviews conducted with teachers and students. Based on

observations and interviews that have been carried out, students prefer to learn with the help of learning media, especially if they study independently, there are interesting illustrations and practice questions can further strengthen students in learning. This certainly makes it easier for students to understand the material and understand concepts.

In the Task Analysis stage, the researcher analyzes the core competencies (KI) and basic competencies (KD) related to the material of equations and quadratic functions. The purpose of task analysis is to identify the material for equations and quadratic functions that will be studied by students in the media. At the Concept Analysis stage, the researcher identifies, and systematically arranges concepts related to the material of equations and quadratic functions that will be applied in learning media, so that later the media created can improve students' conceptual understanding. In the Specifying Instructional Objectives stage, it is carried out to determine learning objectives based on the analyzes that have been done previously. By writing the learning objectives, researchers can find out the material for equations and quadratic functions that will be compiled into the media.

Design Stage

At this stage, the aim is to design the developed learning media and evaluation tools. The steps taken are compiling the design of the product to be developed in the form of a storyboard which will facilitate the process of making learning media. Once implemented, the initial product design will be generated. The design phase consists of four stages, namely: Preparation of Benchmark Reference Tests, Selection of Media According to Purpose, Format Selection, and Initial Design.

Preparation of benchmark reference tests, the tests are arranged based on the results of the formulation of learning objectives in accordance with the basic competencies in the 2013 curriculum. The evaluation tests developed are adjusted to the level of students' cognitive abilities. The test indicators are made related to understanding the concept. Media selection according to purpose, in this study, researchers chose the GeoGebra applet to be developed. The purpose of using the GeoGebra Applet is to improve students' understanding of mathematical concepts, especially in the matter of equations and quadratic functions. The choice of format, the selection of the presentation format is adjusted to the content of the learning materials used in the development of the GeoGebra applet. The purpose of choosing this format is to make the developed GeoGebra applet attractive and make it easier for students to learn. The initial design, at the design stage, makes the initial design of the GeoGebra applet media which will later be developed. Design the GeoGebra applet media as an initial guide in making media later, with the initial design it will make it easier for media preparation. In the development of media applets, the design of the media used is in the form of storyboards.

Development Stage

After the media applet storyboard has been compiled, the next step is to compose the GeoGebra applet learning media which will later become an initial media product. Making learning media in this development research using GeoGebra software. In the design stage, in addition to completing the initial media product, an evaluation

instrument was also prepared to assess the developed learning media. The instruments include media expert evaluation questionnaires and material expert evaluation questionnaires, response questionnaires for teachers and students, and evaluation questions instruments. At the develop stage, the initial product is developed so that it will produce a final product that has product quality with good criteria.

In the development of this media, 3 GeoGebra applets were created. In the GeoGebra 1 Applet, presenting material on quadratic equations. In the GeoGebra 2 applet, presenting material on quadratic functions. In the GeoGebra 3 Applet, presenting a game in which it contains practice questions for contextual problems.

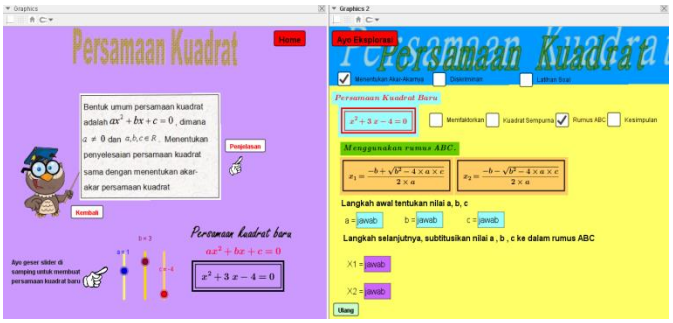

Figure 1. Quadratic equation applet

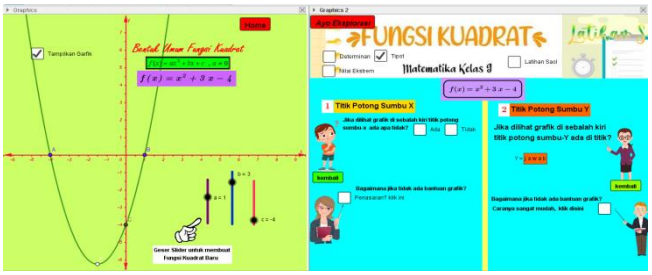

Figure 2. Square function applet

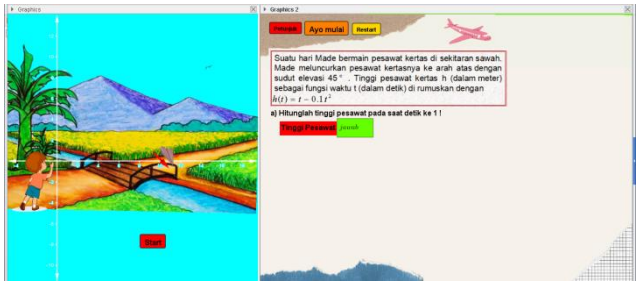

Figure 3. Game applets.

The validity of the developed media is carried out after producing the media in the form of the final product. Validity is carried out by material experts and learning media experts by providing an assessment of the GeoGebra applet media. Based on the results of assessments from media experts and material experts, it shows that the learning media developed is included in the valid criteria in the aspect of validity, because it meets the eligibility of the experts and is in accordance with the established criteria. The summary of the overall validity results can be seen in Table 1.

Table 1. Overall expert assessment results.

No	Validity	Average Score
1	Media Expert	4.86
2	Material Expert	4.11
	Amount	8.97
	Total average	4.48
	Criteria	Very Worthy

Overall, it can be concluded that the GeoGebra applet media equations and quadratic functions that have been developed have met the criteria for being very feasible to be tested on students.

The discussion of research results in this study is divided into 3 (three) subs in order to answer the problems contained in the formulation of the proposed problem, as follows:

Characteristics of GeoGebra Applet Media

In making learning media development using GeoGebra software as an application in making GeoGebra applets. The purpose of using the GeoGebra Applet is to improve students' understanding of mathematical concepts, especially in the matter of equations and quadratic functions. The GeoGebra Applet is a learning media created with the GeoGebra application, there are several benefits of the GeoGebra Applet in learning mathematics, namely, as a demonstration and visualization medium, as a tool to build a concept, and as a tool to prepare teaching materials, especially for teachers.

The validity of the developed media is carried out after producing the media in the form of the final product. Validity is carried out by material experts and learning media experts by providing assessments and suggestions on the validation sheet that has been provided. the recapitulation of the results of the GeoGebra applet-based learning media validity test by media experts was 4.86 in the very feasible category and the average score from material experts was 4.11 in the appropriate category. Based on the average of the results of the assessment of material experts and media experts, an average of 4.48 was obtained which was in the Very Eligible criteria. So overall it can be concluded that the GeoGebra applet media equations and quadratic functions that have been developed have met the criteria for being very feasible to be tested on students.

The characteristics of the GeoGebra applet media of quadratic equations and functions for grade IX junior high school students developed in this study are as follows: (1) There are interactivity features in the form of practice questions regarding understanding the concept of equations and quadratic functions. Practice questions contained in the media that help students understand the concept. Before answering the questions in the media, the previous students explored independently by fiddling with the media, then the students concluded what they had learned by answering the exercises. So that there is interaction between the media and students and vice versa. When students answer the questions correctly, students can continue on the next menu. However, when students answer incorrectly, students are directed to re-explore. The second interactivity feature is a game related to application questions, where the questions branch out in this activity, namely the next question appears after students have successfully answered the first question. (2) GeoGebra applet media is oriented

towards understanding the concept of equations and quadratic functions. This can be seen in the media that presents real problems in everyday life that are close to students so that students can more easily understand the material. The media guides students to find their own concepts of quadratic equations and functions. The practice questions and questions provided are related to understanding the concept. Therefore, the developed media can help students understand the concept of equations and quadratic functions. (3) The developed GeoGebra applet media consists of three media which includes quadratic equation material, quadratic function material, and games related to application questions. (4) GeoGebra media applets can be accessed online and offline. It can be accessed online using a smartphone and laptop/PC, without downloading the GeoGebra application, while if you use it offline, you must download the GeoGebra application.

Practicality of GeoGebra Applet Media

Practicality is done to find out how students and teachers respond to the GeoGebra applet, it can be seen from the results of the questionnaire filled out by teachers and students. Limited trial conducted in SMP Negeri 8 Singaraja involving 32 students and a class IX teacher. The level of practicality of the developed media can be seen through practicality questionnaires given to students and teachers after using the GeoGebra applet learning media. The following is a summary of the results of the analysis of student responses to the GeoGebra applet media of equations and quadratic functions for SMP Class IX, which is presented in Table 2.

Table 2. Student response assessment results

Respondent	Average	Respondent	Average	Average Total Score	Criteria
S1	4.8	S17	4.4	4.5	Very good
S2	4.3	S18	4.4		
S3	4.9	S19	4.7		
S4	4.1	S20	4.5		
S5	4.5	S21	4.7		
S6	4.7	S22	4.4		
S7	4.5	S23	4.5		
S8	4.2	S24	4.3		
S9	4.8	S25	4.8		
S10	4.2	S26	4.6		
S11	4.1	S27	4.9		
S12	3.9	S28	4.3		
S13	4.7	S29	4.4		
S14	4.3	S30	4.5		
S15	4.5	S31	4.1		
S16	4.4	S32	4.8		

Based on Table 2, the average obtained from the student response questionnaires is 4.5 so that based on the criteria of the media practicality test, the criteria are very

good. Regarding the recapitulation of the teacher's response questionnaire results, it can be seen in Table 3.

Table 3. Teacher response assessment results

Teacher Response Questionnaire	Questionnaire Data
Number of questionnaires	14
Total score	75
Total Average	5.0
Criteria	Very good

Based on Table 3 the average obtained from the teacher's response questionnaire is 5.0 so that based on the criteria of the media practicality test, the criteria are very good. Based on the results of a limited trial of the GeoGebra applet media, the equations and quadratic functions of Class IX SMP are efficiently used, giving a positive impact to its users which can be proven by the practicality of the GeoGebra applet-based learning media in the very good category with a student score of 4.5 and a teacher score of 5.0.

Effectiveness of GeoGebra Applet Media

The effectiveness of learning media GeoGebra applet equations and quadratic functions of SMP class IX developed in this study was measured by looking at the results of students' learning mastery tests after learning to use learning media GeoGebra applets quadratic equations and functions are shown in Table 4.

Table 4. Effectiveness test results

Variation	Trial Class Data
Highest Score	95
Lowest Score	62
Number of Completed Students	27
Number of Students Incomplete	5
Classical Completenessl	84.37%
Criteria	Very good

Based on the analysis of the results of the concept understanding test, 84.37% classical completeness was obtained from 32 people. The number of students who completed was 27 people while 5 people did not complete. So it can be concluded that the GeoGebra applet learning media is an effective quadratic equation and function with a very good level of effectiveness. The results of this study are in line with the results of research by Suryawan & Permana (2020) and Anggraeni et al. (2021) which both develop learning media with the GeoGebra tool as an exploration medium and effectively improve students' understanding of mathematical concepts.

▪ CONCLUSION

Based on the results and discussion described above, the conclusions from this study are: Characteristics of the GeoGebra applet media, equations and quadratic functions for junior high school students in grade IX developed in this study. GeoGebra consists of three media, and the GeoGebra media applet can be accessed online and offline. The level of practicality of the GeoGebra applet media equations and quadratic functions for grade IX junior high school students can be seen based on the results of the teacher and student response questionnaire analysis is 5.0 and 4.5 which have a very good level of practicality. The level of effectiveness seen from the percentage of classical completeness achieved during the trial was 84.37% meaning that the effective learning media used in learning with the effectiveness level was at a very good level.

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