Implementing Augmented Reality in Inclusive Education: Experiments and Potential

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Abstract

Technological developments often support the development of learning methods, where currently the implementation of e-learning is quite common. Do not miss inclusive school Students can be helped in their education through the use of this technology, namely the use of Augmented Reality. This study aims to look at the implementation and potential that can be provided by the presence of Augmented Reality for inclusive education. This research was conducted using a descriptive qualitative approach. The data used in this study were obtained from the library study method. The results of this study then found that Augmented Reality cannot be implemented in general as a learning medium in schools like other e-learning media. However, the use of Augmented Reality can help educators to provide knowledge for students. In the case of inclusive education, generally, the presence of Augmented Reality has a positive impact and is liked by students. This shows that the existence of Augmented Reality can be useful as a learning medium for inclusive education.

Keywords: *Augmented Reality (AR), Education, Inclusive, Potential.*

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A. INTRODUCTION

Progress in information and communication technology (ICT) doesn't solely expand educational opportunities via e-learning and the utilization of diverse existing online platforms. Different kinds of tools can aid in the educational process, including ubiquitous learning (u-learning), Augmented Reality (AR), Virtual Reality (VR), mobile learning (m-learning), games, gamification, and learning analytics. Similarly, modern technological advancements have led to an increased prevalence of mobile devices in education, particularly benefiting children with disabilities or distinct educational requirements (Peñarrubia-Lozano et al., 2021).

Specifically, augmented reality enables the fusion and overlay of tangible and virtual elements with the intended information. Simultaneously, supplementary data isn't restricted to visual perception alone; it can extend to encompass all senses, encompassing auditory, olfactory, and tactile sensations. This makes augmented reality a promising strategy to support teaching and learning processes (Park et al., 2020). Although the role of a teacher cannot be replaced in guiding students, the presence of augmented reality technology offers the potential to optimize the delivery

of subject matter, as it facilitates diverse modes of presentation, interaction, and engagement of students within the educational process (Challenor & Ma, 2019).

Inclusion students are one of the powerless groups. This group is vulnerable to discrimination, especially in employment opportunities. In the past decade, data from the Ministry of National Education (Ministry of National Education) showed that 356,192 children in Indonesia experienced special needs, but only 85,645 children, or around 41% had received education services in special schools (SLB) and integrated schools. The remaining 270,547 children, or around 59% of Indonesian children with special needs, have not received educational assistance (Okafor, 2021). In addition, when viewed linearly, the number of unemployed children with special needs is proportional to the population in general. A number like this is no small matter; rather, they are problems that must be reduced or suppressed through action or empowerment. The basis for this analysis of thought is the low quality of children resources with special needs which results in being unable to compete in development so the inclusion group becomes poor (Wong et al., 2021).

Currently, all schools can accept Children with Special Needs. However, there are barriers to inadequately experienced education services for Children with Special Needs, so students and local recognition are still not strong. This is in line with various problems that arise. Generally, the problem that occurs in inclusive schools is that the material provided is still the same as regular general lessons, only the level of difficulty is slightly different (Giese et al., 2022). So, there is no psychomotor charge yet. The impact that occurs is that after graduating from junior high school, it is difficult for inclusive children to continue to high school because City Government assistance has not yet reached the high school level. Only inclusive children from affluent/affordable families can continue to SMA LB, but for those who can't afford them they will be at home to help their parents or there will be no more activities (Rianawaty et al., 2021).

Through the brief explanation above, the researcher then intends to see the potential that the implementation of augmented reality can provide for inclusive schools in Indonesia.

B. LITERATURE REVIEW

1. Augmented Reality

Augmented reality constitutes a technological fusion of two-dimensional and/or three-dimensional virtual elements within an actual environment, subsequently projecting these virtual components in real-time. The concept of three dimensions, often denoted as 3D, pertains to the spatial realm of entities possessing length, width, and height. These virtual entities present data through labels or objects exclusively perceptible via a mobile phone camera or computer interface. The mechanics of augmented reality involve the analysis of real-time objects as captured through the camera system (Yuan et al., 2021).

Azuma provides a definition for augmented reality wherein it encompasses the amalgamation of actual and virtual entities within a physical setting, operating

coactively and immediately. This amalgamation extends to the alignment of objects in three dimensions, encompassing the integration of virtual elements into the tangible world. Achieving the fusion of real and virtual components necessitates suitable display mechanisms, interactivity hinges on specific input tools, and successful integration mandates proficient tracking mechanisms. According to Bimber and Raskar, Augmented Reality means integrating synthetic information into a real environment (Yin et al., 2023).

As outlined by Haller, Billinghurst, and Thomas, the focus of Augmented Reality research revolves around the advancement of technology facilitating the instantaneous integration of computer-generated digital content with the physical realm. Unlike Virtual Reality (VR) technology which brings the user completely into an artificial environment, Augmented Reality allows users to see three-dimensional virtual objects projected onto the real world (Ens et al., 2019).

According to Jun Yeon Ma and Jong Soo Choi. The difference between Augmented Reality and Virtual Reality is:

Table 1. Differences between Augmented Reality and Virtual Reality

Augmented Reality	Virtual Reality
AR adds or combines the real world with virtual objects	VR replaces the real world with a virtual world completely
Users can interact with the real world and, at the same time can see the real and virtual worlds and distinguish between them	The user enters the virtual world and disconnects from the real world, hypothetically, the user cannot distinguish between the real world and the virtual world
Requires a mechanism to combine the real and virtual worlds	Requires a mechanism to populate the entire virtual world for the user
AR uses Smartphone/wearable device handheld displays	VR using Head Mounted Display (HMD)

Augmented Reality embodies a notion that fabricates three-dimensional visuals with an illusion of reality. This progression can be deconstructed into multiple stages and constituents. To actualize the three-dimensional image, the Augmented Reality framework initially necessitates an assessment or perception of the surroundings within which the virtual entity is intended to be projected (Gholizadeh et al., 2023). Subsequently, a tracking procedure is executed on designated entities, determining the precise placement of the virtual object's depiction. Following this, the entity is acknowledged and assessed. Once identification and assessment of its position and alignment are accomplished, the system undertakes the portrayal procedure of the entity, causing it to manifest on the display apparatus (Park et al., 2020). According to Silva, Oliveira, and Giraldi (Introduction to Augmented Reality), the important components that must exist are:

a. Scene Generator
   The Scene Generator functions as a constituent responsible for rendering the image captured by the camera. It acquires virtual entities, subsequently subjecting them to processing in preparation for their display (Venkatesan et al., 2021).
b. Tracking System
   The tracking system is the most important component in Augmented reality. In the tracking process, a virtual object pattern detection is carried out with real objects so that it is synchronous between the two in the sense that the virtual projection and the real projection must be the same or close to the same so that it affects the validity of the results to be obtained (Eswaran & Bahubalendruni, 2022).
c. Displays
   In developing an AR-based system where the system combines the virtual world and the real world, several fundamental parameters need to be considered, namely optics and video technology. Both have a relationship that depends on the factors of resolution, flexibility, point of view, and tracking area. There are limitations in the development of Augmented reality technology in terms of the process of displaying objects. Among them is that there must be limitations on lighting, screen resolution, and differences in image lighting between virtual and real images (El Barhoumi et al., 2022).
d. AR Devices
   Several types of media can be used to display Augmented reality-based objects, namely by using optics, virtual retina systems, video viewers, AR-based monitors, and AR-based projectors (Syed et al., 2022).

2. Inclusive Education

Inclusive education signifies an educational approach that brings together children with special requirements and typically developing children in a shared learning environment. According to Hildegun Olsen, inclusive education denotes that educational institutions should cater to all children, irrespective of their physical, cognitive, socio-emotional, linguistic, or other circumstances. This encompasses children with disabilities as well as those who are exceptionally talented. Moreover, this approach should encompass children who are street-involved or engaged in child labor, even if they originate from distant or nomadic communities (Paseka & Schwab, 2020). Inclusive education encompasses children hailing from ethnic, linguistic, or cultural minority backgrounds, as well as those originating from disadvantaged or marginalized regions or communities. Inclusive education constitutes an educational provision tailored for students with distinct educational requirements within mainstream educational institutions (elementary, junior high, senior high, and vocational schools), encompassing diverse categories such as disabilities, slow learners, and various learning challenges that are classified as extraordinary (Sonmez & Gokmenoglu, 2023).

As per Staub and Peck, inclusive education encompasses the complete integration of children with varying degrees of disabilities, spanning from mild to severe, within regular classroom settings. This underscores that mainstream classrooms serve as appropriate learning environments for children with disabilities, regardless of the specific nature of their disorders. Synthesizing multiple perspectives, it can be deduced that inclusive education denotes an educational provision catering to students with distinctive requirements, encompassing physical, cognitive, socio-emotional, linguistic, or other conditions, with the aim of collectively receiving educational support within conventional school settings (Robiyansyah, 2020).

Broadly speaking, education entails a purposeful and premeditated endeavor to establish an environment conducive to learning and a structured process through which students proactively cultivate their capacities, encompassing religious and spiritual resilience, self-discipline, individuality, intellect, moral integrity, and proficiencies necessary for their personal growth, societal well-being, national progress, and state advancement (Law No. 20 of 2003, Article 1 paragraph 1) (Abbas et al., 2021). Hence, the fundamental core of inclusive education lies in the embodiment of the human entitlement to education. An inherent outcome of this entitlement is that every child possesses the entitlement to attain an education free from prejudice based on factors such as disability, ethnicity, religion, language, gender, and abilities, among others. Pragmatic objectives inherent in inclusive education encompass objectives directly aimed at children, educators, parents, and the broader society (Byrne, 2022).

Attributes within inclusive education manifest through various channels, including interconnections among individuals, competencies, seating layouts, educational resources, materials, and assessment methods, expounded as follows:

a. Connection
   Creating a friendly and welcoming environment is exemplified through practices such as maintaining proximity and a cheerful expression when interacting with deaf children. Classroom assistants, often parents, offer encouragement to deaf students while also providing support to other students in need.
b. Ability
   Educators, students hailing from diverse backgrounds and possessing varying abilities, and parents serve as companions within this context.
c. Seating arrangements
   Diverse seating configurations encompass options like gathering in circles on the floor or sitting together on benches, fostering visual interaction.
d. Study material
   A variety of materials catering to all subjects, including innovative approaches in teaching mathematics, are conveyed through captivating and stimulating activities. This includes employing role-playing techniques, posters, and traditional wayang puppetry for language lessons, making the learning experience more engaging, challenging, and enjoyable.

e. Source
   Educators formulate daily plans that involve students, such as requesting them to bring affordable and readily accessible learning resources to the class for utilization during specific lessons.
f. Evaluation
   Evaluation, observation, and portfolio management encompass the compilation and assessment of children's work over specific time frames (Solone et al., 2020).

Inclusive education involves both typical students and those with special needs. To foster holistic development in individuals, student mentoring is essential. This mentoring process aims to facilitate the optimal development and enhancement of skills among students (Crispel & Kasperski, 2021).

The curriculum ought to be customized to accommodate the child's requirements, as opposed to compelling the child to conform to a standardized curriculum. As a result, it should facilitate opportunities for adapting the curriculum to suit individual children. As explained by Tarmansyah, curriculum adaptation is a fundamental model within inclusive educational institutions. The initial adaptation pertains to recognizing that theoretical models consistently present a simplified version of intricate reality. The subsequent adaptation concerns curriculum components specifically geared towards learning, which will receive more extensive consideration during practical implementation (Kaffenberger, 2021). In inclusive schools, the curriculum employed is the standard curriculum designed for typical children, but it's adjusted or modified to align with the students' initial abilities and distinctive attributes. Furthermore, according to the Directorate of PLB, modifications can be made by modifying time allocation, modifying content/materials, modifying teaching and learning processes, modifying facilities and infrastructure, modifying the learning environment, and modifying classroom management. The curriculum will create avenues for every child to realize their potential, fostering their unique talents, abilities, and individual differences (Sofri & Ziv, 2023).

C. METHOD

This research will carry out a descriptive qualitative approach to explore the implementation of augmented reality in the context of inclusive education. Through this approach, researchers will explore various literature and research related to the use of augmented reality technology in creating an inclusive learning environment. By referring to relevant sources, this study aims to gain in-depth insight into how augmented reality technology has been applied in education for students with various special needs. The data that forms the basis of this research will be obtained through a careful literature study of various sources that discuss the use of augmented reality in inclusive education. Information regarding implementation, learning methods used, and the impact of implementing this technology will be collected from various journals, scientific articles, and other trusted sources. These data will be processed systematically to identify general patterns, successes, and challenges that arise in

integrating augmented reality in an inclusive education environment. The results of this analysis are expected to provide a comprehensive picture of the potential of augmented reality technology in increasing accessibility, interaction, and learning effectiveness for students with special needs.

D. RESULT AND DISCUSSION

1. Application of Augmented Reality in Education

Augmented reality within the educational sphere has yet to be widely adopted and integrated as an interactive educational tool in schools. This is primarily due to the absence of educational institutions that have made it a compulsory medium for learning purposes. Especially during the current pandemic, the teaching and learning process is carried out at home or study from home (SFH) which utilizes several technologies such as Webex and Zoom to carry out the teaching and learning process. However, not with a laboratory that requires technology that can contain laboratory entities and implement them virtually without reducing the goals in them. So it requires the application of augmented reality. This augmented reality can change information into a visual form that is capable of displaying small, large, fast, and slow objects and can be seen clearly with the naked eye without assistance so that students will receive learning in a visual form that is easy to understand.

The utilization of Augmented Reality in the realm of education offers a substantial advantage as an instructional medium with a significant impact. Students engaging with augmented reality-enhanced content tend to comprehend wave material more effortlessly in comparison to those who don't utilize augmented reality. This conclusion is drawn from a comparative analysis of the learning outcomes between these two student groups. Augmented reality can also support teaching staff by adding props in the form of augmented reality to reconstruct real objects that cannot be seen with the naked eye. In addition, augmented reality also allows the visualization of objects that are difficult to see, such as human organs and similar objects. AR also makes the teaching and learning process not tied to class hours or classrooms, because students can study learning material anywhere and anytime. Derived from the conducted research, it can be deduced that augmented reality constitutes a technology permitting students to engage with visual entities seamlessly integrated into the physical environment, thereby affording a realistic visual experience of these interactions.

2. Types of Augmented Reality Applications in Education

Yuen clarifies AR applications for education into five types, namely:

a. Discovery-Based Learning (DBL) can serve as a valuable approach to furnish users with supplementary insights concerning real-world locations, concurrently while focusing on points of interest. Such applications frequently find application in settings like museums, astronomy education, and historical sites.

b. Object-Modeling (OM) finds utility within Object-Modeling applications as well. This type of application facilitates students in obtaining instant visual feedback regarding the appearance of a specific item from various perspectives. Furthermore, OM empowers students to delve into physical attributes and execute interactions among objects. Certain applications even enable students to create virtual objects for the purpose of investigating their physical attributes or interactions with other objects. The resultant three-dimensional models can be rotated, color-adjusted, and stylized, offering instructional content through diverse viewpoints. This type of application is also used in architecture and human anatomy education.
c. AR Books bridge the divide between digital and physical learning, seamlessly merging the two. These augmented reality books offer 3D virtual displays and interactive encounters for students. Equipped with unique devices like specialized glasses, users can don these glasses to witness 3D characters leaping from the pages of the book, delivering an immersive experience.
d. Game-Based Learning (GBL) has witnessed a notable surge, with video games emerging as a potent educational tool. Consequently, educators frequently harness games to simplify intricate concepts for students. Augmented Reality (AR) technology enriches the learning process by merging virtual information with interactive gameplay, furnishing fresh and robust avenues for comprehending the tangible world. This variant of AR gaming commonly finds application in disciplines such as archaeology, history, anthropology, and geography. Another AR gaming category empowers users to generate virtual objects or characters and subsequently embed them within specific real-world locations, allowing for interactive engagement with these virtual elements.
e. Skill training is a domain where Augmented Reality (AR) applications hold significant promise due to the immersive virtual context they offer. These applications are employed to educate individuals in particular tasks, such as hardware mechanics in the military or aircraft maintenance. For instance, in aircraft maintenance, AR displays guide each stage of a repair, highlight required tools, and provide textual instructions.

3. Augmented Reality as Learning Media

Augmented reality has entered various fields in life, one of which is the field of Education, which is used for laboratory research aids and is also used for learning media in classrooms. Learning media serves as a facilitative instrument that enhances communication and interaction between educators and students during the process of teaching and learning. By employing learning media, student engagement can be heightened, thereby fostering greater motivation and encouraging increased active participation in the learning journey. By leveraging augmented reality, the fields of Education and entertainment can be combined, thereby creating new methods to support learning and teaching in both formal and informal environments. Augmented Reality (AR) shares analogous characteristics and roles with learning media, serving

as a conduit for information exchange between teachers and students, elucidating the transmission of provided information, and delivering motivational impetus while fostering curiosity in the learning process.

According to Dunleavy & Dede, Augmented Reality (AR) functions as an educational medium that enhances learning experiences through the integration of two interconnected theoretical frameworks. The first is the situated learning theory, which posits that learning is inherently contextual and the quality of learning stems from the interactions among individuals, locations, objects, processes, and culture. The second is the constructivist learning theory, suggesting that individuals construct fresh knowledge and comprehension by building upon their existing knowledge and beliefs, which are influenced by their developmental stage, prior experiences, and socio-cultural context. So, it can be concluded that augmented reality as a learning medium is a structured series of activities in which there is interaction between students, teachers, and teaching materials by utilizing augmented reality technology in a conducive learning environment to achieve the expected goals.

Augmented reality is considered feasible if it is implemented in learning media such as research on the use of augmented reality applications for electronics subjects which the highest total score is 100, so that they can be classified as adequate and can be implemented as learning media. In elementary school science subjects, the incorporation of augmented reality into learning materials has yielded highly favorable outcomes, indicating its practicality. Student reactions to this medium have been exceedingly positive, with a strong enthusiasm for engaging in learning. Similarly, courses centered on digital systems that leverage augmented reality as a learning medium are regarded as highly viable and beneficial for students' educational experiences. Moreover, augmented reality-based learning media stimulates critical thinking among students regarding real-life problems and occurrences. This is facilitated by AR's capability to visually represent abstract concepts, thereby enhancing comprehension of object structures. Research findings predominantly express positive feedback from students regarding the integration of augmented reality into learning materials. Augmented reality proves especially helpful to subject teachers who require visual aids, as it outperforms conventional methods in aiding visualization.

4. Implementation of Augmented Reality in Inclusive Schools

Education is support for science, technology, culture, society, and civilization; these various sectors become one unit within the educational framework and become an inseparable unit. Schools are a country's resource as a way of teaching and working on ongoing population and community human resources. In turn, training is grouped into three, namely formal, casual, and non-formal schools. Formal teaching is an efficient, organized, layered, layered movement, from elementary school to college. Then, at that time, casual training was an interaction that lasted throughout the ages because of the tendency of schooling to have an impact on the development of one's (personal) character. While non-formal schooling is all types of education that are

completed deliberately, and arranged, outside of formal schooling, exercises that are fully intended to serve certain students in achieving their learning goals.

The implementation of non-formal learning patterns is carried out through mentoring Inclusive Students and the introduction of Augmented Reality technological innovations to inclusive students in the form of Study Tours. After the Study Tour will be monitored through mentoring and at the end of the activity will be evaluated to what extent the awareness, understanding, and skills of schools have increased in providing inclusive education services based on Entrepreneurial Knowledge Practice as an effort to empower Children with Special Needs. Monitoring is carried out throughout the year of work implementation, directly or through communication media. Evaluation of program implementation and program sustainability in the field after the PKM activities were carried out in the last month of implementation and at this stage a follow-up plan was also prepared. All activities are documented, scientifically reviewed, and published so that outputs in the form of scientific publications, modules, and business group prototypes according to community needs are expected to be formed.

This pattern of non-formal learning through study tours can be found in the research of Sugiyanto et al. (2023). The visiting strategy, better known as the Study Tour, is a technique that in practice invites students to concentrate outside the classroom where later students will be coordinated to obtain material and assets that are completely different from what has been completed in class. This is expected to cause students to have broad insights. In addition, observation visits are also the task of an educator so that students can be more sensitive to the wider world, especially to learning resources. This shows that learning assets can be anywhere. In this study tour, students will be invited by the teacher to go somewhere (more often it is a tourist spot). Where later students will get free entertainment and build memories with their friends. Later students will be given the task of compiling travel notes or reports on the roads that have been taken and what examples can be taken during the visit. In this study tour activity, inclusive students also do simulation learning based on Augmented Reality technology. The simulation strategy is a technique whose implementation looks like realizing where the teacher will understand an incident, for example, a fire simulation, and then students will apply it in a real form such as training to rescue victims from a fire accident.

More simply, in this game technique students will practice what they have learned in real life, where students must be active and always correspond endlessly with existing circumstances and friends. The contrast between recreational techniques and exhibition strategies is that when performance techniques occur the use of devices through learning media to expand learning, while student demonstrations will provide direct models as field practice based on topic hypotheses. It is a learning method in which students will imitate an event or hypothesis into the actual structure. The benefits that can be taken from this reproductive strategy are: that students can perform a skill and can find answers to a problem quickly, encourage students to be

able to talk with other people, and encourage students to develop psychomotor, emotional, and mental skills.

Based on the results of his research, Sugiyanto found that the results of student responses in large group trials showed that Augmented Reality media can help students with special needs by improving students' understanding skills in listening to material and information. Learners show an interest in understanding learning with great value. The presence of Augmented Reality media can make it easier for students to master the material. Where students are more active in participating in learning. This can be seen when collecting important information directly to students as a whole, where students can understand the material and data obtained efficiently and precisely. Then Wide Reality media has images that can become real enough to attract students' attention and is assisted with sound so that it can make students more focused on High Reality media which contains material. Augmented Reality media, is equipped with a submenu that is equipped with interesting pictures so that students' interest in the material becomes more concentrated. In the example, students who use Rising Reality media are more focused on the material being focused on so it is easier for students to recognize advanced illustrations.

E. CONCLUSION

Augmented reality remains underutilized within the educational landscape, primarily due to the absence of educational institutions mandating its incorporation as an essential learning tool. The integration of Augmented Reality in education presents a potential resolution for educators, offering an alternative to conventional video conferencing for disseminating knowledge to students. Augmented Reality's unique capability lies in the merging and overlaying of tangible and virtual elements with intended information. Additionally, this technology extends beyond visual input, encompassing other senses such as auditory, olfactory, and tactile perceptions. So, with the help of AR, subject teachers who need visualization find it helpful compared to learning that still uses conventional methods. The Significance of Learning Progress for Students with Special Needs in Learning Improvement where the development of learning for comprehensive students currently needs to take advantage of existing data innovations. The advancement of expanded Augmented Reality media is one of the efforts to understand comprehensive training objectives. Useful exercises occur intelligently with students, where students are very excited to try the development of new E-learning mechanics. This action is expected to provide answers for Children with Special Needs (ABK) who are increasingly mobile, empowered, and have information, able to answer real-life, financial, and social problems, for example having courage, having choices to communicate goals, doing business, participating in friendship exercises, and are free in carrying out their life tasks. The responses of inclusive students to Augmented Reality Media are generally very positive.

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