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Analysis of the Development of Augmented Reality Based Learning Media on High School Physics Material

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ABSTRACT

One of the purposes of using information and communication technology is to increase the efficiency and effectiveness of learning. One technology that can be used is augmented reality (AR) technology. One innovation that can be developed is the development of AR-based learning media. This research discusses the effectiveness of developing Augmented Reality (AR)-based learning media in an effort to increase students' understanding of high school physics material. To measure the level of effectiveness, it is seen from the results of the Validation Test from material experts, media experts, as well as responses from surveys conducted among practitioners. This research is due to students' low understanding in studying physics material which is very difficult to imagine or understand because the concepts are abstract. Therefore, there is a need for innovative learning media so that abstract physics concepts can be explained by visualizing them using Augmented Reality (AR). The research method used was a quantitative approach and literature study as a data collection method. This research took 10 references related to research objectives published from 2017 to 2023. From the analysis carried out, it was found that the use of Augmented Reality (AR) in physics learning can improve students' understanding abilities in physics learning.

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INTRODUCTION

Current developments in technology and information make it easier for humans to carry out various activities. One of them is the aspect of information that can be easily accessed and obtained from various sources. This causes humans to adapt themselves to existing technological developments. Technological developments also influence increasingly sophisticated ways of learning by utilizing technological developments. The

use of technology in learning has shifted the delivery of material using the lecture method to the use of interactive learning media. Learning media which previously took the form of print media, has now changed to audiovisual media which can be viewed or accessed online via the internet network. (Ardiansyah & Nana, 2020).

Most of the learning systems that are widely used today still use the teacher centered model. In this model there tends to be one-way conversation which causes a lack of response from students being taught. This will have a negative impact on student understanding. When teachers interact back and forth with students, students will understand more quickly. And when there are students who don't understand the material, interaction will make it easier for the teacher to know which students don't understand it so they can explain it in more detail. The strategy for dealing with current education is through a shift in the educational paradigm formulated by BNSP, some of which are changing the learning process from teacher-centered to student-centered, from isolation to a networked environment, from passive to active investigation, from virtual/abstract to world context. real, from personal to team-based learning, etc. (Moeloek, 2010)

The scope of physics is broadly divided into two groups, namely Classical Physics and Modern Physics. Classical physics examines phenomena on a macroscopic scale, such as the motion of objects, heat, electricity and magnetism around us (Shankar.R, 2014). To understand classical physics, we can easily observe every event that occurs, but we need props to make observation easier. Conditions during learning often experience problems with missing teaching aids or equipment being damaged. Therefore, it is a problem that often occurs and requires quite large costs to buy or repair damaged equipment. In modern physics examining phenomena microscopically, the main concepts in modern physics involve understanding the behavior of matter and energy at very small levels (quantum scale) and under conditions of high speed or in strong gravitational fields (theory of relativity). In modern physics material, it will be more difficult to understand or simply imagine events that have never been seen by the eye.

Based on the problems that arise, physics learning media is needed that can improve understanding of physics concepts, most of which are difficult for students to imagine or are abstract. So to improve the quality of learning, educators must explain physics concepts well with learning media that can visualize physics concepts so that students can understand the material more easily. One application of educational technology is the use of Augmented Reality-based learning media.

Augmented Reality (AR) is a system that combines real and virtual objects in a real environment, carried out interactively in real time, and allows integration between objects in three dimensions (Azuma RT, 1997). AR is a combination of real and virtual objects in a real environment. Running interactively in real time, and virtually is possible with appropriate display technology, interaction is possible through certain input devices, and good integration requires effective tracking (Ronald, 2008). Singgih Yuntoto explained that augmented reality (AR) is a two or three-dimensional virtual object created by technology and projected in real time, but the system is close to the real environment (Yuntoto S, 2015). From several definitions according to the experts above, it can be concluded that Augmented Reality is a system that can combine real and virtual objects through certain inputs with good integration and can run simultaneously.

The main advantage of AR is that it is able to provide good visuals in an effort to help improve students' understanding of material that is difficult to imagine in real life. This creates a more interesting and enjoyable learning atmosphere. AR as a system has the advantage of being able to interact between real and virtual objects in real time by displaying objects in 3 dimensions.

Through learning media which contains Augmented Reality (AR), the learning process

will be more fun, interactive and easy to use (Mustaqim et al, 2017). The use of AR in learning is able to provide an interesting learning atmosphere and has the potential to be a good learning medium in an effort to improve the ability to understand material, think critically, and build reciprocal interactions between students and teachers. Apart from that, AR media can also increase students' imaginative power (Iqliya & Kustijono, 2019).

METHODS

This research uses a quantitative literature approach method. Literature study or literature review is an activity to connect research problems with relevant theories. Researchers collect various literature, in order to build theoretical concepts as a basis for research. The literature collected is publications from 2017-2023.

In this approach the author collects data obtained from articles that are analyzed and researched without any field observations made by the researcher. The literature analyzed is articles that discuss the development of Augmented Reality (AR)-based learning media in high school physics material. Researchers analyzed the results and conclusions in the form of validity test results and practicality tests from various literature. The procedures carried out are: 1) determining the research topic; 2) collect articles related to the research topic; 3) group the articles that have been obtained based on research topics; 4) analyze relevant articles; 5) compiling articles from the analysis results (Budiarti et al., 2022).

The collected articles are then analyzed for research variables. From this process, the researcher grouped the variables into two groups, namely the results of the validation and practicality test. In the validity test, testing is carried out by material experts and visual experts, and in the practicality test, testing is carried out by teachers, students and students. The assessment carried out has the following criteria.

Table 1. Validity and Practicalization Test Results

Interval	Category
80-100	Very good
61-80	Good
41-60	Enough
21-40	Not enough
1-20	Very less

RESULTS AND DISCUSSION

Results

Researchers collected articles discussing the use of Augmented Reality (AR) in high school physics learning. The consideration used is taking physics lessons that require high reasoning to understand learning material such as Kinetic Theory of Gases, Sound Waves and Optics, Unidirectional Current Circuits, and Crystal Structure. Then the collected articles are presented in table 2 below.

Table 2. List of Analyzed Article Codes

No	Article Codes	Name of Researcher	Year of Publication
1	A1	Saifuli Sofi'ah, Sugianto Sugianto	2017
2	A2	Fauzi Bakri, Diah Ambarwulan, Dewi Muliyati	2018
3	A3	Lilin Nazwa Khunaen, Wenty Dwi Yuniarti, Muhammad	2020

		Ardhi Khalif	
4	A4	Yessi Affriyenni, Galandaru Swalaganata, Vita Ria Mustikasari, Isnanik Juni Fitriyah	2020
5	A5	I Kadek Darsika Aryanta	2021
6	A6	Syifa Ariama, Feli Cianda Adrin Burhendi	2022
7	A7	Anggun Simaremare, Nugroho Adi Promono, Dewi Setio Putri, Fiona Putri Parama Mallisa, Sabrina Nabila, Fatiha Zahra	2022
8	A8	Novita Wulandari , Esa Hidayatul Adha , Bayu Setiaji	2022
9	A9	Bagus Yusuf Ilhamsyah, Sudarti Sudarti, Singgih Bektiarso	2022
10	A10	Devi Pauziah, Wahyu Dian Laksanawati	2023

In the Table 2, the researchers sorted the articles collected based on the year of publication. Articles are sorted from oldest to newest. And code the articles according to their order. The research also looks at the development of learning media, and what kind of materials many researchers use in AR development.

In the articles collected, researchers found various types of learning media were developed, such as books, modules, applications, websites and games. From the various learning media obtained, then group the articles based on the type of learning material developed. Then from the grouping of articles, the percentage of each type of learning media developed was obtained. Researchers have compiled table 3 to group the types of learning materials developed.

Table 3. Grouping of Types of Learning Materials

No	Type of learning material	Article Code	Total	Percentage
1	Book	A1, A2, A5, A8	4	40%
2	Module	A3, A8, A10	3	30%
3	Application	A4	1	10%
4	Website	A6, A9	2	20%
5	Games	A7	1	10%

From the 10 articles in question, several types of teaching materials were developed, namely books, application modules, websites and games. Where in the book there are around 4 articles that develop Ar image-based printed books. Then from the Module, 3 AR-based articles were developed. Using the website, 2 articles were developed. Meanwhile, 1 article each is being developed for applications and games. So data was obtained that the type of learning media that was most widely developed was books based on Augmented Reality (AR).

The use of learning media cannot be separated from the material contained, so further analysis is carried out on the material that is often used in learning. From the articles collected, various learning materials were obtained. From this diverse material, researchers grouped articles that discussed the same material. And researcher gave the percentage of each material.

Table 4. Distribution of Learning Media In Terms Of Learning Materials

No	Learning Materials	Article Code	Total	Percentage
1	Geometry Optics	A1, A4	2	20%
2	Sound Waves and Optics	A2, A3	2	20%

3	Fluid	A5	1	10%
4	Dynamic electricity	A6	1	10%
5	Kinematics	A7	1	10%
6	Direct Current Circuit	A8	1	10%
7	Kinetic Theory of Gases	A9	1	10%
8	Crystal Structure	A10	1	10%

From the articles researched, the development of AR-based learning media contains various learning materials such as Geometry Optics, Sound Waves and Optics, Fluids, Dynamic Electricity, Kinematics, Direct Current Circuits, Kinetic Theory of Gases, Crystal Structure. Of all this material in Geometry Optics, Sound Waves and Optics there are 2 articles each. From these data it can be seen that the material most often used in developing Augmented Reality (AR) based learning media is Geometry Optics and Sound Waves and Optics.

Next, the researchers obtained data in the form of validity test results and practicality test of AR-based learning media. The effect of this application is seen from the feasibility of using AR such as the accuracy of the material used, the appearance of using AR, as well as the opinions of practitioners taken from the results of filling out questionnaires by students, teachers and students. The results of the validation test and practicality test can be presented in the following Table 5.

Table 5. Validity and Practicalization Test Results

No	Article Code	Validity Test Results		Practicality Test Results		
		Materials	Visual	Teacher	Collegian	Student
1	A1	66.76	61.76			69.84
2	A2	95.95	88.44	93.43		84.68
3	A3	95	6.67	86.67		89
4	A4	88	87		92	89.75
5	A5	92.17	93.07	86.33		89.9.0
6	A6	90	88.22			90.18
7	A7	82.5	90.97			97.50
8	A8	80	83.30		84.67	91.70
9	A9	79.59	78.57			73.13
10	A10	83.0	88.30		88.60	

From the results obtained by researchers, it can be concluded that the use of AR-based learning media has satisfactory test results from material experts and media (visual) experts who are assessed by lecturers who have expertise in this field. The material validation test uses several indicators, namely: suitability of the material, consistency of the material, language in which the material is written. In the material validation test, nine out of ten materials obtained a score above 75, which indicates that the AR used has a high level of material validation. The visual validation test uses several indicators, namely: suitability of the image to the material, an AR display that is easy to operate and understand, and an attractive display design. In the visual validation test, nine out of ten materials obtained a score above 75, which indicates that the AR used has a high level of material validation.

Responses from practicalists who use AR such as teachers, students and students also show satisfactory results as evidenced by the assessment given by the practicalizers that nine out of ten materials get a score above 75, which indicates that the AR used has a high level of material validation. This shows that the use of learning media based on Augmented Reality (AR) has received a good response from practitioners. Responses from teachers who

gave practicality scores averaged 88.81 in the very good category. For responses from collegians, they gave a practicality score with an average of 88.42 in the very good category. And the students got a practicality score with an average of 86.18 in the very good category.

Discussion

From the research carried out, satisfactory results were obtained from both validation tests and practicality tests. Here we can analyze that all the Augmented Reality (AR) based learning media used have received a very good response. This is in line with research (Bakri et al, 2018) which contains excellent learning material so it can be easily understood. A good and attractive appearance is also needed to support a good learning process. This is in line with research (Ariyanta, 2018) which provides a very good visual appearance.

Augmented Reality (AR) based learning media used by teachers in learning is very helpful in the learning process. This is in line with research (Khunaen et al, 2018) which has been proven to facilitate learning in the classroom. The use of this media is also used by collage which is used in learning. In accordance with research (Affriyenni et al, 2020) that this learning media is also very good for use in collages. Augmented Reality (AR) based learning media can also increase students' interest in learning. This is in accordance with research (Simaremare et al, 2022) which developed a physics educational game based on Augmented Reality (AR).

CONCLUSION

Based on the results of the researcher's analysis, it can be concluded that Augmented Reality (AR) based learning media is suitable for use as a physics learning media. It is hoped that AR-based learning can increase students' understanding and create an interesting and enjoyable learning atmosphere. However, not all AR can achieve the desired learning goals. This must have a validation test from experts in order to achieve the desired learning objectives. In the future, it is hoped that AR can become one of the learning media used by teachers to improve students' ability to understand. And for those that will be created in the future, they will have a high level of material suitability and good visuals so that they can achieve better learning goals.

REFERENCES

Affriyenni, Y., Swalaganata, G., Mustikasari, V., & Fitriyah, I. (2020). Pengembangan Media Pembelajaran Fisika Pada Materi Optik Geometri Berbasis Augmented Reality Dengan Unity Dan Vuforia. *JIPVA (Jurnal Pendidikan IPA Veteran),* 4(2), 160-174.

Ardiansyah, A. A., & Nana, N. (2020). Peran Mobile Learning Sebagai Inovasi Dalam Meningkatkan Hasil Belajar Siswa Pada Pembelajaran Di Sekolah. *Indonesian Journal of Educational Research and Review*, 3(1), 47-56.

Ariama, S., & Adrin Burhendi, F. C. (2022). Pengembangan Website Sebagai Media Pembelajaran Fisika Berbasis Augmented Reality Dengan Menggunakan Metode Marker Based Tracking Pada Materi Listrik Dinamis. *Jurnal Penelitian Pembelajaran Fisika*, *13*(2), 181–190.

Budiarti, R. P. N., Fauziah, N., Jannah, Z., & Ningsih, T. N. (2020). LEGIT BOLTAS (Learning Gadget Bola Tata Surya) Based on Augmented Reality in SDI Raden Patah Surabaya. *Proceedings of the International Conference On Ummah*, 1-16.

Bakri, F., Ambarwulan, D., & Muliyati, D. (2018). Pengembangan Buku Pembelajaran Yang

Dilengkapi Augmented Reality Pada Pokok Bahasan Gelombang Bunyi dan Optik. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika*, 4(2), 46-56.

Gusmida, R., Rahmad, M., & Islami, N. (2016). Pengembangan Media Pembelajaran Fisika Menggunakan Teknologi Augmented Reality pada Materi Teori Kinetik Gas SMA Kelas XI. *Jurnal Online Mahasiswa*, 3(2), 1-12.

Iqliya, J. N., & Kustijono, R. (2019). Keefektifan Media Augmented Reality untuk Melatihkan Keterampilan Berpikir Kritis Siswa. *Prosiding Seminar Nasional Fisika (SNF)*. Vol. 3, 19-25.

Khunaeni, L. N., Yuniarti, W. D., & Khalif, M. A. (2020). Pengembangan Modul Fisika Berbantuan Teknologi Augmented Reality pada Materi Gelombang Bunyi untuk SMA/MA Kelas XI. *Physics Education Research Journal*, *2*(2), 83-94.

Moeloek, et all. (2010). *Paradikma Pendidikan Nasional Abad XXI*. Badan Standar Nasional Pendidikan (BNSP), 1-57.

Mustaqim, I dan Kurniawan, N. (2017). Pengembangan Media Pembelajaran Berbasis Augmented Reality. *Jurnal Edukasi Elektro*. 1(1): 36-48.

Shankar, R. (2019). F*undamentals of Physics I: Mechanics, Relativity, and Thermodynamics*. Expanded Edition. New Haven: Yale University Press.

Simaremare, A., Promono, N. A., Putri, D. S., Mallisa, F. P. P., Nabila, S., & Zahra, F. (2022). Pengembangan Game Edukasi Fisika Berbasis Augmented Reality pada Materi Kinematika untuk Siswa SMA. *Jurnal Ilmiah Pendidikan Fisika*, *6*(1), 203-213.

Sofi'ah, Saifuli, Sugianto Sugianto, dan Sugiyanto Sugiyanto. (2017). Pengembangan Laboratorium Virtual Berbasis VRML(Virtual Reality Modelling Language) Pada Materi Teori Kinetik Gas. *UPEJ Unnes Physics Education Journal*, 6(1), 82-90.

Wulandari, N., Hidayatul Adha, E., & Setiaji, B. (2022). Pengembangan Media Pembelajaran Berbasis Augmented Reality Pada Materi Optika Geometri. *Jurnal Penelitian Dan Pembelajaran Fisika Indonesia*, *4*(1), 22-26.

Yusuf Ilhamsyah, B., & Bektiarso, S. (2022). Pengembangan Modul Fisika Berbasis Augmented Reality Materi Rangkaian Arus Searah Untuk Siswa SMA. *Jurnal Pembelajaran Fisika*, 11(3), 98-105.