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Student Worksheets Assisted by Augmented Reality on Critical Thinking Skills in High School Physics: Study of Teacher Perceptions in Indonesia

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Abstract

This study is classified as a quantitative descriptive research. The objective of this study is to assess the necessity of utilizing Augmented Reality to support student workbooks in high school physics, with a specific focus on enhancing critical thinking abilities. The research employed a purposive sample methodology as the sampling method. The study topic survey employed a questionnaire as the instrument. The researcher given a Google form link to post this questionnaire, which was then completed online within a defined timeframe. This research focuses on high school physics teachers in Indonesia, specifically those located in 17 provinces including Aceh, North Sumatra, Riau, Jambi, South Sumatra, Lampung, Bengkulu, Banten, West Java, Central Java, East Java, DIY, West Kalimantan, Central Kalimantan, NTT, Maluku, and Southwest Papua. The research study had a total of 84 participants. The research findings indicate that (1) 49% of high school students demonstrate a high level of critical thinking skills in physics subjects; (2) 91% of high school teachers utilize student worksheet in physics instruction; (3) There is a 93% demand for incorporating student worksheet assisted by Augmented Reality in physics learning; and (4) 42% of teachers prefer student worksheet in a printed format. According to this study, there is a requirement for student worksheets supported by Augmented Reality in physical format to enhance students' ability to think critically during the process of studying physics. This first investigation will be extended into further research with the aim of creating student workbooks supported by Augmented Reality to enhance critical thinking abilities in relation to the subject of impulse and momentum.

Keywords: student worksheets, augmented reality, critical thinking skills

INTRODUCTION

Physics is the science that studies natural phenomena that occur in everyday life and explains how they occur (Mousavi & Sunder, 2020). Physics is not only formulas and theories that must be understood, but also concepts that must be understood in depth (Hubert, 2021). Many students experience difficulties learning physics. This happens because students are not accustomed to observing phenomena that occur around them or conveying facts that occur in everyday life. Even though, according to Deng et al. (2019), the aim of learning physics as a branch of natural science is to recognize, respond to, and appreciate science and to instill critical, creative, and independent thinking habits in building knowledge (Van Dusen & Nissen, 2019). So it can be concluded that students who have difficulty understanding physics learning will have critical thinking skills that are not yet optimal.

Students' ability to think critically is defined as their ability to judge or evaluate something (Heim et al., 2022), analyze arguments, draw conclusions using reasoning, and make decisions or solve problems. In line with this, Rahardhian (2022) states that critical thinking skills are very important for everyone if they want to successfully solve problems in difficult circumstances. To make important decisions, each person must analyze and evaluate his or her living conditions. However, Benyamin's (2021) research found that the critical thinking skills of high school students who focus on physics are in the low category. According to data from Ufairah's research (2020), students' critical thinking abilities are characterized by an indicator of student activeness of 62.5%, students' memory of 73.8%, students' understanding of how physics can be applied in everyday life of 73.8%, students' ability to identify scientific phenomena was 54.8%, and student learning outcomes that met the minimum completeness criteria were 64.5%. So we need a learning medium that can help improve students' thinking skills. One of the learning media that can improve students' critical thinking skills is student worksheets. Annisa & Suparma (2021) also added that to improve students' critical thinking skills, student worksheets with a problem-based learning approach are needed.

Student worksheets are one of the learning media that a teacher can use to make the learning process more enjoyable. The worksheet is an educational tool that contains student exercises designed to facilitate the learning process (Syukri et al., 2023). In line with this, Lal et al. (2019) stated that student worksheets are media or printed teaching materials that contain instructions for work carried out by students based on competency and learning objectives to improve each student's abilities. Student worksheets consist of a compilation of information, concepts, and understandings that students will develop by solving the provided tasks (Siahaan & Siahaan, 2022). Felitasari & Rusmini (2022) stated that the use of student worksheets effectively improves students' learning outcomes, information, and mental abilities. Using worksheets has been proven to increase effectiveness in the teaching and learning process in the classroom because it allows students to carry out individual or group work activities to solve the problems listed on the student worksheets. Marlina et al. (2020) have conducted research on the development of Science Student Worksheets for junior high school studentsbased on critical thinking skills and produces valid and practical student worksheets. Existing student worksheets use 2D images, even though it would be more interesting if they were equipped with 3D images using augmented reality.

Augmented reality (AR) is a technology that provides a display of 2-dimensional or 3-dimensional objects (Bakri et al., 2023), video, sound, and other features on a smartphone. Kencana et al. (2021) stated that augmented reality (AR) is a type of technology that combines virtual or digital elements with the real world, giving users the impression that they can interact through layers of object information in front of their eyes. Agreeing with this, Miftahussa'adah et al. (2023) also said that to make it easier for teachers and students to learn, augmented reality learning media are needed. Yu (2023) also added that the use of augmented reality learning media is considered effective for improving student learning outcomes. Augmented Reality can be used in the development of worksheets that are customized by a particular learning model (Denny et al. 2023). Supriasih et al. (2022) in research that has been carried out, the result is that the remaining 61 percent can use Augmented Reality in learning activities discussing the Solar System at SMPN 3 Rantau Bayur. In previous research, In the same case, Lindner et al. (2022) also emphasized that student worksheets with the Augmented Reality (AR) feature are very good for application in learning. Çakıroğlu et al. (2022) stated that students need student worksheets with the help of augmented reality. Based on this, it is important to carry out this study to find out how important and necessary augmented reality-assisted student worksheets are for students' critical thinking skills for teachers in the physics lesson process at school.

METHODS

This research uses a quantitative descriptive approach, using purposive sampling techniques. The sampling method used in this research was a purposive sampling technique. Purposive sampling is a sampling technique used by researchers if the researcher has certain considerations in taking samples or determining samples for certain purposes. Purposive sampling was used in this research because it has several advantages, namely that the selected sample is a sample that suits the research objectives,

the method is easy to implement, and the selected samples are generally people or individuals who are easy to meet or approach by researchers. The instrument used in this survey was a questionnaire containing several questions about indicators of high school teachers' use of student worksheets and the level of students' critical thinking skills. This questionnaire was published using a Google Form link provided by the researcher and was completed online at a predetermined time so that the questions in the questionnaire could only be viewed individually by the teacher who was the research subject. The questionnaire is in the form of closed questions. The questionnaire functions to obtain data on student worksheet needs, assisted by augmented reality, and the level of critical thinking skills of high school-level students. The distribution of the questionnaire was carried out by taking a sample of physics teachers from the islands of Sumatra, Java, Maluku, Kalimantan, NTT, and Papua. In detail, the distribution area covers 17 provinces: Aceh, North Sumatra, Riau, Jambi, South Sumatra, Lampung, Bengkulu, Banten, West Java, Central Java, East Java, DIY, West Kalimantan, Central Kalimantan, NTT, Maluku, and West Papua Power. The total subjects used in the research were 84 high school physics teachers. The data generated from the questionnaire will be analyzed using descriptive analysis methods.

RESULTS AND DISCUSSION

Research Results

Research on teachers' needs for student worksheets assisted by augmented reality begins with analyzing students' critical thinking skills in understanding physics learning at school. The results of the level of students' critical thinking skills regarding students' physics material obtained in the research can be seen in TABLE 1. Based on this table, the results show that 7 teachers out of all teacher respondents with a percentage of 8%., chose the level of students' critical thinking skills regarding physics material at the high school level as good. very good with. Then, 31 teachers out of all teacher respondents with a percentage of 37%, chose that the level of students' critical thinking skills regarding physics material at the high school level was good. And, 41 teachers out of all teacher respondents with a percentage of 49%, chose that the level of students' critical thinking skills regarding physics material at the high school level was good. pretty good. Also, 5 teachers out of all teacher respondents with a percentage of 6%, chose that the level of students' critical thinking skills regarding physics material at the high school level was not good.

TABLE 1. Indicators of the Critical Thinking Level of High School Students in Physics Material

No	Indicators	Information	Amount	Percentage
13	The level of students' critical thinking skills regarding physics material at the high school level	SB	7	8%
		B	31	37%
		C	41	49%
		K	5	6%

SB = Very good
B = Good
C = Enough
K = Not enough

Next is an analysis of the results of the use of student worksheets by high school teachers. Based on the results of the analysis of the use of student worksheets by high school teachers in TABLE 2, the highest result was that teachers saw the potential for using student worksheets as a tool in physics lessons for 84 teachers out of all teacher respondents with a percentage of 100%. Furthermore, the number of teacher respondents who need student worksheets in the teaching and learning process, especially in physics learning, is 81 out of all teacher respondents, with a percentage of 96%. Meanwhile, the number of teacher respondents who had made student learning worksheets for physics lessons was 80 out of all teacher respondents, with a percentage of 95%. On the other hand, the number of teacher respondents who felt difficulties in selecting student worksheets for physics lessons was 61 out of all teacher respondents, with a percentage of 73%.

TABLE 2. Use of student worksheets by high school teachers.

No	Indicators	Information	Percentage
1	Teachers who need student worksheets in the teaching and learning process, especially in physics learning	81	96%
2	Teachers see the potential for using Student Worksheets as a tool in physics lessons	84	100%
3	Teachers find it difficult to select student worksheets for physics lessons	61	73%
4.	The teacher once made students' learning worksheets for physics lessons	80	95%

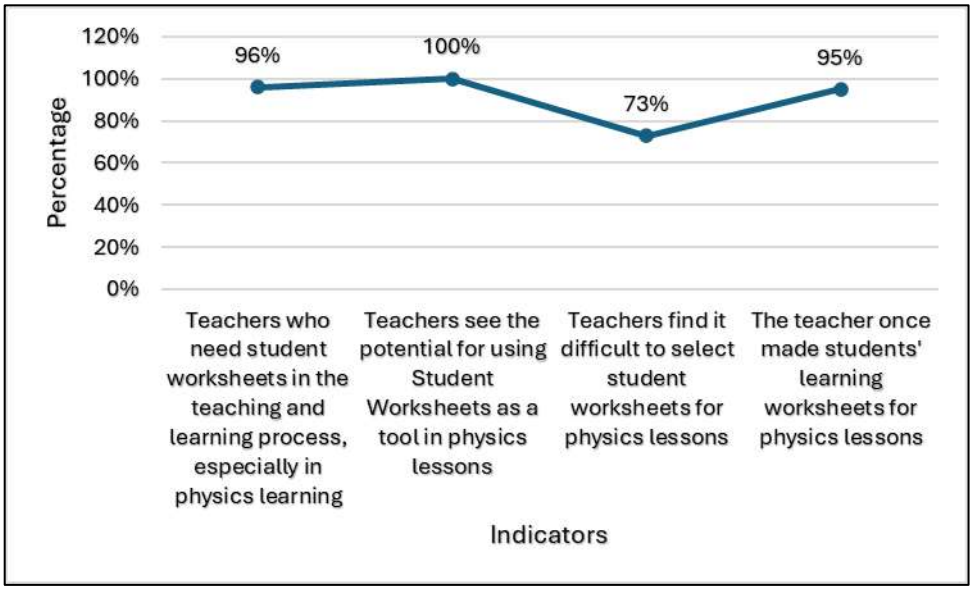

FIGURE 1. Use of student worksheets by high school teachers.

Next is an analysis of the results of using student worksheets assisted by augmented reality by high school teachers. Based on the results of the analysis in TABLE 3, the highest result obtained was that teachers agreed that students' worksheets assisted by augmented reality were used as teaching materials for physics learning in schools. As many as 78 of the total number of teacher respondents agreed, with a percentage of 93%. Furthermore, the number of teacher respondents who had never used student worksheets assisted by augmented reality by teachers was 68 out of the total number of teacher respondents, with a percentage of 81%. Meanwhile, the number of teacher respondents who knew the role of student worksheets assisted by augmented reality in physics learning was 54 out of the total number of teacher respondents, with a percentage of 64%. On the other hand, the number of teacher respondents who did not know about learning physics using student worksheets assisted by augmented reality was 52 out of the total number of teacher respondents, with a percentage of 61%.

TABLE 3. Use of student worksheets assisted by Augmented Reality for high school teachers.

No.	Indicators	Information	Percentage
1	Teachers do not yet know about learning physics using student worksheets assisted by Augmented Reality	52	61%
2	Teachers who have never used student worksheets assisted by Augmented Reality in physics learning	68	81%
3	Teachers do not yet know the role of students' worksheets assisted by Augmented Reality in learning physics	54	64%
4	Teachers who agree that students' worksheets assisted by Augmented Reality are used as teaching materials for physics learning in schools	78	93%

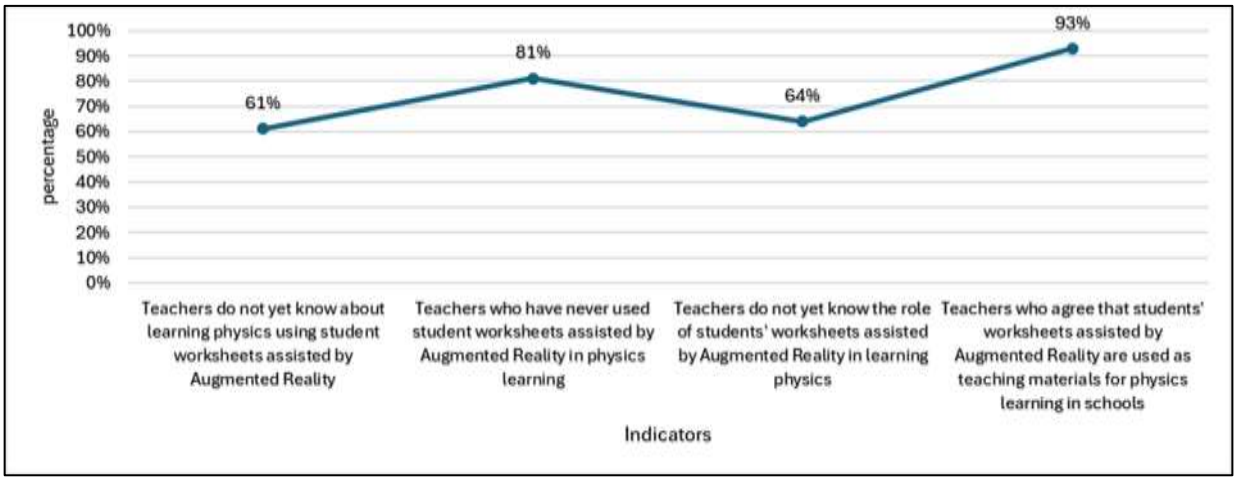

FIGURE 2. Use of student worksheets assisted by Augmented Reality for high school teachers.

So that the physics learning process using student worksheets assisted by augmented reality can be carried out well, the researchers also analyzed the equipment that supports learning activities in high school. Based on the analysis of TABLE 4, it was found that the highest number of respondents were 79 teachers out of the total number of respondents, with a percentage of 94% stating that the school had devices that supported the learning process, such as projectors, LCDs, computer laboratories, and others. Furthermore, the number of teacher respondents regarding the use of communication devices such as cellphones or laptops at school for the learning process of students at school was 70 out of the total number of respondents, with a percentage of 83%. Meanwhile, the number of teacher respondents regarding the use of WiFi to support students' needs at school was 49 out of the total number of respondents, for a percentage of 58%.

TABLE 4. Equipment to support learning activities in high school.

No	Indicators	Information	Percentage
1	Schools allow students to bring and use communication devices such as cellphones or laptops to school for the students' learning process at school	**70**	83%
2	Schools use wifi to support the needs of students at school	**49**	58%
3	Schools have devices that support the learning process such as projectors, LCDs, computer laboratories and others which aim to support students' learning needs.	**79**	94%

Furthermore, this research also seeks to find out teachers' needs for the types of student worksheets needed to support the learning process at school and make it easier for teachers to explain the material. The results of the questionnaire analysis of the results of the questionnaire distributed by teachers who liked digital-based student worksheets were around 20%. About 42% of teachers prefer print-based student worksheets. And teachers who like digital and print-based student worksheets are 37%.

TABLE 5. Types of student worksheets needed to support the learning process.

No	Indicator	Information	Total Number	Percentage
1	Teachers prefer digital or print based student worksheets	D	17	20%
		C	35	42%
		DC	31	37%

D = Digital based
C = Print based
DC = digital and print-based

Discussion

Based on the results and studies in this article related to the analysis of the use of student worksheets assisted by augmented reality on critical thinking skills, it can be said that a teaching medium is needed

that can optimize students' critical thinking skills. One of the learning media that helps in the teaching process at school is student worksheets. However, teachers' need for student worksheets is not just for worksheets that are monotonous and make students bored so that they do not develop students' critical thinking skills. The solution needed so that student worksheets can be interesting and able to foster students' critical thinking skills is to use student worksheets based on augmented reality. Student worksheets assisted by augmented reality are needed to make it easier for teachers to provide conceptual explanations in physics learning at school. The need for print and digital-based student worksheets has received a good response from teachers for use in schools. Teachers still like print-based student worksheets to facilitate the physics learning process at school, but the development of student worksheets so that they are attractive and can foster students' critical thinking skills gets good enthusiasm from teachers. This is because many teachers still find it difficult to select worksheets. Student work for the physics lesson. Based on this, student worksheets assisted by augmented reality in printed form are needed to improve students' critical thinking skills in the physics learning process. It is recommended for future researchers to develop student worksheets with the help of augmented reality to improve critical thinking skills in physics material.

One of the most frequently used learning media is worksheet. Based on the results of the analysis of the use of student work sheets by high school teachers in TABLE 2, the highest result is that teachers see the potential of using students' work sheets as a 100% physical learning aid. This shows that all teachers agree that students' work sheets can be an effective tool. Furthermore, the percentage of students' work sheets required by teachers was 96%. This rate shows that teachers really need the student's work sheet in the learning process. While data on teachers' percentages of students who have made the study sheet for physics lessons was 95%, it reveals that students' work sheets are very often chosen as a learning medium for teachers. On the other hand, teachers have had 73% difficulty choosing the students' working sheets for physical lessons. In line with the results of previous research, Petters (2021) also revealed that the use of student worksheets in learning minimizes the role of educators but more activates learners. So to increase the student's interest in learning, teachers can do so by making the students' worksheets more systematic, colorful, and illustrative.

In order for the study of physics with the help of augmented reality student worksheets to be done well, the researchers also analyzed the equipment supporting the learning activities in high school. Based on the analysis of TABLE 4, the highest results presented are that schools have supporting devices for learning processes such as projectors, LCD, computer laboratories, and others by 94%. This shows that schools that have technology-supported devices are already doing very well. Furthermore, the use of communication devices such as mobile phones or school laptops for the learning process of pupils in school increased by 83%. This percentage shows that the school that supports learning physics using technology is already excellent. Whereas the data of the school using wifi to support pupils' needs in schools by 58% revealed that WiFi in support of pupil needs in school is quite good. According to the data generated, Hutanto (2021) stated that better learning outcomes and performance are influenced not only by the teacher's ability to deliver lessons but also by the facilities and resources available. Schools should pay more attention to their learning facilities because they are vital to the learning process. According to Brink et al. (2020), the facilities required by students during the learning process are classrooms, libraries, laboratories, lights, tables, chairs, desks, spiders, removals, textiles, and LCD. Furthermore, the research also investigates the needs of teachers in relation to the kind of student work sheets that are needed to support and support the learning process in the school as well as to make it easier for teachers to explain the material. The result of the survey was shared by teachers who preferred digital student worksheets at about 20%, and teachers that preferred printed student workshops at a higher percentage of 42%, followed by 37% for teachers which preferred both digital and printed students' worksheets, so it can be concluded that teachers still choose printed pupils' workshops to use.

CONCLUSION

According to the findings and research presented in this article on the examination of the impact of augmented reality-assisted student worksheets on critical thinking abilities, it can be concluded that an instructional tool is necessary to enhance students' critical thinking skills. Student worksheets are a type of learning material that aids with the instructional process at school. Nevertheless, teachers

require student worksheets that are not only repetitive and dull, but also fail to foster the development of critical thinking abilities in children. To enhance students' critical thinking abilities and make student worksheets more engaging, the solution lies in utilizing augmented reality-based worksheets. There is a demand for student worksheets enhanced with augmented reality to facilitate teachers in delivering conceptual explanations during physics lessons at school. Teachers have responded positively to the need for both print and digital student workbooks in schools. instructors continue to prefer using print-based student worksheets to support the physics learning process in schools. However, there is a growing interest among instructors in developing student worksheets that are visually appealing and promote the development of students' critical thinking abilities. This is due to the fact that numerous educators still encounter challenges when it comes to choosing appropriate worksheets. Student engages in the completion of physics coursework. To enhance students' critical thinking abilities throughout the physics learning process, it is necessary to utilize augmented reality in the form of printed student worksheets. Future researchers are advised to utilize augmented reality to enhance critical thinking abilities in physics coursework by creating student workbooks.

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