

## Augmented reality: Interactive and fun learning media to improve students learning outcome

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**Abstract:** This research aims to analyze the role of Augmented Reality (AR) as an interactive and engaging learning medium to enhance students learning outcome. This research involves experimental studies conducted on 52 accounting education students from the class of 2023 at Semarang State University. Data were collected using tests, questionnaires, and interviews. The data were analyzed using descriptive percentages and Gain Normality Test. The results of this research show that *first*, AR media can be an effective and enjoyable interactive learning media; *second*, AR media has been shown to enhance student learning outcomes, with the average score increasing from 21.08 in the pretest to 70.60. Before receiving the materials, the students' score was only 20. After receiving the materials, their score was 80. This represents a significant improvement of 49.52 points. Additionally, the TAM analysis suggests incorporating augmented reality media into the learning process.

**Keywords:** *learning methods, learning media, augmented reality.*

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### INTRODUCTION

Student learning outcomes are a crucial component of learning activities. This is because the results of this learning have significant benefits as a foundation for making decisions in planning and implementing future learning. For educators, the results of learning assessments can be used to identify the challenges students are facing, allowing for the development of corrective solutions (Santoso, 2013; Idrus, 2019)

Information and communication technology (ICT) advancements have broadened education's reach through e-learning and the use of various online platforms (Lin, et.al, 2015) Some of the platforms that can be used to enhance the teaching and learning process include ubiquitous learning (u-learning), augmented reality (AR), virtual reality (VR), mobile learning (m-learning), games, gamification, and learning analytics (Nincarean, Alia, Halim, & Rahman, 2013). Sulaiman (2012) defines learning media as any tool or method used to convey messages from the sender to the recipient, with the aim of stimulating students' thoughts, feelings, attention, and interest, as well as their will, in a manner that facilitates the learning process and effectively achieves learning goals. According to Bruner (1996) as cited in Arsyad (2013), there are three primary levels of learning modes: direct experience, pictorial experience, and abstract experience. To ensure the success of the teaching and learning process, students should be encouraged to utilize all of their senses (Arsyad, 2013). Learning media can be defined as a practical and valuable tool for communicating educational messages (Sanaky, 2013).

AR is a modern visualization technology that enhances sensory perception by overlaying digital objects onto the real world. According to Azuma, Baillot, Feiner, Julier, and MacIntyre (2001), the primary characteristics of AR are the simultaneous display of real and virtual objects, the real-time nature of interactions, and the geometric registration of both real and virtual objects. Due to technological requirements, such as the need for AR glasses, the use of AR was limited to research institutions and the military sector during the 1990s and early 2000s (Billinghurst, Clark, & Lee, 2015). With the emergence of smartphones and tablet computers around 2007, there was a substantial change as AR technology became available for everyday use (Billinghurst *et al.*, 2015).

In education, the use of AR have primarily focused on its effects on learners, the impacts of which are easily understandable. According to Bacca-Acosta, Baldiris Navarro, Fabregat Gesa, and Graf (2014), the most frequently reported benefit of using AR in educational settings is that it enhances students' learning performance, leading to increased motivation. Saltan and Arslan (2016) found evidence that the use of AR improves academic performance, students involvement, motivation, and satisfaction.

The use of smartphones is still a matter of concern for most schools because many students primarily focus on online games and are not serious about learning (Mamonto *et al.*, 2021). AR applications have the potential to be developed as a medium for attractive, interactive, and enjoyable learning materials. The application contains a 3D feature and can be accessed using a cellphone. AR is designed to be visually appealing using 2D and 3D displays, enabling students to engage in learning actively. The process of using AR is divided into two stages: the first for educators and the second for students. First, educators design the content that will be delivered in the Augmented Reality application. Second, students are provided with an application created by the educator and a barcode. Students install this application on their individual cell phones. Students can use the system by scanning the barcode provided by the teacher, which will then automatically display the learning material on each student's cell phone. This is a novelty for this research because there are still very few economics teachers researching or implementing economic learning using AR applications.

## **METHOD**

This experimental study involved 52 accounting education students from Semarang State University's Class of 2023. Tests, interviews, and questionnaires were used to gather data. The Gain Normality Test and descriptive percentages were used to analyze the data. The Miles and Huberman (1994) model was used to analyze the data from the interviews, specifically data reduction, data display, and drawing conclusions.

## **FINDINGS AND DISCUSSION:**

Based on the pre-test and post-test responses from 52 Accounting Education students in 2023, the data indicates a significant improvement in students' academic achievement. Meanwhile, the interview results indicate that students are highly interested in the media used, finding 3D applications interesting and enjoyable to use.

According to Cook and Campbell (2007), a pretest and posttest design (within-subject design) involves administering treatment to a group of research subjects before conducting a posttest on the same group. A set of questions related to the material covered in the upcoming class is administered during the pretest. In addition, augmented reality-enabled marketing

materials were provided as part of the treatment. Each student’s smartphone contained a barcode that could be scanned to access this content. A posttest is conducted by having the participants fill out the same set of questions again using a Google Form after the treatment has been administered. The researcher examined the obtained scores after receiving the pre- and post-test scores. The examination utilized is the increase ordinariness test. The outcome of this test is used to determine how well the treatment worked. Meltzer’s formula for determining the gain’s normality is as follows:

$$N - Gain = \frac{\text{The posttest score} - \text{The pretest score}}{\text{The Ideal Score} - \text{The pretest score}}$$

The result of the normality gain test is referred to as N-Gain. The score obtained after the test is reflected in the posttest score. The score obtained prior to the test is shown by the pretest score. The ideal score is shown in the Ideal Score section. Table 1 displays Meltzer’s interpretation of the effectiveness criteria based on the normality gain value.

Table 1  
*Classification of N-gain score values*

Score N-Gain	Category
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

Source: Karinaningsih (2010)

The results of the research data processing, including the Normality Gain Value Results from the Pretest and Posttest, are shown in Table 2, while the results of recap interviews with students are shown in Table 3. From the results of the Table 2, the average value for the pretest was 21.08, and the average value for the posttest was 70.60. From these results, the mean difference was 49.56522. We consider this difference to be quite significant in enhancing students’ academic achievement. Before receiving the materials, the students’ score was only 20. However, after receiving the materials, their score was 80.

Based on Table 3, it is evident that AR is an intriguing learning tool due to its numerous advantages. AR can help students understand abstract concepts by displaying them in 3D form, making them more tangible. In addition, AR can enhance student interaction, thereby impacting student learning outcomes. The research results indicate that the AR application is a favorable medium, as evidenced by Perceived Usefulness, Perceived Ease of Use, Attitude Toward Use, Behavioral Intention, and Actual Use.

Based on the interview results in Table 3, the perceived usefulness of the AR application has a significant impact on students’ enthusiasm in participating in class learning, making it more interesting and enjoyable. This results in enthusiasm and interest in working on questions. The research results showed that many students believed that using AR as a learning tool increased students interaction and enthusiasm. Many students believe that utilizing AR media can enhance their understanding of the material. This is because the material is presented in both 2D and 3D formats and can be accessed through smartphones. In addition, it is more practical to use and does not require a lot of display features.

**Table 2**  
*Results of normality gain values from pretest and posttest*

Name	Pretest	Posttest	Score Gain		
Ananda Aulia Wijayanti	30	70	40	70	0.571429
Athia Febriyanti	20	70	50	80	0.625
Purwanti	20	80	60	80	0.75
Audi Kartika Wijaya	20	80	60	80	0.75
Maya Puspita Ningrum	20	60	40	80	0.5
Putri Aulia Larasati	30	70	40	70	0.571429
Rafa Arga Puspito	20	70	50	80	0.625
Zahra Maila Putri	20	70	50	80	0.625
Nadiah Rahmatina	30	70	40	70	0.571429
Nabila Ramadhani	20	60	40	80	0.5
Diva Maya	20	90	70	80	0.875
Jessica Artya Sevira	20	80	60	80	0.75
Muhammad Wildan Ilhamsyah	20	80	60	80	0.75
Neza Min Abdiva	30	70	40	70	0.571429
Indah Umairah	40	60	20	60	0.333333
Tanaya Nafi' Wibowo	60	70	10	40	0.25
Ghina Annisa Rahma	20	100	80	80	1
Naira Widya Kusuma	20	30	10	80	0.125
Davina Ramadyanti Luqyana	0	50	50	100	0.5
Luthfia Zani Ramadhani	0	50	50	100	0.5
Sindi Nurfaidah	0	70	70	100	0.7
Nur Khanifatul Jannah	30	80	50	70	0.714286
Revalina Bica Kristina	30	90	60	70	0.857143
Rejeki Findriyan	40	90	50	60	0.833333
Adhe Maylina Nur Afifah	60	80	20	40	0.5
Hanipah Maisa	70	80	10	30	0.333333
Nurafiyanti	20	60	40	80	0.5
Readina Rukhanita	20	60	40	80	0.5
Rizq Nana Nazura	10	80	70	90	0.777778
Yuni Kurniawati Dewi	10	70	60	90	0.666667
Zidan Ahmad Fahrizal	0	60	60	100	0.6
Lina Marlina	0	60	60	100	0.6
Ghifari Adib Al Hibban	0	50	50	100	0.5
Dona Octavia Rohmah	20	80	60	80	0.75
Auliya Syakilata Ahda	30	70	40	70	0.571429
Rahma Fauziyah	40	60	20	60	0.333333
Itsna Azkia Nabila	40	80	40	60	0.666667
Mutiara Az-Zahra	40	80	40	60	0.666667
Rifki Ardiansyah	0	50	50	100	0.5
Rayyis Yafa Ishmah Azfa	0	60	60	100	0.6
Muhammadsamsulma'arif	0	80	80	100	0.8
Ahmad Wafiq Rafi Ardani	0	80	80	100	0.8
Silvia Yunita Fernanda	10	70	60	90	0.666667
Cynta Marsyah Alhamdi	10	70	60	90	0.666667
Sri Rahayu Rahmadhani	10	80	70	90	0.777778
Aji Pamungkas	20	80	60	80	0.75

Tabel 3  
*Recap of student interviews results (next page)*

No	Technology Acceptance Indicators	Description	Interview Results	Number of interviewees
1	Perceived Usefulness	Practical use	The tool is helpful and very practical, with minimal use of displays. It can be accessed via smartphone and offers attractive 2D and 3D displays.	5-100%
2	Perceived Ease of Use	Its features make it easy to use. Attractive, not dull.	Interesting, not boring.	5-100%
3	Attitude Toward Using	Attitudes towards AR	The experience is very enjoyable and encouraging, making learning feel like playing.	5-100%
4	Behavior Intention	Behavioral Intention	Stimulates interest in using AR applications.	5-100%
5	Actual use	Further Implementation	It is hoped that teachers and students will utilize it.	5-100%

Source: Processed data (2023)

Perceived usefulness refers to the perception that using a system can improve performance (Krisnawijaya & Dewi, 2019). Nurzanah and Sosianika (2019) stated that perceived usefulness is the extent to which a user believes that using a specific technological system will enhance user performance. Meanwhile, according to Samar, Ghani, and Alnaser (2017), perceived usefulness is defined as an attitude that refers to a person's positive or negative feelings toward carrying out a certain behavior.

This finding aligns with the opinion of Permatasari and Prajanti (2018) that perceived ease of use is defined as the extent to which a person believes that using technology will be effortless. This implies that if someone perceives a technology as easy to use, they are more likely to use it. Perceived usefulness is considered the primary factor in increasing interest in using technology (Raza, Umer, & Shah, 2017). Attitudes towards the use of an application can be influenced by the positive response experienced by users, either directly or indirectly, towards the existence of the application (Wulandari, Japariato, & Tandijaya, 2022). This is because augmented reality applications can enhance interaction and motivation. Saltan and Arslan (2017) found evidence that the use of AR enhances academic performance, students involvement, motivation, and satisfaction.

*Students' perceived ease of use of AR applications.* The research results show that, according to students, the AR platform is easy to use. By simply scanning the barcode

provided by the educator, the learning material will automatically appear on each student's cellphone. According to Krisnawijaya and Dewi (2019), Perceived Ease of Use refers to users' perception that the system and technology being used are easy and not burdensome. This is consistent with the findings that Perceived Ease of Use AR is easy to operate and use its features. Pasanda and Kusumawati (2020) found that perceived ease of use has a positive effect on perceived usefulness. This signals to school administrators the importance of considering Perceived Ease of Use when implementing technology for the learning process. The two aforementioned factors can be utilized as variables in research to assess user acceptance of an information system under construction or already in operation (Surendran, 2012). This finding also reinforces Diptha's (2017) conclusion that ease of use has a significant positive impact on user satisfaction.

Consistent with the findings of Hansen, Saridakis, and Benson (2018), the perceived ease of use (from TAM theory) significantly enhances (positively moderates) the impact of perceived behavioral control (from TPB theory) on the intention to use the network. There is a significant and positive relationship between perceived ease of use and attitudes toward use (Maharani & Usman, 2021). Meanwhile, the study by Tyas and Darma (2017) found that the perceived ease of use of the system has a significantly positive impact on perceived usefulness). If someone believes that an information system is useful, they will use it (Permatasari & Prajanti, 2018).

The findings of this research align with those of Davis (1989), indicating a significant correlation between perceived ease of use and current use. This implies that when someone finds a technology easy to use, it will impact the future use of that technology. The perception of being easy to use also influences the desire to use the AR application. Therefore, the perceived ease of use has a positive and significant effect on the perceived usefulness (Tyas & Darma, 2017) and also has a significant positive effect on the attitude toward use (Maharani & Usman, 2021).

*Attitudes of students toward using AR applications.* The research results also indicate that when teachers utilize AR as a learning medium or as a pretest and posttest platform, students feel at ease and are able to follow the flow of the AR. Students only need to understand the relatively easy steps, which most students are enthusiastic about working on. Students believe that they do not feel pressured when taking the pretest and posttest because the AR interface is visually appealing and allows students to have fun. In addition, the use of AR can promote a sense of competitiveness by enabling users to answer questions. According to Krisnawijaya and Dewi (2019), "Attitude toward Using" refers to a positive or negative attitude toward a product. This can be applied to predict a person's behavior or intention to use or not use a product. Nustini and Adhinagari (2020) stated that trust is essential for information technology users to enhance individual performance. If the user has a positive impression, it does not rule out the possibility that someone will be interested in using the application (Wulandari *et al.*, 2022). Apart from that, attitude towards technology can be interpreted as a person's positive or negative feelings towards using it, which can influence their behavior (Jundullah, Umar, & Yudhana, 2019). Therefore, the level of acceptance of e-learning by students, as measured by the Attitude Toward Using factor, is classified as high (Lee & Wella, 2018). However, the results of this study are not consistent with the findings of Tyas and Darma (2017), which indicate that user attitudes (attitude toward using) do not significantly affect the acceptance of information technology (IT acceptance).

*Behavioral intention to use AR applications among students.* The research results indicate that students find the use of AR as a learning tool to be highly enjoyable and engaging, with high levels of enthusiasm among the students. Behavioral intention to use refers to a person's willingness to engage in a specific behavior. An individual will engage in a behavior if they have the intention to do so. Behavioral intention is a strong predictor of system use by users (Permatasari & Prajanti, 2018). Meanwhile, according to Krisnawijaya and Dewi (2019), Behavioral Intention to Use refers to the behavioral tendency to continue using a technology. In line with the concept above, the results of this research indicate that students are enthusiastic about taking the pretest and posttest using AR and are able to follow the process seamlessly. From the information, it can be seen that students have the intention to use AR as a platform for the next pretest and posttest (also for teaching and learning process?). The users' attitude towards accepting the existence of technology can be an influential factor in generating interest in its use (Wulandari *et al.*, 2022). The user's engagement with the system will be beneficial during e-learning implementation (Alfian & Tjahjadi, 2019).

The findings of this research support Maharani and Usman's (2021) conclusion that there is a positive and significant relationship between perceived usefulness and behavioral intention to use. Additionally, they found that this relationship is mediated by attitudes toward use. There is a strong and positive relationship between the perceived ease of use and the intention to use, which is mediated by the attitude towards use. Meanwhile, the findings of Tjokrosaputro and Cokki (2020) demonstrate that the perceived ease of use and perceived usefulness influence the intention to use. Lee and Wella's (2018) research findings indicate that there is a high level of acceptance in using e-learning among students who consider Behavioral Intention factors. Daryanes and Ririen (2020) suggested that students' engagement in learning could be increased if they could track their level of success and attention. The intention to use e-money is partially influenced by the variables perceived ease of use, perceived usefulness, and perceived trust (Budiman, 2021). The intention to use is influenced by perceived usefulness and ease of use (Sumardi & Andreani, 2021). According to Widaningsih and Mustikasari (2022), attitudes toward use and perceptions of usefulness can influence the adoption of information technology. Therefore, the behavioral intentions to use the technology will be positively impacted if the technology is suitable for the task and can be seen in use (Sulistyaningsih, 2022).

*Students' actual use of AR applications.* Research findings show that AR technology can be used as a learning tool in every classroom lesson because it is easy to understand. The technology utilized in AR is just as effective as other learning system technologies. Students appreciate the ease of access and simple steps required to use AR, which makes them happy when every lesson incorporates AR. The concept is based on the idea that the actual conditions of system use are represented by measuring the frequency and purpose of technology use. The perceived ease of using the system does not significantly influence its actual usage. The perceived usefulness does not have a significant influence on actual usage. The perceived usefulness does not have a significant influence on the acceptance of information technology (IT). Meanwhile, the user's attitude toward using information technology does not significantly influence the acceptance of IT (Tyas & Darma, 2017).

The results of this study corroborate the findings of Widaningsih and Mustikasari (2022) that perceived usefulness, perceived ease of use, perceived comfort, and attitudes toward use can influence the adoption of information technology. The intention to use significantly

influences usage behavior. There is a positive influence of behavioral intention on usage, as users still intend to use the system when e-learning activities are ongoing. Research by Lee, S. S., & Wella, W. (2018). shows that students who actually use e-learning have a high level of acceptance for its use. The results of this research align with Budiman's (2022) findings that intention to use influences usage behavior. This means that when someone intends to use it, it will influence their usage behavior. Jundullah *et al.* (2019) explained in their research that the level of technology usability falls under the category of satisfaction.

Behavior refers to the actions of a person. In the context of using information technology systems, behavior actually pertains to the use of technology (Permatasari & Prajanti, 2018). According to Rahman (2020), individuals engage in a behavior if they have the desire to do so. The findings of this research also corroborate the results of According to Sumardi and Andreani (2021) and Widaningsih & Mustikasari (2022), actual use is influenced by factors such as perceived ease of use, perceived usefulness, attitude toward use, and intention to use.. This indicates that when an individual perceives ease of use, usefulness, attitude toward use, and positive intention to use technology, including AR applications, they are more likely to apply the technology in the real world. In other words, when an augmented reality (AR) application is perceived as easy to use, the benefits are significant. It will foster a positive attitude towards using it, and a person's intention to use the AR application in learning activities will also increase. This implies that when students and teachers, as technology users, find the AR application easy to use and beneficial, it will foster a positive attitude towards the AR application. This, in turn, will increase the intention and impact of implementing the AR application as a learning platform.

According to the Technology Acceptance Model (TAM) perspective, the AR application as a learning medium meets the acceptance criteria, which include perceived ease of use, perceived usefulness, attitude toward use, intention to use, and actual use.. The acceptance of this augmented reality (AR) application indicates that AR is not only user-friendly but also serves as an enjoyable learning platform, capturing students' interest as if they were playing games. The additional benefit is that students can explore their potential, leading to an increase in students learning outcome as evidenced by the posttest results.

## **CONCLUSION:**

The conclusions of this research are that AR is effective interactive learning media. The effectiveness of the AR application can be seen in the higher posttest results. Second. The AR application represents an innovative learning tool that has been found to be more enjoyable, as indicated by the results of the TAM analysis. The analysis revealed that student acceptance is quite positive across various dimensions, including Perceived Usefulness, Perceived Ease of Use, Attitude Toward Using, Behavior Intention, and Actual Use. It is recommended to implement AR applications in the student learning process. Universities need to encourage and motivate educators about the importance of innovation in learning to support the achievement of educational goals.

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