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Mixed Reality Technology and Its Opportunities to Improve Soft Skills

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Abstract: Mixed reality is a technology that combines virtual and augmented reality. Mixed reality provides students with the opportunity to engage in direct treatment within various practical processes. The use of mixed reality is often implemented in courses that are abstract in nature, require expensive equipment and materials, or involve dangerous practicum activities. This research is a literature study using a systematic literature review to provide an overview of the use of mixed reality in learning. The sample used consisted of Scopus articles in the last 20 years from various branches of science from various countries. Data were analyzed quantitatively and descriptively. The research results showed that 16 articles using mixed reality were relevant to the research objectives. The study notes that the application of mixed reality has been conducted in several fields, most frequently in the medical field. The use of mixed reality can enhance scientific attitudes, cognitive abilities, performance, and more.

Keywords: Mixed reality, Technology, Soft skills,

Introduction

One kind of hybrid environment is called mixed reality (MR), in which interactive virtual items can be transferred to the actual world, combining the virtual and the real. Over the past 20 years, MR has seen further changes in principle (Milgram et al., 1995). While the initial Milgram et al. (1994) notion of MR was limited to visuals, modern MR encompasses a variety of human-computer interface (HCI) techniques, including gestures, spatial sound, and environmental input (Cheng et al., 2020). The primary application of AV is in entertainment. AR is more widely used than AV because AV has been adopted by a significantly smaller range of fields than AR. Because of this, it can occasionally be difficult to distinguish between AR and MR (Raja, 2024). As an illustration, Microsoft introduced the HoloLens (Microsoft, 2017) head-mounted device (HMD), which is classified as an MR device even though it overlays virtual data on the physical world—an application that falls under Milgram's definition of augmented reality.

Recent developments in MR have great potential to be significant in a number of fields, including training and education. According to recent studies, VR/MR can effectively improve secondary school pupils' effectiveness and learning attitudes. While there have been studies looking at how effective university students are at learning, there hasn't been much research done on them comparing the MR or ER experience with standard teaching methods in learning design courses (Fernández-Batanero et al., 2024). MR is an innovative approach that incorporates content learning along with the application of practical instruments for realization (Dalinger et al., 2020). The development of mixed reality research can be seen in Figure 1 below.

Figure 1. MR's position is between the physical environment and the virtual environment

One kind of hybrid system that combines virtual and physical components is called mixed reality (MR). A sliding scale between a wholly virtual and fully physical environment and one that is entirely tangible is how many experts define mixed reality (Rokhsaritalemi, 2020). An explanation on MR was given in (Milgram et al., 1995) many years ago. It was described as a linear continuum, with fully real environments (reality) and fully virtual environments (virtuality) at either end. The Even after many years, the definition of the traits of MR remains true. Within the reality-virtuality-continuum, MR applications have a higher proportion of real aspects; for example, virtual objects situated in the real world can be classified as augmented reality (AR). On the other hand, augmented virtuality (AV) describes the integration of real-world physical things into a virtual environment. Despite the defnition of MR evolving, it is still possible to observe the major characteristics of MR. Parveau and Adda (2018) classifed MR into 3iV classes: First, it consists of both real and virtual contents and allows data contextualization. Second, the digital content is required to be interactive in real time. Third, the content needs to be spatially mapped and correlated with the 3D space.

Figure 3. Hololens device for MR/eR

Mixed reality (MR) is widely used for training and education, and early research suggests that it is an effective teaching tool (Ke et al., 2016; Robinson et al., 2020). Research of (Awang et al., 2018; Cecil et al., 2013; Roberts et al., 2010) investigated how to use a virtual learning environment (VLE) in education to work together on problems related to training, education, and entertainment utilizing VR and AR technologies. The findings showed that learners' comprehension of some events might be improved, motivated, and stimulated by the suggested VLE in ways that the traditional learning technique could not readily accomplish. Under the virtually entertaining environment, users can learn quickly and engagingly. Several studies on MR show that MR has a very good effect on improving students' abilities in various fields such as medicine, biology, genetics, earth, physics, art chemistry and even in educational training. The use of MR in the world of health and medical sciences has been widely carried out, including research by (Veer et al., 2022) using MR to increase students' knowledge of the content of physiology, anatomy, pharmacology and pathology. Researchers use MR to describe the impact of asthma on the anatomy of the bronchioles and the effectiveness of the drugs used and management of asthma attacks. The potential use of MR can be widely adopted in education, from primary school to higher education levels.

Science learning in Indonesia varies depending on the region and the teacher's abilities (Ahmad Ahid Syaifulloh et al., 2023; Husaen & Yuliani, 2023). However, in general, science learning is assisted using simple technology both in the learning process and in practical activities. Practical activities cannot be carried out on all materials due to several things such as tools and materials that are not available, labor that is still very simple, activities that involve dangerous materials and resources that are still inadequate (Meyer et al,2018). These limitations can be overcome by providing an online (virtual) practicum environment. The weakness of virtual laboratories is that students cannot directly experience or carry out practical activities directly. The use of immersive technology in the form of mixed reality is able to overcome the weaknesses of virtual practicum activities. Unreal performance from virtual practicum can be overcome with immersive practicum. The discovery of MR technology is very necessary in implementing practicums in science learning. This research aims to look at opportunities for using mixed reality in practical activities in science learning in Indonesia.

Method

This research work uses a procedure known as a literature study or systematic review, which involves searching several search keywords in journals published after 2004 on Google Scholar. The results are displayed in Table 1. Numerous academic databases, including Scopus, IEEE Explore, Science Direct, Sage Pub, and others, are still accessible through Google Scholar. The use of keywords for the mixed reality science education focus. Eleven journals from diverse academic subjects made up the research sample, which demonstrated how using MR affected different students' soft skills. Both quantitative and qualitative data analysis was done to identify potential uses of MR in science education in Indonesia.

Results and Discussion

Based on the data, it was found that in Mixed Reality research, the software used varied. Specifically, 54% of studies used HoloLens, 7% used Mursion, 13% used Smallab, and 13% used Unity 3D and unidentified software 13%. The percentage of HoloLens usage of 54% reflects the dominance of this device in Mixed Reality research. HoloLens, as a high-class Mixed Reality device developed by Microsoft, offers an immersive and interactive three-dimensional visualization experience.

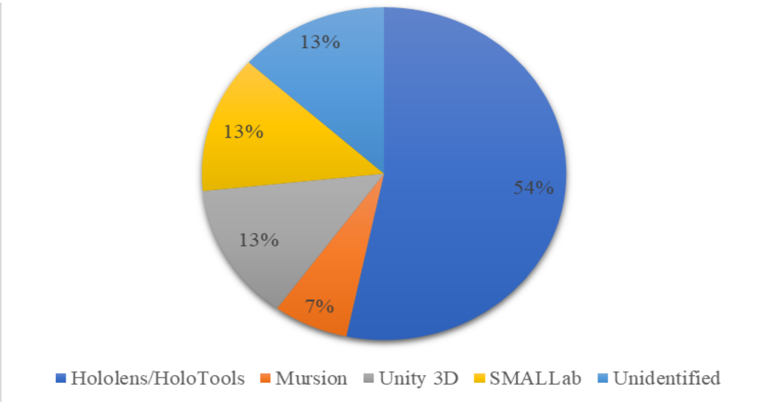

Figure 4. Type of hard and software used in developing and using MR

Microsoft created the cutting-edge augmented reality (AR) gadget HoloLens in 2016. It is a wearable, mixed reality (MR) head-mounted display (HMD) that enables users to interact with the world through holograms while engaging all of their senses (Leonard & Fitzgerald, 2018; Liu et al., 2018). With its central processing unit, graphics processing unit, and holographic processing unit, HoloLens is a set of perspective holographic glasses that can do real-time spatial mapping and processing (Al Janabi et al., 2020; Wyss et al., 2021, 2022). Furthermore, compared to traditional AR equipment, its features are more sophisticated and include stereoscopic three-dimensional (3D) displays, gaze and gesture designs, spatial sound designs, and spatial mapping (Furlan, 2016; Wangm et al., 2018). Based on Park's research, 2021, it shows that there are 44 articles that use Microsoft Hololens in various fields, namely 19 papers in the field of medical auxiliary devices and systems, 5 papers about medical education and simulation, 8 papers about industrial engineering and 7 papers about civil engineering and architecture (Park et al., 2021). In my research, some article used hollolens wich is (Robinson et al., 2020; Ruthberg et al., 2020; Tang et al., 2020) and other.

The diversity of software used, such as Mursion, Smallab, and Unity 3D, creates a wider research scope and shows that Mixed Reality research involves various platforms. Mursion, for example, is known as a virtual simulation for interpersonal skills training. The term "mixed reality" refers to the fact that both human and computer elements collaborate to produce a realistic experience in the Mursion environment. The system requires little setup. A computer, a camera, and a microphone are part of the setup, which allows users to communicate with avatars in personalized scenarios displayed on a screen. Because of the human element, the avatars may communicate and engage with the user in real time just like real people would (Ferguson & Sutphin, 2022; Hartle & Kaczorowski, 2019). According research from Dalinger et al. (2020) Musion software can be used to develop mixed reality in the teaching practice of prospective teachers. The use of mixed reality with Mursion software can increase self-confidence, self-efficacy and transfer or knowledge.

Unity 3D is a game development engine that can also be used to create Mixed Reality applications. We created a three-dimensional universe with software called Unity3D. Video games and computer simulations are the main uses for Unity Technologies' cross-platform game engine (MV & Tippannavar, 2024; Zulfadli et al., 2023). The use of Unity 3D and Smallab suggests that some research may focus more on developing custom content or simulations.

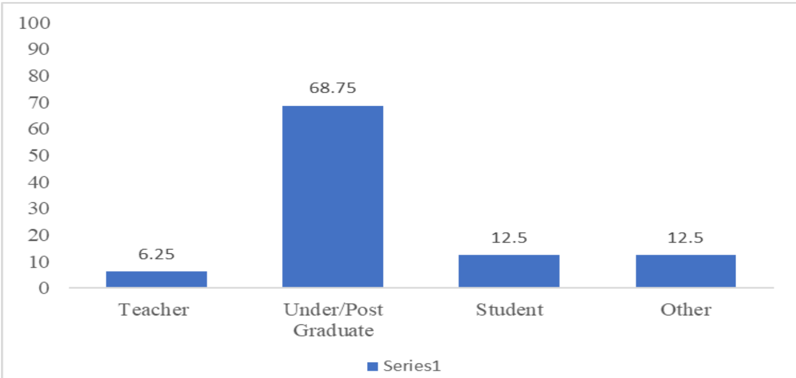

Figure 5. Subject research of MR

The data from the figure above shows that the majority of research subjects using mixed reality are under/post graduates with a percentage of 68.75%. while teachers were the smallest sample with a percentage of 6.25% or only 1 person. Meanwhile, 12.5% of students, both junior and high school, were in the mixed category or a combination of teachers, students, academics and college students. The percentage of subjects in the research sample shows that the use of mixed reality in learning is still very limited and is mostly done at the university level. This is because the development of mixed reality requires quite high capabilities with a combination of several research areas such as informatics engineering, software and others (Banjar et al., 2023; Cindioglu et al., 2022). Apart from that, the devices used to access mixed reality, for example Hololens, are very sensitive and very expensive so not all campuses or schools have these devices. Based on articles that use students as subjects, the majority of those sampled are medical and health students (Hang et al., 2023; Lu et al., 2022; Maniam et al., 2020).

Students who dominate as research subjects show a great opportunity for the application of Mixed Reality technology in the tertiary environment. This research can provide a basis for developing Mixed Reality-based curriculum and learning strategies at the tertiary level. Although the numbers are relatively smaller, research involving teachers and students also provides important insights. The implications can extend to the development of Mixed Reality technology that suits the needs and challenges at the primary and secondary education levels (Mihaela, 2013). The combination of teacher, student, and student participation provides a more comprehensive understanding of the effects of using Mixed Reality at various levels of education. Combining these perspectives supports a holistic approach in designing and implementing Mixed Reality technology in various educational contexts.

The figure above shows that the most mixed reality research is carried out in medical and health science study programs with a percentage of 43.75%, while in the fields of education and science each 12.5% and the least is carried out in the fields of architecture and arts 6.25% each. %. Many studies in the health sector show that learning or practical activities, especially those related to surgery, require ideal stimulation by approaching real conditions in the field or actual objects (Chen et al., 2020; Ruthberg et al., 2020). Research conducted shows that the use of mixed reality can produce results that are not much different from the use of direct objects (Barrie et al., 2019). The use of mixed reality in health and medicine can help reduce the costs of purchasing practical objects and can be used repeatedly (Lu et al., 2022). Use of Mixed Reality in health education may involve virtual surgical simulations, diagnostic training, or clinical skills development (Pellas et al., 2020). In addition, this technology allows students and health professionals to practice and deepen their understanding without real risk (Silvero Isidre et al., 2023)

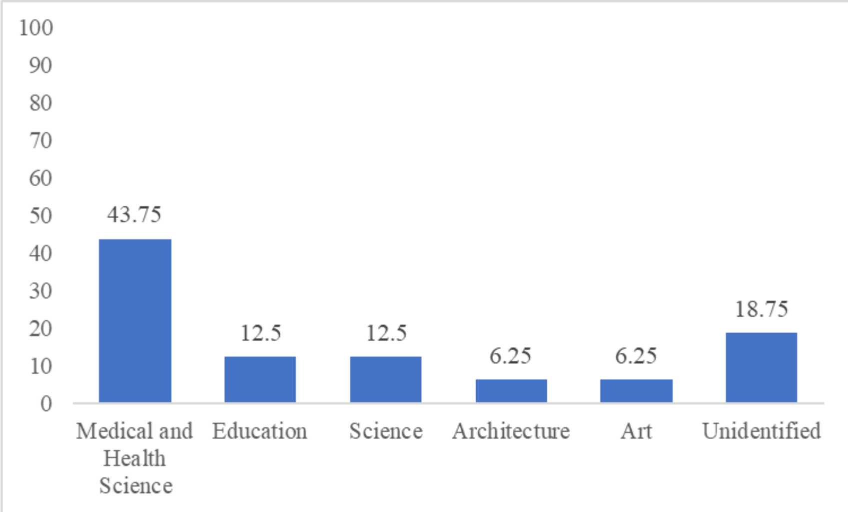

Figure 6. Area research MR

The use of mixed reality in the field of education in the sense of faculties that will produce teacher candidates is very rare. There are several factors that underlie why mixed reality is rarely used. Because it uses very high costs both to develop products and to purchase facilities, apart from that, learning for prospective teachers, especially in Indonesia, still focuses on simple concepts that can be carried out in the field when they become teacher. The very diverse condition of school facilities in Indonesia makes it impossible to implement mixed reality in classroom learning at both middle and high school levels. Based on the picture above, there are 2 articles that use mixed reality for preservice teachers. The use of mixed reality for preservice teachers aims to help students anticipate obstacles during teaching practice at school (Walters et al., 2021). Based on this research, prospective teacher students using mixed reality in teaching simulations can increase self-confidence, self-efficacy and knowledge (Dalinger et al., 2020). Apart from that, the use of mixed reality can be used in various fields such as architecture and construction (Wang, 2009), art (Hang et al., 2023), science (Uhomoibhi et al., 2020) and other fields (Tang et al., 2020).

The selection of a particular study program for Mixed Reality research needs to be linked to the special needs and characteristics of each field of study. The contextuality of the study program will ensure that the implementation of Mixed Reality has a relevant and beneficial impact (Plecher et al., 2019). Seeing that health and chemistry related study programs are also involved in Mixed Reality research, there is an opportunity for interdisciplinary collaboration. This collaboration can bring great benefits, combining knowledge and approaches from various disciplines to create a holistic learning experience.

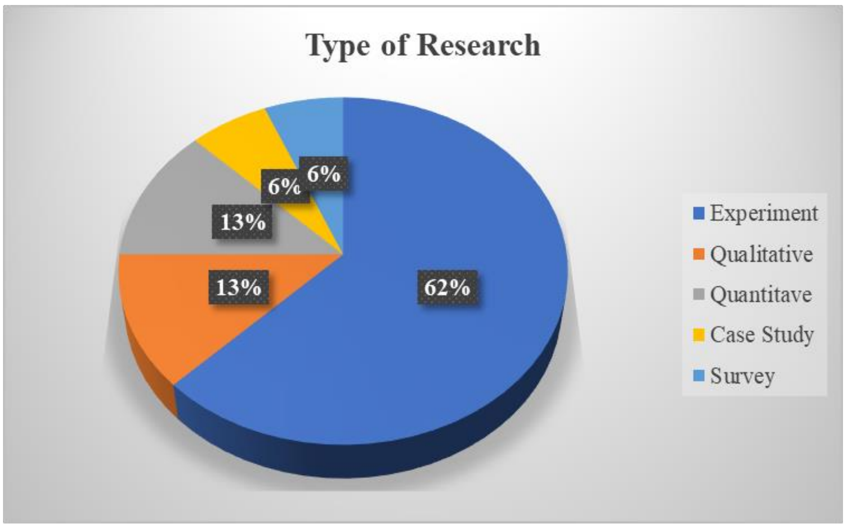

Figure 7. Method of resarch in MR

The dominance of quantitative experiments in Mixed Reality research reflects efforts to provide empirical and objective evidence of the effectiveness or successful use of this technology. This approach allows researchers to directly measure the impact of implementing Mixed Reality on specific variables, such as increased student understanding, performance of a particular task, or level of user engagement. Quantitative experimental results can provide a strong basis for making decisions and recommendations regarding the effectiveness of Mixed Reality in the context of science learning (Papastergiou, 2009).

The advantages of quantitative experiments include their ability to provide data that can be measured and tested statistically, allowing for the generalization of research results to a larger population. However, the challenge that may be faced is the complexity and contextuality of the user experience in Mixed Reality technology which may be difficult to measure precisely with quantitative methods alone. Therefore, a combined approach with qualitative methods or case studies may be needed to gain a more complete and in-depth understanding of the implications of applying Mixed Reality in science learning.

Table 1. Dependent Variabel in MR Research

Author & Years	**Thema**	**Dependent Variabel**
(Dalinger et al., 2020)	A mixed reality simulation offers strategic practice for pre-service teachers	confidence, self efficacy and transfer of learning
(Tang et al., 2020)	Evaluating the efectiveness of learning design with mixed reality (MR) in higher education	learning outcomes
(Chen et al., 2020)	Can virtual reality improve traditional anatomy education programmes? A mixedmethods study on the use of a 3D skull model	theory and indentifikasi test
(Robinson et al., 2020)	Evaluating the Use of Mixed Reality to Teach Gross and Microscopic Respiratory Anatomy	Understanding and Activities
(Ruthberg et al., 2020)	Mixed reality as a time-efficient alternative to cadaveric dissection	time management and Mastery Concept
(Birchfield et al., 2009)	Earth science learning in SMALLab: A design experiment for mixed reality	Mastery Concept
(Veer et al., 2022)	Incorporating Mixed Reality for Knowledge Retention in Physiology, Anatomy, Pathology, and Pharmacology Interdisciplinary Education: A Randomized Controlled Trial	Attitude, Cognitive and Retention
(Tolentino et al., 2009)	Teaching and Learning in the Mixed-Reality Science Classroom	Concept, Spatial Reasoning, Reformed Teaching Observation Protocol (RTOP)
(Maniam et al., 2020)	Exploration of temporal bone anatomy using mixed reality (HoloLens): development of a mixed reality anatomy teaching resource prototype	Cognitive and Psikomotoric
(Uhomoibhi et al., 2020)	A study of developments and applications of mixed reality cubicles and their impact on learning	learning environment
(Walters et al., 2021)	Mixed-Reality Simulation With Preservice Teacher Candidates: A Conceptual Replication	conceptual replication
(Hang et al., 2023)	The impact of mixed reality serious games on mortise and tenon learning in college students	Knowledge, Retention and motivation
(Almufarreh, 2023)	Exploring the Potential of Mixed Reality in Enhancing Student Learning Experience and Academic Performance: An Empirical Study	Performance, Experience and statisfaction
(Lu et al., 2022)	Applications of Mixed Reality Technology in Orthopedics Surgery: A Pilot Study	communication and understanding, spatial awareness and effectiveness
(Vasilevski & Birt, 2020)	Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environments	learning environment
(Wainman et al., 2020)	The Critical Role of Stereopsis in Virtual and Mixed Reality Learning Environments	learning modality and streopsis

The use of Mixed Reality (MR) technology has had a positive impact in various learning domains. Mixed Reality creates an environment that combines the real world with virtual elements, opening up new opportunities in education. Several studies contained in the table provide in-depth insight into how Mixed Reality can impact various aspects of learning, one of which is students' soft skills. Some soft skills that can be improved by using mixed reality as follows:

1. Cognitive Domain: Based on the article analysis that has been carried out, the use of mixed reality can improve students' cognitive abilities and knowledge (Lu et al., 2022; Maniam et al., 2020; Walters et al., 2021). Students who use mixed reality have quite a good effect on their knowledge and even several studies show that there is no significant difference between the use of mixed reality and actual practicum (Robinson et al., 2020). Several types of cognition that can be trained with mixed reality are concept mastery, reasoning, understanding, spatial reasoning, conceptual replication and learning outcomes.

2. Psychomotor Domain: Apart from the cognitive domain, students' abilities in the psychomotor sector remain a concern. Many research activities are carried out in practicum activities in the fields of health, arts, education and architecture (Almufarreh, 2023). Some psychometrics that can be trained are performance in surgery, time management, activities in practicum etc.

3. Effective domain: Attitude is one domain of learning that is often a concern. Attitude formation can be carried out during the learning process and practical activities in the laboratory (Veer et al., 2022). Based on the article analysis, it shows that attitudes can be trained and improved in learning using mixed reality. Some attitudes that can be improved are spatial awareness, retention, confidence, self-efficacy, attitude, static action etc

4. Other soft skills: Apart from the three domains above, mixed reality can train, improve various other variables such as motivation, communication, experience, learning environment, learning modality and stereopsis (Lu et al., 2022; Vasilevski & Birt, 2020; Wainman et al., 2020).

Summarizing the Table 1 that Mixed Reality has a significant role in improving various aspects of learning. By creating a more interactive, realistic and engaging learning experience, this technology opens up new potential in improving the quality of education. Therefore, the implementation of Mixed Reality can be considered a progressive step in designing effective and innovative learning methods.

Conclusion

Based on the research conducted, it can be concluded that the use of mixed reality is not yet widely used and has a very good opportunity to be implemented in Indonesia. Apart from that, the research results also show that mixed reality can be used to train students' cognitive, psychomotor and affective and other abilities. Apart from that, mixed reality research in the field of education, both in learning and in science practicum activities, is still very rare and few. This provides an open space for researchers in the field of education who collaborate with the field of technology to develop and test the effectiveness of MR in improving various domains of learning.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

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