Digital Technology in Physics Learning in the 21st Century: Study Literature Review

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Abstract: *Digital technology has great potential to improve the quality of physics learning, especially in the 21st century. The implementation of digital technology aligns with the demands of 21st-century learning, which emphasizes the importance of technological literacy and adaptability to change. This research employs a literature review method, analyzing 200 research articles from the Google Scholar database spanning 2019-2024. The findings indicate that the most commonly used digital technologies in physics learning include Augmented reality (AR), digital comics, Virtual Laboratory, Virtual Reality (VR), Android, Google Sites, and Articulate Storyline. Digital technology allows easy and fast access to convey information and/or learning materials, and can improve students' digital literacy skills.*

Key Words*:* digital technology; physics learning; learning in the 21st century

Introduction

Learning physics is often considered difficult and boring due to the lack of interaction and visualization. This causes students to have difficulty understanding abstract physics concepts. In addition, the lack of educational resources and infrastructure is also an obstacle in improving the quality of physics learning. In physics learning, learning media is needed that can support in visualizing abstract physics concepts. The use of learning media plays an important role in supporting effective physics learning, especially in the 21st century.

Physics learning in the 21st century faces great challenges in improving the quality and effectiveness of the learning process. Today's 21st century learning emphasizes several important aspects that prepare students for success in the era of globalization. The characteristics of 21st Century Learning are four main competencies (4C), namely Critical Thinking, Creativity, Communication and Collaboration. The influence of digital technology is also an important role in learning in the all-digital 21st century.

The development of digital technology offers a great opportunity to overcome this challenge. Digital technology can help increase learning motivation, deepen understanding of concepts, and develop student skills (Andriyeni & Zakir, 2023). Digital technology can be an effective solution to overcome these challenges. With digital technology, physics learning can become more interactive, fun, and effective. For example, computer simulations, educational videos, and physics learning applications can help students visualize complex physics concepts.

The development of technology in the modern era makes teachers have to innovate regarding the learning media used in learning. The use of media in learning has undergone many changes, starting from its initial physical form, now there are many online learning media (Bezemer & Kress, 2008). Digital technology has brought significant changes in science education, both in terms of learning methods, content, and infrastructure used. The use of digital technology allows students to learn independently and continuously, facilitates interaction between students and teachers, and provides easier access to more varied learning resources.

This research aims to identify the use of digital technology in the 21st century in physics learning. The results of this research are expected to contribute to the development of more effective and innovative physics learning in the 21st century.

Method

This research is study literature review. This method is carried out by identifying, reviewing, evaluating and interpreting all available research. With this method, the researcher reviews and identifies journals systematically which in each process follows the steps that have been set.

This research is based on a search in the Google Scholar database conducted in November 2024. This database was chosen because the purpose is to obtain reviews of the use of digital technology in science learning. To build a corpus of analysis, the first phase of the study limited the search to journal articles published between 2019-2024, published in Indonesian, by combining the keywords "digital technology", "physics learning", and "learning media", and identified in titles, abstracts, or keywords.

A total of 200 articles were identified at the end of this phase and imported into the Publish or Perish software. Second, a complete review of the abstract is carried out and, if necessary, a complete review of the article. To form the final analysis corpus, inclusion and exclusion criteria of the identified articles are applied. Articles are included when it allows the identification of one or more digital technologies used to support learning, and when data is collected through science learning samples. Third, the information is extracted from the search results of the article and organized based on the type of digital technology, school level, year of publication, and learning method adopted.

Results and Discussion

Digital learning can be one of the alternatives in physics learning in the 21st century. Physics learning using digital technology can facilitate students to learn in a more interesting and interactive way. Learning strategies or methods are one of the things that affect teachers in teaching in the classroom. With the advancement of digital technology, these learning methods can be improved by integrating digital technology as part of physics learning.

There are physics concepts that use a lot of learning media with digital technology that aim to display physics concepts well so that they are easy for students to understand.

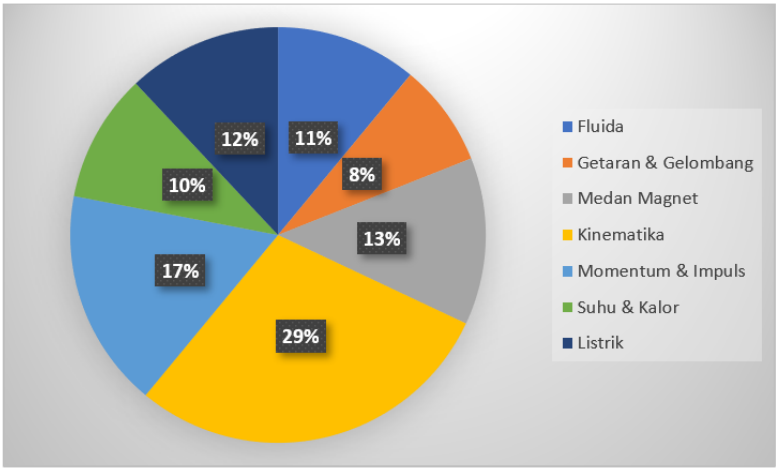

Figure 1. Physics concepts that are widely displayed in digital learning technology

Of the several existing physics concepts, there are 7 physics concepts that are often made in digital learning media, including kinematics, momentum & impulse, electricity, fluids, magnetic fields, temperature & heat and vibration & waves. Kinematics is the most widely created material in digital learning media because it requires effective concept visualization.

From the 30 articles identified, the identification of the most widely used digital learning media in physics learning can be obtained, as seen in figure 2.

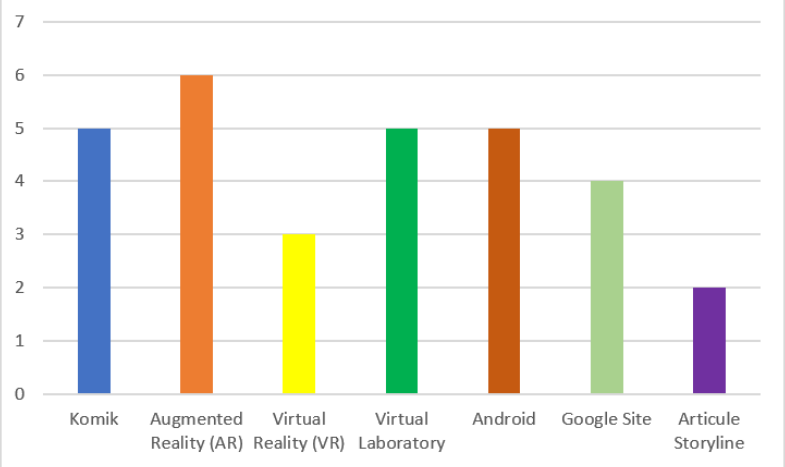

Figure 2. Digital technology in physics learning

In Figure 2, it can be seen that the digital technologies in physics learning that are widely used are Augmented reality (AR), digital comics, Virtual Laboratory, Virtual Reality (VR), Android, Google Site, and Articulate Storyline. Augmented Reality is most widely used by teachers in physics learning because AR can be a very effective learning resource to show physics concepts in a more interactive and interesting way. Teachers can visualize physics materials to show abstract physics concepts. AR provides a highly immersive and immersive learning experience. Through AR devices, students can experience physics concepts in a more real way (Liu et al, 2021; Zakaria et al, 2023). Students can explore the virtual environment, interact

with 3D objects, and observe natural phenomena directly (Setyawan & Fatirul, 2019; Mukti, 2019). This helps students to understand physics concepts in a more profound and embedded way in memory.

Digital comics can help visualize complex physics concepts. By combining text and images, comics can visually illustrate how physics concepts work in a context that is easier for students to understand (Pinatih & Putra, 2021; Riwanto & Wulandari, 2019). Usually in digital comics there are characters and avatars that can be used to represent physics concepts (Mulyati & Susanti, 2022; Azizul et al, 2020).

Some physics experiments are difficult or expensive to do in the laboratory. Physics simulations allow students to conduct experiments virtually without the need for actual equipment and materials. The available virtual practicum displays simulations of physics concepts that can be done by students and teachers as if they were carrying out a practicum in real life (Weith et al, 2022; Ben Ouhai et al, 2022). Virtual practicums that can be done in physics learning include Phet Simulation, V-lab, and Olabs. Learning by utilizing PhET simulations makes students excited and interested in doing practicum so as to complete student learning outcomes (Oktavianus et al, 2022). The existence of simulations with Phet Simulation virtual practicum can increase students' understanding of concepts and students' motivation to learn (Mahardika et al., 2022; Sumarauw et al., 2017).

Google sites are the latest learning media that is trending in the end. Google sites is a website-based application that displays complete material like a blogspot or can be used in independent learning such as the Learning Management System (LMS). Google sites can help differentiate learning and adapt materials to students' needs and develop digital skills.

Learning with mobile learning refers to the use of mobile devices, such as smartphones or tablets, in the learning process. The use of this android-based application is in accordance with current digital developments so that students can access learning without space and time restrictions. Many mobile learning applications in physics lessons incorporate elements of games to motivate and engage students in learning (Atika et al, 2022; Astuti et al, 2018). In addition, educational games can also be used as one of the interactive learning media (Hamka, 2022). Educational games are usually made using the java programming language which is then run on the android platform. According to Ramdani et al. (2022), mobile-based learning applications are more effective in improving learning outcomes and interests than traditional methods and independent learning experiences without applications.

Articulate storylines can increase students' understanding of concepts because the media presents material in the form of a combination of text, images, animations, interesting and interactive features, and can be accessed anytime and anywhere via smartphones or laptops, so that it can provide ease of learning, foster learning independence, and overcome students' difficulties (Febriansyah, 2023; Dani & Arief, 2022).

Digital technology has an important role in physics learning because digital technology allows easy and fast access in conveying information or physics materials. With the help of digital technology, abstract physical concepts can be better explained and visualized through images, animations, and videos. This visualization helps students understand concepts that

are difficult to understand through oral or text-only explanations. Digital technology also allows simulations and virtual experiments in physics learning. Students can conduct experiments or simulations in a safe and controlled virtual environment, manipulate variables, and can observe the results of experiments appropriately (Agustina et al., 2020). Digital technology facilitates collaboration and communication between students and teachers without the limitations of space and time. Students can collaborate on projects, share ideas, and get feedback from others through online platforms or communication apps. Students can access learning materials anytime and anywhere through digital devices, allowing for independent learning and individual adjustment (Komalasari, 2020).

Conclusion

Digital technology can facilitate physics learning in the 21st century. Based on the literature review, it can be concluded that the most widely used use of digital technology in physics learning is Augmented reality (AR), digital comics, Virtual Laboratory, Virtual Reality (VR), Android, Google Sites, and Articulate Storyline. The use of digital technology has an important role in physics learning because it helps to increase the effectiveness and efficiency of physics learning. Digital technology allows easy and fast access to convey information and/or learning materials, and can improve students' digital literacy skills.

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