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Use of Augmented Reality in Biology Learning

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ABSTRACT
Augmented Reality (AR) technology is the latest innovation that can be an effective solution for educators to provide innovative, informative and interesting learning experiences. AR allows the presentation of virtual objects in 3D virtual form that is integrated with real environments in real time, so that it can transform abstract concepts into experiences that are more real and can be applied directly. This research aims to analyze the use of Augmented Reality in Biology Learning at school. This research uses a qualitative approach with descriptive methods. The research results show that the use of Augmented Reality (AR) technology in biology learning has a significant positive impact. The use of AR allows students to explore biological concepts in more depth through interactive 3D object visualization. Students respond positively to immersive and engaging learning experiences, which motivate them to actively engage. AR's ability to present biological concepts concretely makes it easier for students to understand complex material. In addition, AR also provides opportunities for collaboration, independent exploration, and integration of modern technology in the biology learning process, making it an effective tool for achieving learning goals in the high-tech era.
Keywords: Learning, Biology, Augmented Reality (AR).

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INTRODUCTION

The Industrial Revolution 4.0 era, which is marked by rapid advances in the internet and digital technology, has had a significant impact on various aspects of life, including the world of biology learning. This development creates a borderless environment, forcing education to adapt to these changes (Jayawardana & Gita, 2020). In the context of biology learning, Revolution 4.0 brings new challenges that need to be overcome. Learning must focus more on developing four key characters for the 21st century, namely critical thinking and problem solving skills, creativity and innovation, collaboration and communication (Sadikin et al, 2020).

The importance of involving students in developing these abilities demands a learning approach that is open and adaptive to current technological advances. Teachers need to utilize innovations such as Augmented Reality (AR) or Virtual Reality (VR) in teaching biology, creating deeper learning experiences and facilitating better understanding of abstract concepts (Hafzah, 2020). As a response to the dynamics of the Industrial Revolution 4.0, biology learning must become the center of developing 21st century skills, preparing students to face the ever-changing demands of the future (Zubaidah, 2019).

The learning process can be viewed as a complex form of communication that involves three main elements: the teacher as the party who conveys the learning message, students as recipients of the message, and learning material as the substance of the message (So seenin, 2022). Aripin (2012) emphasized that the success of teachers in delivering learning material is closely related to the extent to which interactions between teachers and students can run smoothly. This interaction includes not only the delivery of information but also understanding, response, and feedback from students.

In an effort to increase the effectiveness of delivering learning messages, the role of intermediaries or media becomes crucial. Learning media can be in the form of tools that support concept visualization, simulations, or representation of lesson material (Kustandi & Darmawan, 2020). The use of media can not only facilitate student understanding, but also make the learning process more interesting and interactive. By utilizing media, teachers can create a more comprehensive learning experience, enrich communication in the classroom, and meet the diverse needs of students in understanding subject matter (Hanikah et al, 2022). As a result, the interaction between teachers, students and the media can create a more dynamic and effective learning environment.

One trend that is increasingly receiving attention in the world of education is the use of learning media with Augmented Reality (AR) technology. AR is a technology that expands the real world by

adding computer-generated content, such as text, images and videos (Saputro & Saputra, 2015). The uniqueness of AR lies in its three main characteristics: integration between the real world and virtual elements, interaction with users in real time, and implementation in 3D space. With AR, users are given the freedom to manipulate 3D virtual images and view them from various angles, creating an experience that is close to real reality (Indriani & Abidin, 2022).

Arifitama (2017) explained that AR technology is an evolution of Virtual Reality (VR) with a different concept. If VR takes users into a three-dimensional environment that is separate from the real world, AR actually adds a virtual layer to the surrounding reality by displaying additional or raised objects. In this way, AR creates experiences that unite the 3-dimensional virtual world with the real world, providing a new dimension to learning by stimulating student engagement and understanding in a more direct and interactive way. In an educational context, AR technology opens up opportunities to present course material in a more interesting and engaging way, allowing students to learn in a more practical and engaged way.

The application of Augmented Reality (AR) technology in the learning process offers an innovative learning experience and can improve students' skills and knowledge. By utilizing AR, learning not only becomes more dynamic, but also provides opportunities for students to be actively involved in understanding abstract concepts (Kamelia, 2015). In the context of the industrial revolution 4.0, where technology plays a central role, the development of learning processes needs to adapt to the characteristics of modern learning.

Research conducted by Marzouk et al (2013) shows that the implementation of AR in Biology learning, especially using game techniques, has a positive impact. Learning about human anatomy becomes more fun, collaborative and attractive. AR opens the door to presenting anatomical information visually and interactively, allowing students to explore the structure of the human body virtually. This not only creates more interesting learning but also provides a more holistic and practical learning experience. Thus, the use of AR in the context of Biology learning can be an inspiring model for utilizing technology to increase learning effectiveness in the era of the industrial revolution 4.0.

The research aims to explore and identify the impact of implementing Augmented Reality (AR) technology in Biology learning, especially on the topic of human anatomy. The main objective of this research is to assess the extent to which the use of AR can improve the quality of learning, increase the level of student engagement, and improve understanding of biology learning concepts. It is hoped that the benefits of this research will contribute to the development of innovative learning methods in the industrial revolution 4.0 era, by combining AR technology to create a more enjoyable, collaborative and attractive learning experience in the context of Biology lessons.

METHOD

This research adopts a qualitative approach with descriptive methods. Data collection was carried out through literature studies, where researchers detailed previous research that was relevant to this research problem (Anggito & Setiawan, 2018). A literature review is a search process that presents research subjects by summarizing information from various documents or library materials, such as books, scientific journals and research supporting documents. The author uses previous studies relevant to this topic to critically examine knowledge, ideas and scientific findings obtained from literature related to the Use of Augmented Reality in Biology Learning. The data analysis method is carried out descriptively qualitatively, following Milles and Hubberman's interactive model which involves data reduction stages, data testing or analysis, and conclusion drawing and verification stages.

RESULTS AND DISCUSSION

Augmented Reality (AR), as defined by Afissunani (2014), is the integration of 3D virtual objects into a device screen that can interact in real time with real objects, which are created using a computer. The main goal of AR is to develop technology that provides a unique experience in observing virtual objects projected on the real world. AR technology can make this happen by displaying certain information in the real world using devices such as webcams, computers, Android smartphones, or special glasses (Azuma, 1997). Thus, AR becomes an effective means of conveying information to users by projecting 2D or 3D objects into the surrounding environment.

The application of AR in the learning process opens up opportunities to increase interactivity, effectiveness and diversity of learning media. Mustaqim (2017) mentions several advantages of AR, such as high interactivity, effectiveness of use, wide implementation in various media, simple object modeling capabilities, relatively low production costs, and ease of operation. However, there are several drawbacks, including sensitivity to changes in viewing angle, limited number of AR creators, and the need for a fairly large memory capacity on the device used.

In the context of Biology learning, the use of AR can have a positive impact by making learning more interactive, interesting, and supporting understanding of scientific concepts. Although there are some challenges, such as changes in sensitive viewpoints, the sustainability of its development is becoming increasingly important. In line with technological developments, teachers are challenged to adapt and integrate AR into learning methods, create a learning environment that is responsive to current developments and improve the quality of learning in an era of ever-developing technology.

According to Arifitama (2017) there are four components that must be considered in developing and using AR, namely:

a. Hardware To develop AR-based media, a PC/computer with specifications that are not too large can be used. According to Mustaqim and Kurniawan (2017) the minimum specifications for the computer used are Core I3 processor, 3GB RAM, 320 GB HDD, Windows 7 operating system can create learning media using AR.
b. Software Application tools used to develop AR include : Unity 3D, Blender, Vuforia SDK, and Java SDK.
c. Scanning Tools Tools for scanning AR Markers or Barcodes can utilize Smartphone cameras.
d. Marker The first component is hardware. The hardware used can be a PC, laptop, smartphone or tablet. PCs and laptops are used as application development tools, while smartphones and tablets are used as the base on which applications will be embedded or installed.

The second component is software resulting from development that has been carried out in an AR application creation software. PC, Android and IOS platforms. The third component is a scanning tool or scanner to scan patterns and activate AR. The tools used for scanning are webcams for PCs or cameras that are available on smartphones and tablets. The final component is a marker as the location of the AR object's appearance point. Marker development itself requires pattern formation techniques. Patterns can be black and white or non-patterns. Each pattern will first be tested for how compatible and suitable it is for use as a marker with special software.

The use of Augmented Reality (AR) in biology learning provides a number of significant benefits, including:

1. Interactive 3D Visualization

The application of Augmented Reality (AR) technology in biology learning opens the door to revolutionary visualization experiences. With AR, students can utilize the visualization of biological objects in an interactive 3D format, creating an immersive and engaging learning experience. For example, students can explore the organs of the human body, observing cell structures in a way that makes it seem as if the biological objects are present before their eyes. The advantage of this interactive visualization is that it provides an opportunity for students to gain a richer and deeper understanding of the structure and function of biological organisms.

By allowing students to see organs, cells or biological organisms more realistically, AR not only presents course material visually, but also stimulates their sense of sight, enriching the learning experience. The ability to manipulate 3D objects in a real context creates a link between abstract concepts and the physical world, making it easier for students to better internalize and remember biological information. Thus, AR is not only an innovative learning tool but also an effective means of deepening students' understanding of structure and function in biological studies.

2. Immersive Learning Experience

The use of Augmented Reality (AR) in a learning context creates an impressive and engaging learning experience. AR brings students into an immersive learning environment by integrating virtual objects into the real world. In this process, students are not just passive spectators, but actively interact with virtual objects that appear around them. For example, in biology lessons, students can watch the structure of human cells or organs appear on their desks, allowing them to explore and understand biological concepts in a more hands-on way.

The uniqueness of this interactive experience not only increases student engagement but also stimulates their motivation to learn. The ability to interact with virtual objects creates curiosity and a desire to understand more deeply. As a result, students not only engage their sense of sight, but also experience hands-on experiences that have a positive impact on understanding and retention of information. By designing lessons that present biological concepts through AR, educators can create a dynamic and interesting atmosphere, motivating students to explore and dive into the subject matter with high enthusiasm.

3. Understanding Abstract Concepts

The application of Augmented Reality (AR) technology opens the door to presenting biological concepts that are difficult to understand in the abstract in a more concrete and up-to-date way. For example, the concept of the microscopic structure of cells or complex interactions in ecosystems can be realized in the form of 3D virtual objects that appear in the real world through AR. By visibly visualizing

these concepts, AR allows students to observe and explore complex details that are difficult to achieve with traditional methods. The learning process which was originally theoretical and abstract is transformed into a more lively experience, making it easier for students to understand and internalize biological concepts which are often complex.

Furthermore, AR's advantages in presenting biological concepts concretely have a positive impact on students' understanding. Students' ability to see and interact with 3D objects in real contexts helps them build stronger mental images regarding the subject matter. This not only provides deeper understanding but also stimulates students' creativity and critical thinking. In this way, AR can be considered an effective learning tool in helping students overcome the difficulties that often arise when understanding complex and abstract biological concepts.

4. **Collaboration and Interaction**

The application of Augmented Reality (AR) technology in biology learning opens up opportunities for students to engage in dynamic collaborative experiences. With AR, students can collaborate directly in observing and exploring biological objects that appear in the real world through their devices. For example, in the study of ecosystems, students can share information, exchange opinions, and jointly explore various aspects of the living environment that are realized in the form of 3D virtual objects.

The advantage of collaboration in AR learning experiences is not only enriching the learning process but also building mutual understanding interactively. Students can support and motivate each other, creating a learning environment that supports the exchange of ideas and joint problem solving. Collaboration in the exploration of biological objects allows students to see different perspectives, stimulates critical thinking, and broadens their view of the subject matter. Thus, AR becomes not only an individual tool but also a means to strengthen the concept of cooperation and collaboration among students, creating a more dynamic and engaged biology learning experience.

5. **Independent Learning**

The use of Augmented Reality (AR) in biology learning opens the door to in-depth independent exploration. AR provides an opportunity for students to become independent explorers in the world of biological concepts. By manipulating AR objects, students can control their learning experience, adapting it to their individual learning styles. For example, they can speed up or slow down the visualization of objects, repeat material, or adjust their focus according to individual learning needs.

This independent exploration gives students the freedom to explore biological concepts according to their level of understanding and interest. This personalized learning process supports deeper understanding and provides space for students to develop learning strategies that suit their own learning styles. In this way, AR becomes not just a static tool but a catalyst for personalized and customized learning experiences, accommodating students' individual needs and encouraging the development of independence in biology learning.

6. **Technology Integration**

The integration of Augmented Reality (AR) in biology learning creates a significant breakthrough by bringing teaching into the high-tech era. Utilizing AR opens up opportunities to design motivating and dynamic learning experiences. By integrating modern technological elements, biology learning becomes more interesting and relevant for students living in the digital era. For example, students can use their devices to view and interact with biological objects directly in the real world, turning learning into an experience that is not only informative but also enjoyable.

The use of AR not only provides technological sophistication in learning, but also creates learning that is more responsive to student needs. By utilizing high technology, biology learning can be adapted to modern students' learning styles, taking into account their digital habits and preferences. This creates a relevant and inspiring learning environment, which motivates students to engage more actively in the learning process and broadens their experience in exploring biological concepts. Thus, the use of AR not only encourages innovation in biology education but also ushers learning into an era of technology that continues to develop.

7. **Understanding the Ecosystem Environment**

The application of Augmented Reality (AR) technology has had a significant positive impact in the study of ecosystems and biodiversity, giving students a deeper understanding of the complexity of the relationships between organisms and the environments in which they interact. Through AR, students can visualize various ecosystem components directly in the real world, creating concrete and immersive learning experiences. For example, they can see how different organisms interact with each other in an ecosystem, such as how plants, animals, and microorganisms contribute to environmental balance.

AR also allows students to explore ecosystem dynamics more interactively. They can see how changes in the population size of one species can affect other species and the environments in which they live. This provides a better understanding of ecological concepts, such as food chains, nutrient cycles,

and symbiotic relationships between organisms. By engaging students directly through virtual elements that appear in the real world, AR creates a more vivid learning experience, stimulates curiosity, and deepens students' understanding of the dynamics of ecosystems and biodiversity. Thus, the use of AR in the context of ecosystem studies has a positive impact in shaping students' understanding of the importance of balance and diversity in the natural environment.

CONCLUSION

The use of Augmented Reality (AR) in biology learning has a significant positive impact. AR enables the visualization of biological objects in an interactive 3D format, giving students a more in-depth learning experience of the structure and function of organisms. AR's ability to create immersive and engaging learning experiences motivates students, while its unique way of presenting biological concepts in a concrete manner makes it easier to understand complex concepts. Furthermore, AR provides a space for students to collaborate on learning experiences, building shared understanding interactively. Students are also given the opportunity to carry out independent exploration, manipulating AR objects according to their respective learning styles . The integration of AR brings biology learning into the high-tech era, creating a responsive learning experience and integrating modern technological elements in the learning process. In the context of ecosystem studies, AR opens up opportunities for a better understanding of the relationships between organisms and their environments. Through AR, students can visualize ecosystem dynamics in a concrete way, providing a deeper understanding of biodiversity and complex interactions between organisms.

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