Practicality of Augmented Reality Books in Physics Learning: A Literature Review

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Sections Info

ABSTRACT

In the digital era, the rapid development of science and technology provides convenience in teaching and learning; media is needed to provide practicality in supporting learning. Augmented Reality media is a practical solution as a learning medium in visualizing a material when the learning process, especially in physics, requires more visualization for the concepts displayed. ***Objective:*** *This research analyzes the practicality of augmented reality learning media in physics learning.* ***Methods:*** *Descriptive research using the literature review method to find out, identify, assess, and interpret related to the augmented reality book practicality research obtained from various sources such as journals, books, and the internet. The literature review method analyzes, identifies, and provides interpretation and evaluation of some existing research that is relevant to the research topic.* ***Results:*** *Through studies conducted using the literature review method, it can be found that: 1) Augmented reality in education has yet to be widely implemented and applied as a supporting medium for interactive education in schools. 2) The application of augmented reality is a practical solution for educators to support them in providing knowledge to students in addition to video conferencing. 3) The practicality of augmented reality books in physics learning is valid. 4) The use of augmented reality books in physics learning is considered to improve the quality of student learning.* ***Novelty:*** *Previous researchers have never done this research, which analyzes the practicality of augmented reality learning media in physics learning.*

INTRODUCTION

Teaching and learning activities are not just mutual interaction during the learning process to improve the quality of the school and increase student learning achievement. The learning process can occur due to interactions using the information or material delivery tools (Novitasari et al., 2021). These tools for conveying information are learning media. In learning activities require supporting factors, including the existence of learning media. One of the teaching tools that teachers can use to deliver lesson plans and foster student creativity and attention during the learning process so that learners are motivated to learn is learning media (Tafonao, 2018).

Learning media by applying technology can provide an overview in developing more interesting learning techniques. Technology development can also be used to innovate learning media development to make the learning process more attractive to students (Sulistiani et al., 2021). Learning media can be used to send messages from teachers to students. In this case, it stimulates students' thoughts, feelings, attention, interests, and attention so that the learning process can be intertwined (Elmunsyah et al., 2019). The benefits of learning media are that they can make concrete abstract concepts, present

objects that are difficult to get, visualize objects in the classroom, and show movements that are too fast or slow (Isa et al., 2022).

Learning media must provide practicality when used. Some subjects need practical auxiliary media for time efficiency and can provide detailed visualization of the subject to be delivered (Tafonao, 2018). Physics is considered to require visualization to understand the concept. Physics is considered a complex subject to understand because it is very abstract. Therefore, learning media is needed to facilitate and understand abstract participants (Mahardika et al., 2020). There are no terms from words that are difficult for students to understand because the illustration on an LKS or book only includes a few words in the material and the absence of a clear picture of these terms (Sulistiani et al., 2021). Using technology as a learning medium allows teachers to shorten the time in providing an overview of concepts using learning media that is enhanced with technology to make learning more exciting and have a positive impact on student academic performance to make the effect practical and easy to use (Septian & Burhendi, 2022).

In the digital era, the rapid development of science and technology provides convenience in teaching and learning and media that can provide practicality in supporting learning (Munir et al., 2022). One of the popular media resulting from the use of technology in education is the beginning of the application of android-based Augmented Reality technology (Aripin, 2018). To achieve teaching goals, the right strategy is needed during the learning process (Istiqomah & Haryono., 2019), using learning tools that can aid in the process of learning, such as Augmented Reality-based learning tools, is one of them (Alyousify & Mustafa, 2022). Adaptasi must be done in the world of education, especially towards various forms of development of science and technology, one of which is using Augmented reality in education (Munir et al., 2022).

A technology called augmented reality integrates different virtual things (two- or three-dimensional) with different natural objects in a precise and three-dimensional environment. The various virtual objects are projected into real-time to be integrated and able to interactively walk in the real world (Mutia et al., 2019). Augmented Reality technology is a form of learning media innovation efforts from conventional methods that utilize various guidebooks to support the learning process and instill students' understanding of the material presented (Cieza & Lujan, 2018).

Augmented Reality media will have a practical effect on students in visualizing material during the learning process (Purwaningtyas et al., 2022), especially in learning physics which requires more visualization for the concepts displayed (Septian & Burhendi, 2022). Augmented Reality media is suitable and supports the practicality of learning so that students can see visualizations of their material in the form of 2D and 3D objects in real life. Augmented reality is a technology that allows combining 2D or 3D virtual objects into a natural state and projecting them in real-time (Alyousify & Mstafa, 2022).

It is known from the description above that learning media is essential for establishing high-quality learning. The entire learning process is not only related to student internal achievement factors, but external factors also play an essential role in learning in the classroom (Malina et al., 2021). It takes a learning medium that offers practicality in visualizing an object. Augmented reality is one of the media that is considered to be used to visualize abstract concepts practically to understand and compile objects or models and support the process of developing the quality of science learning (Rahmawati et al., 2022) so this study aims to analyze the practicality of augmented reality learning media in physics learning.

RESEARCH METHOD

This descriptive research uses the literature review method to find out, identify, assess, and interpret related research topics (Hamilton et al., 2021). The practicality of augmented reality books is obtained from various sources such as journals, books, and the internet. The literature review method analyzes, identifies, provides interpretation, and evaluation of several existing studies (Nistrina, 2021) and is relevant to the research topic to answer research questions, provide additional learning materials and look for gaps from previous research so that it can be helpful for further research (Ariyanto et al., 2021). Up to 30 credible publications and articles from both domestic and foreign sources were investigated in this investigation. The journals and texts that were used were released between 2018 and 22. Researchers gather information and carry-on drawing conclusions about qualitative research outcomes using the research methodology of literature studies displayed in Figure 1.
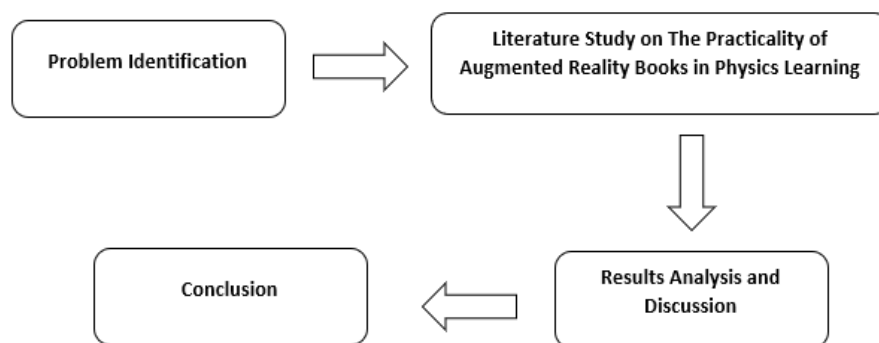

Figure 1. Research Flow

This study's initial part focused on identifying issues with schooling. The second stage involved reviewing up to 30 national and international publications and articles about the applicability of augmented reality books that were published between 2016 and 2022. The third stage of the research process is analysis, which the researcher undertakes after reading the pertinent articles, followed by a discussion of the results. The researcher designs conclusions based on the findings and analysis in the fourth step by reading pertinent articles.

RESULTS AND DISCUSSION

Results

Augmented Reality

Based on identification related to the practicality of using augmented reality books it is known that: 1) With the help of augmented reality (AR), which enables the conversion of virtual items into 3D ones, the learning process can be made more engaging. 2) In comparison to simulation tests with merely selected text, AR can not only have the benefit of three-dimensional virtual objects but is also simple to use (Dewi & Sahrina, 2021), which can enhance the learning effect (Haryanto et al., 2019). 3) Augmented Reality technology can design an information concept from print to video media using AR technology. 4) The built system can recognize markers and display the loaded video via URL. Therefore, this technology needs print media such as pocketbooks as support (Idris et al., 2022; Pan, 2021).

Advantages and Disadvantages of Augmented Reality Books

The advantages of augmented reality book namely: 1) Opportunities of employing augmented reality technology to improve learning experiences, create learning circumstances, and inspire learners include psychological immersion, crossing time and space boundaries, dynamic engagement, and cross-border knowledge fusion (Voronina et al., 2019; Lu et al., 2020). 2) In addition to providing teachers with new instructional media, augmented reality technology can also encourage students to learn new information and contribute creative input during practical applications (Challenor & Ma, 2019; Lv, 2020). Whereas the disadvantages of augmented reality book is the use of augmented reality books requires equipment and learning media that support optimally to display visualization of 3D material models that are well studied so that the images displayed display them as well as possible (Thees et al., 2020).

The practicality of Augmented Reality Books on Physics Learning

In the era of modern technology, teachers must deliver material in a modern but still practical way. 1) Augmented reality is an alternative for teachers to create an interactive learning process, increase the potential of students to understand the concept of physics, and increase student learning motivation (Bistaman et al., 2018). 2) Since users may investigate and control from a range of diverse angles, which were not previously considered in the realm of education, augmented reality's practicality has the ability to engage, excite, and motivate learners (Anugrah, 2021). 3) Studies has also demonstrated that AR raises student achievement. The example using augmented reality in the book as shown figure 1 and figure 2.

Figure 2. Mosquito Spray in Augmented Reality View
Source: (Nistrina, 2021)

Figure 3. Venturimeter in Augmented Reality View
Source: (Nistrina, 2021)

Figures 2 and 3 demonstrate an example of learning media utilizing AR dynamic fluid material to encourage students' mindsets in tackling difficulties and phenomena in daily life. It because augmented reality (AR) may visualize abstract concepts to grasp and practically form an object model.

Discussion

After a review of the literature, it was determined that using multimedia technology, particularly augmented reality in interactive learning, was effective in raising student learning standards. However, the application of augmented reality in education has not been very common, and it is not being used as much in the instruction of school-age children (Damar & Turkey, 2022; Isa et al., 2022). The term "learning based on augmented reality" (also known as "augmented reality-based learning") refers to a set of structured activities (Alyousify & Mstafa, 2022) that involve interaction between students, teachers, and learning resources while leveraging augmented reality technology in a supportive learning environment (Lu et al., 2020). In order to provide interactive and engaging learning (Elmunsyah et al., 2019) that can aid students in understanding the presented content, learning based on augmented reality is built by paying attention to learning objectives, cognitive development, and student characteristics (Nurhafifah et al., 2021). However, there are several obstacles to embracing augmented in education (Bistaman et al., 2018), including issues with integration with conventional learning techniques, expenditures for the creation and upkeep of augmented systems, and aversion to new technologies (Liyuan, 2020; Riska Dewi & Anggaryani, 2020).

As incorporating virtual things (text, photos, and animations) into the real world, augmented reality allows users to explore the natural world (Challenor & Ma, 2019) more pleasantly and fascinatingly (Alyousify & Mstafa, 2022). This allows learners to gain real-world experience and then actively learn. However, augmented reality books require a large enough storage capacity so that a larger memory capacity is needed to download applications from augmented reality (Cieza & Lujan, 2018; Dewi & Sahrina, 2021). The use of augmented reality technology in the education sector marks a new step forward in the development of educational technology (Kanti et al., 2022) that fosters independent learning, moving away from traditional teacher-centered learning modes and toward new learning modes in which students acquire knowledge and skills through new environments and informational tools (Al-Hassan et al., 2020). It also promotes the development of students' fundamental qualities (Idris et al., 2022) and is consistent with the educational philosophy of a fresh round of teaching reform (Chang et al., 2022). Augmented reality is being used more and more in education because of its distinct benefits (Sahin & Yilmaz, 2020).

According to Urlings (2022), In using media that displays the practicality of the student's perceptual experience in visualization, which needs to be continuously enhanced and optimized, augmented reality has a lot of potential. The demands of students must be given more consideration in the area of media demonstrations, which also must be updated and enhanced (Aripin, 2018; Urlings et al., 2022). The characteristics of interest development must be further improved in the area of program logic structure. The display part of the form keeps getting better (Agustiana et al., 2021; Isty et al., 2021). Based on the research that has been done, the majority provide positive feedback from students regarding augmented reality in learning media. Through augmented reality, teachers of subjects that require visualization find it helpful with the practical effects offered compared to conventional learning.

Most students recognize augmented reality in learning media, according to prior study, which is considered favorable feedback. When opposed to learning that still relies on traditional methods, teachers of disciplines that call for visualization think that augmented reality is helpful. One of the goals in promoting learning, particularly physics, is to increase the variety of learning media available to students both physically (Lu et al., 2020) and digitally (Roopa et al., 2020). One way to offer useful learning media is through augmented reality. In efforts to raise the caliber of students, teachers play a part. By using augmented reality in the classroom (Arici et al., 2019), teachers may benefit from technology advancements in education (Andromeda et al., 2018). The use of media in education is accomplished by include it in the curriculum to help students visualize abstract concepts into tangible forms in 2D or 3D graphics (Lima et al., 2022; Putri et al., 2021).

CONCLUSION

Fundamental finding: Through studies conducted using the literature review method, it can be concluded that: 1) Augmented reality in education has yet to be widely implemented and applied as a supporting medium for interactive education in schools 2) The application of augmented reality is a practical solution for educators to support them in providing knowledge to students in addition to video conferencing 3) The practicality of augmented reality books in physics learning is valid 4) The use of augmented reality books in physics learning is considered to improve the quality of student learning. **Implication:** The findings from this study can be used as a reference in developing physics learning media, especially the development of digital books based on augmented reality. **Limitation:** The number of articles used as sources is only 30, including international and national articles. **Future research:** Learning based on interactive augmented reality applications is recommended to be developed in further research for materials and physics subjects with the addition of the QR code scan feature which is a trend among students because of its practicality.

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APPENDIX

Table A1. Results of Review of Articles Related to the Use of Augmented Reality in Learning Physics

Author	Research Purpose	Research Result
(Nandyansah & Suprapto, 2019)	This study aims to produce an augmented reality-based learning medium to train feasible abstract thinking skills (valid, practical, and effective).	The medium of augmented reality to train abstract thinking skills in atomic models is declared feasible because it meets the validity, practicality, and effectiveness criteria.
(Widyanti et al., 2021)	Analyzing the needs, using a STEM approach integrated with augmented reality technology on magnetic field matter.	The results revealed that teachers have never created integration-assisted learning resources between STEM and augmented reality technologies.
(Thees et al., 2020)	Investigate the positive impact of learning with augmented reality (AR) systems in various instructional scenarios.	Performance and cognitive load are assessed as dependent variables. Although AR conditions did not indicate learning gains in conceptual knowledge tests, they reported a much lower foreign cognitive load than traditional conditions.
(Sumardani, 2020)	This research aims to make Augmented Reality applications on LKPD right-hand rules.	From the black box testing test results, it was found that the percentage of success of the application system was 100%, which indicated that the application had worked properly on smartphone use.
(Roopa et al., 2020)	The goal is to apply interactive augmented reality experiences and promote situational, experimental, and transformative learning as the basis of cellular augmented reality learning theory.	Teachers are better able to attract students' attention and inspire them, while students are given new opportunities to imagine their abstract subjects and concepts and receive practical skills.
(Putri et al., 2021)	The purpose of this study is to analyze the application of AR in physics laboratories by providing bibliometric analysis so that opportunities can be presented for further research.	It is known that the everyday use of HOTS in physics laboratories and the low achievement of HOTS. Hence, the results of the study suggest involving the use of AR in physics laboratories as one of the new activities.
(Nurhafifah et al., 2021)	This study aims to investigate the Development of Interactive Multimedia Science Integrated learning in the 21st century.	It is known that students only study science with low competence, so it is necessary to update student learning resources in AR technology.
(Fidan & Tuncel, 2019)	This study investigates the effect of Augmented Reality (AR) assisted Problem-Based Learning (PBL) on learning achievement and attitudes toward physics subjects as part of science education.	AR technology can be a potentially effective tool for activating students' positive emotions in the PBL process.

Author	Research Purpose	Research Result
(Akçayir et al., 2016)	This study investigates the effects of augmented reality (AR) technology in science labs on students' laboratory skills and attitudes toward the laboratory.	AR technology significantly improves the development of student laboratory skills. AR technology improves students' laboratory skills and helps them build a positive attitude toward physics labs.
(Liyuan, 2020)	Investigating the differences and characteristics of education between virtual reality and augmented reality technologies, analyzing the application of virtual reality and augmented reality technologies in the field of education.	Virtual reality and augmented reality technologies provide technical platforms or tools for teachers and students and develop new teaching modes and methods.
(Law & Heintz, 2021)	Studying the applications of AR education and related methodologies, especially from a pedagogical rather than from the perspective of human-computer interaction.	There is still plenty of room for improvement to make this promising tool maximize the potential of AR to benefit children to learn in and out of school.
(Riska Dewi & Anggaryani, 2020)	Describe the feasibility of validity and effectiveness in making physics learning media with Android-based Augmented Reality on visual tool material.	The validity of creating physics learning media with Android-based Augmented Reality on optical tool materials has met the validity criteria.
(Faqih & Jaradat, 2021)	Investigating the integration of TTF and UTAUT2 theories to investigate the adoption of augmented reality technologies in education: perspectives from developing countries.	The results revealed a positive effect of the suitability of task technology in the process of adoption of augmented reality in educational settings.
(Kanti et al., 2022)	Increase the efficiency and effectiveness of learning. One of the technologies that can be utilized is Augmented Reality (AR) technology.	Analysis of the development of augmented reality-based learning media with the POE2WE model on gas kinetic theory material can make the learning process easier to understand by students.
(Aryanta, 2021)	Describe the validation of Physics Augmented Reality to improve students' understanding of concepts and measure the effectiveness of developing Physics Physics.	The results of the practicality assessment by teachers and learners, the BUGAR module is declared very valid, practical, effective, and practical to be used in physics learning.
(Urlings et al., 2022)	Provides an overview of existing research on the uses and effects of AR in education.	Limited evidence from this topic suggests the potential of AR to be practical in education.
(Hidayati et al., 2019)	Develop valuable and practical student worksheets based on augmented reality as support in virtual laboratory activities for nuclear fission learning materials.	Based on the results of observations, students' understanding of nuclear physics learning materials is still relatively low because it has yet to be supported by augmented reality.

Author	Research Purpose	Research Result
(Chang et al., 2022)	Assessing the impact of AR on three levels of learning outcomes.	AR technology has benefited all three learning outcomes, with a larger average size of the effect on performance outcomes.
(Anugrah, 2021)	Aims to reveal the validity and practicality of augmented reality.	The results showed that augmented reality-based media is valid and practical for lecturers and students.
(Rosdandi et al., 2022)	Produce an Augmented Reality-based class X TAV learning media design application at SMKN 2 Sibolga that is valid, practical, and effective.	Augmented Reality-based class X TAV learning media at SMKN 2 Sibolga has proven valid, practical, and effective.
(Sahin & Yilmaz, 2020)	Investigate the impact of learning materials developed with augmented reality (AR) technology on the achievement and attitudes of high school students towards courses and determine their attitudes towards AR applications.	The results reveal that students are happy and want to continue using AR apps in the future.
(Andromeda et al., 2018)	Investigate the practicality of AR-based IGI learning models in learning.	The results of this study show that the AR-based IGI learning model developed is valid and practical to use when learning.
(Alkadri & Fauzi, 2021)	Analyze the media used by students in high school physics learning and determine the suitable media for developing flood-themed teaching materials.	Electronic-based learning media can be used in physics learning and developing electronic-based flood-themed teaching materials.
(Ibisono et al., 2020)	Describes the effectiveness of Augmented Reality-based pocketbooks to improve the learning achievement of high school students.	Augmented Reality-based pocketbooks on planetary motion materials used to improve the learning achievement of high school students were declared effective.
(Fransisca et al., 2019)	Producing learning media in E-Learning, which is applied to digital simulation subjects at SMK Padang.	The study results show that E-Learning is a suitable learning medium for teachers and students.
(Bi et al., 2021)	Investigate the application of augmented reality (AR) technology in training low-voltage line faults.	The application of augmented reality (AR) technology in training low-voltage line interference has significantly increased speed.
(Lima et al., 2022)	Investigate the integration of augmented reality in the learning environment.	AR research in education primarily focuses on student-centered aspects that are understood to be among the least important factors for adoption.
(Agustiana et al., 2021)	Describes the views of Islamic school physics teachers on the importance of Augmented Reality-assisted LKS	The results showed that Augmented Reality-assisted LKS could increase the potential for student involvement in

Author	Research Purpose	Research Result
	teaching materials in facilitating student involvement in the learning process.	physics learning during the pandemic by implementing a learning management system tailored to student learning needs and facilities.
(Arici et al., 2019)	Uncovering research trends over the past six years through content analysis and reviewing the bibliometric results of articles related to augmented reality (AR) in science education.	The results show that recent AR articles focus primarily on mobile learning and e-learning environments.
(Elfitra et al., 2021)	Investigating Students' perceptions of Media Augmented Reality (AR) Calculus Course.	Based on the average, the score of the observation aspect of AR learning media is included in the feasible category.