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Implementation of Physics Education Technology (Phet) Media on Student's Science Concept Understanding: A Literature Review

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ABSTRACT

Media *Physics Education Tehcnology* (Phet) has been widely used in science or science learning to help students understand abstract concepts more easily. The aim of this literature study is to determine whether Phet media can contribute to increasing students' understanding of science concepts more significantly. This research uses a literature review or literature review methodology. The results of the review show that Phet media has significant potential to improve students' understanding of science concepts. Phet's interactive and visual simulations help students develop deeper and lasting understanding and encourage them to learn actively and independently. Overall, this literature study supports the use of Phet media in science learning to improve conceptual understanding and learning quality.

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Introduction

Education is the driver of everything. Everyone needs education, humans experience a learning process, namely the process of acquiring new knowledge and experience that they have never had. Education always changes over time. (Septriyani & Yektyastuti, 2023). In education there is learning. In essence, learning is an interaction between students and their environment which results in positive behavioral changes (Yektyastuti & Ikhsan, 2016). In learning there is learning media. Teachers use learning media as a method to provide information to students from reliable sources, making learning easier. (Haryadi, 2021). One of the innovations used to increase understanding of science concepts is Phet media. Phet or *Physics Education Technology* is media created by the University of Colorado. This media is one of the media that develops along with the development of technology. Phet is an interactive computer simulation for science teaching and learning (*science)*, biology, physics, chemistry, mathematics and other sciences in the form of animation. Phet simulations are very interesting and encourage students to learn through direct exploration (Sahida, 2022). Furthermore, Phet is able to provide immediate feedback. regarding the impact of changes made by

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teachers and students in using this media. In this way, students can explore causal relationships and scientific questions through research simulations (Rizkiana & Apriani, 2020a). In this medium, abstract material can be presented and explained directly, making it easier for students to carry out quantitative research. Phet includes measuring instruments such as thermometers, stopwatches, rulers and voltmeters (Sahida, 2022).

The advantage of Phet simulation is that it allows ideal experiments that are not possible with real tools and materials. Apart from that, according to Simbon and Sahyar in (Rizaldi et al., 2020) there are advantages to using Phet in learning, namely: 1). Students are more familiar with basic concepts or ideas, 2). Can help students remember recent learning. 3) Students are encouraged to use intuitive thinking and develop their own hypotheses. 4). brings inner satisfaction and, 5). Learning will become more interesting. Apart from the advantages of Phet, it also has several disadvantages. This is in line with Khoiriyah's opinion in (Rizaldi et al., 2020) which explains that there are weaknesses in the Phet simulation media including: 1. the effectiveness of the learning stage depends on student independence, 2. the applications carried out are limited to "jar" format file, 3. depending on the number of computers offered by the school.

Understanding and concept are two terms that form conceptual understanding. Understanding, interpreting, translating, or communicating knowledge in a way that is different from what was previously learned is referred to as understanding, according to Uno and Mohamad. (Ningsih, 2019). In other words, understanding is the mastery of something by the mind. Understanding has meaning which is the basis for placing the stages of learning in their dimensions. While concepts are basic units of thought formed by knowledge schemas, related models are used to group objects into categories (Radiusman, 2020). So conceptual understanding is an individual's ability to understand a concept. Students can be said to know a concept if they understand the meaning or understanding of the concept (E. M. Pratiwi et al., 2022).

Among the factors that cause students to not understand the concepts of science lessons are as follows: 1) students do not have facilities that allow them to use learning support media to help them understand science concepts; 2) less varied learning models; and 3) there is no learning that involves simple experimental activities that prove scientific and systematic steps for the truth of natural science theory (D. A. Pratiwi et al., 2020).

Based on the explanation above, the author conducted a preliminary study by examining the findings of previous preliminary studies on students. It was found that the low understanding of science concepts among students may be due to the fact that many teachers still use uniform learning media, that teachers do not have an important role in creating new media, and that creating new media can be a challenge for teachers (Arijumiati et al., 2021). Apart from that, the slow development process is caused by teachers' lack of time to develop learning media (Arijumiati et al., 2021). Based on the explanation previously described, the author then focuses on the media *Physics Education Technology* (Phet) to improve students' understanding of science concepts. The aim of this literature study is to ensure that Phet media can contribute to increasing students' understanding of science concepts more significantly so that educators and other researchers can use it as a resource during the teaching and learning process.

Method

This research applies a specific research methodology called literature review *(literature review)* or literature review. Literature review is a type of research activity that involves collecting information and data from books and other library sources such as reference books, previous study findings, papers, notes and journals related to the problem being discussed. Research activities are carried out in an organized manner to combine, organize, and analyze data using specific techniques or software to identify solutions to current problems. According to Rita Kumalasari. Library research is a type of research activity carried out in libraries using a variety of sources, including references, previous research findings relevant to the topic at hand, articles, notes and magazines. Actions carried out methodically to collect, analyze and close data using a certain approach or strategy to identify solutions to the problems faced (Sari & Asmendri, 2020). According to Zed in (Melinda & Zainil, 2020) the most important characteristics of library research are: 1) the challenge of direct research with textual or numerical data, 2) library materials can be used immediately, 3) library materials are essentially secondary sources, 4) the condition of the materials libraries are not separated by time and space. This literature review method is used to develop concepts using Physics Teaching Media (Phet) to improve understanding of science concepts.

The data sources in this research consist of 11 journal articles about physics education technology (Phet) media to increase understanding of science concepts. Documentation methodology is the method used in this research to collect data. Documentation methodology is a technique where researchers observe material about something or variables in the form of journals, notes, books, papers, or articles, and so on (Sari & Asmendri, 2020). However, the data analysis technique used in this research is the content analysis method. Content analysis is a research tool that focuses on the content and positive characteristics of media. Content analysis techniques can be used to investigate the nature of objects using books, texts, essays, articles and all kinds of interviews that can be analyzed (Sari & Asmendri, 2020).

Results

Media *Physics Education Technology* (Phet)

According to Nurfadhillah, learning media are all physical and technical spaces related to learning stages that will help teachers communicate subjects better to students and achieve predetermined learning goals. (Nurfadhillah et al., 2021). So in conclusion, any instrument or method used in the learning process is considered a learning medium, a learning medium to help teachers convey information, facilitate understanding and increase student learning motivation. This media can be in the form of real objects, images, sound, video, animation, and even interactive software.

One example of interactive software-based learning media is Phet media or Virtual Phet lab. Virtual laboratories teach content in the form of computer software designed to allow students to perform experimental activities as if they were conducting experiments in a real laboratory. The University of Colorado in Boulder, United States created a simulation program known as Physics Education Technology (Phet) (Sahida, 2022). Phet is an online simulation of a laboratory that includes science, biology, physics, chemistry, mathematics and geoscience material (Arifin et al., 2022). This simulation can be done offline by downloading

it for free from the website or by accessing it online at https://phet.colorado.edu. And this phet can be used on PCs (Personal Computers), laptops, or Android-based cellphones *iphone operating system* (IOS) for free. This simulation provides various subject matter for experiments that can be practiced in learning and has the ability to explain things that are immaterial and impossible for the human senses to witness directly.

In research by Wieman in (Martanti et al., 2021) several advantages or benefits of using Phet simulations in learning are stated, namely: 1) Phet gives students a good understanding of basic scientific concepts, 2) students can feel like scientists when learning , 3) learning becomes more interesting because students can explore simulations in learning, learning in different and fun ways and 4) can be used as a way of learning that requires interaction with students. Apart from the advantages of using a variety of phet, there are also various ones weaknesses or lack of usage This phet media is only available for simulation, without any instructions on how to use it. so educators must use creativity to create the desired learning according to the material being studied (Martanti et al., 2021).

The use of Phet simulation media in science learning has many benefits, including: 1). Scheduling learning becomes more interesting, visual and interactive: Phet simulation media helps students relate more to the learning material and makes learning more interesting and interactive. 2). Improving reasoning abilities: Phet simulation media can improve students' reasoning abilities by providing a variety of interesting and enjoyable text, sound, image and animation displays. 3). Facilitates understanding of science concepts: The use of Phet simulation media has proven successful in helping students understand science concepts. 4). Improving science process skills: Phet simulation media can help students develop science process skills, such as creating deeper knowledge and increasing learning motivation. 5). Improving learning performance: The use of Phet simulation media is proven to produce better learning outcomes for students and the best results in improving learning. 6). Improving critical thinking: Using Phet simulation media in physics classes can improve students' critical thinking. Overall, the use of Phet simulation media in science teaching offers significant benefits in terms of increasing conceptual understanding and improving science process skills as well as improving student performance.

Understanding of Science Concepts

Understanding scientific concepts has a substantial impact on the teaching and learning process and forms the basis of learning outcomes. This is in line with Santrock's view which explains that the key component of learning is understanding concepts (Radiusman, 2020). Understanding concepts will also be able to improve students' critical thinking and increase their understanding of concepts related to the material being taught (Susilawati, 2022). And understanding the concept can support students in summarizing, grouping and simplifying information (Radiusman, 2020). So in short, understanding concepts is the capacity for someone to understand the relationship between one concept and another and understanding concepts is not just memorizing definitions or facts, but rather understanding the meaning and application of concepts studied in depth.

There are many aspects that influence students' conceptual understanding of the learning information conveyed by teachers during the learning process in

the field. Affective variables and cognitive factors are two large categories that are part of these components, according to Risqilah. Students' enthusiasm for learning, their independence in the classroom, and their self-confidence are examples of affective elements. Critical thinking and mathematical communication skills are included in the cognitive component (Lu'luilmaknun dkk., 2022).

Based on Heruman's opinion, there are several indicators of concept understanding, namely: 1) repeating concepts that have been taught; 2) determine whether or not there are requirements needed to develop the concept; 3) implement the concept algorithmically; 4) convey examples of concepts that have been studied and other examples; 5) write concepts in various forms of representation; 6) combining related concepts; 7) and determine the conditions needed to form the concept (Atmaja, 2021). Apart from that, Riana Kartinawati and Suhito define indicators of concept understanding as follows: 1) Restate the concepts obtained. 2) Categorize objects according to certain properties and concepts. 3) Using various representation techniques to communicate concepts. 4) Using concepts to solve problems (Lu'luilmaknun dkk., 2022). By considering the opinions above, it can be concluded

Indicators of concept understanding include: 1). Restate the concept. 2) Assign categories to items based on certain attributes that match the concept. 3) Provide real and fictional examples of a concept. 4) Using different representation techniques to express concepts. 5) Linking related concepts. 6) Apply concepts or methods to solve problems.

Discussion

Data in tracking media implementation *Physics Education Technology* (Phet) on the ability to understand science concepts, which the author obtained from 11 related journal articles based on previous data sources. The article data was obtained by compiling and analyzing research findings. Literature review findings in a number of publications that increase understanding of science concepts using media *Physics Education Technology* (Phet). Several studies show that the media *Physics Education Technology* (Phet) can foster the ability to understand science concepts. The findings of this research are related to the research results of Rian Hidayat, Lukman Hakim and Linda Lia in their research which stated that in experimental class X, the average understanding of concepts was 85.00, while in control class X it was 71.92. Calculation of t > paired t test table has a result of 8.17 > 1.67. This shows a significant effect, and it is concluded that, compared with conventional learning, models *guided discovery learning* using Phet simulation media greatly influences students' understanding of physics concepts. (Hidayat et al., 2019). In line with Ismaun's opinion, students at SMA Negeri 1 Mawasangka showed the impact of using Phet Simulation media on their understanding of the concept of molecular models, as evidenced by their grades. *N-gain* 0.13 for class *low* (g, ≤ 0.3) for control and value classes *N-gain* 0.72 for class *high* (g > 0.7) for the experimental class, with a significance level of 0.025 < 0.05. (Ismaun, 2019).

Based on research findings by Fitria Rizkiana and Herlina Apriani, which show that although students' understanding of differentiating indicators and providing examples is different, their understanding of comparative indicators and explanations remains the same, it can be concluded that the use of Phet simulations has an impact on students' understanding of concepts (Rizkiana &

Apriani , 2020). Based on the results of research conducted by Mahirah Ulfa Abadi, Mustafa and Andi Ulfa Tenri Pada. In his research, Phet's use of STEM methods assisted by simulation helped improve understanding of physics. student. This was demonstrated by researchers using an objective test given after giving the posttest, which stated that there was an improvement (Abdi et al., 2021).
Based on the results of research carried out by (Aziza et al., 2021), with the research title "Phet Simulation: Its effectiveness in understanding the concept of molecular shape". Research findings indicate that hypothesis testing is for Independent Sample *T-tes* produces that learning by implementing When used in experimental classes, Phet's simulation media outperforms book media in terms of helping students understand ideas related to molecular form material. Based on research conducted by Cecep Fathurohman et al with the research title "Application of Phet simulation media to increase students' conceptual understanding of fluid material" from this research, the results showed that students' conceptual understanding of Phet simulation media learning has increased. This is proven based on the calculation results, where the average value of N-gain shows that H_{the} rejected and H_a accepted. In particular, the average N-gain of the experimental class was 0.51, compared to the control class of 0.22, and students' understanding of concepts through the use of Phet simulation media was successful. The results of calculations using the t-test for the experimental and control groups show this. Then we get t_{thick} =2.01 and t_{count} = 6.90. Additionally, $t_{count} > t_{table}$, or 6.90 > 2.01, found by comparing t_{count} with t_{table}. (Fathurohman et al., 2019).

Research conducted by Mamluatin Ni'mah and Wahono Widodo in their research shows that, overall, the use of a structured inquiry model for learning, assisted by the Phet virtual laboratory, can be assessed as very good. The average N-gain value of all sub-concepts that obtained the high category and the significance value in the t-test shows how much the application of the learning model influences students' understanding of the concept of dynamic electrical materials. Implementation utilizes a structured inquiry model for assisted learning *virtual-lab Phet* also received a very high level of good response (Ni'mah & Widodo, 2022). Research carried out by A.A. Rais, L. Hakim and Sulistiawati. In this research, it was concluded that students who used the guided inquiry-based learning model supported by Phet had a more advanced understanding of concepts than students who used the learning model. *direct intruction* (Rais et al., 2020). Research carried out by Wirna Yurinsa, Suandi Sidauruk and Karelius in their research stated that learning using worksheets supported by phet media could increase students' understanding of concepts in predicting molecular shapes (Yurinsa et al., 2019).

Research conducted by Petri Reni Sasmita, Zainal Haryanto and Nana Sutrisna, which shows that Phet interactive simulation media, on average *N-gain* 0.68, which is in the middle range, can improve students' understanding of physics subjects. Furthermore, with an effect size score of 0.83, at a large level, Phet's interactive simulation media has an impact on students' understanding of physics ideas (Sasmita, Petri Reni et al., 2023). In line with research conducted by Intan Nur Maulida, Muhammad Taufik and Kosim, with the research title "Students' understanding of physics ideas is influenced by Phet media in the model *discovery learning"*. Findings from the research conducted, data analysis, hypothesis testing at the 5% significance level, and discussions support the idea that the model

discovery learning In research learning implemented through Phet media, it has an impact on students. students' understanding of physics (Maulida et al., 2022).

Based on several studies presented and related along with the title of this author's research, it can be concluded that the impact of media implementation *Physics Education Technology* (Phet) has significant potential to improve students' understanding of science concepts. Phet's interactive and visual simulations help students develop deeper and lasting understanding and encourage them to learn actively and independently.

Conclusion

Based on the results of analysis of several journals related to the impact of media implementation *physics education technology* (Phet) on the ability to understand science concepts. From this it can be concluded that Phet learning media can actually be applied to the ability to understand scientific concepts in the learning process at school, and also the application of learning media using Phet media can provide positive benefits to students in the learning process. Learning through media *Physics Education Technology* (Phet) can also develop critical thinking, stimulate students' interest and motivation to learn, teach good communication skills and increase their knowledge of technology.

Based on research that has been carried out by previous researchers regarding media implementation *Physics Education Technology* (Phet) towards the ability to understand science concepts, based on all research findings, the author can say that there has been a real increase in the ability to understand science concepts when implementing media *Physics Education Technology* (Phet).

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