The Effectiveness of Using Augmented Reality-based Learning Media in Physics Learning: Literature Study

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ABSTRACT

This study aims to describe the effectiveness of using augmented reality-based learning media in physics learning. This effectiveness is in terms of increasing understanding of concepts, interest in learning, learning outcomes and students' critical thinking skills. This research is motivated because there is still a lack of understanding of physics because of its abstract concept and lack of innovation in learning so that it can reduce learning outcomes. Therefore, innovation is needed in the physics learning process, namely augmented reality learning media. This study uses a quantitative approach with data collection methods in the form of literature studies. The literature sources used come from the Google Scholar indexing portal, Sinta, Garuda and others. Researchers got 10 references related to the study objectives starting from 2014 to 2022. The results of the literature study show that the use of augmented reality in physics learning can improve conceptual understanding, increase interest in learning, improve learning outcomes and improve students' critical thinking skills in learning physics.

Keywords: effectiveness, learning media, augmented reality, physics

1. INTRODUCTION

In the current digital era, science and technology is developing rapidly. This development has an impact on information that is increasingly accessible and easy to spread all kinds of knowledge from all corners of the world through the boundaries of place, distance, time and space. This has resulted in humans in today's digital era will always be dependent and connected to technology. Technology has changed and affected the daily life of a human being, so if someone in this current era 'stutters technology' it will be too late in knowing all kinds of information. Information has an important role, in the era of the information society (information society) or the knowledge society (Nana et al, 2019).

However, the learning model that has been going on so far is still dominated by teacher centered, where a teacher is still a storehouse of knowledge while students are passive. In general, education is often interpreted only as a transfer of knowledge or knowledge (Budiman, 2017). Where more students receive and listen to the knowledge of the teacher. This results in a lack of student understanding of a concept. The low understanding of the concepts possessed by students will affect

the learning outcomes obtained. Learning outcomes determine the quality of graduates or educational products created. In addition to learning models, the lack of use of facilities and infrastructure, especially learning media, also causes the learning process to be ineffective. The use of learning media with basic technology has a very positive impact on the ability and willingness of students to participate in the learning process (Hikmayanti et al., 2016).

One of the uses of technology in education is the use of Augmented Reality technology in learning. Augmented reality (AR) is a technology that visually augments a real-world environment by projecting computer-generated information onto the eye. They also state that AR is a rapidly growing research field that aims to fully integrate the virtual with the real environment (Pai, Y.S, et al, 2016). Thus AR can be interpreted that real objects in real time are added to virtual objects that appear when using a tool or device on the real object. So that there is a relationship between the virtual world and the real world with the help of a camera (Siahaan et al., 2019)

Augmented Reality (AR) is an environment that incorporates 3D virtual objects into the real environment. Augmented Reality as a system has three characteristics, namely, the ability to combine real and virtual objects, the ability to be interactive in real time, and the ability to be used on 3D objects. The main advantage of AR is the ability to create immersive hybrid learning environments that combine digital and physical objects, thereby facilitating the development of processing skills such as critical thinking, problem solving, and communicating through collaborative, interconnected exercises (Akçayır & Akçayır, 2017).

By using Augmented Reality as an alternative learning media, it is hoped that a learning activity can be more interesting for students (Mustaqim, I., 2017). Through Augmented Reality, it can be a solution to overcome modules or trainers which are quite expensive and cannot be purchased by schools. Students can still do practicum by seeing the goods as they are in real, but in virtual form. In this literature review, the authors focus on knowing the effectiveness of using Augmented Reality in learning physics.

2. EXPERIMENTAL

The writing method in this study uses a quantitative approach with data collection methods in the form of literature studies (Jaelani, et al, 2020). The reason the author uses the literature study collection method is because the main source is entirely in the form of articles that are analyzed and researched without any field observations from researchers. The literature study that was collected related to the use of Augmented Reality (AR) in physics learning. Literature collected in the period 2014-2022. The literature studied is the result of research that has been published in journals and proceedings.

The literature study research instrument uses a checklist sheet to select various articles according to the research topic. The research procedure includes 1) determining the research theme, namely the effectiveness of augmented reality-based physics learning media; 2) search and collect various articles on Google Scholar, Sinta, Garuda, and other websites; c) classifying various types of articles relevant to the research theme, d) synthesizing relevant articles by marking the important points in each article; and e) writing articles from the results of the synthesis. The analysis technique in this study is in the form of content analysis techniques, namely studying the description of the content, the characteristics of the message, and the development (term) of a content (Budiarti et al., 2022).

3. RESULTS AND DISCUSSION

Researchers grouped the percentage of research articles based on the population level and student samples to determine the distribution of augmented reality-based physics learning. Consideration of population and sample selection in this study is the result of research that has been published in various national journals using populations and samples from students from elementary, junior high, high school to university levels during augmented reality-based physics learning in terms of four aspects, namely understanding concepts, interest in learning, learning outcomes and critical thinking skills. Furthermore, Table 1 shows the percentage of research results in augmented reality-based physics learning at various levels of education.

Table 1. Percentage of use of augmented reality media at various levels of education

No	Educational Stage	Total	Pencentage (%)
1	Primary School	2	20%
2	Junior High School	1	10%
3	Senior High School	6	60%
4	University	1	10%

Table 1 shows that teachers have used augmented reality-based physics learning media in Indonesia. The results show that augmented reality-based physics learning media is widely applied in high school (60%) then at elementary school (20%), junior high school (10%) and university (10%).

Furthermore, Table 2 shows the effect of applying augmented reality-based physics learning media. This effect is applied from increasing understanding of concepts, interest in learning, learning outcomes and students' critical thinking skills.

Table 2. Application of AR-based learning media in physics learning

No	Physics concept	Discussion	References

Concept Understanding			
1	Heat Transfer	The results show that AR-assisted problem solving learning has a major effect on heat transfer material so that students' understanding of concepts increases.	(Ismail, 2021)
2	Quantum Physics	Modules equipped with Augmented Reality technology can package abstract quantum concepts and phenomena into real and easily understood by students.	(Chaeranti et al., 2018)
3	Solar System	The results of the study show that the AIR-based solar system learning poster can support elementary school students' understanding.	(Sumardani et al., 2013)
4	Electromagnetic Induction	Can provide insight into what benefits and difficulties students find in learning when interacting with AR-based learning environments.	(Ibáñez et al., 2014)
Interest to learn			
5	Circular motion	The learning motivation of students is very high with the AR-based Edumu application as a learning medium that strongly supports the learning process of students.	(Kusniati et al., 2021)
6	Solar system	The implementation of AR-based Legit Boltas as an effective medium in learning the solar system at SDI Raden Patah Surabaya can increase the interest and motivation of fifth grade elementary school students and this shows that the learning process is stable.	(Budiarti et al., 2021)
Learning outcomes			
7	Planetary Motion	The use of Augmented Reality media is able to increase the posttest average value to the pretest value, this value is a very meaningful value for improving student learning outcomes so that Augmented Reality media is proven to improve learning outcomes.	(Ibisono et al., 2020)
8	Flat Mirror	Learning activities using learning media with Augmented Reality technology can improve	(Nesi & Purwaningsih,

		student learning outcomes, it can be concluded from student learning outcomes scores before being given treatment and after being given treatment increase.	2021)
9	Electromagnetic Induction	Research shows that the use of AR-based applications can improve learning attitudes and learning outcomes. This study provides a case for the application of AR technology in secondary physics education.	(Cai et al., 2017)
Critical Thinking Ability			
10	Magnetism	Augmented Reality learning media can train students' thinking skills in science learning. Critical thinking skills include the skills of analysis, synthesis, interpretation, evaluation, and making assumptions that equip students in the 21st century.	(Vari & Bramastia, 2021)

Based on table 2, it can be grouped four influences after students use AR-based learning media. There are several materials that implement AR, namely heat transfer material, quantum physics, the solar system, circular motion, plane mirrors and magnetism. The reason why the material is implemented based on AR is because through the use of AR it will help visualize abstract physics concepts. Especially concepts that cannot be observed directly through the five senses, such as quantum physics and the solar system. The purpose of designing AR-based learning media is to provide users with more detailed information than real objects.

The use of AR-based physics learning media can improve students' understanding. The results of Ismail's research (2021) that learning with the Augmented Reality-assisted problem solving learning model on heat transfer material can significantly improve students' understanding of concepts in the experimental class. Seen from the results of the Pretest and Posttest that have been carried out in the experimental class, the Pretest average value of 42.97 and the average value of the Posttest was 83.91. So that it is obtained that the comparison between the Control class and the Experiment class. The comparison for those using the Conventional Learning Model assisted by Power Point with the Experiment class using the AR-assisted Problem solving Learning Model is very significant. So that the use of AR-based learning media in experimental class students has a big influence on increasing students' understanding of concepts.Motivasi peserta didik merupakan salah satu tolok ukur dalam menentukan keberhasilan dalam pembelajaran (Maulidya et al., 2021).

Students who do not have the motivation to learn will not be able to do learning activities.

The absence of learning activities will certainly have an impact on learning objectives. If the learning objectives are not achieved, then it reflects the failure of the educator. The results of the study by Kusniati, et al (2021) showed that students' learning motivation increased with the augmented reality-based Edumu application as a learning medium that strongly supports the learning process.

AR-based learning media can also improve student learning outcomes (Chen, 2015). Based on the research results of Ibisono et al. (2020) some students experienced an increase in learning outcomes in the high category because they were given an Augmented Reality-based pocket book on planetary motion material. This Augmented Reality-based pocket book can visualize the shape of the pictures in the planetary motion material into 3D visuals that can be observed by students. This 3D Visual can make it easier for students to understand and see the details of the shape of the image so that the material can enter their long-term memory. This is also reinforced by Noviana's research, (2018) which states that Augmented Reality media is able to increase the posttest average value to the pretest value, this value is a very meaningful value for improving student learning outcomes so that Augmented Reality media is proven to improve learning outcomes.

Utilization of educational media using augmented reality can stimulate students' mindsets in critical thinking about problems and events that occur in everyday life. From the media used, it is hoped that students will try to think about criticizing existing problems and have imaginative power and activeness in following lessons. Based on the results of the study, it was found that augmented reality media can effectively train critical thinking skills in cognitive abilities in the form of interpretation, analysis, evaluation, concluding, and explaining, as well as increasing the imaginative power of students (Iqliya & Kustijono, 2019).

4. CONCLUSION

Based on the results of a literature study on the effectiveness of using augmented reality in physics learning, it is widely applied at the high school level and then at the elementary, junior high and college levels. The results of the analysis show that AR-based physics learning media can improve conceptual understanding, increase interest in learning, improve learning outcomes and improve critical thinking skills of users. Literature sources are identified by title, abstract, and keywords. At the end of the selection of articles based on the overall content, and relevance. Literature sources analyzed in the year range from 2014-2022.

This study still has several limitations, such as the main reference source used as the main source of research is still limited from research results from Indonesia. The research results from Indonesia used in this article are also not entirely, or the majority have not come from reputable international journals. Therefore, further research is needed that can overcome the problems of this research by increasing the variety of research results. Further researchers also need to use reference

sources from scientific articles that have been published in various reputable international journals so that their usefulness can be applied universally.

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