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Technology readiness for augmented reality integration in instructional design: Students' perception

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Abstract

This research aims to explore perception of students' technology readiness in integrating instructional design based Augmented Reality (AR). This research was qualitative research. The technique of collecting data used interview technique. The sample of this research was 17 students who have used augmented reality in learning in English Education Study Program of Universitas Muhammadiyah Muara Bungo. The technique of data analysis used thematic analysis. Researchers used MAXQDA 24 software to analyze qualitative data. The findings showed that four positive and two negative perceptions of integrating AR. Positive perceptions include optimism, innovation, perceived usefulness, and ease of use. Students believe AR enhances English instruction and transforms teaching in a digital era. It also helps develop technical skills through user-friendly tools and pre-built assets, enabling content creation without advanced programming. Negative perceptions include discomfort and insecurity in AR use. Discomfort arises from technical issues like scanning difficulties, device overheating, image freezes, internet dependency, hardware limitations, high data consumption, and app instability. Insecurity stems from limited technical skills and challenges in conceptualizing AR designs.

Keywords

Augmented reality, instructional design, technology readiness, 21st century learning

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Introduction

Augmented reality (AR) seeks to deliver information that is directly aligned with the physical world. Augmented reality transcends mobile computing by connecting the virtual and real worlds, both spatially and intellectually (Schmalstieg & Höllerer, 2016). AR is a technology that enables users to integrate real-world sensory experiences with virtual elements in real-time, allowing for the visualization of actual settings alongside digital things. AR integration is becoming progressively pertinent in the application of innovative learning media (Clarke, 2014). AR has the potential to enrich the educational experience by rendering it more interactive and captivating. Moreover, AR can enhance participatory learning experiences and promote active engagement. Nonetheless, this AR integration presents numerous problems with AR expertise and training for both current and prospective educators.

Successful integration of AR in education necessitates that instructors acquire technical expertise in utilizing AR tools and crafting interactive learning experiences (Carmigniani & Furht, 2011). Nonetheless, numerous educators possess insufficient training and expertise with AR technology, rendering its use in the classroom problematic. In the absence of adequate support, educators may have difficulties with technical challenges, content development, and connecting AR with curriculum. The potential benefits and challenges of integrating AR in the field of English education. AR becomes a powerful tool for enhancing student engagement, fostering deeper learning, and preparing educators for the future of digital education.

AR has garnered increasing attention in the field of education due to its potential to enhance learner engagement, provide immersive experiences, and support the understanding of abstract concepts (Akçayır & Akçayır, 2017; Radu, 2014). While a growing body of literature has explored the pedagogical benefits and technical implementation of AR in instructional settings, there remains a significant gap in understanding the technology readiness of students, particularly those preparing to become educators, in integrating AR into instructional design. Most existing studies tend to focus on the use of AR from the perspectives of in-service teachers (Bower et al., 2014), institutional implementation (Wu et al., 2013), or learner outcomes after exposure to AR-based instruction (Garzón & Acevedo, 2019). However, little is known about how ready pre-service teachers or university students perceive themselves to be in terms of adopting and utilizing AR as a design tool in instructional planning. This is a critical oversight, given that these students will be key actors in the future implementation of educational technology.

Furthermore, prior research rarely applies established frameworks, Technology Readiness Index (TRI) to assess the psychological and behavioral predispositions of students toward AR adoption (Parasuraman, 2000). Even fewer studies investigate this in the context of instructional design rather than AR usage alone. This limited attention to the perceptions and readiness of students in educational settings, especially in developing countries where access, training, and familiarity with AR tools may vary widely, highlights a critical gap in the literature. The integration of AR in education has significantly transformed the way students engage with learning materials. AR enhances instructional design by providing interactive, immersive, and visually rich learning experiences (Dunleavy & Dede, 2014). As education

increasingly transitions to digital learning environments, AR has gained increasing attention for its potential to bridge the gap between theoretical knowledge and practical application. However, the effectiveness of AR integration depends on students' technology readiness, which refers to their ability and willingness to adopt new technologies in learning (Parasuraman & Colby, 2015).

This research aims to explore students' perceptions of technology readiness in integrating AR into instructional design. It examines both positive and negative perceptions in integrating AR-based instructional design. The findings will provide insights into how AR can be better integrated into educational settings, addressing potential barriers while maximizing its benefits for learning and teaching. The research will provide actionable recommendations for educators and institutions to optimize the integration of AR in instructional design.

The novelty of this research lies in its dual emphasis: (1) understanding students as future educational designers and implementers of AR, and (2) utilizing a validated readiness framework (TRI) to analyze their readiness. This research contributes to the body of knowledge by providing empirical data on student readiness, identifying potential barriers and enablers, and offering implications for teacher training, curriculum development, and technology support systems in higher education. This study aims to explore students' perceptions of their technology readiness in integrating Augmented Reality (AR) into instructional design. Specifically, the research is guided by the following questions:

1. What are students' positive perceptions regarding their technology readiness for integrating Augmented Reality into instructional design?
2. What are students' negative perceptions regarding their technology readiness for integrating Augmented Reality into instructional design?

Literature Review

Technology readiness

Technology Readiness is a critical construct in understanding individuals' acceptance and adoption of emerging technologies. Introduced by (Parasuraman, 2000), Technology Readiness is defined as "people's propensity to embrace and use new technologies for accomplishing goals in home life and at work". This construct provides a comprehensive psychological framework that identifies not only users' enthusiasm for technology but also their apprehensions, making it highly relevant in the context of educational technology integration. The Technology Readiness Index (TRI), developed by Parasuraman, comprises four dimensions: optimism, innovativeness, discomfort, and insecurity. Optimism refers to a positive belief in the benefits and efficiency of technology, while innovativeness reflects a tendency to be among the first to adopt new technologies. Conversely, discomfort indicates a perceived lack of control over technological tools, and insecurity reflects skepticism or distrust toward the functionality and reliability of technology (Parasuraman, 2000). The interplay of these enablers and inhibitors determines an individual's overall level of technology readiness.

In education, particularly in higher education and teacher training, technology readiness plays a pivotal role in shaping how pre-service teachers and students approach instructional design involving digital tools. Studies have demonstrated that technology readiness significantly affects attitudes toward the use of learning technologies, such as learning

management systems (LMS), virtual reality (VR), and augmented reality (AR) (Joo, Park, & Lim, 2018; Lin, Shih, & Sher, 2007). Individuals with high levels of optimism and innovativeness are more likely to perceive technology as beneficial and show greater willingness to experiment with it in pedagogical practices (Walczuch, Lemmink, & Streukens, 2007). Despite the growing integration of advanced tools such as Augmented Reality in education, there is a limited number of empirical studies that specifically examine students' technology readiness in relation to AR integration in instructional design. Existing research has largely focused on measuring learning outcomes or evaluating AR applications, rather than assessing students' psychological preparedness to utilize AR as an instructional design tool (Garzón & Acevedo, 2019; Akçayır & Akçayır, 2017). This presents a significant gap in the literature, particularly because successful integration of AR in learning environments requires not only access to technology but also user readiness and confidence.

Moreover, most studies on technology readiness have been conducted in commercial or service industries, with relatively fewer applications in the education sector. As such, there is a growing need for research that contextualizes the TR construct within the domain of educational technology, especially in developing countries where digital literacy, infrastructure, and support systems may differ significantly from those in more developed regions (Adukaite et al., 2017). Therefore, exploring students' technology readiness in relation to AR integration can provide critical insights into both the enablers and barriers that influence their engagement with this emerging technology. It can also inform instructional design practices, curriculum planning, and teacher education programs that aim to incorporate AR in meaningful and sustainable ways.

Augmented reality in higher education

AR has gained increasing attention in higher education due to its ability to enhance learning experiences by overlaying digital content onto the real world. AR enables students to interact with three-dimensional models, simulations, and real-time data, making abstract concepts more tangible (Aukstakalnis, 2016). Studies have shown that AR can improve student engagement, motivation, and knowledge retention, particularly in fields such as science, engineering, medical education, and language learning (Schmalstieg & Höllerer, 2016). The successful implementation of AR in higher education depends on several factors, including technology accessibility, institutional support, and students' readiness to adopt new digital tools (O'Shea, 2011). While AR has demonstrated its potential to revolutionize education, further research is needed to explore best practices for integrating AR into diverse academic disciplines and addressing challenges related to cost, usability, and scalability.

In instructional design, AR provides opportunities for active learning, allowing students to develop digital content and interact with immersive environments (Jerome & Greenberg, 2021). AR fosters higher-order thinking skills, problem-solving abilities, and collaboration, which are essential for 21st-century education. However, the successful integration of AR in higher education depends on students' technology readiness, as their willingness and ability to adopt AR tools play a critical role in determining its effectiveness (Dunleavy & Dede, 2014). Higher education institutions must provide adequate training, technical support, and user-friendly AR tools to ensure that students can leverage AR effectively. Incorporating step-by-

step tutorials, guided exercises, and collaborative AR projects can enhance students' confidence and encourage experimentation with AR-based learning materials (Mealy, 2018). Additionally, integrating AR within learning management systems (LMS) and other familiar digital platforms can help students transition smoothly into using AR for instructional design.

Instructional design integrated augmented reality

Instructional design are materials that can be used by educators to convey lesson material to students with the aim of helping learning occur (Stefaniak, 2024). Instructional design includes all resources that can be used to support the delivery of instruction, including textbooks, images, graphics, video, audio, and information technology (Brown & Green, 2019). Therefore, it can be concluded that learning media can be print, audio, visual or multimedia media which provide variations in the delivery of information. The aim of using instructional design is to facilitate understanding, improve memory, and build students' skills through a more varied and interesting approach (Redding, 2018). Based on various expert views, it can be concluded that instructional material has many important functions in supporting the learning process. The use of appropriate and innovative instructional design can strengthen students' understanding of subject matter, facilitate interaction between teachers and students, and maintain students' interest and concentration in learning. Instructional design can also improve students' memory through the use of images, videos and audio which stimulate students' sense of sight and hearing.

Instructional design has an important role in supporting learning that focuses on students' understanding (Mayer, 2014b). By proper development and application, instructional design can be an effective means of increasing students' understanding of instructional material. In exploring the role of instructional design in increasing students' understanding, it is important to explore concepts related to the effectiveness of learning media (Betrancourt, 2012). One concept that can be a guide is multimedia learning theory. This theory emphasizes that the use of instructional material that presents information through various sensory channels such as visual and audio simultaneously can facilitate students' understanding (Mayer, 2014a; Mayer & Moreno, 1998). In this context, it is important for teachers to pay attention to the design and use of instructional material that can optimize multisensory interaction. Instructional design in the 21st century reflects the evolution and development of information and communication technology (Marikyan & Papagiannidis, 2023). Education in this era is increasingly integrating technology in the learning process to increase student engagement, facilitate access to information, and develop skills that are relevant to the demands of the times. Instructional design integrated AR is a form of instructional design that is very relevant and reflects technological developments in the 21st century. One of the new multimedia technologies is augmented reality (Carmigniani & Furht, 2011). By combining 2D or 3D virtual objects into the real world, AR technology can project or display these virtual objects in real time.

Methodology

Research design, site, and participants

This research was qualitative research. The research employed a descriptive qualitative approach, allowing for an in-depth understanding of students' experiences. This research was conducted at the English Education Study Program, FKIP, Universitas Muhammadiyah Muara Bungo. Respondents were selected using a purposive sampling method, focusing on students who had experience in using AR for instructional design. The participants were selected using several criteria, namely: (1) Student of the English Language Education Study Program at Muara Bungo Muhammadiyah University; (2) Students who have used augmented reality in learning (user); (3) Students who have created instructional materials integrated augmented reality (creator). The total number of respondents was 17 students.

Data collection and analysis

Researchers collected the data by using interview (Creswell, 2009). Semi-structured interviews (in-depth interviews) are less rigid than structured interviews (Creswell, 2012). The purpose of a semi-structured interview is to explore a topic more openly and allow the interviewee to express their opinions. This research used an interview protocol as research instrument. The qualitative data was obtained by conducting forum group interview using semi-structured interview. The researchers conducted forum group interviews twice consisting of 9 students as participants in part 1 and 8 students as participants in part 2. The forum group interview was conducted and recorded using zoom meeting. The data were recorded in the form of videos. The researchers did the transcriptions of the students' utterances to serve as data. For qualitative data analysis, the researchers used thematic analysis as suggested by (Creswell, 2012). The stages including organizing data for analysis, coding process, using codes to develop descriptions and themes of data, represent findings through narrative and visuals, make interpretations, and validate the accuracy of the findings. Researchers used MAXQDA 24 software to help the researchers in coding process. Researchers set six themes on MAXQDA software to make code system. Researchers identified the code the data from the transcription. After finish in coding process, researchers presented the findings by using visual tools.

Findings

This Research aimed to explore students' perceptions of technology readiness in integrating AR into instructional design. This result presents an in-depth analysis of the experiences of English Education students in designing instructional design that is integrated with AR technology. Findings of this research showed various positive and negative perception related to the design process, including technical challenges and technology readiness. These findings showed six themes in exploring students' perception: optimism in AR, innovation of AR, discomfort in AR use, insecurity in AR use, perceived of use, and perceived ease of use.

Students' positive perception

The findings of the study reveal a generally positive perception among participants toward the integration of AR, particularly highlighting four key dimensions: optimism, innovation, perceived usefulness, and ease of use. These aspects reflect a favorable attitude and readiness to embrace technological advancements, suggesting that users not only recognize the practical benefits of the technology but also feel confident and enthusiastic about its implementation. Such positive perceptions are essential, as they play a significant role in influencing users' willingness to adopt and effectively utilize emerging tools in educational and professional contexts.

Optimism in AR, the researchers present the findings obtained from the theme of optimism in AR. There are four sub-themes obtained from the interview results. The following table is a sub-theme of the optimism theme in AR.

Table 1. *Optimism in AR*

Themes	Sub-Themes
Optimism in AR	AR is more widely used
	Used for future teaching
	More ideas in the future
	Taught in Higher Education

The theme "optimism in AR technology" in the context of English language instruction reflects students' positive attitudes and forward-looking perspectives on the integration of AR in education. This theme, explored through four sub-themes - AR is more widely used, used for future teaching, more ideas in the future, and taught in higher education - highlights students' Perception on AR's expanding role and its potential in reshaping instructional approaches and educational environments. It as a transformative tool that will be widely adopted, instrumental for future teaching, a source of innovative educational ideas, and increasingly integrated into higher education curricula (Smink et al., 2022). This optimism emphasizes students' belief that AR technology will not only enhance English language instruction but also reshape how future generations approach learning and teaching in an increasingly digital era. The following statement was found in data 1.

"Berharap lebih banyak lagi digunakan oleh para pengajar gitu mem"
(Hope it will be used more by teachers like that)- Data one

The data showed the respondents' hopes that AR technology can be adopted more widely by teachers in the learning process. Respondents see the great potential of AR to enrich students' learning experiences through a more interactive and engaging approach. The use of AR by teachers can provide benefits, increase the appeal of the material, help students understand the material more easily, and provide a deeper learning experience through 3D visualization and animation. It is the respondents' optimism about the acceptance of new technology in education. Supporting statement was also found in data 2.

> *"Karena kelihatannya seru mem untuk diaplikasikan mengajar kalau nanti untuk PLP misalnya atau nanti di masa yang akan datang gitu mem"*
> (Because it looks fun to apply it to teaching, for example for PLP or in the future)- Data two

Based on the data above, it showed that students' enthusiasm for the use of AR-based learning media in the future. Respondents see AR as a technology that can provide an interesting and interactive teaching experience, especially in PLP or teaching practice in schools. The use of AR is considered "exciting" because it presents material more visually and dynamically, which can increase student interest and learning effectiveness. This indicates students' optimism that AR has great potential to be applied in future teaching.

Innovation of AR, the researchers present the findings obtained from the innovation of AR theme. There are five sub-themes obtained from the interview results. The following table is a sub-theme of the innovation of AR theme.

Table 2. *Innovation in AR*

Themes	Sub-Themes
Innovation of AR	As an innovation in learning
	Many students are beginners in using AR
	AR as an invention because has not been widely used in learning media
	A new experience in AR designing

The theme "innovation in AR technology" encapsulates students' perspectives on AR as a pioneering force in education. Students view AR as a groundbreaking learning tool that, although still new and unfamiliar to many, holds great promise for reshaping educational practices. From being an innovation in learning media to offering new opportunities for design, AR is seen as a versatile and underutilized tool with the potential to transform education by making it more interactive, engaging, and applicable to real-life scenarios (Wyss et al., 2021). Students' experiences reflect both the challenges and excitement of integrating an innovative technology that has yet to be widely adopted in learning, but that offers significant promise for future educational practices. The following statement was found in data 3.

> *"Ini adalah inovasi baru dalam pembelajaran yang membuat pembelajaran menjadi lebih menyenangkan"*
> (It is a new innovation in learning that makes learning more fun.)-Data three

The use of AR in English learning provides many benefits and offers an innovative learning experience. Innovative AR technology often triggers students' curiosity and enthusiasm, thereby increasing their motivation to learn. Students' perceptions of AR as an innovation in English learning are generally positive if the technology is used effectively and relevantly to the learning material. AR integration can enrich the learning experience and help students acquire English skills in a more engaging and effective way.

Perceived of use, the researchers present the findings obtained from the perceived of use theme. There are ten sub-themes obtained from the interview results. The following table is a sub-theme of the perceived of use theme.

Table 3. *Perceived of use*

Themes	Sub-Themes
Perceived of Use	AR inspires enthusiasm for learning
	Improve teaching abilities
	Easier to understand the material
	Arouses curiosity
	Increase learner engagement while learning
	Improve instructional design skills
	Improve critical thinking skills
	Improve creative thinking skills
	Improve cognitive skills
	Improve instrumental skills

The theme "Perceived Use of AR in Education" explores students' perceptions of the benefits and positive impacts of integrating AR into instructional material design. AR technology has been perceived as a tool that sparks excitement and motivation in both educators and learners. The interactive and immersive nature of AR creates a dynamic learning environment that reduces monotony and fosters a sense of enthusiasm during the learning process. It provides visual and interactive content that supports clearer explanations and better student comprehension. The visualization of 3D models and interactive elements helps bridge the gap between theory and practice, making content more accessible. AR has a unique ability to stimulate curiosity and a desire for exploration. AR minimizes distractions and sustains attention by providing hands-on experiences that align with real-world scenarios. Designing AR-integrated instructional materials challenges students to think critically about content presentation, organization, and delivery. The following statement was found in data 4.

> *"Pas dicoba game interaktifnya di kelas jadi seru mem, jadi bisa buat kuis mem"*
> (When I tried the interactive game in class, it was really fun, so I could use it for a quiz)- Data four

The respondent's statement reflects positive experiences in implementing AR-based interactive games in the classroom. Respondent highlighted how interactive game features can make the learning atmosphere more exciting and interesting for students. One form of implementation mentioned is the use of AR to create quizzes, which allows students to actively participate in the learning process. With the interactive element, students not only receive information passively but are also involved in activities that encourage a deeper understanding of concepts. This shows that the integration of interactive games in AR-based learning can increase student engagement, motivate them to learn, and create a more dynamic and enjoyable classroom atmosphere. Supporting statement was also found in data 5.

> *"Belajarnya itu lebih ingin tahu itu tuh terbuat dari apa kok bisa bergerak gerak gitu kan lebih meningkatkan apa ya eee meningkatkan suasana menyenangkanlah dalam kelas"*
> (Learning is more curious what it is made of, how it can move like that, it will improve what, eee, it will improve the fun atmosphere in class)-Data five

The data showed how the use of AR-based learning media can increase learners' curiosity. AR-based learning media can display objects that move and interact visually, so students are encouraged to explore and understand more deeply about how the objects move and how AR technology brings learning materials to life. This interest not only adds to the fun atmosphere in the classroom, but also stimulates a deeper curiosity about the material being taught. When students are actively involved in the exploration and understanding process, students tend to be more motivated and enthusiastic in participating in learning.

Perceived ease of use, the researchers present the findings obtained from the perceived ease of use theme. There are two sub-themes obtained from the interview results. The following table is a sub-theme of the perceived ease of use theme.

Table 4. *Perceived ease of use*

Themes	Sub-Themes
Perceived Ease of Use	Easy to use as a user
	Easy to design AR

The theme "Perceived Ease of Use " explores students' perceptions of how user-friendly AR tools and platforms are, both from the perspective of general usability and the process of designing instructional materials integrated with AR. Students generally perceive AR applications as intuitive and easy to navigate, especially when using pre-designed AR content. The user-friendly interfaces, simple controls, and clear instructions provided by many AR tools make it accessible even for beginners (Hill, 2022). From a design perspective, students found that certain AR platforms offer simplified tools and templates that streamline the AR creation process. Pre-built assets, libraries of 3D models, and user-friendly design interfaces enable students to create interactive AR content without requiring advanced programming or design skills. However, while some platforms are easy to use, students noted that a basic understanding of design principles and AR integration techniques is still necessary to maximize the tools' potential. The following statement was found in data 6.

> *"Assembler ini mem aplikasi AR yang gampang banget mem, salsa pernah coba-coba dulu aplikasi lain, susah mem harus tau Bahasa pemogramam gitu mem"*
> (This assembler is a really easy AR application, Salsa has tried other applications before, it's difficult, you have to know the programming language)-Data six

The data indicated that the ease of use (user-friendliness) of an application is an important factor in their technological readiness in designing AR. Respondents compared Assembler with other AR applications that require programming knowledge, and they felt that Assembler was much easier to use. It indicated that accessibility and an intuitive interface can increase

their confidence and motivation in exploring AR technology. In addition, previous experience with more complex applications made them appreciate the ease offered by Assembler. Thus, the existence of applications that do not require high-level technical skills is one of the main factors that encourage student engagement and readiness in adopting AR in learning.

Students' negative perception

Negative perceptions regarding the use of Augmented Reality (AR) are often characterized by feelings of discomfort and insecurity. These perceptions can hinder the effective adoption and integration of AR in educational and technological settings. Discomfort may stem from technical issues, unfamiliar user interfaces, or the physical strain associated with prolonged AR usage. Insecurity, on the other hand, is frequently associated with users' lack of confidence in their technical abilities, concerns about data privacy, or difficulties in understanding and applying AR design concepts. Recognizing and addressing these negative perceptions is essential to ensuring a more accessible and user-friendly AR experience.

Discomfort in AR use, the researchers present the findings obtained from the discomfort in AR use theme. There are eight sub-themes obtained from the interview results. The following table is a sub-theme of the discomfort in AR use theme.

Table 5. *Discomfort in AR use*

Themes	Sub-Themes
Discomfort in AR use	Difficulty when scanning barcodes
	Cellphone heats up
	The image is stuck
	Internet signal interference
	Need compatible cellphone specifications
	Paid features
	Requires a large internet quota
	The application often exits by itself

The theme of "Discomfort in AR Use" reveals a range of technical and practical challenges that students encounter while using AR technology. While students see the potential of AR to enrich their learning, difficulties with scanning, device overheating, image freezes, internet dependency, hardware requirements, paid features, high data consumption, and application instability all hinder their ability to fully benefit from AR's advantages. Addressing these issues would enhance the usability and accessibility of AR, helping students to have a more consistent and positive experience with this emerging educational technology (Montalbo, 2024). The following statement was found in data 7.

> *"Sedikit kesulitan mem untuk men-scan gambarnya mem jadi gambar yang telah diberikan itu lama sekali baru keluar"*
> (It was a little difficult to scan the image so the image that was provided took a long time to come out)-Data seven

The data above reveal technical constraints in using AR when scanning barcodes. Respondents experienced delays in displaying AR objects after the scanning process, which caused discomfort and disrupted the learning flow. This problem can be caused by several factors, such as slow internet connections, less than optimal mobile phones. Delays in displaying images make the learning experience less efficient, even though AR should be designed to provide fast and easy interactions. These kinds of constraints show that although AR has great potential, there are technical challenges that need to be overcome to improve the user experience. Supporting statement was also found in data 8.

> *"Fitur-fiturnya juga terkendala itu karena kebanyakan yang seru itu malah premium gitu mam untuk yang free-nya terbatas"*
> (The features are also limited because most of the exciting ones are premium, ma'am, the free ones are limited)-Data eight

The data above showed that the challenges faced in designing AR-based learning media. Respondents feel that interesting or fun features in the AR platform are mostly only available in the premium version. Meanwhile, the features that can be accessed for free are limited, thus inhibiting creativity and flexibility in designing AR learning media. This indicates that limited access to premium features can affect the quality and variety of learning designs that can be created, reducing the potential for maximum use of AR to create interactive and engaging learning experiences.

Insecurity in AR use, the researchers present the findings obtained from the insecurity in AR use theme. There are two sub-themes obtained from the interview results. The following table is a sub-theme of the insecurity in AR use theme.

Table 6. *Insecurity in AR use*

Themes	Sub-Themes
Insecurity in AR Use	Lack of AR design skills
	Difficulty determining the design

The theme "Insecurity in AR Use" highlights the challenges students face when integrating AR into instructional material design. This theme emphasizes feelings of uncertainty and self-doubt that arise during the AR development process. Many students expressed insecurity due to their limited technical skills in AR design. Despite their familiarity with general design tools, AR integration requires specialized knowledge and technical expertise that students often lack (Patel, 2019). This gap creates hesitation and reduces their confidence in creating effective and engaging AR-based learning materials. Another significant factor contributing to insecurity is the difficulty in conceptualizing and finalizing an appropriate AR design. Students often found it challenging to determine how AR features should align with instructional goals and how to balance visual aesthetics with functional effectiveness (Sunger & Çankaya, 2019). These sub-themes suggest that addressing insecurity in AR use requires targeted training programs, access to user-friendly AR tools, and clear instructional design frameworks. By overcoming these

barriers, students can feel more confident and competent in integrating AR technology into educational materials. The following statement was found in data 9.

> *"Tapi pas mau bikin pembahasannya yang kesulitan karena kan belajar AR tuh baru baru ini juga memang begitu"*
> (But when I wanted to make a discussion, it was difficult because I've only just learned AR recently, and that's how it is.) – Data nine

The data above indicated that respondents have difficulty in determining the concepts and topics that will be developed into AR-based learning media. It is due to the respondents' lack of experience in learning and mastering AR technology, which they have just learned. Lack of understanding of the potential and limitations of AR as a learning medium makes it difficult for respondents to visualize and design content that is in accordance with the material to be delivered. The novelty in the use of this technology means that respondents do not yet have sufficient insight or mature ideas about how to integrate AR into learning materials effectively. This difficulty highlights the importance of deeper experience and exploration in the AR design process so that students can create media that is not only visually appealing but also relevant and useful for the learning process.

Discussion

Students' positive perception

This research showed positive perception among participants toward the integration of AR in educational settings, with four key dimensions emerging: **optimism**, **innovation**, **perceived usefulness**, and **ease of use**. These findings align with existing literature and provide nuanced insights into the readiness and receptiveness of learners and educators toward emerging educational technologies.

Optimism, in this research, reflects participants' confidence that AR can significantly enhance teaching and learning experiences. This dimension resonates with the Technology Readiness Index (TRI) proposed by (Parasuraman, 2000), which positions optimism as a positive of technology adoption. Participants in this research perceived AR as a promising tool capable of enriching instructional delivery, fostering engagement, and improving learner outcomes. This optimism may stem from AR's ability to provide immersive, interactive, and contextually rich learning experiences, as supported by (Billinghurst and Duenser, 2012), who emphasize the motivational affordances of AR in education.

The dimension of innovation underscores participants' willingness to embrace novel technologies for educational enhancement. This finding is congruent with (Davis, 1989) Technology Acceptance Model (TAM), which posits that individuals are more likely to adopt new technologies if they are perceived as innovative and capable of improving performance. The perceived innovativeness of AR, particularly its potential to bridge abstract concepts with concrete visualizations, aligns with the cognitive theory of multimedia learning (Mayer, 2009), which suggests that learning is more effective when verbal and visual materials are presented simultaneously.

Perceived usefulness, another key dimension, was prominently noted by participants, indicating their belief that AR can improve teaching effectiveness and learning outcomes. This aligns with earlier findings by (Wu et al., 2013), who demonstrated that AR contributes positively to students' academic performance and conceptual understanding. In English language learning, specifically, AR applications have shown promise in enhancing vocabulary acquisition, reading comprehension, and learner motivation (Ibáñez & Delgado-Kloos, 2018). Participants in this research perceived AR not only as a supplement to traditional instruction but also as a transformative tool that can scaffold learners' understanding of complex or abstract language concepts.

Ease of use emerged as a critical factor influencing participants' attitudes toward AR integration. Consistent with the TAM framework (Davis, 1989), perceived ease of use significantly contributes to users' acceptance of technology. The participants' positive views in this dimension suggest that AR tools used in the research were sufficiently user-friendly, thereby reducing cognitive overload and technical barriers. This finding is essential because the more intuitive and accessible the AR technology, the more likely it is to be integrated into instructional design by both novice and experienced educators (Bacca et al., 2014).

In summary, the interplay between these four dimensions optimism, innovation, perceived usefulness, and ease of use, suggests a high degree of technology readiness among participants for integrating AR into educational settings. The convergence of these positive perceptions not only supports the feasibility of AR integration but also highlights the need for institutional support in terms of training, infrastructure, and content development to sustain this enthusiasm and ensure long-term implementation success. Future research should explore how these perceptions evolve over time and investigate contextual factors, such as institutional policy, technological infrastructure, and discipline-specific needs, that may mediate the relationship between perceived readiness and actual classroom integration of AR.

Students' negative perception

While the integration of AR into educational and technological settings offers considerable potential, this research also reveals significant negative perceptions that may impede its widespread adoption. Specifically, two recurring themes, discomfort and insecurity, emerged as barriers to effective AR use. Understanding and addressing these issues is critical for fostering a more inclusive and supportive environment for AR implementation.

Discomfort among users often stems from technical challenges, such as system instability, connectivity issues, or the complexity of user interfaces. These technical barriers can create cognitive overload and user frustration, thereby diminishing the learning experience (Bower et al., 2014). Moreover, prolonged use of AR devices has been associated with physical discomfort, such as eye strain, headaches, or fatigue, particularly when immersive features are not ergonomically optimized (Dey et al., 2018). These physical and technical limitations can negatively affect user engagement and motivation, limiting the educational effectiveness of AR.

Insecurity, another significant negative perception, frequently arises from users' limited confidence in their ability to effectively navigate and utilize AR technologies. This aligns with the concept of "technology anxiety" described by (Meuter et al., 2003), which refers to the

apprehension individuals experience when required to use new or unfamiliar technological tools. Participants in this study reported feeling overwhelmed by AR's design requirements and expressed concern about their ability to apply these tools effectively in instructional settings. Such insecurity can be especially pronounced among educators or learners with limited prior exposure to digital tools. Concerns related to data privacy and security further compound feelings of insecurity. As AR systems increasingly rely on personal data and location-based services, users may be hesitant to adopt them due to perceived threats to their privacy (Craig et al., 2009). These anxieties are not unfounded; studies have noted that ethical and security considerations in AR have yet to be adequately addressed in many mainstream applications (Yoo & Kim, 2019). Without transparent data governance and user-friendly privacy settings, trust in AR technologies may remain limited.

Furthermore, challenges in understanding and applying AR design principles represent another layer of insecurity. The creation of effective AR content often requires users to possess a combination of technical, pedagogical, and design skills (Akçayır & Akçayır, 2017). For many users, especially those without prior training, the complexity of AR design tools can create a steep learning curve, reinforcing negative attitudes toward adoption. These findings underscore the importance of user-centered design and capacity-building initiatives to support AR integration. Providing comprehensive training, intuitive interfaces, and ergonomic hardware can help alleviate discomfort, while promoting digital literacy and ensuring transparent data protection protocols can address feelings of insecurity. As (Selwyn, 2016) emphasizes, technological integration in education must be accompanied by critical reflection on its social, psychological, and ethical implications. Without addressing these concerns, the potential of AR to transform learning may remain unrealized for many users. In general, the negative perceptions of AR, manifested through discomfort and insecurity, highlight the need for more empathetic and inclusive approaches to educational technology design and implementation. Recognizing and mitigating these barriers is essential to ensuring that AR is not only innovative but also accessible, sustainable, and equitably beneficial.

Conclusion and Recommendations

This research explored students' perceptions regarding the integration of AR in educational settings. Students expressed generally positive attitudes toward AR, emphasizing its potential through four key dimensions: optimism, innovation, perceived usefulness, and ease of use. These dimensions indicate a strong readiness to adopt AR as a tool for enhancing teaching and learning experiences, driven by its capacity to deliver immersive, engaging, and visually enriched content. On the other hand, the research also identified negative perceptions, primarily characterized by feelings of discomfort and insecurity. Discomfort often stemmed from technical complexities, physical strain, or interface difficulties, while insecurity was linked to a lack of confidence in using AR technologies, concerns about data privacy, and difficulty understanding AR design principles. These findings showed that while AR holds significant promise, its adoption is hindered by psychological, technical, and usability-related barriers. several recommendations are proposed to support the effective implementation of AR in education: Provide comprehensive training and support systems for both educators and

learners, investigate pedagogical effectiveness, develop and evaluate professional development models.

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