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The Effectiveness of Android-Based Science Learning Model to Increase Student Learning Outcomes

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Abstract: The objectives of this study are: 1) to analyze the need for an android-based science learning model to improve learning outcomes; 2) to design an android-based science learning model to improve learning outcomes; 3) to analyze the feasibility of an android-based science learning model to improve learning outcomes; 4) analyzing the effectiveness of the android-based science learning model to improve learning outcomes. This study uses Research and Development (R&D). The data analysis techniques are analysis of pre-test and post-test results, model feasibility analysis and effectiveness. The results of this study are described in a needs analysis, model design, feasibility test and effectiveness test. Needs analysis shows that there is a need for an appropriate learning model to improve students' science learning outcomes. Hence, the android-based science learning model is used. The model design uses ten steps of research with its products, namely guidebooks and android-based learning applications. Feasibility test with N-Gain test. The feasibility test with the Expert Judgment Test consists of media, material, and learning experts. Test the effectiveness with homogeneity, normality, and t-tests. The homogeneity test of the significance value of student learning outcomes is 0.151> the value of = 0.05 then H0 is accepted. The normality test has a significance value of more than 0.05, so it is normally distributed. T-test, using paired samples t-test, obtained a significance value (2 tailed) 0.000 <0.005.

Keywords: Development, experiment, android

1. Introduction

Education is a process of producing human with qualities and developing human in mastering science and technology that can be implemented for nation's character building (Pratama et al., 2021). In addition, education is one of the efforts to improve the personality, civilization, and progress of the nation in the future. Law No. 20 of 2003 concerning the National Education System, article 1 (1) stated that: "Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation, and state. "

In the learning process with the experimental learning model, students are given the opportunity to experience themselves or do it themselves, follow the process, observe an object, analyze, prove and draw their own conclusions about a particular object, state, or process (Gusau & Mohamad, 2020). The teacher's role in the experimental learning model is to provide guidance so that the experiment is carried out carefully which could avoid errors or mistakes (Dita et al., 2021).

Android is a complete, open, and free platform. Complete means that designers can take a comprehensive approach when they are developing the android platform. The operating system is secure and provides many tools for building software and allows opportunities for application development. Open means that the android platform is provided through an open license (open source) so the developers can freely develop applications. Free means no license or royalty fees to develop on the android platform, no membership fees, and no testing fees required. Android applications can be distributed and traded in any form (Gharaat et al., 2021).

Digital learning applications become a new learning space for teaching staff which makes them more optimal in mastering media-based communication and interaction styles. Their confession was also published through social media related to their longing to meet directly with students in the learning room (Sofiyati et al., 2021). The teaching staff remains in the corridor of learning achievement based on three educational domains; namely cognitive, affective,

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and psychomotor, students are often provided with assignments that hone their productivity to keep working.

Almost all children, including Primary School/Islamic Primary School students, already have objects with the android operating system embedded in their smartphones. Based on the various advantages contained in the android system, it can be used to create an android-based learning media in science learning materials (Dita et al., 2021). The material that will be developed in the process of making the android-based learning media is the human respiratory organ in class V semester 1 students at Primary School/Islamic Primary School. By developing an android-based learning media, it is hoped that Primary School/Islamic Primary School students can use it as an independent learning medium to study the human respiratory organs both inside and outside the classroom.

1.1 Conceptual Framework

Iskandar (1996) in Harefa & Sarumaha (2020) argues that "science is a subject that provides opportunities for critical thinking practice". Conant (Bundu, 2006) also expressed his opinion that science is a building or a series of concepts and conceptual schemes that are interconnected as a result of experimentation and observation. The same thing was also stated by Wonorahardjo (2010) that "science has the meaning of referring to knowledge that is in the system of thinking and theoretical concepts in the system, which includes all kinds of knowledge, about anything".

Android is an open-source software platform for mobile devices. Android contains an operating system, middleware and basic applications. Android provides an open platform for developers to create applications. Android OS base is Linux Kernel 2.6 which has been modified for mobile devices. The definition of Android according to some experts is described as follows:

a) According to Arifianto (2011) and Sarkar et al. (2019), Android is a mobile device on an operating system for cellular phones based on Linux.
b) According to Hermawan et al. (2011) and Jackson (2017), Android is a Mobile OS (Operating System) that grows in the midst of other OSes that are developing today. Other OS such as Windows Mobile, i-Phone OS, Symbian, and many more. However, the existing OS runs by prioritizing core applications that are built by themselves without seeing the considerable potential of third-party applications. Therefore, there are limitations of third-party applications to obtain native mobile data, communication between processes and limitations of distribution of third-party applications for their platforms.

Learning arises in different ways as learners inquire into natural phenomenon, grapple with challenging problems, raise and address questions, interact with other people directly in conversation or indirectly through resources (e.g., books or videotapes), and reflect on their own thoughts and ideas (Horsley & & Sikorová, 2015).

2. Methodology

2.1 Research Design

In this study, a research and development design were used with ten steps of implementation by referring to Borg and Gall theory. According to Borg and Gall (in Sugiyono, 2013) states that research and development (R&D), is a research method used to develop or validate products used in learning.

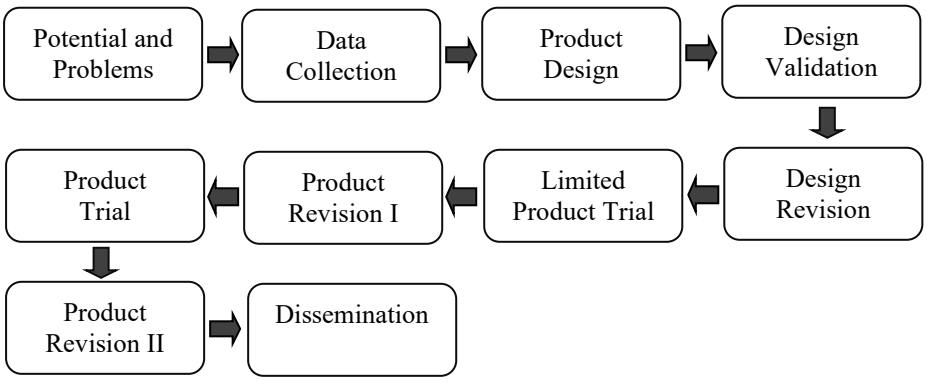

Fig. 1. *Research and Development* (R & D) steps

2.2 Respondents of The Study

The subjects in this study were all fifth-grade students in Kudus Regency. The selection of research subjects was based on several factors that were taken into account such as subject equality, teacher quality, school quality, and an analysis of identified needs so that the selection of research subjects could represent the overall population. The sample in this study were fifth-grade students of Muhammadiyah Primary School No. 1.

2.3 Data Collection

The data collection techniques used were interviews, observations, and tests. Interviewing students and teachers as a method of data collecting aims to explore information related to the needs of an android-based science learning model. In addition, the data collection technique used was observational guidelines which aim to collect edutainment (education and entertainment) learning data. Data obtained from observations are used to analyze the needs of the learning model, with the data sources collected from teachers and students.

Data collection techniques with tests can be used to measure basic abilities and achievements. The type of test in this study is an achievement test, a test used to measure a person's achievement after learning something (Saccenti et al., 2020). This test was conducted to measure the improvement of student learning outcomes in science learning. The test results are used as initial and final data to compare learning outcomes as a result of development and research treatment.

2.4 Data Validity Test

Validity of the data will be tested through validity and reliability tests. A measurement scale is valid if it does what it is supposed to do and measures what it should measure. The validity criteria can be determined by looking at the Pearson Correlation value compared to the level of significance. If the value of Sig <0.05 then the statement in the questionnaire is declared valid (Augustine & Kristaung, 2013).

The instrument is said to be reliable if the instrument used to measure the same object will produce the same data, although in different people, times, and places. Sugiyono (2013) explains that reliability testing with consistency intervals is done by trying the instrument only once then the results obtained are analyzed with certain techniques. Instrument reliability testing can be done with several techniques including KR-20 (Kuder Richardson).

2.5 Data Analysis

The data analysis technique is the activity of compiling and presenting research data obtained through research results. Data analysis is needed to test the truth of the research hypothesis. In accordance with the main purpose of the study to test the data needs, level of feasibility, and product effectiveness. Then the data analysis technique used is the analysis of the results of the pre-test and post-test, analysis of model feasibility, and effectiveness.

Analysis was obtained from teachers' response analysis, students' response analysis, and material analysis. Meanwhile, the feasibility is calculated by calculating the pre-test and post-test values through N Gain calculations and *expert judgment* tests. As for the effectiveness of the prerequisite test through the homogeneity test, normality test, and t-test.

The calculation of N Gain is obtained from the pre-test and post-test scores. Expert assessment tests were obtained from material experts, media experts, and learning experts. While the homogeneity test aims to determine whether the object under study has the same variance (Apfelbaum et al., 2014). The homogeneity test used in this study was SPSS version 23 software with Levene's test. Normality test was used to determine whether the data population is normally distributed or not, if the data is known to be normally distributed, parametric statistical tests are used, provided that the data for each variable is normal. Meanwhile, if the data is not normally distributed, a non- parametric statistical test is carried out (Sugiyono, 2013).

The effectiveness of product development is done by comparing the average value in the experimental class and the control class using the independent sample t-test. The test indicator for independent sample t-test is if the value of Sig (2 tailed) > 0.05 then H0 is accepted. So, there is no difference in the average value in the experimental class and the control class. If the value of sig (2 tailed) < 0.05, then H0 is rejected. Then there is a difference in the average value in the experimental class and the control class. The total number of respondents was 43 students, consisting of 18 experimental class students and 25 control class students. The results of average score of the experimental class students were 95.50 and the control class obtained an average score of 81.48. So, we can conclude that the average value of the experimental class is better than the average value of the control class, so using the android-based science learning model is very effective to apply to students.

3. Findings and Discussion

3.1 Needs Analysis

3.1.1 Teacher Response Analysis

Needs analysis based on the teacher's response can be seen in the results of observations before using the android-based science learning model.

Observations done on teachers were focused on three objectives which are learning, student responses, and teachers with 16 questions that can be used as explanations. Based on the results of observations made to one of the teachers of Muhammadiyah Primary School No. 1 Kudus class V, we can know that by using the previous science learning model, teachers are less able to explain science material with a percentage of 70%. In addition, the teacher does not involve students in answering questions by 80%. Students are also less asked to give an opinion by 60% and give less reflection by 60%. Teachers also find it difficult to use the previous science learning model and in delivering science learning materials. So, we need the right learning model, namely the android-based learning model.

3.1.2 Student Response Analysis

Needs analysis is also done through the students' responses. Observations on students were also conducted. Observations are aimed at three objectives which are learning, student responses, and teachers with 16 questions that can be used as explanations. Based on the results of observations made to the fifth-grade students of Muhammadiyah Primary School No. 1 Kudus, we can see that by using the previous science learning model, 70% of students did not get the opportunity to ask questions and comment on the materials that had been delivered. In addition, students also feel less helpful in participating in the 70% lesson. Students were also less motivated to learn by not recording important points and understanding the material by 70% and 60%, respectively. Therefore, seeing these conditions, android-based learning is needed to improve children's learning outcomes (Triyanti et al., 2021).

3.1.3 Material Analysis

Based on the results of the needs analysis as the basis for developing an android-based science learning model, it can be concluded that the concept of the human respiratory organ material has 3 types of concepts; 1) Concrete concepts 54% 2) Abstract concepts 8% and 3) concepts that state 38% processes. The results of the concept analysis show that the topic of human respiratory organs is mostly a concrete concept with a percentage of 54%. Concrete concepts can make students experience misconceptions in understanding the material so it has an impact on students' low science learning outcomes (Oviawe, 2020). Students need help to make it easier to understand concepts that are classified as concrete, this proved that the use of android-based learning models is one of the solutions to overcome these problems.

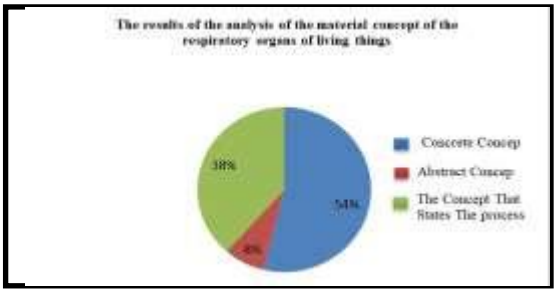

Fig. 2. The Results of the Analysis of the Material Concept of the Respiratory Organs of Living Things

3.2 Model Design

3.2.1 Potential Problems

In the early stages of the research, the method used is the method of observation and interviews to determine the need to develop an android-based experimental learning model in elementary school science learning. In this case, observations were made to both the teachers and students during experimental science learning. While the interviews were addressed to the teachers and 5th-grade students of Muhammadiyah Primary School No. 1 Kudus regarding experimental science learning that had been carried out during online learning.

3.2.2 Data Collection

In this stage, researchers collected the data that is used as material for model development and also to overcome potential problems. The instruments used in data collection were interviews, observation, and test guidelines. Data information was obtained through an analysis of the needs of students and teachers on the android-based experimental learning model in science learning in elementary schools. The data collected are learning tools and student learning outcomes.

3.2.3 Product Design

Learning model plans are made based on potential and problems. At this stage, the researchers compiled a design for the development of an android-based experimental learning model for human respiratory organs in science learning in elementary school with the following designs: 1) an android-based experimental learning model design for science learning in elementary school in the form of a guide book and 2) Android-based science learning model in the form of learning applications.

Fig. 3. Guidebooks & Learning Applications Based on Android

3.2.4 Design Validation

Design validation can be done through expert judgment. At this stage the product is validated by 3 validators, the validators that the researchers used were material experts, media experts, and learning experts.

3.2.5 Design Revision

Design revisions or improvements are made after getting an assessment from media experts, material experts, and learning experts.

3.2.6 Limited Product Trial

Revisions are made based on the assessment and advice of the experts, then tested on a limited number of students. The subjects were 33 students and 1 science teacher for fifth grade at Muhammadiyah Primary School No. 1 Kudus.

Based on the results of the observations made to the students of Muhammadiyah Primary School No. 1 Kudus class V after using the android-based science learning model, we were able to determine the average achievement of each aspect is more than 3.00. which is in the very good category.

3.2.7 Product Revision I

Product revision is done by analyzing the deficiencies found, then immediately making improvements to the product.

3.2.8 Extensive Product Trial

Extensive product trials were carried out after limited product trials and product revision I. Product usage trials were carried out on August 15, 2021, after product revision I which had been tested on students and based on the results of validation by experts. The subjects were 58 students and 1 science teacher for fifth grade at Muhammadiyah Primary School No. 1 Kudus, Lukman Hakim Muslim Primary School, and Singocandi Primary School No. 2.

Based on the results of field trials conducted on students of Muhammadiyah Primary School No. 1 Kudus class V, obtained test data for using the Android-based science learning model, namely in manuals with a percentage of 87% and android applications with a percentage of 92% on the "very good" criteria. At the time of learning using the media of mathematics textbooks based on the Android-based science learning model, students began to be enthusiastic in learning the material for the fifth-grade human respiratory organs and students were more active in experimenting with making human respiratory organs in groups and students were easier to understand the material presented by the teacher (Harun et al., 2021).

3.2.9 Product Revision II

In the trial using the Android-based science learning model, it was found that students were very enthusiastic about learning science material and experimenting with making respiratory organs in humans in groups. Based on observations made during the learning process, as many as 87% of students were able to understand the material presented in the manual, students were able to operate according to the manual so that students' ability to operate according to the manual increased from 87% to 90%.

Testing the use of the product on an Android-based learning model application, it is known that at first the percentage of the trial was 92% to 93% in the very good category. Although the Android-based learning model is already in the very good category, there are still some things that are included in the product development revision notes, namely the zoom application should be included in the same application but due to application limitations, the zoom application cannot be included in one application. The same application with other icons. But this does not reduce the enthusiasm of students who still feel motivated because they have mastered the material well and with their friends can complete the tasks of the main teacher in the task of experimenting in groups to make human respiratory organs.

3.2.10 Dissemination

The product developed is an android-based science learning model in the form of a Guidebook and an android application that has been declared effective in several tests, so the product can be mass-produced and can be applied as a learning model by collaborating with publishers/companies to be applied to educational institutions. In addition, the product can also be socialized to teachers and the general public so that they can participate in using it as the main learning model during this distance learning period.

3.3 Appropriateness

3.3.1 N-Gain

The need test for model development was carried out by experimental class students. Test the need for model development using the difference in the results of the pretest-posttest about the same pretest or post-test.

Based on the analysis of N Gain seen that the average of the class with the Gain control is 0.4 classification of being with the level of effectiveness "quite effective' ($0.30 \leq g < 0.7$). While the average experimental class is 0.8 with a high Gain Classification with an "effective" level of effectiveness ($g > 0.70$). This shows the experimental class that using an android-based learning model is feasible to use.

3.3.2 Expert Judgment (expert test) Material Expert Test

The results of the assessment of the material expert obtained the average score of the material expert test, which was 94% in the "very good" category and was feasible to use. At this stage, the material expert responds to the data processing material in class V contained in the Android-based science learning model which will then be tested empirically on class V students.

3.3.3 Media Expert Test

The results of the assessment from media experts obtained an average score of 98% and were in the "very good" category. This shows that the product is feasible to be tested on fifth-grade students of Muhammadiyah Primary School No. 1 Kudus.

3.3.4 Learning Expert Test

Based on the learning expert test, we can see that the average aspect has scored 5 points with the percentage value of the validator being 98%. Thus, the Class V Science Learning Implementation Plan at Muhammadiyah Primary School No. 1 Kudus is in the very good category and can be implemented in the classroom.

3.4 Effectiveness

Through prerequisite test with:

3.4.1 Homogeneity Test

Homogeneity testing aims to show that two or more groups of sample data come from populations that have the same or homogeneous variance. If the significance value obtained > = 0.05, then H0 is accepted, so that the variance of the data on science learning outcomes in the experimental class and control class is homogeneous.

Table 1. Test of Homogeneity of Variance

		Levene Statistic	df_1	df_2	Sig.
Learning Outcomes	Based on mean	4.035	1	41	.151
	Based on median	2.881	1	41	.197
	Based on median and with adjusted df	2.881	1	27.221	.101
	Based on trimmed mean	3.843	1	41	.157

In the output table of the homogeneity test, it is known that the significance value of student learning outcomes based on the mean is 0.151 > the value of = 0.05 then H0 is accepted, so that the variance of the data on science learning outcomes in the experimental class and control class is homogeneous).

3.4.2 Normality Test

Normality test is used to determine whether the data population is normally distributed or not, if the data is known to be normally distributed, parametric statistical tests are used, provided that the data for each variable is normal.

Table 2. Tests of Normality

		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Learning Outcomes	Pre-test Experiment	.195	25	0.95	.843	25	.051
	Post-test Experiment	.236	25	.091	.872	25	.055
	Pre-test Experiment	.217	18	.095	.841	18	.056
	Post-test Experiment	.187	18	.095	.901	18	.059

a. Lilliefors Significances Correction

Based on the normality test, it was found that the significance value of Kolmogorov-Smirnov for student learning outcomes both in the experimental class and the control class was more than 0.05, so it was normally distributed. In the initial test (pretest) the experimental class obtained a significance value of 0.095 > 0.05, which means that it is normally distributed. In the results of the posttest experimental class, a significance value of 0.091 > 0.05 was obtained, which means that it is normally distributed. Meanwhile, in the control class, the significance value of the pretest questions was 0.095 > 0.05 with a normal distribution n and the post-test significance value of 0.095 > 0.05 with a normal distribution. Thus, the test hypothesis is accepted and the sample comes from a normally distributed population.

3.4.3 t-Test

The effectiveness of product development is done by comparing the average value in the experimental class and the control class using the independent sample t-test. The test indicator for independent sample t- test is If the value of sig (2 tailed) > 0.05 then H0 is accepted. So, there is no difference in the average value in the experimental class and the control class. If the value of sig (2 tailed) <0.05, then H0 is rejected. Then there is a difference in the average value in the experimental class and the control class.

Table 3. Paired Samples Test

		Paired Differences					t	df
		t			95% Coefficient Interval of the Difference			
			Std. Deviation	Std. Error Sig (2-tailed)	Lower	Upper		
Pair 1	Pre-test Control Post-test Control	11.440	7.142	.000	-14.388	-8.492	-8.009	24
Pair 2	Pre-test Experiment Post-test Experiment	22.111	3.123	.000	-23.664	-20.558	-30.041	17

Based on the data processing table of the 5th-grade students of Muhammadiyah Primary School No. 1 Kudus using the paired samples t-test above, it was obtained a significance value (2 tailed) of 0.000 <0.005, then H0 was rejected. Thus, there is a difference in the average value in the experimental class and the control class.

Table 4. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error
Learning Outcomes	Control Class	81.48	25	8.559	1.712
	Experiment Class	95.50	18	3.365	.793

The total number of respondents was 43 students, consisting of 18 experimental class students and 25 control class students. The results of the average value of the experimental class students were 95.50 and the control class obtained an average score of 81.48. So, we can conclude that the average value of the experimental class is better than the average value of the control class, so using the android-based science learning model is very effective for students. This is also in accordance with other supportive research conducted by Jilan Rizkiana Pangestuti, in 2019, with the title "The Effectiveness of Android-Based Integrated Science Learning Media on Science Learning Outcomes of Light Materials and Optical Instruments in Class VIII MTs NU Ungaran Academic Year 2018/2019", it was found that the Android-based interactive science media can attract students to be more active in learning, and can use this learning media as a tool to improve student learning outcomes.

4. Conclusions and Recommendations

The conclusions of this study are: 1) In this development research, using the Research and Development (R&D) development step from Sugiyono (2013). The 10 steps of research and development are potential problems, data collection, product design, design validation, design revision, product trial, product revision I, usage trial, product revision II, and mass production. Products in the development of this science learning model include guidebooks and android-based learning applications. 2) Feasibility with N Gain and the result shows that the average of the control group was 0.4 (test) and 0.4 (non-test) with Gain Classification of being with the level of effectiveness "quite effective" (0.30 ≤ g <0, 7). While the average experimental class is 0.8 (test) and 0.8 (non-test) with a high Gain Classification with an "effective" level of effectiveness (g>0.70). This shows in the experimental class that through tests using an android-based learning model it is feasible to use. In addition, the feasibility test is also carried out with the Expert Judgment Test consisting of media experts, material experts, and learning experts. The results of the assessment from material and media experts obtained an average validity score of 87.71% and were in the "very good" category. 3) Test the effectiveness of developing an Android-based science learning model carried out by homogeneity test, normality test, t-test. (a) in the homogeneity test, it is known that the significance value of student learning outcomes based on the mean is 0.151 > the value of = 0.05 then H0 is accepted, so that the variance of the data on mathematics learning outcomes in the experimental class and control class is homogeneous). (b) in the normality test, the Kolmogorov-Smirnov significance value was obtained for student learning outcomes both in the experimental class and in the control class, which is more than 0.05, so it is normally distributed. (c) In the t-test based on the data processing table, the learning outcomes of 5th-grade students of Muhammadiyah Primary School No. 1 Kudus using the paired samples t-test above, obtained a significance value (2 tailed) of 0.000 < 0.005, then H0 is rejected. Thus, there is a difference in the average value in the experimental class and the control class. The total number of respondents was 43 students, consisting of 18 experimental class students and 25 control class students. The results of the average value of the experimental class students were 95.50 and the control class obtained an average score of 81.48. So, we can conclude that the average value of the experimental class is better than the average value of the control class, so using the android-based science learning model is very effective for students.

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Conflict of Interest

The authors declare no conflicts of interest.

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