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THE INFLUENCE OF USING PHET DIGITAL MEDIA ON MATHEMATICS LEARNING OUTCOMES FOR FRACTION MATERIAL FOR CLASS 3 SDN 1 TLOGOTUWUNG

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Abstract

This study aims to determine the effect of using PhET digital media on the mathematics learning outcomes of grade 3 students at SDN 1 Tlogotuwung. The basis of this study is the insufficient education achievement of learners, especially the physical learning outcomes, as well as the lack of optimal use of innovative and interactive learning media in the learning process.This research adopts a qualitative approach, specifically utilizing a Pre-Experimental Design framework. The specific design implemented in this study is the One Group Pretest-Posttest model, which involves measuring the same group of participants before and after the intervention. The population targeted in this study consists of all third-grade students enrolled at SDN 1 Tlogotuwung. From this population, the sample was drawn, comprising two sets of data pretest and posttest results each involving 25 students. To gather the required data, a multiple-choice test was employed as the main research instrument, serving to evaluate students' understanding and learning outcomes before and after the use of the intervention. The data analysis methods employed included the normality test also matched pairs t-test. The data indicated a notable difference in students' educational attainment who used the PhET digital media and those who did not use it. This is proven by the results of the Double-

Sided T-Test 0.000 which shows a significance value of less than 0.05. Thus, it may be inferred that utilizing PhET digital media yields a beneficial impact on improving students' mathematical learning outcomes.

Keywords: Learning Outcomes, PhET Digital Media, Mathematics, Fractions

Abstrak

Penelitian yang dilaksanakan mempunyai tujuan agar dapat memahami keterkaitan antara pemakaian media digital PhET kepada hasil pembelajaran matematika pecahan siswa kelas 3 SDN 1 Tlogotuwung. Penelitian yang dilakukan didasari karena minimnya perolehan hasil pembelajaran matematika peserta didik, terutama pada materi pecahan, serta kurang optimalnya penggunaan media pembelajaran yang inovatif dan interaktif dalam tahap pembelajaran. Penelitian ini mengimplementasikan pendekatan kuantitatif dengan tipe Pre-Experimental Design. Dalam penelitian dimana sedang dilaksanakan menerapkan *One Group Pretest-Posttest sebagai model pendekatanya*. Populasi pada penelitian yang dilakukan ialah peserta didik tingkat 3 SDN 1 Tlogotuwung seluruhnya, dengan sampel terdiri dari kelas pretest dan kelas posttest yang masing-masing terbentuk dengan 25 peserta didik. Alat yang dimanfaatkan dalam proses pengumpulan data adalah pengujian perolehan pembelajaran berubetuk soal berpilihan ganda. Metode analisa data dimana diterapkan merupakan pengujian normalitas serta pengujian Paired Sample T-Test. Hasil temuan selama pelaksanaan penelitian memperlihatkan bahwa terjadi temuan berbeda dan penting diantara perolehan nilai pembelajaran matematika siswa dimana menggunakan media digital PhET dengan yang tidak menggunakannya. Perolehan tersebut terbukti karena hasil pengujian Paired Sample T-Test 0,000 dimana mengemukakan nilai signifikansinya dibawah 0,05. Jadi karenanya, bisa didapatkan suatu kesimpulan bahwasanya pemanfaatan media digital PhET memberikan dampak positif kepada meningkatanya perolehan dan prestasi dalam pembelajaran matematika peserta didik, dalam topik pecahan.

Kata Kunci: Hasil Pembelajaran, Media Digital PhET, Matematika, Pecahan.

INTRODUCTON

The development of digital technology in the world of education has driven a major transformationthroughout the educational process, especially at the Elementary School (SD) level (Hikma & Amiruddin, 2023). However, there are still many elementary schools in rural areas that have not utilized digital technology optimally in learning. A central problem is students' underachievement in the subject of Mathematics, especially in fractions. Fractions in grade 3 students begin to recognize simple fractions by understanding that fractions indicate parts of an object or group. For example, they learn that 1/2 means one of two equal parts. This learning is carried out using pictures or concrete objects to make it easier to understand (Ariyanto et al., 2020). This material is often considered difficult by students because it is abstract and requires a strong conceptual understanding. At SDN 1 Tlogotuwung, the evaluation results showed that most grade 3 students had not achieved the Learning Objective Achievement Criteria (KKTP) in fractions (Tanjung & Nababan, 2020).

Seeing these conditions, researchers see the need for innovation in learning media that can help students understand fraction material more concretely and enjoyably. One of the efforts made is to utilize interactive digital media that can bridge the understanding of concepts visually. PhET (Physics Education Technology) digital media is considered capable of

answering these needs because it provides interactive simulations that support visual, dynamic, and exploration-based Mathematics learning. PhET stands for Physics Education Technology. This is a platform that provides interactive simulations based on research in the fields of mathematics and science. This simulation is designed to be interesting, interactive, and can be accessed for free, with the aim of enhancing the efficiency of mathematics instruction and learning of mathematics (Sylviani et al., 2020).

This research is highly relevant to the issues of low student achievement in fractions and the limited use of technology in elementary school learning. The use of PhET digital media aligns with the demands of the Independent Curriculum, which encourages active and innovative learning while developing 21 st-century competencies such as critical thinking, problem-solving, and digital literacy. Thus, this study contributes to overcoming the gap between the development of educational technology and learning practices in elementary schools, especially in remote areas (Laksono et al., 2023).

The novelty of this study lies in the application of PhET digital media in the context of fraction learning in grade 3 of elementary school, which has so far been used more in science or physics learning. According to Santrock (2024), digital media can increase students' learning motivation through visualization of concepts that suit children's learning styles. In addition, Piaget's constructivist learning theory emphasizes the importance of active student involvement in building understanding through direct experience, this is supported by the interactive features of PhET that allow students to manipulate fraction objects virtually. This study expands the scope of PhET media application to the realm of basic mathematics and proves its effectiveness in a local (rural) context.

The aim of this study was to determine the effect of using PhET digital media on the mathematics learning outcomes of class 3 fractions at SDN 1 Tlogotwung.

METHODS

This research adopts a qualitative approach. Qualitative procedure is an activity of collecting, analyzing, and displaying in numerical form the most complete and empirical data. The researcher uses experimental research, employed a Pre-Experimental Design, specifically the One-Group Pretest-Posttest type. The population in this research consisted of all students in the grade 3 SDN 1 Tlogotuwung. The samples in this study were all class 3 SDN 1 Tlogotuwung students consisting of 25 students, 14 men and 11 women, applying a total sampling technique, where all individuals in the population were selected as participants. The collection technique in this study was a test and documentation. The test used in this study was a multiple choice test given to students of class 3 SDN 1 Tlogotuwung, the documentation was used as supporting evidence for the research. The analysis technique used in this study is parametric inferential analysis. Parametric inferential analysis in this study is used to describe students' learning outcomes through the scores of the scores formed by the PhET digital media and to describe the values of students' abilities obtained using the pretest and posttest scores, namely the normality test using the pretest and posttest and the Pyred Single T-Test.

RESULTS AND DISCUSSION

The research was conducted in 3 meetings. The first meeting was a pretest to determine the students' abilities. The questions used in the pretest had gone through a validation process by the researchers and tested in SPSS. Furthermore, the second and third meetings used the Problem Based Learning (PBL) model in the experimental class. This model involves activities such as identifying problems, developing solution strategies, conducting group investigations, and evaluating the solutions obtained.

The questionnaire covered the topic of recognizing callers, including activities to recognize callers using digital media PhET, while the control group did not use the media. The final meeting was a posttest using questions that were different from the indicators that had been validated, as follows:

1. Pretest and Posttest Results

The pretest results reflect the level of initial ability possessed by students. A description of the initial ability of students in the control class can be seen in table 1.

Table 1. Description of Pretest and Posttest Value Data

Class	Highest Value	Lowest Value	Average	Median	Mode	Standard Deviation
Pretest	80	30	50.80	45.00	40	14,908
Posttest	100	75	87.20	85.00	85	6,627

Based on table 1, it is known that the average pretest and posttest scores have a significant difference with a difference of 36,4. The pretest score shows an average of 50,80 with a deviation of 14,908, while the posttest score increased to an average of 87,20 with a deviation of 6,627. This average increase of 36,4 indicates that the use of PhET digital media has a significant positive impact on improving students' mathematics learning outcomes in fractions.

2. Normality Test

To ensure that the collected data meets the assumption of normal distribution, a normality test is conducted using the Shapiro-Wilk statistical method. This test is one of the most commonly used techniques for assessing normality, especially when dealing with small sample sizes, as it is sensitive in detecting deviations from a normal distribution. The purpose of conducting a normality test is to determine whether the values obtained from measurements or observations are distributed in a pattern that closely follows the bell-shaped curve of a normal distribution. The test is used using the SPSS program which is based on the Siswanto test.

The calculation of the height can be seen in the following 2 table:

Table 2. Results of Pretest and Posttest Normality Test

	Shallpiro-Wilk		
	statistic	Df	Sig.
Pretest	.926	25	.069
Posttest	.983	25	.941

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In table 2 above, it can be seen that if Sig > If the significance value is greater than 0.05, the residuals are considered to be normally distributed; however, if the significance value is less than 0.05, the residuals are deemed not normally distributed. It is known based on table 2 that the sig value. for the pretest is 0.069 and the posttest is 0.941 thus, it can be inferred that the data follows a normal distribution based on the significance value. (2-tailed) is more than 0.05.

3. Paired Sample T-Test

In this study, a paired sample t-test was employed as the statistical method to analyze whether there were any significant differences between students' pretest and posttest scores. This analysis was conducted to determine the extent to which the use of PhET digital media influenced student learning outcomes. By comparing the scores obtained before and after the implementation of the digital media, the test aimed to identify measurable changes in students' academic performance. The paired sample t-test was carried out using the Statistical Package for the Social Sciences (SPSS) version 24, specifically for the Windows operating system. This software facilitated a detailed and systematic comparison of the two sets of scores. The outcomes of the paired sample t-test, including the statistical values and significance levels, are presented in the table shown below for further interpretation and analysis :

Table 3. Paired Sample T Test

Paired Sample T Test									
		DadRed Differences					t	df	**Sig. (2-ta(iled)**
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Intervall of the Difference				
					Lower	Upper			
Dadir 1	PRETEST - POST TEST	-36,400	12,035	2.407	-41,368	-31,432	-15.123	24	**.000**

In Table 3 above, the decision rule is as follows: If the significance value (Sig. 2-tailed) is found to be less than 0.05, this indicates that the null hypothesis (Ho) must be rejected and the alternative hypothesis (Ha) is accepted. On the other hand, if the Sig. (2-tailed) value exceeds 0.05, it suggests that there is insufficient evidence to reject the null hypothesis, and thus Ho is accepted while Ha is rejected. Referring to the results obtained from the paired sample t-test, the significance value was 0.000, which is clearly lower than the 0.05 threshold. Therefore, it can be inferred that the null hypothesis is rejected, and the alternative hypothesis is accepted, indicating a statistically significant difference between the pretest and posttest results. So there is a significant influence of the use of digital media PhET on the learning outcomes of mathematics in fractional material for grade 3 SDN 1 Tlogotuwung

This research was conducted at SDN 1 Tlogotuwung which until now has not yet implemented learning media in the learning process, the teacher still uses the lecture method predominantly with written notes in notebooks as a source of learning. Theory(Mahmud Syahruddin, 2023)mentioning medial learning media as everything that can be used to help and facilitate the learning process in the form of tools, materials, sources and technology used. Research conducted by (Wardani et al., 2024), it is stated that the use of learning media has a

positive impact on students' learning outcomes, including increased learning achievement, learning motivation, and active involvement in the learning process.

The medial learning process is caused by several factors, such as the limited availability of school facilities, lack of teacher training in using media, and minimal access to technology in alternative learning resources. This condition has an impact on low student learning outcomes, as well as lack of active student involvement during learning. Theory (Hasan et al., 2021)discuss the medial learning process in order to clarify the medial learning process in which educators convey learning in learning resources for students. The research conducted bySalri et al., (2022)to calcify the balhwalThe role of teachers as instructors in increasing student activity through learning media, especially in the teacher's continuous encouragement to increase student learning activity by using visual media and audiovisual media that create a conducive and enjoyable environment.

In the implementation of the research, the researcher found that students experienced difficulties in understanding the material of the calrenal process, not all visual aids that made it easier for them. The learning process was monotonous and students showed a low level of palpation during learning. Audiovisual media is a media that is able to present moving pictures, but accompanied by written and verbal explanations, this is in line with the theory.(Ichsan et al., 2021). Research byIntalnialsalri et all., (2022)to make the use of audio-visual learning media more optimal and effective in learning as an effort to grow students' learning enthusiasm. The increasing students' learning enthusiasm will also increase their learning achievement.

During the process of introduction and use of learning media, teachers begin to realize the importance of choosing media that are in accordance with the learning objectives that have been set, smooth media in explaining the material and informality that will be conveyed in the media chosen according to the students' abilities in line with the theory.(Purbal, ON, 2023). Research bySallim & Utalmal, (2020)The matter of determining the accuracy of the selection of learning media is a summative evaluation in this study which is carried out based on four criteria for the accuracy of the selection of learning media, namely: suitability with the material, suitability with student characteristics, suitability with student learning styles, and suitability with supporting facilities.

The learning process is ongoing, students usually experience difficulties in following the learning process but instead become more confident in using digital media. They show a high desire to know in the form of learning triggers that have always been hidden. TheoryThe Most Beautiful (2024)Digital learning media is a type of education in learning that encapsulates components of hard devices that are interconnected in informal technology and communication to create educational materials such as sending text, video, and audio. Research by (Nokal, 2021) Medial learning medial learning occupies an important position as one of the components of the learning system. Medial learning medial learning communication does not always occur in the learning process, it cannot always run optimally.

The implementation of digital media usage provides various advantages for teachers and students in the learning process, especially for students in grade 3.Sari et al., (2024)put forward the medial maladjustment of digital learning, namely having the maladjustment to convey the maladjustment that is common to become common. Thus, students who see and

hear about knowledge through the medial that is common will receive informal information from their friends. Research byJediut et al., (2021)The most important thing about digital medial maladfalt is to increase students' learning motivation. Motivation is the main driving force in the learning process. Apart from motivation, learning activities are not the same.

The use of digital learning media provides a positive impact on the learning process of students, although obstacles are still found in the media such as poor internet connection, incompatible devices or software that can disrupt the learning process, this is in line with the theory.Widianto Edi (2021). With the help of these constraints, research by Anam et all.(2021)The advantages of digital media in learning are that it brings class examples to life, makes it easier for teachers to convey material, students can understand material more easily, it is effective and more efficient.

The research results show that the use of PhET can improve student understanding. This aligns with Santrock's opinion that visual media can increase student motivation and attention, thus positively impacting conceptual understanding. The comparisons obtained in the pretest were 50.80. The posttest comparisons resulted in a value of 87.20. The use of digital media PhET was successful in improving students' learning outcomes by trying directly, such as conducting virtual experiments. PhET digital media helps make learning more visually understandable and enjoyable by presenting learning concepts in an intuitive form that can be modified by the user, such as arranging steps, moving objects, and seeing things in a trial.(Preliminary, 2024)

In the context of mathematical learning, mediation helps students to understand abstract concepts, such as reasoning. This study shows that the use of mediation has a significant impact on students' comprehension of abstract concepts. This theory is in line with(Rudi & Riyalnal 2020)which conveys abstract learning medial features that are difficult to explain directly to students can be concretized and then simplified through medial learning malformal features.

In the learning process, researchers provide materials that are included in the learning plan, researchers explain the materials using digital media PhET. In one of the pretest implementations, students tend to be passive in doing as much as possible, besides that, it is supplemented with examples from the students' mouths, making them less able to concentrate on the feedback. Concentration is needed by students in the learning process, by concentrating they can remember and understand the materials given by the teacher. If the students' concentration and motivation are greater, the learning outcomes they get will increase (Winata, 2021).

Next, the treatment was carried out using digital media PhET. In the first meeting, students were introduced to digital media PhET, researchers experienced the students' initial conversation, listened to the explanation, recognized the conversation using digital media PhET. This hall aims to ensure that students have a new concept in recognizing the problem through digital media which is taught according to the explanation (Aisyah et.all 2025)The use of digital media in the learning process can help students understand the material that is being taught later, so that they can achieve the Learning Objective Accomplishment Criteria (KKTP).

This research is complemented by research conducted by Susilawati et al., (2022), which shows that learning that uses digital media PhET in learning media with a scientific approach has many advantages for the learner, namely that students are more actively involved in the learning process, learning that focuses on students allows them to find concepts independently, helps students understand concepts more easily, trains students' critical thinking skills, students can rationalize their abilities because they can learn while learning, and increases digital literacy skills in students. PhET digital media is an interactive, interactive environment, and a permanent place for students to learn through discovery.(Uwambajimana & Minani, 2023).Ansori (2024)Introduction to the use of PhET digital media in physical learning significantly enhances students' conceptual understanding of learning. First, students are introduced to the various ways in which PhET's visual features are used to facilitate learning. Thus, students can relate concepts to the real objects they encounter on a daily basis.

PhET digital media is designed to help students engage in scientific research through inquiry-based methods. Explanation is also designed by implementing the following design principles: encouraging scientific exploration, providing interactive elements, making the invisible obvious, including a variety of representations (e.g., general, object, graphic, etc.), using relationships with realities, providing indirect guidance to users (e.g., by providing controls) in the effective exploration process, and creating simulations that can be used flexibly in a variety of educational contexts.(Sylviani et al., 2020).

The research was conducted byPriyalwalti (2021), the PhET has successfully stolen the attention and increased students' interest, making the material learning more interesting and enjoyable. As a recommendation, the researcher encourages teachers to expand the use of PhET digital media, not only to facilitate the delivery of material, but also to provide a more significant impact on improving students' learning outcomes.(Omoy, 2023). Learning is very important in education and can be seen as a measure of student success in school education.(Marliana et al., 2024).

Student learning outcomes at the elementary school level are an important indicator in assessing the success of the learning process that has been implemented (Isnatul et al., 2024). The improvement in student achievement following the use of digital instructional tools PhET is a major factor in the development of learning outcomes. Before the use of media, most students had difficulty understanding learning outcomes, such as dividing an object into a large object and comparing learning outcomes. According to Rahman (2021) learning activities are the things that are memorized by students after carrying out learning activities. Research by (Azizah, 2022) to evaluate how successful the learning experience has been in terms of knowledge, skills, and attitudes.

This study measures the cognitive abilities of 3rd grade elementary school students based on Bloom's talkonomy. The results of the study indicate that after the use of digital learning media, there is an increase in students' abilities in the four levers. This is consistent with(Sarimuddin et al., 2021)The students are not only able to recognize the definition and examples of fractions (C1), but also understand the concept of parts of a whole (C2), determine the value of fractions (C3), and compare two different fractions (C4). However, this increase may also be indluenced by external factors, such as student learning motivation,

differences in initial abilities, and teacher skills in operating digital media that support learning effectiveness.

CONCLUSION

According to the findings on the analysis on the process of learnings, this demonstrates that the significance value (2-tailed) obtained from the paired sample t-test is 0.000, indicating it falls below the 0.05 threshold. The use of digital media PhET has a positive effect on the learning process of students in class 3 SDN 1 Tlogotuwung. The use of this media can increase the concept of learning through interesting visual and interactive displays, so that students are more active and enthusiastic in following the educational experience. The use of PhET digital media provides improved learning outcomes for students, as seen from the differences in pretest and posttest scores in the same group. Thus, PhET digital media has proven to be effective in supporting students' competency development, particulary in processing learning outcomes. Therefore, teachers are advised to utilize this media not only for fractions but also for other mathematics topics, so that its use can be implemented more widely across various learning levels.

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