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Research Artikel

AUGMENTED REALITY IN HIGH SCHOOL ELECTRICITY LEARNING: A NEEDS ANALYSIS

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Abstract

One form of educational and technological development is using Augmented Reality as an alternative learning media today. This study aimed to identify the needs of high school students for Augmented Reality-based Learning in Electricity Topics. This research involved 60 high school students in Samarinda. Data was collected using instruments such as observation sheets and questionnaires. The data analysis technique used descriptive qualitative and quantitative. The observation results show that the learning media commonly used are video and virtual simulations through the lecture method. Students are also used to and allowed to use smartphones to access modules and learning materials in class. The results of the questionnaire data analysis show that most students agree that the use of technology is needed to study electricity topics. The majority of students recognize the potential of AR but lack practical experience with it, indicating a significant opportunity for its integration into learning. This research concludes that augmented reality learning is needed as an alternative learning media for electricity. Therefore, we recommend that stakeholders be able to use or develop Augmented Reality media as a source of learning.

Keywords*: Augmented reality; electricity; high school students.*

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INTRODUCTION

Along with the development of integrated and unified technology (Wei, Guo, Yang, Liu, & Zhang, 2019), it is necessary to implement aesthetic and creative digital media to adapt to these developments (Rubio-Tamayo, Barrio, & García, 2017), including in Education field (Efwinda, Puspita, Damayanti, Hakim, & Syam, 2023; Rahmawati, Haryanto, & Sulaeman, 2021). The learning process requires innovation, especially in utilizing technology and media development, one of which is mobile applications used for learning media (Setyawan, Rufi'i, and Fatirul 2019). One mobile application-based learning media development is learning media with Augmented Reality, commonly called AR (Kuswanto & Radiansah, 2018).

The physics subject itself consists of concrete and abstract concepts. It requires teacher readiness to teach (Sulaeman, Efwinda, & Putra, 2022) in a way that makes it easier for students to understand the topic (Efwinda & Mannan, 2020). Abstract physics concepts such as Electricity, magnetism, and modern physics are difficult to visualize, causing students to have difficulty studying them (O. Yilmaz, 2021). In addition, there is a tendency for students to have low motivation and difficulty in understanding electrical topics (Fino, 2018; Ramdani et al., 2021). Another challenge in learning the topic of electricity is the lack of laboratory facilities in some schools (Ouahi et al., 2024). Therefore, strategies are needed to address the various challenges in teaching this electricity topic.

Learning supported by Augmented Reality technology has great potential to facilitate students learning topics related to abstract concepts, space, and the like (Wahyudi & Arwansyah, 2019). Many researchers have shown that Augmented Reality-based learning can stimulate learning motivation and improve student learning outcomes (Al-hassan, H.Suad, & Ali, 2020; Cai, Liu, Wang, Liu, & Liang, 2021; Ismail, Festiana, Hartini, Yusal, & Malik, 2018; Permana, Muliyati, Bakri, Dewi, & Ambarwulan, 2019).

Several studies on the utilization of AR in science learning have been conducted, for example, by Amalia & Suryani (2019), which applies AR to human respiratory system learning. Other research studies are by Alfa & Asrizal (2024), which integrates AR for sound wave learning, and by Stolzenberger, Wolf, & Trefzger (2021). However, the research that has analyzed the need for AR technology to be used as a learning medium for Electrical Topics is still limited.

Creating digital learning media is needed to help achieve learning objectives. Needs analysis is the primary step in determining the condition of media use. This study focuses on analyzing the needs of high school students for Augmented Reality learning media for the topic of electricity. This research aims to identify the needs of high school students for augmented Reality learning media on the topic of electricity. This research can be helpful in describing how the need for AR integration in learning, especially learning about electricity topics. This research recommends that all educator stakeholders map the need for the use of augmented Reality in learning electricity topics in high school.

To guide the direction of the research, the research questions are as follows:

1. How is learning about electrical topics usually carried out in schools?
2. How is the availability of learning facilities?
3. How do students perceive using AR technology to learn electricity?

METHOD

The method in this study is descriptive, with the primary objective of focusing on the need for Augmented Reality Media-based learning for high school students, especially in electrical topics. The descriptive method was chosen to describe the original state of a condition, which in the context of this research is a condition related to the need for the application or integration of AR in learning, especially on the topic of electricity, without any special treatment or manipulation of the research subject. This study took samples using purposive sampling. The sample in this research is high school students, totaling 63 people consisting of 32 men and 31 women in a Senior high school in Samarinda, Indonesia. The reason for selecting the sample is that this school is one of the schools in

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Samarinda that is already familiar with the use of technology for physics learning. In addition, the sample was selected because of the ease of access for this part of the population.

Data collection techniques include observation sheets to determine the needs of the facility or school environment and Google Forms questionnaires to determine the needs according to students' opinions. Before collecting the research data, we submitted a research permit letter indicating our willingness to collect data from the school and research subjects. Direct meetings were held with the school's physics teacher for our observation activities; then, related to the data collected by questionnaires, we used Google Forms and shared the filling link for students to fill in through the teacher. Observations were made following the National Education Standards Agency standards, including facilities and infrastructure standards and learning process standards, while the questionnaire was adapted by Nor and Halim (2021).

In addition to referring to the standards of facilities and infrastructure and the learning process, the components observed are also adjusted to the needs related to the integration of AR in learning, especially physics learning. For example, in addition to the availability of white-boards, books or modules, and teaching aids, do schools already have or are familiar with the use or utilization of technology that supports the integration of AR in learning, such as the use of LCDs, laptops, smartphones, and others. The learning methods or models commonly used also need to be observed to analyze their potential for integration with AR media. Another component that is no less important to observe is student behavior. Whether most students are active or passive will also be a consideration when integrating AR into learning.

The observation sheet can be seen in Table 1.

Table 1. Observation Sheet

No.	Observed aspects	Does	Does Not	Information
1	**Learning Media Used**			
	a. White-board			
	b. Book/module			
	c. LCD/ Laptop			
	d. Props			
	e. Smartphone			
	f. Others			
2	**Learning Methods**			
	a. Lectures			
	b. Q&A			
	c. Discuson			
	d. Demonstration			
	e. Team Work			
	f. Task assignment			
	g. Experiment			
3	**Students Behavior**			
	a. Active			
	b. Passive			
4	**Others**			
	a. Competence			
	b. Interest			
	c. Crea-tive-ness			

The questionnaire rubric is presented in Table 2.

Table 2. The questionnaire rubric

No	Questions	Type of questions
1	What kind of learning methods have been used to learn electricity?	Open question
2	In learning Electricity, technology is needed to make electrical topics easy to understand!	Statement with five answer choices: Strongly agree, agree, neutral, disagree, and strongly disagree
3	In learning Electricity, learning media will support Electricity that looks abstract!	Statement with five answer choices: Strongly agree, agree, neutral, disagree, and strongly disagree
4	Augmented Reality technology-based learning media is needed to learn electricity!	Statement with five answer choices: Strongly agree, agree, neutral, disagree, and strongly disagree
5	Do you know Augmented Reality (AR)?	Statement with two answer choices: Yes and no
6	If you know have you ever used an AR-based application?	Statement with two answer choices: Yes and no

The data analysis technique used is quantitative descriptive, which describes the results of calculating the percentage of answer choices given by all participants.

RESULTS AND DISCUSSIONS

In this section, the research results will be presented based on the contents of the observation sheet and questionnaire. The observation is carried out by observing the lessons and the facilities at the school. The observation sheet has four observed components: Learning Media Used, Learning Methods, Students Behavior, and Others. The observation results can be seen in Table 3.

Table 3. Observation Results

No.	Observed aspects	Does	Does Not	Information
1	**Learning Media Used**			
	a. White-board	✓		There is one in each class.
	b. Book/module	✓		Students have e-modules and books that can be borrowed from the library.
	c. LCD/ Laptop	✓		Each classroom has an LCD and computer connected to the internet, which the teacher can use.
	d. Props		✓	There are no teaching aids used in learning.
	e. Smartphone	✓		Used by students to access e-modules and learning materials in class
	f. Others	✓		Teachers show video shows and virtual simulations during the learning process.
2	**Learning Methods**			
	a. Lectures	✓		
	b. Q&A	✓		
	c. Discussion	✓		
	d. Demonstration	✓		
	e. Team Work	✓		
	f. Task assignment	✓		There is an assignment at the end of each learning meeting.
	g. Experiment	✓		Performed once a month
3	**Students Behavior**			
	a. Active	✓		Almost all students are active in learning.
	b. Passive	✓		A small group of students
4	**Other**			
	a. Competence	✓		A small group of students
	b. Interest	✓		A small group of students
	c. Creativeness	✓		A small group of students

Table 3 shows that, in the Learning Media Used aspect, the observation school has adequate facilities, but for props, there is still a lack of assets to support the understanding of content in the classroom. In the Learning Methods aspect, physics teachers have used various learning methods to support Electricity learning at the school. The experimental procedure has been applied to physics learning. Still, in general, it is only done once a month, showing a lower frequency of application compared to physics learning without experiments, for example, through lectures and discussions in class.

According to Students Behavior, it is found that most students are active in class, and only a tiny percentage are passive in class. For another aspect, the students have their competence, interest, and creativity in different groups of students.

The questionnaire results are presented based on the statements and questions in the questionnaire. The learning methods in electricity topics can be seen in Figure 1.

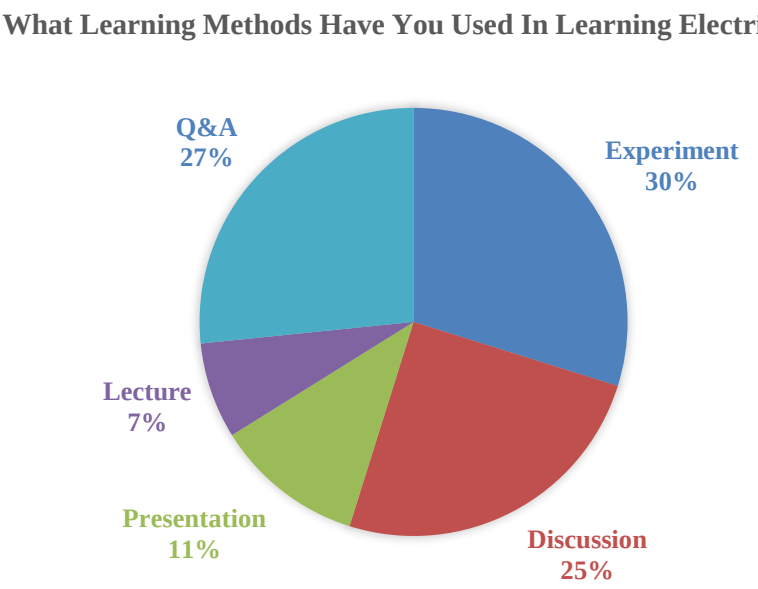

Figure 1. Learning methods that students have used in learning Electricity

In Figure 1, it is found that all students only choose five learning methods. The experimental method has the highest percentage of all student answers. Meanwhile, the lecture method is the method with the lowest rate. Thus, students use the experiment method more often than the lecture method to learn Electricity. In overall learning, students have used various learning methods, according to Figure 1. Experimentation is the most common method used to learn electricity. Augmented Reality can be integrated as a learning medium using experimental techniques, especially if the school does not have teaching aids or the material being experimented with is abstract. According to some previous research, augmented Reality can be used to create a more effective learning environment and build learning methods that are more interactive (Suprapto, Ibisono, & Mubarok, 2021). This statement is reinforced by the results of research conducted by Ziden, Ziden, & Ifedayo (2022), which shows a significant difference in student learning outcomes in science learning between groups of students who learn with AR integration and groups of students who learn without AR integration. The group of students who received learning with AR integration had better learning outcomes; this study also showed that student motivation and learning outcomes were positively related. Research by Liu, Yu, Chen, Wang, & Xu (2021) also showed similar results; they grouped students into three groups. Students learned using AR, using 3D models, and traditional experiments. The results showed that student learning outcomes in the group of students who used AR in learning had the best learning outcomes with positive student perceptions.

Creating a learning environment for students helps improve students' concept understanding abilities, especially in learning Electricity, which is one of the advantages of using Augmented Reality-based learning (Alzahrani, 2020; Ismail et al., 2018). Research by Ismail et al. (2018) showed that using AR in learning the physics of electricity improved students' conceptual understanding with a moderate increase in the category. Furthermore, research by Alzahrani (2020), who conducted a systematic review by analyzing 28 studies from reputable journals on the benefits of using AR, showed that the benefits of AR are wide and varied, not only related to student knowledge but also in increasing student involvement in learning. Integrating Augmented Reality into electricity learning will make learning methods more diverse and increase student interaction during education.

Then, the results of the analysis of student needs for using technology in electricity learning are presented in Figure 2.

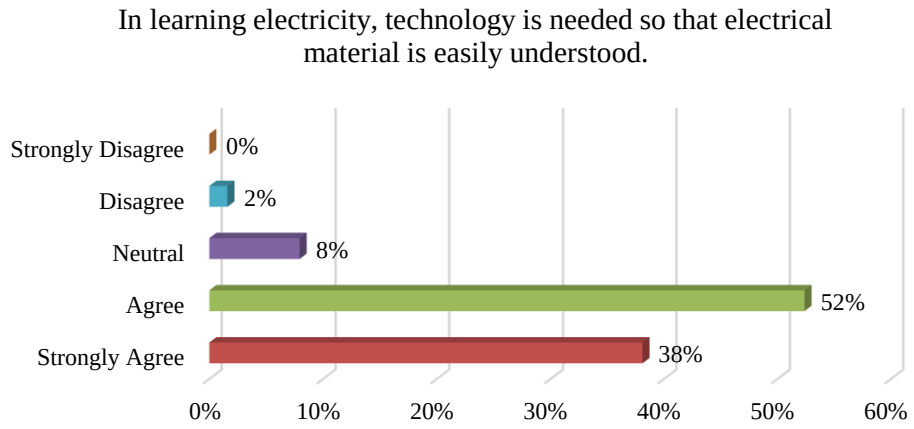

Figure 2. Percentage of Technology Needs in Electricity Learning

More than half of the students expressed positive answers following Figure 2. This result is evidenced by 52% of students selecting the "agree" choice and 38% choosing the "strongly agree" choice that they need technology to help them understand electricity topics more quickly. On the other hand, 2% "disagree," but none of the students "strongly disagreed" with the use of technology in electricity learning. Technology can be used in education by integrating it as a learning media. According to Figure 2, almost all students answered positively regarding the need for technology in electricity. This result states that the use of technology impacts the effectiveness of the learning process, which is to attract students to actively participate in learning Electricity so that it is easy to understand. Technology in learning is a characteristic of 21st-century learning that needs to be used in learning Electricity; this provides an opportunity for teachers to apply and develop technology in education (Sumardani, Putri, Ramadhan, Bakri, & Muliyati, 2019). Research by Wibowo (2023) and Dilmen & Atalay (2021) also show the benefits of AR for the development of students' 21st-century skills, such as critical thinking, collaboration, communication, creativity, innovation, making inferences, and problem-solving skills. This technology can convey concepts to students quickly. The advantages possessed by Augmented Reality technology can be applied to electricity learning (Yu et al., 2022). Technology's importance in education can be a learning medium for a more enjoyable class. The results of the analysis of learning media needs in learning Electricity can be seen in Figure 3.

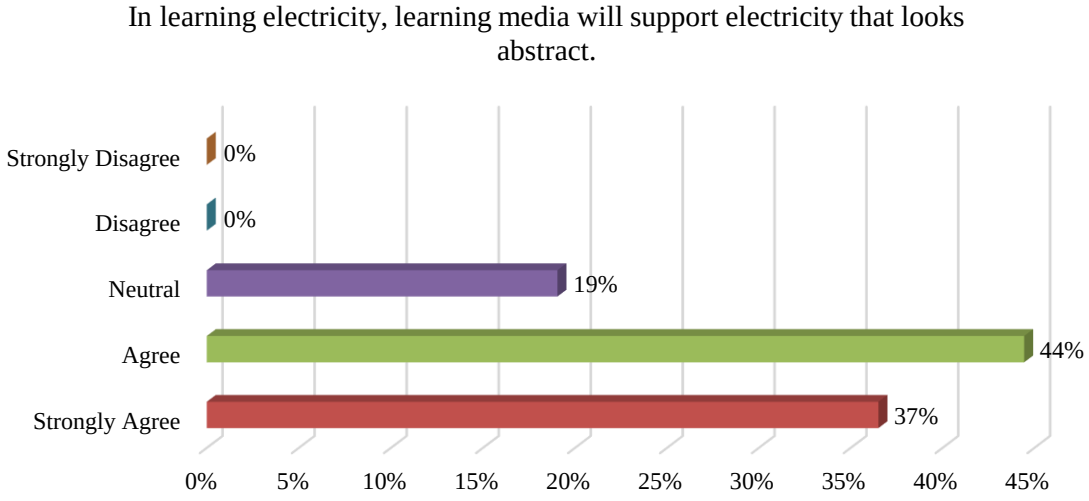

Figure 3. Percentage of Learning Media Needs in Electricity Learnin

According to Figure 3, students expressed positive answers. For the results, "agree" is the choice with the highest percentage of 44%, and the lowest is "disagree" and "strongly disagree" with 0%. Following Figure 3, more than all students realize that Electricity Topics have many abstract concepts. Some abstract concepts related to this topic include electric field, potential energy, electric potential, Coulomb force, etc. These abstract characteristics are the causes that we cannot see the concepts in Reality with the naked eye, and it is challenging to bring simple examples related to electricity topics into the classroom (Faridi, Tuli, Mantri, Singh, & Gargrish, 2021; Kesonen, Asikainen, & Hirvonen, 2011; Z. A. Yilmaz & Batdi, 2021). Thus, there is a need for learning media to support electricity learning.

According to Rusli, Hermawan, and Supuwiningsih (2017), teaching media serves to enlarge or minimize items that cannot be brought into the classroom to increase the attention of students attraction. It can present different complex or abstract events at the school. Learning media, with its benefits, can help in learning electricity, which is considered abstract. Augmented Reality can be one of the learning media that can solve problems related to the abstractness of electrical topics. Augmented Reality-based learning in electrical issues concludes that more than half of all students need alternative learning media to create 3D models of objects that are difficult to visualize (Hendriyani et al., 2019). In Figure 4, it is known that most students expressed a positive answer to the need for Augmented Reality as a technology in electricity learning. However, most students choose neutral. Most students do not have experience utilizing or using AR for physics learning, so they choose neutral. Furthermore, the results of Augmented Reality needs in electricity learning are presented in Figure 4.

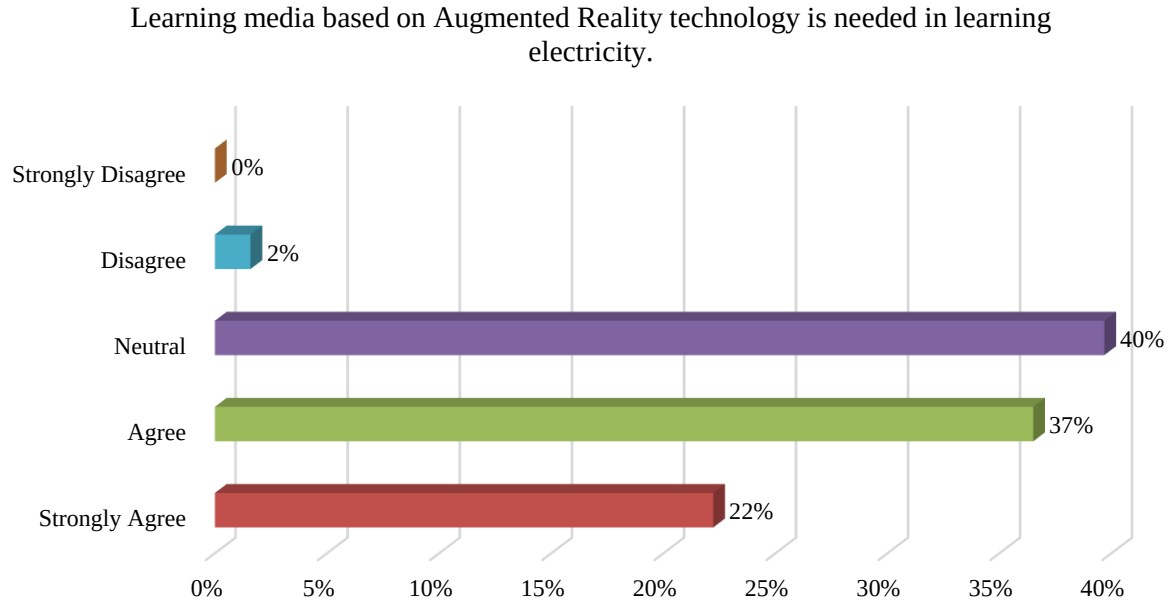

Figure 4. Percentage of AR Needs in AR Learning

Figure 4 shows that Neutral choice has the highest percentage of the statement regarding the need for AR in electricity learning. However, more than half of all students stated "Strongly Agree" and "Agree," with a total percentage of 59%. Students' knowledge about Augmented Reality can be seen in Figure 5.

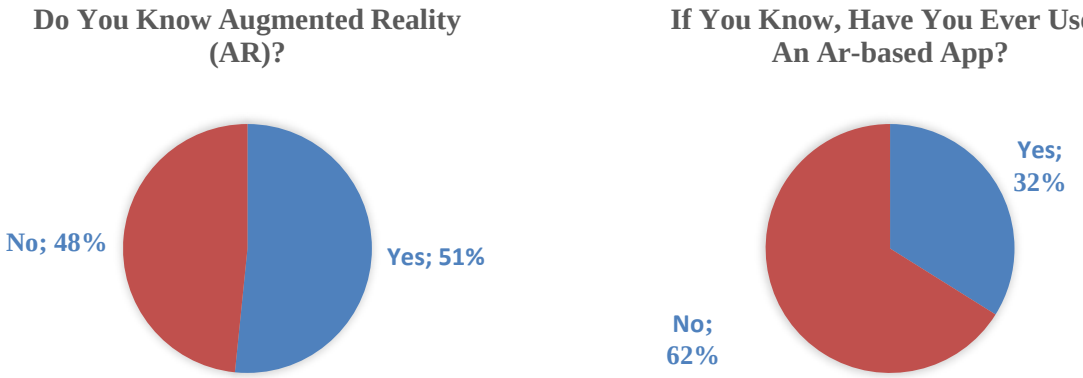

Figure 5. Students' knowledge of Augmented Reality

According to Figure 5, more than half of students know AR, with a percentage of 51%. On the other hand, only 32% of students learn and have used AR. The result of the observation helps us understand the external factors of the learning environment that are necessary for the needs of augmented Reality in electricity learning. Based on Table 3, there is still a lack of teaching aids and technology to assist in understanding student concepts, especially in displaying ideas visually and improving students' spatial abilities (Alzahrani, 2020; Kadir & Yani, 2012). The lack of teaching aids can be a need to be met to enhance understanding of electrical topics.

AR can bridge the problem of a lack of teaching aids, especially on topics that contain many abstract concepts, such as electricity. AR marker technology can display 3D visualizations, and students can conduct experimental trials many times without worrying about the cost of using experimental tools and materials and a higher level of security (Schiano Lo Moriello et al., 2022). Augmented Reality can help in making visualization or helping the lack of props or laboratory equipment to support experiments in Augmented Reality learning (Bakri, Permana, Wulandari, & Muliyanti, 2020; Kusuma, 2018; Rohmah, Sujana, & Yuana, 2017). Augmented Reality can help with cost-effective and efficient development for students (Hafirizka, Nasir, and Syafi'i, 2022; Hendriyani, Effendi, and Novaliendry, 2019). For example, the use of AR platforms that can be used for free by users while presenting 3D visualization of an object, for instance, through Assembler, can be one of the supports to state that AR can be more cost-effective compared to traditional methods. Using these objects as a simulation or experiment can be done repeatedly. Many students can also use AR objects without worrying about the lack of tools and materials, and they do not require maintenance costs or storage space compared to traditional experiments. So, based on the observation, AR is needed because of the lack of teaching aids or laboratory equipment for learning electricity.

Students need augmented reality technology as an alternative learning media to help them learn electricity. Augmented Reality can facilitate the creation of an effective learning environment for students. With its advantages, Augmented Reality can combine audio and visual and, with its interaction, can involve all sensory learning students who combine various formats such as video text, images, animation, and audio (Garzón & Acevedo, 2019; Nuraini, Sunaryanto, Nagari, & Marsely, 2019). Furthermore, research by Acevedo, Cruz, Aguilar, & Bautista (2022) recommends that the development of AR needs to consider pedagogical aspects to obtain more effective results to be implemented in learning. A meta-analysis conducted by Garzón & Acevedo (2019) on 4705 papers published in significant journals shows that AR significantly improves student learning.

Augmented Reality as a technology can achieve learning objectives with better teaching assessment, as evidenced by increased cognitive competence in students (Sandoval Pérez et al., 2022; Villanueva et al., 2021). Based on this result, there is a need for Augmented Reality technology-

based learning as a medium for learning electricity topics.

Following Figure 5, it is known that half of all students have knowledge of Augmented Reality, and around one-third of all students have used Augmented Reality applications. Augmented Reality-based learning can improve or support students' digital literacy in 21st-century learning (Nuraini et al., 2019). Augmented Reality is a technology that combines virtual objects or objects in 2D or 3D form into a natural environment (Sujadi, Rusnandi, & Fauzyah, 2015). Technological advances in 21st-century learning can provide opportunities for educators to develop interactive learning media with technology that has become a trend lately, namely Augmented Reality.

In addition, Augmented Reality is seen as an extension of a person's sense of sight and hearing (Jingen Liang & Elliot, 2021). Augmented Reality as a learning medium can reduce verbalism and lay a real foundation for thinking. The content is easier to understand, and the learning method will be more varied so students do not feel bored (Wahid, 2018). The advantages of augmented Reality have a role in the learning process of channelling messages to students (Sundaygara, Pratiwi, and Hudha, 2019). So, Augmented Reality can meet the needs of learning Electricity for better learning.

CONCLUSION

In conclusion, augmented Reality is needed as a learning medium for senior high school students to learn about electricity topics. The observation results state that the experimental approach is the most common method for senior high school students to learn electricity. Still, there is a lack of props or laboratory equipment to visualize the results of student experiments on electrical topics. Specifically, practical applications of AR can be used and are relevant for electrical issues such as visualization of electric fields or Coulomb's law.

Following observation results, the questionnaire also shows that more than half of all students gave positive statements and tended to agree that technology integration is needed to study Electricity, especially Augmented Reality Technology. Technological advances have also made it easier to access AR with the availability of free platforms for AR use, such as Assembler. The use of AR in learning can also be a solution for schools with facilities that have not been able to fulfill the provision of some relatively more expensive teaching aids.

So, we recommend that all stakeholders support integrating technology like Augmented Reality in learning physics to answer the needs of 21st-century students. Training for teachers and students to incorporate AR in learning is also needed to support this study's findings.

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