JPPIPA 9(7) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Student Response to the Use of Augmented Reality Media in the Circulatory System in Humans

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Received: May 18, 2023
Revised: June 3, 2023
Accepted: July 25, 2023
Published: July 31, 2023

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DOI: 10.29303/jppipa.v9i7.3922

Abstract: This study aims to explore the students' response to the use of Augmented Reality (AR) media in learning the circulatory system in humans. Until now, students have relied on textbooks consisting of pictures and text as their learning source. However, they face difficulties when studying topics such as the circulatory system that require complex visualization. A survey method was employed to collect data from students of the Biology Study Program at IPB University. The research sample consisted of 20 randomly selected respondents. The survey was conducted using a structured questionnaire designed to gather information about student engagement, conceptual understanding, interest, and preferences in using AR learning media. The questionnaire included questions about the respondents' response to their experience using AR media, perceived benefits, difficulties encountered, and suggestions for the development of future AR media. The collected survey data was analyzed using descriptive statistical methods. Descriptive statistics were used to summarize and depict the distribution of students' responses to the use of AR media in learning the circulatory system in humans. The results of this study can be concluded that the use of AR media in learning the circulatory system in humans has shown great potential. The majority of students responded positively, finding the use of AR media visually appealing and easy to learn.

Keywords: Augmented reality; Circulatory system; Learning media; Student response

Introduction

History shows that the development of media always follows technological advancements. New innovations change the way we consume and interact with media content. One form of innovative learning media that keeps up with current developments is the emergence of Augmented Reality (AR) (Sangari et al., 2022). AR is a technology that combines the real world with virtual elements, creating a more immersive and interactive experience for users (Isnanda & Ardianto, 2022). This technology allows users to see and interact with virtual objects that are integrated into their surrounding environment. With the help of devices such as smartphones, tablets, or specialized glasses, users can add digital elements like images, videos, or additional information to their real-world surroundings (Yuliana et al., 2021). In the field of advertising, AR enables companies to create engaging and immersive advertisements by showcasing their products in a real-life context (Tonapa & Kurniawati, 2021). In the entertainment world, AR has provided more immersive experiences through interactive games and virtual concerts where users can directly interact with their favorite characters and artists (Endarto & Martadi, 2022). In the field of education, AR has transformed the way students learn by providing more engaging and interactive experiences (Usmaedi et al., 2020).

Although AR technology has been around for some time, its utilization in education has not been fully optimized. One of the main reasons why the utilization of AR in education is not optimal is the limitation of infrastructure and resources (Arifin, 2021). There are also challenges in developing relevant and effective AR content for educational purposes. Creating high-quality AR content requires specialized knowledge and skills in design, software development, and creating visually appealing content (Kazanidis & Pellas, 2019).

How to Cite:
Limbong, A. M. N., Putri, D. A. P., Mujiono, Casmat, M., & Soko, I. P. (2023). Student Response to the Use of Augmented Reality Media in the Circulatory System in Humans. *Jurnal Penelitian Pendidikan IPA*, *9*(7), 5453–5459. https://doi.org/10.29303/jppipa.v9i7.3922

Additionally, the use of AR media in education is often hindered by a lack of awareness and understanding of its potential and the significant benefits it can provide. Many educational institutions and educators have not fully realized how AR can enhance the learning experience and help students understand difficult concepts through clearer and more interactive visualizations (Andayani et al., 2022).

There have been numerous research studies that demonstrate the significant benefits of AR as a valuable medium in the context of education. Maulana et al. (2019) stated that AR has tremendous potential to enhance student interaction and engagement in the learning process. One of the primary benefits of AR in education is its ability to visualize abstract or complex concepts (Ewais & Troyer, 2019). By using digital elements integrated into the real world, AR allows students to see, manipulate, and interact with virtual objects directly. This can help students understand difficult concepts in a more tangible and concrete way (Aripin & Suryaningsih, 2019). AR also promotes experiential-based learning, where students can learn through hands-on and direct activities. By actively involving students in the learning process, AR helps improve student motivation (Liono et al., 2021).

The subject matter of the circulatory system in humans is one of the complex topics that requires a deep visual understanding (Situmorang & Andayani, 2019). Students often face difficulties in comprehending the material on the circulatory system in humans by relying solely on textbooks. Although textbooks are an important source of information (Kropman et al., 2020), complex topics like the circulatory system in humans are often challenging to grasp through text and two-dimensional illustrations alone. Concepts related to anatomy, physiology, and the interactions between various body parts are difficult to visualize clearly in print form. Textbooks that only feature static images often fail to depict in detail how blood flow works, how organs function, and how the components of the circulatory system in humans are interconnected. The lack of interactivity in textbooks makes it difficult for students to visualize the learning material (Kaplar et al., 2022), such as the processes that occur within the circulatory system in humans.

Difficulties in understanding the material on the circulatory system in humans may also stem from the lack of practical context in textbooks. Textbooks tend to provide theoretical explanations and abstract descriptions without connecting them to real-life applications or everyday situations. Students often need a more practical and real-life-related understanding to relate these concepts to situations they can comprehend. Apriyani et al. (2018) also highlights that textbooks are often less interactive and do not allow students to actively engage in the learning process. Some concepts within the circulatory system in humans require a deep visual understanding and the ability to see and manipulate structures interactively (Aaronson et al., 2020). Students often feel limited in comprehending abstract concepts solely through textbooks without direct experiences or deeper interactive contexts.

In this regard, the use of AR technology is highly relevant and beneficial when used as a medium to deliver the material on the circulatory system in humans (Sugiarto, 2021). AR can provide an immersive and interactive experience (Isnanda & Ardianto, 2022), allowing students to virtually explore the anatomical structures and processes that occur within the circulatory system in humans. With AR, students can directly observe how blood flows through arteries, veins, and capillaries, as well as how vital organs like the heart, lungs, and blood vessels work together. The utilization of AR in teaching materials about the circulatory system in humans will provide a more engaging, interactive learning experience, and facilitate students' understanding of complex concepts. Through realistic visualizations and active participation in learning (Saputri et al., 2018), students can develop a deeper understanding of the anatomy and physiology of the circulatory system in humans. Therefore, the use of AR media can be a beneficial solution to overcome these difficulties. Using AR as a learning medium to study the circulatory system in humans can provide a more engaging, interactive learning experience and help students better understand the concepts (Bulan, 2020).

This study aims to explore students' responses to the use of AR media in learning the circulatory system in humans. The research is motivated by the need to understand how the use of AR can affect students' understanding and interest in studying complex topics such as the circulatory system in humans. Additionally, this study also aims to evaluate students' understanding of the circulatory system in humans after using AR media. Can the use of AR help students better comprehend complex concepts and convey information in a clearer and more engaging manner? By studying students' responses to AR media, this research can provide insights into the potential use of AR in enhancing concept comprehension.

Method

This study utilizes a survey method to collect data on students' responses to the use of Augmented Reality (AR) media in learning the circulatory system in humans. The survey method was chosen because it can efficiently generate representative data and allow data

collection from a number of respondents (Glazerman et al., 2023). The research sample consists of 20 students from the Biology Study Program at IPB University. This sample was randomly selected from the relevant student population. The research instrument used is a questionnaire. The questionnaire is designed to gather data on students' responses to the use of AR media in learning the circulatory system in humans. The questions in the questionnaire cover aspects such as student involvement, concept understanding, and interest, preferences for AR use, and suggestions or feedback regarding the development of AR media.

After the questionnaire is designed, the survey is then conducted among the respondents (Anggraini et al., 2020). Clear instructions and explanations are provided to the respondents regarding the research objectives and the importance of their participation (Alahmari et al., 2019). Subsequently, students are given sufficient time to complete the survey after they have interacted with the learning process using AR media. Once the survey data is collected, data analysis is conducted. The collected data is processed and analyzed using descriptive statistical methods (Laccourreye et al., 2021). Descriptive statistics are used to depict the distribution and patterns of students' responses to the use of AR media in learning the circulatory system in humans. The results of the data analysis will provide a better understanding of students' overall responses (Subekti & Jazuli, 2022).

Result and Discussion

The data analysis of the survey conducted in this study provides an overview of the research respondents and their responses to the use of Augmented Reality (AR) media in learning the circulatory system in humans.

Table 1. Respondent Data

Gender	Age (Years)				Total
	18-21	22-25	26-29	≥30	
Man	2		2		4
Woman	12	1	1	2	16
Total	14	1	3	2	20

The respondents in this study involved 20 students from the Biology Study Program at IPB University, consisting of 4 males and 16 females. There was a significant variation in age among the respondents, but the majority of them were within the age range of 18-21 years old, with a total of 14 students, accounting for approximately 70% of the total respondents.

The involvement of the majority of students in the younger age group, specifically 18-21 years old, can be attributed to several factors. Firstly, in the context of using newer media such as AR and current technologies, as mentioned by Gutandjala (2018), young individuals tend to be more open to technology and have higher exposure to mobile devices and applications. Therefore, younger students are likely to have a greater interest in new technologies and have better capabilities in exploring and mastering AR applications. This aligns with the opinion of Wahyudi (2022) that young individuals are more familiar with the digital world and have a stronger desire to use technology as a learning media.

The involvement of the majority of respondents in the younger age group indicates high enthusiasm and interest in using AR media for learning. Their perceptions and experiences can provide valuable contributions to the development and implementation of AR media as an effective and engaging learning tool in the context of the circulatory system in humans. Although the number of respondents in the older age group may be smaller, their contributions and perspectives are still valuable in obtaining a comprehensive understanding of the responses to the use of AR media in learning about the circulatory system in humans.

Table 2. Use of AR Media

Response	Age (Years)				Total
	18-21	22-25	26-29	≥30	
Easy	13		2	1	16
Very Easy		1	1		2
Very Not Easy					
Not Easy	1			1	2
Total	14	1	3	2	20

The students' responses to the AR media on the circulatory system in humans are generally positive. The majority of students found it easy to utilize this AR media. Only two students found the AR media used for learning about the circulatory system in humans to be difficult to use. These two students, despite having a significant age difference, faced similar challenges. They found it challenging to use the AR media because they were not accustomed to the latest technology and did not have the same level of experience in using applications on mobile phones. This aligns with the findings mentioned by Kaddoura et al. (2023) that those who easily adapt to technological advancements will not face difficulties because they have been accustomed to interacting with technology from an early age.

In addition, they felt less familiar with the operation of the AR media. One student, who was over 30 years old, felt uncomfortable or lacked confidence in operating the application on a mobile phone. They had difficulty adapting to a more interactive learning approach using integrated technology (Akbar & Noviani, 2019).

Throughout their studies, they did not receive sufficient support and guidance in operating AR applications. They lacked access to the necessary resources or training to learn how to use AR media effectively (Jesionkowska et al., 2020).

In using the AR media for the human circulatory system through a mobile phone, there are two parts that require time to do so. Firstly, the time needed to download the application, with an average time of around 3 minutes. Secondly, the time required to use the AR program itself, with a range of time between 15-40 minutes. However, to fully understand the material given its complexity, it takes approximately 1 hour.

Table 3. Material Substance in AR Media

Response	Age (Years)				Total
	18-21	22-25	26-29	≥30	
Clear	9		1	2	12
Very Celar	4	1	1		6
Very Unclear			1		1
Unclear	1				1
Total	14	1	3	2	20

Regarding the content of the human circulatory system in the AR media, the majority of students also provided positive feedback. As many as 90% of students expressed that the use of AR media helped them understand the concept of the human circulatory system better. This is in line with the findings of Sulistianingsih et al. (2022), stating that AR media provides a more visual, interactive, and immersive learning experience. Therefore, students can directly observe how blood flows through blood vessels, visualize the anatomical structures of the human circulatory system in 3D, and even interact with virtual models to deepen their understanding (Gnidovec et al., 2020).

The interactive experience they have when using AR media plays a significant role in concept understanding. Students can actively participate in the learning process by performing actions such as moving virtual objects (Jurizal, 2019), exploring structures within the digital environment, or observing changes that occur in the human circulatory system over time. They can also adjust the scale, remove or highlight specific parts (Sulistianingsih et al., 2022), or observe the process of blood circulation in humans from different perspectives (Sugiarto, 2021). These capabilities allow students to gain a deeper understanding of the interactions among the components of the human circulatory system and the processes that occur within it.

The majority of students, or 90%, have shown a high interest in using AR media for learning about the human circulatory system. They feel that the use of AR makes learning more engaging, enjoyable, and provides a unique learning experience. The experience of using AR media has led most students to prefer it over conventional learning methods such as textbooks (Fidan & Tuncel, 2019). The high interest of the majority of students is also influenced by the novelty and sophistication of AR technology itself.

Table 4. Responses and Interest in the Use of AR Media

Response	Age (Years)				Total
	18-21	22-25	26-29	≥30	
Interesting	11	1		2	12
Very Interesting	2		2		6
Very Unattractive	1				1
Not Attractive			1		1
Total	14	1	3	2	20

One of the main reasons for students' high interest in AR media is the interactive and enjoyable learning experience it provides (Fitria, 2023). AR media allows students to directly interact with virtual objects, engage in independent exploration, and take an active role in their learning (Endra & Agustina, 2019). They can manipulate objects (Goh et al., 2019), observe the internal components of the human circulatory system in detail, and directly witness how each component interacts with one another. AR also provides realistic visualizations that help students visualize and connect concepts that were previously only learned theoretically through textbooks (Weng et al., 2020). As stated by Alfazillah (2021), AR provides an engaging and captivating experience that stimulates interest and learning motivation.

However, there were two students who were not interested in using AR media. They mentioned that although the presented material was clear, their devices or smartphones did not fully support the application. When they downloaded the application on an iPhone, they encountered difficulties in listening to the audio, which lacked intonation. Some of the 3D animations also did not function properly, making it unclear in terms of physiology (Owolabi & Bekele, 2021). For example, while the heartbeat sound played, there was no illustration of how and where the blood flows. One student also mentioned that the application size was quite large, and the loading process when opening the AR app took a considerable amount of time, resulting in lag on the device used.

In addition, the student respondents also provided valuable suggestions and feedback regarding the development of AR media in learning the circulatory system in humans. Some of the proposed suggestions include improving the clarity of the AR interface, providing more structured content, adding interactive features, and integrating it with a broader range of learning materials. It is necessary to improve several components such as a more user-friendly display,

clearer organ images in explanations, better content completeness, and the design and colors of organs should be enhanced to facilitate user understanding of organ differences. There are also some conditions that need to be addressed, such as ensuring availability for iPhone users.

Overall, the results of this research indicate that the use of AR media in learning the circulatory system in humans received positive responses from students. AR media successfully created an engaging learning experience, facilitated concept understanding, and increased students' interest in the learning process. The suggestions and feedback provided by students can also serve as a guide for instructional media developers to enhance the AR learning experience in the future.

Conclusion

The use of Augmented Reality (AR) media in learning the circulatory system in humans shows great potential and benefits. Students responded positively to the use of AR media and reported high levels of engagement in learning with this media. The use of AR media also benefits concept understanding, with realistic and interactive visualizations that facilitate deeper comprehension. Students exhibit a high interest in using AR media in learning and tend to prefer it over conventional teaching methods. The suggestions and feedback from students provide valuable insights for the future development of AR media. Thus, the use of AR media in learning the circulatory system in humans has the potential to enhance the quality of education and enrich students' learning experiences. However, this research has limitations, such as a limited sample size and the use of survey methods that may introduce subjective biases. Therefore, further research with a larger sample size is needed to generalize the findings of this study. By understanding the potential and benefits of using AR media in education, educational institutions can consider integrating AR media into their curricula to enhance the quality of education and prepare students for future challenges.

Acknowledgments
We thank Universitas Terbuka for funding this research and the research team so that the research and writing of this article can be carried out.

Author Contributions
The roles of the authors in this research are divided into executor and advisor in this research.

Funding
This research is funded by the Research and Community Engagement Institute (LPPM) of Universitas Terbuka.

Conflicts of Interest
The authors declare no conflict of interest.

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