

# Implementation of augmented reality media through the metaverse approach in social science learning

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**Abstract:** The purpose of this study is to test and implement the feasibility of Augmented Reality (AR) media in social studies learning that has been designed in previous research, as well as develop an implementation strategy. Augmented Reality (AR) learning media focuses on teachers and students in the classroom in social studies learning. Meanwhile, AR media helps teachers contextualize social studies learning and can be used as a source of social studies learning. Quantitative research approaches use research designs and methods, namely through product testing or socialization, the level of effectiveness using pseudo-experiments in three schools in Bandung City Junior High School. The study results provide information about the feasibility and testing of AR media products that are suitable for use in social studies learning. This states that 97% of students are interested in AR learning. The effectiveness of AR media applications in social studies learning obtained a very high response from students, 90%, while the responses of teachers and students showed promising results in using AR media applications in the classroom.

**Keywords:** augmented reality media; metaverse; social studies learning



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## 1. Introduction

The digital era 4.0, which is currently entering the 5.0 era, shows the increasingly deep integration between humans and technology. In Indonesia, the mission to achieve the Sustainable Development Goals (SDGs) includes inclusive and quality education and supporting lifelong learning for all. However, there are still challenges in the current education system, especially in maximizing technological collaboration to meet diverse learning needs (Susanti, 2020). Augmented Reality (AR) can change how we learn beyond knowledge transfer. AR creates an interactive learning environment where students can dynamically engage with learning content. Research shows that AR can increase student motivation and engagement, particularly in inclusive education, where students with special needs or diverse backgrounds can benefit significantly from this technology (Quintero et al., 2019; Persson et al., 2015). However, there are still areas for improvement, especially in developing robust methodologies to maximize inclusion for underrepresented student groups (Fernandez-Duque et al., 2000).

The application of AR in education not only facilitates knowledge acquisition but also provides hands-on experiences that foster technological adaptation, thereby enhancing the overall learning process. However, the field of AR in education is still in its infancy, and more research is urgently needed to address challenges such as limited sample size and accessibility for students from marginalized communities (Al-Ansi et al., 2023). This underscores the importance of further exploration and development in this promising field.

Augmented Reality (AR) technology can be applied to support learning materials to make them more engaging and interactive. The application of AR to learning materials can provide a more detailed picture of the material and be presented with a

display in the form of 3D animation. In the era of rapid development of information technology, the application of AR in various fields has become an alternative form. AR is an information technology that combines 2D or 3D objects developed with computer applications into a real-life, reality-like environment around the user in real-time. AR technology is a variation of Virtual Reality (VR). The difference with VR is that AR only adds or complements applications in a natural environment with 3D. AR allows users who use applications to view the natural environment using a display as a virtual object.

AR technology provides an engaging learning experience and enables collaboration-based teaching, where learners can share their learning experiences through AR with fellow students. This opens up space for more interactive and collaborative learning (Adamska, 2023). The advantages of AR in simplifying complex concepts through interactive visual representations can also encourage students to think creatively and critically in understanding the material (Coursera, 2023). The adoption of AR technology in education aims to increase student engagement, especially in challenging fields such as science and engineering, which require visual representation and a deep understanding of abstract concepts. AR bridges the education gap by providing broader access to more interactive learning materials, especially for students with a more visual and collaborative learning style (Adamska, 2023).

While AR and Metaverse technologies offer excellent opportunities to improve learning, their practical implementation in the formal education system has yet to be fully explored. The main challenge lies in developing teaching methodologies that can optimize AR and the Metaverse to improve interaction between students and teachers. This includes how teachers can utilize this technology in their daily curriculum and ensure that all students can access and utilize it equally (Lee et al., 2021; Zhao et al., 2022).

The Metaverse, unlike other educational technologies, has the unique ability to support a more personalized and adaptive learning process. It allows students to truly engage in a virtual learning environment that resembles the real world. For example, students can interact with virtual objects, participate in 3D simulations, or collaborate with classmates in virtual spaces that are not limited by physical location. This potential to cater to the individual needs of students, allowing them to learn at their own pace and based on their respective learning styles, makes the Metaverse a powerful tool in education (Kye et al., 2021; Mystakidis, 2022).

With the rapid advancements in AR and Metaverse technologies, there is a pressing need for further research to explore how best to integrate these technologies into education. This includes addressing technology accessibility challenges for students in remote areas or those with limited resources. The development of an inclusive and adaptive curriculum to harness the full potential of this technology is an important step to close the gap in digital education (Mystakidis, 2022).

The Metaverse is a world that allows people to meet and collaborate without geographical restrictions. However, applying the Metaverse in formal learning still faces many challenges, especially in social science education at the junior high school level. There has not been much research on the optimal use of the Metaverse in helping students understand abstract concepts taught in social sciences (Kim et al., 2022). In addition, there is still a lack of information regarding how interaction and collaboration in the metaverse world can significantly change students' learning experiences.

In reality, the Metaverse and AR technology bring great opportunities in creating a more immersive learning environment. This technology can provide 3D visualizations that help students learn complex concepts more understandably and interactively (Lee & Yeon, 2021). In contrast to conventional learning methods, the Metaverse offers a digital space that allows students to interact directly with virtual objects that resemble the real world. In the context of social science lessons, it can help students visualize historical

events, geopolitical maps, or economic concepts that are usually difficult to interpret with just two-dimensional text or images (Jovanović & Milosavljević, 2022).

What is different, in addition to improving visualization, is that collaboration within the metaverse environment allows students to interact with classmates or teachers in real time. This creates a more interactive learning space where group discussions and activities can be conducted virtually without physical limitations, making the learning experience more prosperous and meaningful (Zhao et al., 2022). By utilizing AR and the Metaverse, the social science learning process is hoped to become more contextual, helping students relate lessons to real-life situations relevant to their daily lives (Chen et al., 2021).

The application of AR media development in social studies learning produced in the first year of research still needs to meet the expected effectiveness standards. No data shows the significant impact of AR on improving student understanding in grade 8, primarily related to social studies subjects. Many AR media developed only focus on the visual aspect without considering deep pedagogical integration (Hung et al., 2017). Its ability to provide an immersive interactive learning experience differs from AR. However, the biggest challenge is adapting this technology to the needs of the curriculum and students' abilities (Joo-Nagata et al., 2017). More research is still needed to identify how AR can improve social studies learning consistently, especially in grade 8.

From the introduction above, the study aims to test the effectiveness of using Augmented Reality (AR) media through the metaverse approach in Social Science learning. Through this research, integrating AR and metaverse technology can significantly improve student engagement, understanding, and learning outcomes, especially in social studies. In addition, this approach is considered necessary because it can adapt to the development of the digital era that continues to increase.

This research's theoretical contribution lies in its efforts to enrich the literature on the application of immersive technologies, such as AR and the metaverse, in education. Thus, this research seeks to provide a new understanding of how this technology can be integrated with existing pedagogical approaches. Furthermore, the study provides insights into how students interact with more dynamic and visual learning content, allowing for more holistic and immersive learning.

On the other hand, this research's practical contribution includes providing practical guidance for teachers and educational institutions in implementing AR and metaverse technologies in the classroom. In addition, the results of this research can also be used as a basis for developing a curriculum that is more relevant to students' needs in the 21st century. Therefore, using digital technology through AR and the metaverse is believed to improve a more interactive, practical, and enjoyable learning experience for students.

## 2. Materials and Methods

The research approach considered appropriate in this study combines quantitative and qualitative research, using a mixed method approach and research and development (R&D) methods. Researchers use Research and Development (R&D) to develop AR with a metaverse approach (Creswell, 2014). This research was conducted by collecting data from a population by selecting a sample. The data collection results from the sample will be generalized to the entire population. Technically, this study uses questionnaires and other instruments to measure research variables for respondents (students and teachers). The research location is a junior high school in Bandung with representatives from 3 schools. The research location for these three schools is based on clusters or regional zoning and is supported by UPI. The schools that will be represented include SMPN 13 Bandung City, SMPN 51 Bandung City, and SMP Labschool Bandung City. Observation sheets are used to observe the development of AR media using the

metaverse approach. Observation is a data collection technique that not only measures the attitude of respondents (interviews and questionnaires) but can also be used to record various phenomena that occur (situations, conditions). A questionnaire is a data collection technique that gives a series of questions or statements to other people who are used as respondents to answer. The questionnaire will be used to collect data from respondents. Interviews are data collection techniques conducted face-to-face and direct questions and answers between data collectors and researchers on the source or sources of data. These interviews will be used to obtain data from students and teachers.

### 3. Results

The results consisting of data or findings of research, feasibility, and testing of Augmented reality products can be seen through the results of statistical calculations in the [Table 1](#).

Table 1. Descriptive statistics on the use of augmented reality

		Statistical Descriptive						
	N	Range	Minimum	Maximum	Sum	Average	Std. Deviation	Variant
Entire	78	23	37	60	3865	49.55	5.101	26.017
Valid N	78							

Based on the SPSS calculation in the table above, it is known that the amount of data (N) is 78, with a range value of 23, and the lowest value (minimum) is 37. The highest value (maximum) is 60 with a total of 3865, the average value (mean) is 49.55, the standard deviation is 5.101, and the variance is 26.017. The frequency distribution for each question in the form of a diagram is in [Figure 1](#).

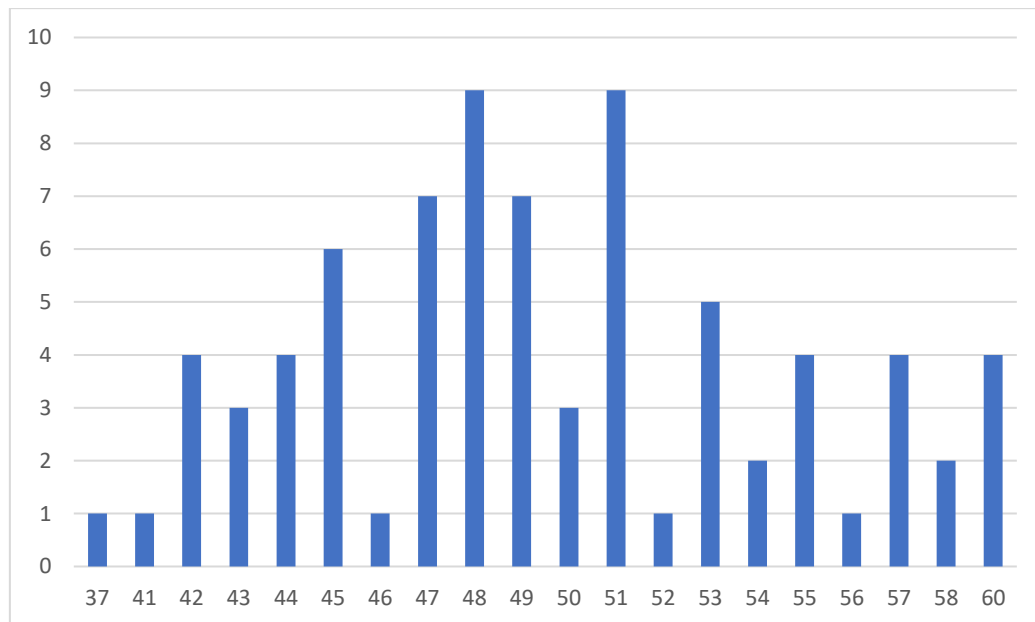


Figure 1. Frequency Distribution

Based on the diagram above, nine respondents were at scores of 48 and 51, followed by seven respondents at scores of 47 and 49. 6 respondents got a score of 45, followed by a score of 53 with five respondents. Based on the table above, the responses range from 4 to 1, spread across several values as above. Using a paired sample t-test, the study results show students' knowledge in the experimental class before and after treatment, using augmented reality media in social studies learning. The results of the recapitulation of the paired sample t-test assessment are presented in the [Table 2](#).

Table 2. t-Test Paired Sample Test Results

		Paired Sample Test					t	Df	Sig. (2-tail)
		Mean	Std. Deviation	Pairing Difference Std. Average Error	95% Confidence Interval of Difference				
					Lower	Above			
Pair 1	Pretest - Posttest	- 33.718	17.991	2.037	- 37.774	-29.662	- 16.5	77	.000
		8					53		

Based on the [Table 2](#), the t-count value is -33.718, with a significance value 0.000. Since the significance value is  $0.000 < 0.05$ , it can be concluded that  $H_0$  is rejected and accepted. Thus, there is a difference in students' level of knowledge after learning using augmented reality media.

Referring to the table, it is known that the t-count has a negative value of -33.718, which is because the average pretest score is lower than the average posttest score, so a negative t-count value can have a positive meaning so that the t-count becomes 33.718. It is known that the value of df (degree of freedom) is 77, and the significance value of  $0.05/2$ , which is 0.025, is used as an essential reference in finding the t-table value so that a t-table value of 2,457 is found. Thus, since the t-count value is  $33.718 > t\text{-table } 2.457$ , it can be concluded that there is an average difference between the pretest and posttest results, which means that there is an influence of the use of augmented reality media in social studies learning in the experimental class.

One of the learning contents of social studies is the sub-material of Hindu Buddhist history. Interest in learning media must attract students' interest by presenting it in an exciting and varied way, providing opportunities for independent learning and making it easier for students to master their competencies ([Elmqaddem, 2019](#)). Augmented reality media is a good and suitable medium that can be used as a learning medium in the classroom. It features colorful AR displays on Hindu Buddhist workpieces that increase students' curiosity in learning with appropriate images, photos, and videos. Learning content material that makes students not bored because other forms of interactive make students not bored; as evidenced by questionnaire data, 97% of students stated that they are not bored in learning using augmented reality media because the learning content is interactive and colorful and equipped with student answers. In the 95% design questionnaire, the colors displayed by augmented reality media are exciting.

Thus, the feasibility and testing of augmented reality media products in social studies learning in the experimental classroom using augmented reality media can be concluded. In addition, media is a learning component related to objectives and materials.

#### 4. Discussion

Learning media is a tool that helps all forms of the learning process in the classroom ([Indarta et al., 2022](#); [Suryani & Santiyasa, 2016](#)). Good learning certainly requires learning media to transfer knowledge between teachers and students. Learning media will also help students motivate the learning process in the classroom. Augmented reality learning media has the same function as a stimulus tool in classroom learning that can harmonize uniform views and experiences with the lesson's content. Moreover, technology-based media continuously changes to create innovative, creative, and fun learning. Augmented reality is a social studies learning medium that can be included in social studies learning content, one of which is the Hindu Buddhist history

sub-material. Interest in learning media must attract students' interest by presenting it in an exciting and varied way, providing opportunities for independent learning and making it easier for students to master their competencies (Wiharto & Budihartanti, 2017). Augmented reality media is a good and suitable medium that can be used as a learning medium in the classroom by having features on colorful AR displays on objects.

Augmented reality is a social study learning medium that can be included in social studies learning content, including the Hindu Buddhist history sub-material. Interest in learning media must attract students' interest by presenting it in an exciting and varied way, providing opportunities for independent learning, and making it easier for students to master their competencies (Rahmadhan, 2021). Augmented reality media is a good and suitable medium that can be used as a learning medium in the classroom. It features colorful AR displays on Hindu Buddhist workpieces that increase students' curiosity in learning with appropriate images, photos, and videos. Learning content material that makes students not bored because other forms of interactive make students not bored; as evidenced by questionnaire data, 97% of students stated that they are not bored in learning using augmented reality media because the learning content is interactive and colorful and equipped with student answers. In the 95% design questionnaire, the colors displayed by augmented reality media are not dull. Thus, it can be concluded that the feasibility and testing of augmented reality media products in social studies learning in the experimental classroom using augmented reality media. Moreover, media is a learning component related to objectives, materials, methods, media, and learning evaluation. Similarly, the characteristics of augmented reality media have many aspects of technology and multi-media that will make learning creative and fun; there is a similarity in the function of media of two learning, which is a tool that can encourage students' interest, attention, and comprehension ability in learning. Learning process. Support for the role of learning media as an extrinsic factor or motive that arises due to external stimulation, namely encouragement from teachers that will make students more enthusiastic in carrying out learning in the classroom, and teachers can more easily transfer knowledge and trigger students' curiosity and attention so that they are interested in learning. Students in the classroom.

As the table above shows, the t-count value is -33.718 with a significance value of 0.000. This significant result, with a p-value of  $0.000 < 0.05$ , leads to the rejection of  $H_0$  and its acceptance. This means that there is a discernible difference in the level of knowledge of students after they have been exposed to learning using augmented reality media, underscoring the importance of this research.

Referring to the table, it is known that the t-count has a negative value of -33.718, which is because the average pretest score is lower than the average posttest score, so a negative t-count value can have a positive meaning so that the t-count becomes 33.718. It is known that the value of df (degree of freedom) is 77, and the significance value of  $0.05/2$ , which is 0.025, is used as a basic reference in finding the t-table value so that a t-table value of 2,457 is found. Thus, because the t-count value is  $33.718 > t\text{-table } 2.457$ , it can be concluded that there is an average difference between the pretest and posttest results, which means that there is an influence of the use of augmented reality media in social studies learning in the experimental class.

These results interpret that the use of augmented reality-based interactive learning media received a very high response from students in the experimental class, so there was an influence on the use of augmented reality media in social studies learning in the experimental class. In addition, it is also supported by mastery of the material using augmented reality, with students answering the questionnaire with a total of 77% point 7 in material mastery and 99% answering to add to my insight into the remaining material from the Hindu-Buddhist kingdom in Indonesia point 8. This suddenly happens to augmented reality media, which can encourage students to open up knowledge with the help of 3D objects. Students will find it easier to understand because they will see objects

that make them create constructions, thinking about reality. After all, there are natural objects that are not imagined, making students more open to understanding the meaning contained in the material in the learning.

Thus, it can be concluded that the use of augmented reality interactive media can vary social studies learning that is adaptive to the characteristics of students in the digital era as a digital native generation. The use of augmented reality media is also said to be a simple implementation of the TPACK framework, which is to incorporate technology in the learning process to be in harmony with the digital era by building student knowledge into concepts that are easy to understand and also by the conditions that students want in this era. With TPACK learning that can be integrated with augmented reality media, it can form the character of students who are ready to face socio-cultural changes, be able to communicate and collaborate to build social relationships, think analytically and critically, and compete with the global world functionally. In addition, augmented reality media stimulates students' interest in deepening learning and can develop students' critical thinking skills. It also provides a medium to measure students' understanding through features to sharpen students through quizzes. This learning medium is very suitable for use and compatible with being implemented in social studies learning and the well-known form of interactive learning.

Augmented reality media stimulates students to be active and responsive because they feel interested in learning presentations combined with digital-based animation media. The main characteristics of junior high school students are known to be part of the digital native generation, namely a generation that can be digitally literate and is flexible and adaptive work-oriented. The use of augmented reality media in social studies learning can facilitate the younger generation, namely the digital native generation, with educational technology that combines the use of digital devices such as laptops, mobile phones, and internet networks in accessing learning media that prioritize visual, audio and audio-visual displays to stimulate student interaction in the learning process. For this reason, augmented reality media is suitable for simplifying complex learning materials, especially social studies learning, which is often characterized by memorization learning, so that augmented reality media can stimulate students' interest in learning social studies with engaging, creative, and energetic presentations.

The responses of teachers and students in developing AR media in social studies learning based on the data from the questionnaire above stated that this AR application is easy to operate because the instructions are clear and easy for students to understand. This shows that respondents disagree with the statement that the learning instructions in this application are confusing. On the other hand, students who have tried this app agree that the learning instructions in the Augmented reality medium are very clear, making it easier for students to operate them in groups and independently. In addition to the easy-to-understand language in the application, teachers and students are taught directly by the research team first when operating AR media, so it is straightforward for them to use this media in the social studies learning process.

In addition, this AR media is easily accessible to mobile phones/laptops, which means students can easily use the application to learn. This is also supported by current learning, which is very close to digital-based learning. AR media is straightforward for teachers and students to accept because it can be used directly on the device they use every day. In addition, this AR media is easily accessible to mobile phones/laptops, which means students can easily use the application in learning. This is also supported by current learning, which is very close to digital-based learning, so teachers and students very easily accept AR media because it can be used directly on the devices they use every day.

The various conveniences in using AR media during social studies learning felt by teachers and students are also inseparable from the ease of understanding historical material, which is generally difficult for students to understand quickly. This AR media is also equipped with various explanatory features in the form of audio-visuals (starting from video features and audio features when objects are seen in Augmented reality), making it easier for students to understand the material from the relics of the Hindu-Buddhist kingdom in Indonesia. This audio-visual-based feature makes social studies lessons within the scope of the history of the Hindu-Buddhist kingdom more colorful, not monotonous or dull. It can increase students' interest in learning so that literacy culture can be improved with AR-based digital media. Especially for the visual part of the use of AR media, the results showed that the majority of 78 respondents (77 respondents) answered that Augmented reality media makes it easier for students to observe the relics of the Hindu-Buddhist kingdom in Indonesia through a three-dimensional display and provide a clear picture how this form of heritage makes it easier for students to observe the relics of the Hindu-Buddhist kingdom in Indonesia. The presence of three-dimensional images makes it easy for students to access various relics of the Hindu-Buddhist kingdom without having to go to cultural sites in person. This learning step is undoubtedly very efficient because it saves teachers and students time, energy, and costs. If teachers and students use AR media, they only need to sit in class with their respective gadgets or laptops so that the learning atmosphere can be more conducive and the material can be delivered and understood optimally.

The advantage of augmented reality is that its development is more economical and easy. Another advantage is that augmented reality can be widely applied in various media. It is possible to create applications on smartphones or in print media such as newspapers, books, and magazines. The application of AR in education can be in the form of research products, namely Augmented Reality-based picture book learning media that is declared feasible and practical to be used by Generation Z students in the mathematics learning process or in developing teacher competence. This is based on assessing the qualifications of media experts, linguists, and material experts. In addition to education, AR can also impact entertainment (including video games) and tourism, architecture, medicine, and industry. The presence of Augmented Reality aims to create a model for teacher skill development by combining Augmented Reality (AR) learning media through a customized metaverse approach. The development of AR Augmented Reality Media through the Metaverse Approach is an innovative learning medium that combines education with technology. So, with this collaboration, students and teachers can balance development with the times.

## 5. Conclusion

The feasibility and testing of augmented reality media products in social studies learning in grade 7 shows that this application is suitable for use. This refers to the results of tests conducted by researchers in the classroom, namely the existence of questionnaire data; 97% of students stated that they are not bored in learning using augmented reality media because the learning content is interactive and colorful and coupled with student answers in the questionnaire, 95% of them have good design and colors. The augmented reality media shown is not dull. The effectiveness of augmented reality media applications in social studies learning in the classroom after being processed shows that the use of augmented reality-based interactive learning media gets a very high response from students, thus affecting students' understanding of the material taught so that it is easier to understand. This is also supported by testing or evaluation features in the Dismus application. The effectiveness of the Dismus application in mastering the material was supported by a questionnaire filled out by students at point 7, with 77% mastering the material and 99% answering that it added to my insight into the material left over from the Hindu-Buddhist kingdom in Indonesia,



point 8. This is suddenly happening with augmented reality media. It can encourage students to open up knowledge with the help of 3D objects. Teachers' and students' responses to developing augmented reality media in social studies learning show good results because both teachers and students are cooperative and welcome using this application in the classroom. This is because AR media is easily accessible to mobile phones/laptops, so students can easily use the application in learning and an attractive interface with complete features.

**Authors Contribution:** A. B. S.: research design, methodology, conducting the research and writing original article, field data collection, data analysis, and revision. D. S. L.: Field data collection, data analysis, exploring references, and composed the report. R. A. D.: Field data collection, data analysis, exploring references, and composed the report. M. H.: Field data collection, data analysis, exploring references, and composed the report. M. A. R.: Field data collection, data analysis, exploring references, and composed the report.

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