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Development of an android-based math equation editor

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Abstract. The long-term goal of this research is to develop Android-based learning as an alternative to mathematics learning. Meanwhile, the specific objective to be achieved in this research is to examine the effect of Mathematics learning media in the form of an Android-based Math Equation Editor on student achievement in high school. This research is a Research and Development (R&D) research. There are 8 stages in this study, namely (1) Potential and problems, (2) Data collection, (3) Product design, (4) Design validation, (5) Design revision, (6) Product testing, (7) Design revision, and (8) Trial usage. The conclusions obtained from the development of the Android-based Mathematical Equation Editor as an exponential learning media are valid, practical and effective. The conclusions of this study are: (1) Android-based Math Equation Editor Products are valid, practical and effective. Its validity can be seen from the results of the validator assessment analysis of the Mathematics learning media in the form of an Android-based Math Equation Editor obtained by Pearson correlation of 0.322; (2) Its practicality is seen from the results of user assessment analysis through limited trials of Mathematics Equation Editor-shaped learning media in the form of Android which shows an average score of 3.958 with practical criteria; (3) Its effectiveness is seen from the results of the analysis of student assessments through field trials of Mathematics Equation Editor-shaped learning media based on Android can improve student mathematics learning achievement in Mathematic.

1. Introduction

Currently Indonesia is in Community 5.0 and Industrial Revolution 4.0. Therefore, the Indonesian people must prepare quality and superior resources [1]. However, the quality of education in Indonesia is still relatively low, one of the causes is low student achievement [2]. Meanwhile, the age has advanced and now, information is a basic need in various aspects of life. In the field of education, technology plays an important role in advancing and developing students' skills. The teacher's task will also be helped by technology.

Science and technology development supports and encourages efforts towards renewal in utilizing the results of the implementation of learning technology. As educators, in their assignments it is expected to use learning media as a tool in the learning process; both simple to sophisticated; such as the use of smartphones as learning media [3]. Implementation of ICT in the education world, will improve the quality of education [4]. Learning must also be supported by the use of ICTs [5]. Such learning can be achieved using Android. Android is a set of software for mobile devices that includes the operating system, middleware, and main applications [6]. Android is designed primarily for touch

screen mobile devices such as smartphones and tablet computers [7]. Android is the right operating system used for the development of mobile learning, cause android is open source and easily installed on any compatible devices [8].

Mathematical learning has cognitive aspects that include behavior that emphasizes intellectual aspects such as mathematical ability or mathematical ability, namely in the form of basic knowledge and skills needed to be able to do mathematical manipulation and thinking skills in mathematics. Teachers in schools who are committed to teaching for deep understanding are more likely to find possible contexts, even though an overall performance at the school is not very good [9]. Likewise, many researchers suggest that engineering practices in education will be effective in directing students to the STEM field which includes science and mathematical disciplines [10]. They can structure their mathematical knowledge through teacher assistance by discussing possible alternative answers [11]. The ability for communicating mathematic shown from writing (written text), drawing, and mathematic expression [12].

The experts have a unidirectional view of it, comparison of the acquisition of learning outcomes through the sense of sight and the sense of hearing is a very prominent difference. Baugh states that approximately 90% of one's learning outcomes are obtained through the senses of view, and only about 5% is obtained through the sense of hearing, and 5% again with other senses. Meanwhile, Dale estimates that the acquisition of learning outcomes through the senses of view is around 75%. Through the sense of hearing about 13%, and through the other senses about 12% [13].

Concerning business learning, achievement means learning achievement achieved by students after carrying out learning activities within a certain period. Learning achievement is a value that shows the results in learning achieved according to the ability of students to do something at a certain time after doing the learning process [14]. Student learning achievement is determined by two factors, it is internal and external factors.

One effort that can be made to give effect to develop student learning achievement is to choose an appropriate learning model and can encourage student enthusiasm to be able to develop student achievement optimally and learn more meaningfully through ICT-assisted learning (Information Communication Technology) which is based on Android. Thus the current learning process will also be greatly helped by the existence of information technology such as gadgets or smartphones. The development of smartphones has different types, such as iOS, Windows and Android.

Android-based learning media can display messages from static textbooks into a new form of learning that is more interactive. Android can combine two or more elements which consist of a bag of text, graphic, image, photo, audio, video and animation in an integrated and interactive way so that it can function as a learning device. According to Levie and Lentz reviewing the results of research on learning through image stimulus and a word or visual and verbal stimulus concluded that visual stimulus results in better learning outcomes for tasks such as remembering, recognizing, recalling, and linking facts and concepts [14].

The urgency of developing Android-based media is optimizing smartphone features that are popular with students and accessible. Now, teachers in algebra and calculus used tablet PCs for their lectures instead of writing on the blackboard or using a projector. As the teacher was solving a problem on the tablet PC, students could see the solution in their own tablet, send immediate answers or questions to the teacher and of course they could keep a record of the lecture [15].

Besides, the development of Android-based media aims as a preventive measure against the negative effects of the internet and gain. With this media can reconstruct the smartphone image as one of the educational media. Android based learning media that already exist are not detailed and specific can be used in exponential material. Previous research has only carried out the development of android-based learning media on the subject of the operating system [16] and on linear program [17], there has not been any specific learning media in the form of extremely mathematical editor that can be used to typed mathematical expression using an android.

The long-term goal of this research is to develop Android-based learning as an alternative to mathematics learning. Meanwhile, the specific objective to be achieved in this study was to examine

the effect of Mathematics learning media in the form of an Android-based Math Equation Editor on student achievement in high school.

2. Method

This research is a Research and Development (R&D). This research is a development innovation with the theme of Android-Based Mathematical Equation Learning Media Design in an effort to improve student achievement by facilitating students to type mathematical expressions using a mathematical equation editor which will be developed into an Android-based mathematical equation learning media that can be accessed using an Android-based smartphone that can be used wherever and whenever.

The stages in this study there are 8 stages, the first is Potential and problems, second is data collection, third is product design, fourth is design validation, fifth is design revision, sixth is product trial, seventh is design revisions, and eighth is trial usage. Data analysis in this study tested differences in the average population in the control class and the experimental class, based on the results of the pre-test and post-test assessments.

In collecting data and information used as materials for developing instructional media that are expected to overcome existing problems. In this study, the data obtained came from observations, interviews, and questionnaires.

3. Result and Discussion

The development procedure is the stages carried out by the researcher by the development model used. This research develops a product in the form of an Android-based Math Equation Editor. The development procedure is designed with a 4D (Define, Design, Develop, Dissemination) development model that has been adjusted according to the needs and limitations so that the following stages of development are obtained [18].

3.1. Defining Phase

The definition stage is carried out before developing teaching materials by determining objectives and problems as a benchmark in the preparation of an Android-based Mathematical Equation Editor. The defining stage consists of five steps: initial-end analysis, student analysis, concept analysis, task analysis, and learning objective specifications

Front-end analysis is a study of the problems faced by teachers in learning mathematics. The analysis was carried out during pre-research through learning observation activities, teacher interviews, and giving questionnaires to students [19]. The pre-research was carried out in Class X of Senior High School 3 Kuningan. In the initial analysis, several problems were encountered in learning mathematics in the classroom. Based on observations, teachers still rarely use interactive learning media by utilizing Android technology. Therefore we need an Android-based learning media to improve mathematics learning achievement.

Analysis of learner characteristics (learner analysis) is carried out as an initial stage in the development of instructional media. The results of the analysis of Class X students at Senior High School 3 Kuningan were obtained to find out how student achievement was. Based on the results of the analysis note that student learning outcomes are still low. Students, in general, have difficulty in writing mathematical expressions using Android.

Concept analysis aims to identify, detail, and systematically compile the tools of the relevant editors to be developed into a Mathematical Equation Editor which is then integrated into high school class 10 mathematics learning in material exponential functions are presented in Figure 1.

Figure 1. Mathematical equation editor tools for exponential material.

Task analysis is done by identifying the main skills needed by the curriculum. This activity is aimed at identifying academic skills that will be developed in learning, namely KD 3.1 applying the concept of rank numbers, root forms and logarithms in solving problems, and KD 4.1 presenting problem-solving for rank numbers, root forms, and logarithms. Analysis of the tasks that have been done on the material Exponential functions as in Table 1.

Table 1. Task analysis of exponential materials

Topic	Task analysis
Exponential	Find the concept of exponents/form numbers of numbers Explain the meaning and characteristics of a positive round rank Change the form of negative rank to positive rank and vice versa Find the negative rank formula, zero power, and fractional power of rank numbers Complete algebraic operations on the rank form using positive rank properties Skillfully apply the concepts/principles and strategies of learning achievement related to exponents or rank numbers Identify the root form number Change the shape of the fractional rank to the root shape and vice versa Understanding the nature of powers in algebra Operate the root form number

3.2. The Designing Phase

This stage aims to develop an Android-based Math Equation Editor so that a prototype (for example an Android-based Math Equation Editor) is obtained to improve mathematics learning achievement. The design phase consists of four steps, namely the preparation of test, media selection, format selection, and initial design (initial design).

The math equation editor application will run on an Android-based cellular operating system and has the function to display a limited-scale math editor. This application must be able to display some mathematical symbols according to the needs in the field. The user will interact with the application through the user interface provided by the application. The user will be presented with a button consisting of the necessary mathematical symbols such as the root function, logarithm, rhythm and fraction.

At this stage is the analysis of software specifications and requirements, the software to be built has features and grooves as:

- exponential equation (a^b)
- fraction equation $\left(\frac{a}{b}\right)$
- root equation $\left(\sqrt[b]{a}\right)$

An explanation of the flowchart is explained as follows: (1) the user starts the program by clicking on the program symbol; (2) the user clicks on the text field first; (3) the user clicks on a symbol or number as needed; (4) users can choose the mathematical symbols needed; (5) the user clicks again on the letters and symbols needed; and finally (6) the method of making the application. This application creation method describes the activities of making programs that illustrate a systematic and sequential approach to software development as shown in Figure 2.

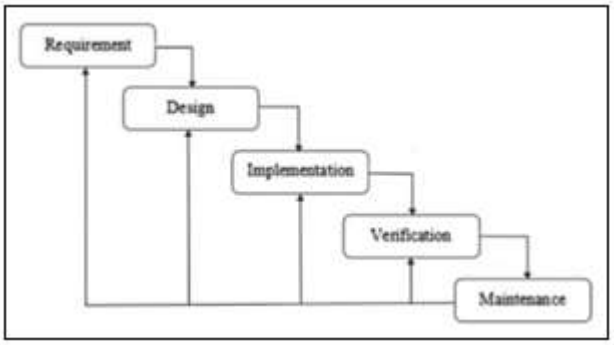

Figure 2. Application development method

Explanation from Figure 2 is there 5 phase of each of the first stages, namely requirements analysis, at this stage, needs analysis needs needed in the interface needs and the required equation requirements are present. The next stage is system design, at this stage the activity is to design the initial appearance according to your desires and needs, while this design only consists of tools/buttons from the template equation and text fields to display the results. The third is implementation, where the implementation of this program is built using the Java programming language with the help of Android Studio as the main application maker. Next is the verification/integration test, in this testing phase examines the extent to which the program can be run, to find out about this program well the testing is limited to competent users and media experts. And finally, the operation and maintenance, which for this final repair phase, is based on the input received when testing limited products.

3.3 Development Stage

The development stage aims to produce a revised Android-based Math Equation Editor draft based on expert input and data obtained from trials. Activities at this stage are expert assessments, limited trials, and field trials.

At the expert appraisal stage, several experts were asked to evaluate the Android-based Mathematical Equation Editor to improve mathematics learning achievement. The validation results of the experts are used as a basis for the revision and improvement of the Android-based Math Equation Editor. Validation data obtained were then analyzed and revised. The revised Android Equation Mathematics Editor is called draft 2. Based on the results of the validation of experts and practitioners, the feasibility of the product being developed is known. The feasibility of this product based on the results of the analysis using SPSS shows:

Table 2. Pearson correlations for expert validation data analysis

	no	total
Pearson Correlation	1	0.322
Sig. (2-tailed)		0.335
N	11	11

Pearson correlation of 0.322 which means more than 0.3, the validation results show well. This shows that the product is based on strong theoretical aspects and that there are consistent interrelationships between products. Based on these results and the opinion of Nieveen [20], it was concluded that the product was valid.

In the limited trial phase, the draft 2 results of the revision after validation were then tested on several students who had different abilities, namely normal, medium, and high. Limited class testing is carried out to test the quality of product development on a small scale. The limited test carried out includes an Android-based Mathematics Equation Editor readability test given to users to get input and suggestions on an Android-based Mathematics Equation Editor. The second revision is called draft 3, which is based on input from a limited trial.

Data analysis on the practicality of learning tools based on user assessment data, in this case, is students through practicality assessment sheets. The practicality of product development is reviewed from three aspects, namely media design, navigation and the suitability of tools with exponential material. Data from the assessment sheet are converted into quantitative data and analyzed to determine its practicality. The results of the practicality data analysis areas in the Table 3.

Table 3. Product practical assessment scores

No.	Aspect	Total score	Average	Category
1	Design media	270	3.99	Practical
2	Navigation	225	4	Practical
3	Conformity	170	4	Practical
Conclusions			3.958	Practical

The third stage is a field trial (developmental testing) which aims to determine the practicality and effectiveness of the product. Field trials are conducted to test the quality of development products on a larger scale. The practicality of the product can be known from the user's practicality assessment sheet. The effectiveness of the product can be known from the student achievement test. Based on the results of the field trials, input was obtained for product revisions. The results of the revision are called draft 4 which is the final product of the Android-based Mathematical Equation Editor development process that has been carried out.

After processing the pre-test and post-test score data on the aspects of mathematical learning achievement in the experimental and control class, descriptive statistics are obtained as shown in the following table:

Table 4. Descriptive statistics of student achievement scores

Test	Experiment Class				
	N	Xmin	Xmaks	$\bar{x}$	Sd
Pretest	32	2	8	5.53	1.37
Post-test	32	14	24	19.11	2.3
Test	Control Class				
	N	Xmin	Xmaks	$\bar{x}$	Sd
Pretest	33	1	12	5.58	2.73
Post-test	33	6	23	17.48	3.37

Based on Table 4 the lowest pre-test scores and the highest pretest scores in the aspects of student achievement in the experimental class were 2 and 8. Similarly, the lowest and highest pretest scores in the control class were 1 and 12. Whereas the average scores for the experimental class were 5.53 and the average value of the control class was 5.58. The experimental class had on average a little smaller than the control class. Meanwhile, from the standard deviation values of the two classes, each experimental class was 1.367 and the control class was 2.77. The standard deviation value in the control class is greater than the experimental class.

From table 4 also seen the lowest post-test score and the highest post-test score in the experimental class respectively 14 and 24. For the control class obtained the lowest and highest scores respectively of 6 and 23. While the average value of the experimental class was 19.11 and the control class by 17.48. The experimental class had higher mean values than the control class. While the standard deviation of the two class of each experimental class was 2.299 and the control class was 3.374. The standard deviation value in the control class is greater than the experimental class.

To provide a clearer picture of the data, the average scores of the two abilities by the study class are presented in the following figure.

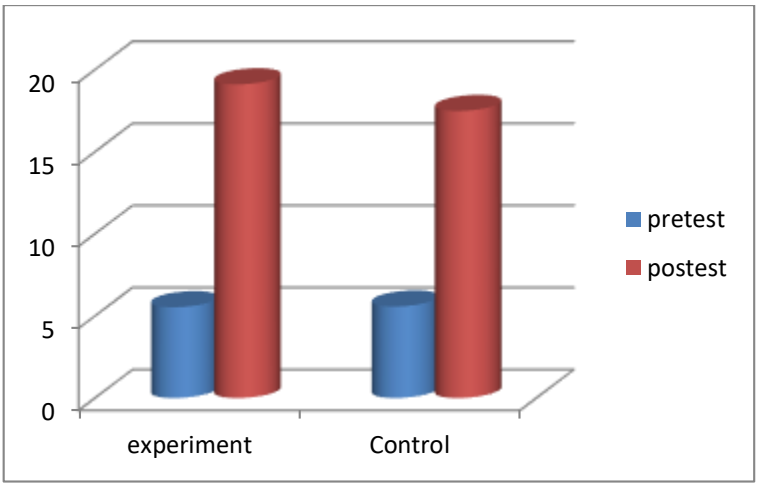

Figure 3. Average pre-test and post-test scores for student learning achievement

The picture above shows the average results of students' pretest and posttest student achievement in each study class. The difference between the mean scores between the pretest scores of the experimental class and the control class was 0.04. This shows that the average pretest scores on the aspects of student achievement between the experimental and control class were relatively different because the scores were almost the same. While the difference in the average post-test scores between the experimental and control class was 1.62. This shows that the Mathematical Equation Editor product is quite effective to improve students' mathematics learning achievement.

3.4 Disseminate Stage

This stage is the stage of using an Android-based Math Equation Editor which has been developed on a broader scale, for example in other classes, other schools, by other teachers and the wider community.

4. Conclusion

Based on the results of the study, several research conclusions were obtained, including: (1) The Android-based Math Equation Editor Product is valid, practical and effective. Its validity can be seen from the results of the validator assessment analysis of the Mathematics learning media in the form of an Android-based Math Equation Editor obtained by Pearson correlation of 0.322; (2) Its practicality is

seen from the results of user assessment analysis through limited trials of Mathematics Equation Editor-shaped learning media in the form of Android which shows an average score of 3.958 with practical criteria; (3) Its effectiveness is seen from the results of the analysis of student assessments through field trials of Mathematics Equation Editor-shaped learning media based on Android can improve student mathematics learning achievement in exponential material.

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