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The Influence of Android – based PhET Interactive Simulations Media on the Cognitive Learning Outcomes of Grade VIII Students on the Material of Elements and Compounds

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***Abstract*— Science learning is learning increase scientific thinking skills reviewed from students cognitive learning outcomes which influenced learning media supporting technological developments as PhET Interactive Simulations. Observations at SMP Negeri 2 Besuki that science learning not utilized PhET Interactive Simulations. This study aims to determine the Influence of Android-based PhET Interactive Simulations Media on the Cognitive Learning Outcomes of Grade VIII Students on Elements and Compounds. The sample was 111 students divided into experimental and control classes. The data collection technique used a test. The results data analysis in the validity test obtained that 20 questions were valid with a sig value (2-tailed) <0.05 and $r_{count} > r_{table}$. The reliability test was 0.861 which means reliable because the results were more than 0.6. The normality test was normally distributed with a sig value test basis > 0.05, the results of the experimental class pretest and pretest - posttest control class 0.200. The posttest of the experimental class was normally distributed with a result of 0.064 although it had a less significant impact. The results of the homogeneity test were declared homogeneous on the basis of the sig value test>0.05 obtained by the pretest 0.903 and posttest 0.714. The hypothesis test obtained a sig value. (2-tailed) of 0.033<0.05, so H_o was rejected and H_1 was accepted, which means there is an Effect of Android-based PhET Interactive Simulations Media on the Cognitive Learning Outcomes of Class VIII Students on the Material of Elements and Compounds.**

Keywords—Science, PhET Interactive Simulations, Cognitive Learning Outcomes, Elements and Compounds

I. INTRODUCTION

The quality of education is a very significant matter and is the most important part in the development and progress of a nation[1]. One effort to improve the quality of education is through the curriculum[2]. In 2019, the Minister of Education and Culture amended and established the Independent Curriculum as an improvement on the 2013 Curriculum. The Independent Curriculum carries the concept of "Freedom to Learn," which gives schools, teachers, and students the freedom to freely innovate, learn independently, and be creative, where this freedom begins with the teacher as the driving force[3]. The independent curriculum is applied to Junior High School learning with the aim of creating enjoyable learning for educators and students because it emphasizes aspects of character development in accordance with Indonesian national values with the six dimensions of the Pancasila student profile. One application of the independent curriculum in learning at the junior high school level is the subject of Natural Sciences.

Science learning is a teaching and learning activity aimed at developing students' knowledge, attitudes, and skills through investigations of natural phenomena[4]. The success of science learning can be seen, among other things, from student learning outcomes. Student learning outcomes can be seen from changes in habits, skills, attitudes, observations, and abilities. Factors influencing student learning success can be seen from internal and external factors, including student management, parental involvement, communication and mastery of the material, and teacher teaching practices through the use of media, particularly science and technology. The use of science and technology can assist teachers in delivering teaching materials, especially in science subject matter groups that include physics, chemistry, and biology[5]. The theories learned in science are not only concrete but also abstract because they need to be understood using concepts that cannot be directly observed[6]. Students can gain more concrete knowledge and develop curiosity through learning media.

Learning media is an intermediary between teachers and students in transferring knowledge. Learning media include visual, audio, audiovisual, tactile, and virtual[7]. One learning media that can be applied in the learning process that is in accordance with the application and development of technology in science learning is virtual reality-based learning media. PhET Interactive Simulations is a computer- or Android-based learning media with a simulation model[8]. PhET Interactive Simulations is an alternative solution so that practical learning activities can still be carried out in the teaching and learning process of science subjects. PhET Interactive Simulations provides a means of providing visual experiences for students to encourage student motivation because it attracts students' attention and concentration, describes abstract concepts by simplifying them, so it is expected to improve student learning outcomes.

Observations from SMP Negeri 2 Besuki, the research location, show that it is the only B-accredited public school in Besuki District. Grade VIII was chosen as the research object based on several aspects, such as that grade VIII is a class in the early formal operational stage, where they begin to be able

to think with an understanding of analytical concepts or the application of certain learning strategies[9]. Grade VIII is the middle class, where grade VII is the transitional adaptation class from elementary to junior high school, while grade IX is the final class that will soon transition from junior high to senior high school[10]. Science learning for grade VIII at SMP Negeri 2 Besuki refers to the companion book, namely the Independent Curriculum Junior High Science package, using the lecture-discussion method. Based on the results of interviews with teachers, especially regarding the material on elements and compounds, student learning outcomes are less than optimal in terms of summative scores.

Based on the background that has been explained, the researcher is interested in conducting a study entitled "The Influence of Android-Based PhET Interactive Simulations Media on the Cognitive Learning Outcomes of Class Grade VIII Students on the Material of Elements and Compounds".

II. Ease of Use

A. Accessbility

Students can acces media for free easily and simply operate PhET Interactive Simulations via android devices both offline and online

B. Interactivity

PhET Interactive Simulations enable students to engage with the environment thanks to clear instructions using Android device features, user-friendly controls, clear simulations without prior technical training, and clarity of the material. Students can actively engage in learning while playing using PhET Interactive Simulations.

C. Concept Visualization

Abstract materials such as elements and compounds that are difficult to understand directly can be explained clearly using visualization features on media that have practical simulations in virtual laboratories, but their function does not replace real laboratories.

D. Direct Feedback

Students responded that the Android-based PhET Interactive Simulations were perceived as easy to use, contributing to a more comfortable and enjoyable learning experience. The ease of use of the media can increase students' cognitive engagement and support good understanding of the material.

III. Prepare Your Paper Before Styling

This study used a quantitative approach with a pretest-posttest control group design. The sample selection in this study used a purposive sampling technique. The sample in this study was classes VIII A and B, consisting of 56 students as the experimental class, and classes VIII C and D, consisting of 55 students as the control class. The instrument used in this study was 20 validated multiple-choice questions.

The research was conducted at SMP Negeri 2 Besuki. The test items used in the study were validated by construct and content validation by science teachers and lecturers, and empirical validation by 64 students in grades XI A, B, and C.

A. Validity and Reliability Test

The validity test in this study used a bivariate test that aims to see each item has a significant relationship with the total score by looking at the Pearson correlation as a practical approach in validity testing. The basis for taking the test if the sig value (2 - tailed) < 0.05 and $r_{count} \geqslant r_{table}$ then the item is valid. The reliability test in this study used the Cronbach alpha test that aims to test the items are interrelated or consistent in measuring the construct[11]. The basis for taking the reliability test if the Cronbach alpha's value > 0.6 then the item is reliable.

B. Normality and Homogenity Test

The normality test in this study uses the Kolmogorov-Smirnov Test, which is used to determine whether the obtained data are normally distributed. The basis for taking the test is that if the significance value is greater than $\alpha = 0.05$, the results are considered normal. The homogeneity test aims to determine whether the sample from the population is homogeneous[12]. The basis for taking the test is that if the sig. value is greater than 0.05, the data are homogeneous.

C. Hypotesis Test

The hypothesis test in this study uses an independent sample t-test which aims to test the effect of an independent variable on the dependent variable, so that the effect of Android-based PhET Interactive Simulations media on students' cognitive learning outcomes can be known. The basis for taking the test if the sig. (2 - tailed) value <0.05, then H_o is rejected and H_1 is accepted, which means there is an influence of Android-based PhET Interactive Simulations media on students' cognitive learning outcomes on the material of elements and compoun.

IV. Using the Template

The instrument used in the study was empirically tested on ninth-grade students, with the result that 20 items were declared valid. After conducting the validity test, the reliability test was carried out, with the result being 0.861, meaning that the 20 items were declared reliable. Furthermore, in this study, to see the effect of the PhET Interactive Simulations media, a pretest and posttest were conducted on students in grades VIII A to VIII D, divided into an experimental class and a control class, with the following results.

TABLE I. Distribution of Pretest and Posttest Results

Data	Experimental Class		Control Class	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Amount	3190	3805	3180	3585
Mean	56,96	67,95	57,82	65,19
Minimum	20	30	20	35
Maximum	70	100	90	95
Variance	268,799	314,343	263,670	268,395
Standard Deviation	16,395	17,730	16,238	16,383

A. Normality Test Results

TABLE II. NORMALITY TEST RESULTS

Data	Experimental Class		Control Class	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Sig. value	0,200	0,064	0,200	0,200
Note	Normally distributed	Normally distributed	Normally distributed	Normally distributed

Based on the table above, the significance values for the pretest and posttest data for the experimental class were 0.200 and 0.064, respectively. In the control class, the pretest and posttest results were 0.200. Therefore, the values meet the requirements for a normally distributed data.

B. Homogenity Test Results

TABLE III. HOMOGENITY TEST RESULTS

Data	Pretest	Posttest
	Experimental – Control Class	***Experimental – Control Class***
Sig. value	0,903	0,714
Note	Homogeneous	Homogeneous

Based on the table above, it is known that the pretest data test results for the experimental and control classes have a significance value of 0.903. The posttest results for the experimental and control classes have a significance value of 0.714. These test results meet the requirement that the data is homogeneous.

C. Hypotesis Test Results

TABLE IV. HYPOTESIS TEST RESULTS

Data	***Independent Sample T Test***
Sig. value	0,033
Note	H_o is rejected and H_1 is accepted

Based on the table above, the results of the independent sample t test show that the significance value (2-tailed) obtained is 0.033 which is smaller than 0.05, so the results obtained are that Ho is rejected and H1 is accepted. These results mean that there is an influence of Android-based PhET Interactive Simulations media on the cognitive learning outcomes of eighth grade students on the material of elements and compounds.a sentence.

D. Discussion

PhET Interactive Simulations effectively improved students' cognitive learning outcomes, as seen from the increase in average posttest scores. The experimental class had an average posttest score of 56.96, increasing to 67.95. This finding supports the assertion that PhET Interactive Simulations improve students' cognitive learning outcomes by fostering critical thinking[13].

PhET Interactive Simulations, accessible on Android devices, also facilitate student use. Students simply access them via mobile phone and can explore and understand the material through the virtual medium of PhET Interactive Simulations, resulting in improved cognitive learning outcomes. This statement is relevant to research that suggests learning activities using Android-based PhET Interactive Simulations are more practical and effective because they are free from the constraints of space and time, thus improving students' cognitive learning outcomes[14].

Learning using PhET Interactive Simulations is a learning medium in a student-centered learning process. Student-centered learning produces more meaningful learning by developing students' creativity and analytical thinking, thus facilitating conceptual understanding. This statement is supported by research that student-centered learning is effective in improving students' cognitive learning outcomes when applied to slow learners because students are actively involved in the learning process[15].

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