APPLICATION OF AUGMENTED REALITY TECHNOLOGY IN PEDAGOGIC PERSPECTIVE OF ELEMENTARY SCHOOL EDUCATION

(Research article)

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Abstract

Virtual Reality and Augmented Reality are immersive technologies that integrate virtual and real-world elements. These technologies have been used to help and improve human capabilities in many fields. The purpose of this article was the study of application of augmented reality technology in pedagogic perspective of elementary school education. The research methodology of this study presented a literature review on the application of Augmented Reality technology to students at the basic education level. Using qualitative content analysis, this study attempted to answer this question; how does the Pedagogic Perspective in elementary school education apply Augmented Reality? 9 Articles that were synthesized from 2013 to 2023 indexed by Google Scholar. The results showed that AR technology can empower four dimensions of pedagogic perspective of elementary school education: multiple senses involvement, retention and attention improvement, concentration and engagement increment and seamless interaction between real and virtual environments. Moreover, such technology application in pedagogic perspective of elementary school education demands three prerequisites for teachers or trainers: AR technology acquaintance, downloading and installing processes, and spatial-temporal flexibility. Hence, it is suggested to view the application of AR technology in pedagogic perspective of elementary school education in line with spatial and temporal atmospheres.

Keywords: Augmented reality, education, pedagogic perspective, elementary school

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1. Introduction

Augmented reality (AR) enables an interactive experience with the real world where objects in the real world are enhanced by computer-generated perceptual information. This technology has positively influenced different fields, such as industry, entertainment, medicine, tourism, among others. Nevertheless, experts assure that this is only the beginning and that the future of AR will bring better, cheaper, and more accessible applications. This technology has also left a positive mark on education. Twenty-five years have passed since the development of the first AR application designed exclusively to be used in educational settings. Since then, AR applications have been successfully implemented at different levels of education, different fields of education, and different educational environments providing multiple benefits for learners. However, there are still some pending issues that must be addressed to obtain the best of this technology to enrich education. Furthermore, it is important to note that as AR hardware evolves, AR applications will evolve, presenting new affordances and challenges for the AR research area. This study provides an overview of AR technology in Pedagogic Perspective of Elementary School Education.

1.1. Augmented Reality

Augmented reality combines real-world entities with computer-generated graphic objects, and its main feature is real-time, which detects, tracks, and interacts with objects at the same time. The augmented reality system can be divided into three general parts. The first part is the duty to receive. It carries real environmental information and is generated by input sensors such as audio, video, graphic images or positioning system data. The task of the second part is to receive information from the first part and analyze it and prepare the information needed to add to the reality. In the third part, the final results are displayed.

The main advantage in implementing Augmented Reality in elementary school students is better learning performance and encouraging student learning motivation (Bacca et al., 2014; P. Chen et al., 2017), because Augmented Reality technology displays attractive graphics for them and there is a direct interaction between the object and the subject of learning, so that students can construct their own knowledge (Bacca et al., 2014; Zimmerman et al., 2016) and can develop their skills and knowledge (El Syed et al., 2011), Augmented Reality can display 3D objects that can be used in real time thus providing a new way to obtain more accurate information about the topic being studied (Sotiriou & Bogner, 2008) and can help improve their performance and improve their psychomotor skills in cognitive tasks (Wu et al. ., 2013).

### 1.2. Pedagogic Perspective of Elementary School Education

Effective pedagogy refers to the classroom management which affects a student`s learning. It provides situation for teachers to explore their teaching abilities to perform effective learning by actively involving students in their classroom`s practices. Students are more enjoy with their learning and can understand clearly about their learning objectives

(Arafani, Handrianto, Uçar, & Karneli, 2021). The effectiveness of teaching learning situation depends on teachers` competencies to what to do and how to do their classroom pedagogy (D'Angel, 2021). In effective pedagogy requires teachers to evaluate their learning priorities. Teachers need to develop the inquiries about their teaching method which may impact to their students. Teachers give intervention to students for improving their learning outcomes (Hilton, Hilton, Ikahihifo, Chaffee, Darrow, Guilmett, & Wiley, 2020; Ibrahim, Abdullah, Yasin, Handrianto, Uçar, & Kenedi, 2021). The orientation of teachers is student`s success with a bigger difference in their teaching process. In primary education, effective pedagogy is based on inquiry-oriented development of students learning. Teachers use the inquiries as their support and inputs to decide their learning priorities in the classroom. Teachers also develop inquiries about the effective strategy for ongoing improvement of the pupils (Rita & Handrianto, 2020; Taufiqurrochman, Muslimin, Rofiki, & Abah, 2020). In this context, the effective pedagogy is also related to development of valuable teaching learning for holistic student`s achievement (Zeng (2020). Values education is the fundamental element of pedagogical infrastructures. Realization of values in education encourages students` well-being in school environment. The values can transform community based on the school`s perspective. The valuable learning implemented by teachers in the classes can trigger impact on parents and community in school around. Teachers don't teach about the material concepts but they also explore the values from their learning. The criteria of effective pedagogy in primary school are measured with in what extent the value added to students` development and their learning outcomes. Students feel their learning valuable to foster their knowledge, skills, and attitudes (Musta`in & Handrianto, 2020; Overby, 2018). They have strong desires to mastery learning materials because they don't want to be part of fail outcomes in instruction. Pedagogical practices of teachers are evaluated by investigating their classroom situation. The socio economic background of students and school community around have to be studied by teachers before starting their classes. Teachers have to really aware about their classroom and try to design good instructional strategies. Numerous research studies have been discussing the topic by highlighting several categories such as: classroom management, teachers` competences, instructional strategies, valuable learning, and students` achievement. The five categories need to be considered by the teachers to set up their instruction. The role of teachers in primary school education is significant to practice effective pedagogy to improve teaching learning quality in the classroom. The effective pedagogy can be concluded that the approaches, methods, and strategies implemented by teachers in the classroom create positive impact to students` learning and their outcomes.

2. Methodology

The research method in this article is a review and it was done by text research method; By reviewing the sources obtained from reliable databases such as Science direct, Elsevier, Google Scholar, and trying to identify the researches done in this regard, in order to raise awareness about the necessity of education, the application of augmented reality is also one of

the main topics. In the period of 2013 to 2023, the recent decade, a total of 196 English articles, related to the application of augmented reality technology in pedagogic perspective of education, were obtained. These articles were reviewed and 84 were removed because of irrelevance in terms of discussed items, methodology, and educational systems. At last, 103 articles were removed because of their irrelevant research question and methodology. Finally, 9 articles were selected to be discussed in details. This selection process has been shown in figure 1.
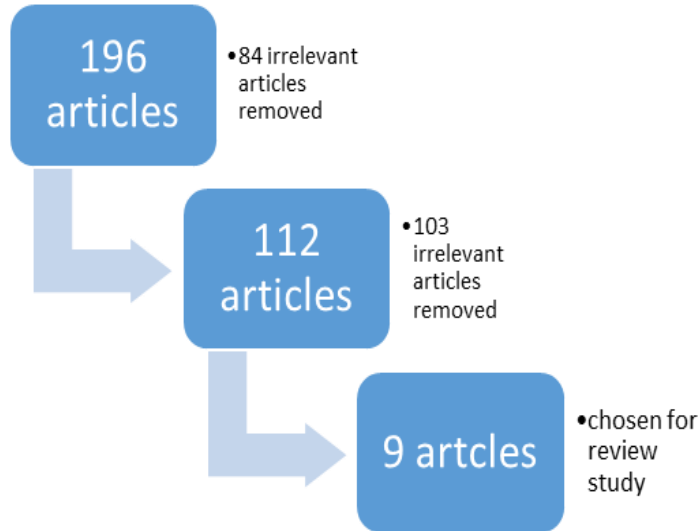
Figure 1: Article Selection Process

3. Findings

After selecting 9 relevant articles, they were studied in details for elaborating the application of AR technologies in elementary school education. In this regard, each article is discussed as follows.

So far, the learning strategy has been designed based on the needs of students and the achievement of student learning outcomes in accordance with the curriculum. Even though the learning strategy is declared effective, it is necessary to reexamine it when collaborating with Augmented Reality technology. Ibáñez & Delgado-Kloos (2018) suggest that Role Playing learning strategies can be collaborated with Augmented reality by utilizing the advantages of AR technology which can display various texts, images, 3D objects and animations (C. M. Chen & Tsai, 2012). The presentation of attractive 3D objects will provide a new learning atmosphere and enjoyment for students (Lu & Liu, 2015) in following the learning process. On the other hand, Bacca et al. (2014) suggest that constructivism learning strategies can also be collaborated with Augmented Reality technology, assuming that interaction with Augmented Reality gives students the freedom to find information, thus potentially increasing knowledge construction activities in students. However, further studies need to be done to find

how Augmented Reality can be designed to help build student knowledge (Zydney & Warner, 2016) and how to measure it (Bacca et al., 2014). The virtual appearance of an attractive 3D object and the same as the original object can improve student understanding (Yoon et al., 2017). Even though it is only a simulation of the original object, AR allows it to provide a learning experience for students, so that student participation in AR can increase students' motivation and spatial abilities. (Han et al., 2023). Understanding certain objects and natural phenomena that are difficult to obtain in the real world will provide a very valuable learning experience for students. For example, urban children who are studying the ecosystem in rice fields, for urban children, rice fields are a step for them. When this interaction occurs, students can deepen their understanding and construct their knowledge (Han et al., 2023).

The 9 articles in relation to the augmented reality technology application in pedagogic perspective of elementary school education are as follows:

Wu et al. (2013) in Current status, Opportunities and Challenges of Augmented Reality in Education state that the application of Augmented Reality in the classroom raises several pedagogical problems that need to be considered, such as many previous educational innovations that have not been well mastered, so that mastery of AR in the classroom can face new obstacles both from schools in providing facilities and teachers' mastery of Augmented Reality. Involving Augmented Reality in learning, of course, requires student-centered learning methods, this will create a gap between the learning methods needed and the learning methods currently being carried out. Another obstacle that will be faced in implementing AR is the curriculum, such as the amount of certain learning content that must be achieved within a certain time. The inflexibility of Augmented Reality will lead to other pedagogical problems such as file content and the order that has been designed, which cannot be changed to accommodate the needs or achievements of students.

Saidin et al. (2015) in A Review of Research on Augmented Reality in Education: Advantages and Applications say that AR technology is portable and compatible with a variety of scenarios that can be used to increase content and education in traditional classrooms, to supplement education in special education classes, to expand content outside the classroom globally, and with other technologies. As it can be combined to enrich the individual programs. Augmented reality technology can bring many benefits and is able to compare different objects in the real world and can enable elementary students to discover information and knowledge of their surroundings. Augmented reality can be used as a basis to support the school of structuralism. In general, augmented reality is a type of learning based on content and experiences and exploratory learning that may connect new layers of information in the real world. In order to augmented reality to be widely used in education, it is better to be accompanied by AR technology. This technology training program is a knowledge-based program for a teacher or trainer. This allows elementary students to explore their degrees in an interactive way. It also encourages students to work together.

Zimmerman et al. (2016) in Using Augmented Reality to Support Children's Situational Interest and Science Learning during Context-Sensitive Informal Mobile Learning mention that to enhance the collaborative task in education using AR applications, one of the most important purposes of an educational environment is to promote social interaction among users located in the same physical space. To become a successful of learner, communication and collaboration are essential part to ensure the involving of students in real world task through the dialogue and interaction among them, curriculum objectives will come alive where learning group in classroom can accomplish meaningful learning and learning experience to children. Working with collaborative peer-work groups is more effective because students try to reach a common goal, sharing tools and activities. These elements show the positive children interdependence when they try to use marker together and learn something among them. The visualization technique is interesting method that enable users especially children not only to observe how objects behave and interact, but also provide children with visual that they may capture, and preserve the essence of physical phenomena with effectively compare than do verbal descriptions. Furthermore, to perform the AR in education specifically for Primary School, there are several things should be provided to ensure the process of teaching and learning through the AR application running effectively. Student in Primary school should be exposed to the AR application where teaching methods are more to the fun games to interact them. In response to the frustration with this situation, we need augmented the classroom technology with various sensors and computer processing.

Yoon et al. (2017) in How Augmented Reality Enables Conceptual Understanding of Challenging Science Content say that the process of teaching and learning should be enhanced parallel with technology evolving to ensure children in future exposed to the varieties of aspect especially in augmented reality fields. Learning should be continued to ensure that our community is rich with useful knowledge, particularly in the field of AR and being able to create something new. Regarding to the past researcher, they believe many advantages when integrating AR technologies toward teaching and learning process. The AR technology enable supports seamless interaction between real and virtual environments and allows the use of a tangible interface metaphor for object manipulation. Hence, AR technology will provide instructors with high students' understanding in the classroom by augmenting physical devices with virtual annotations and illustrations. Besides, the AR technology enable the use of 3D object registration of the virtual and real objects in an AR allows users to view the learning content in 3D perspectives. Regarding to this, the AR technology can help students who have difficulty visualizing complex learning concept and the AR can assist student to understand and learn new concepts with new environment that cannot be viewed in real world.

Sobon et al. (2020) in The Effect of Smartphone Use on Learning Motivation of Elementary School Students in Mapanget District, Manado City state that the marker or image to bring up virtual objects is the main component in using Augmented Reality, so that it can display objects/ learning media without having to go to the location where the object is located. Of course this is one of the advantages of Augmented Realty technology, but this provides a new

meaning for students to understand the location. So that learning does not only occur in the classroom, it is better if the teacher as the instructor designer as well as designing markers or images that can be found where the objects are actually located. For example, showing how to wash hands properly and correctly, using pictures that people often use as signatures for washing hands, so that students can better master the expected learning objectives. However, the most important thing in designing markers or images must be able to be scanned well, because if the images are not well identified, students will have difficulty using Augmented Reality technology. What's more Augmented Reality design in the form of game education is more preferred and attracts students' attention to basic education, so it needs deeper attention when designing Augmented Reality in learning. However, elementary school students need gestures for their growth.

D'Angelo (2021) in Effective Pedagogy in the Context of a Competency-Based Curriculum Reform: Perceptions of Teachers in the Dominican Republic claims that to help students understand and comprehend a high-level piece of text, teachers often use visual aids to support the learning process and help build on the knowledge they already have. Computing tools can be embedded across the curriculum to help students deepen their understanding around a topic, create projects and improve digital literacy skills needed for the future. When taking students on a journey back to key historical events, teachers often use visual cues to help them visualize and make comparisons between the past and present to ensure accurate interpretations are made.

Rita et al. (2021) in Augmented Reality in Informal Learning Environments: A field Experiment in a Mathematics Exhibition insert that students' engagement increases when they create experiences in AR to demonstrate their understanding of a particular concept or standard. When students use augmented reality during a lesson, they want to dive into the content and don't want to stop learning or exploring. They're more willing to use critical thinking, problem-solving, and communication skills to explore the lesson or activity. And using a variety of apps, students can create projects that correlate with curriculum standards and concepts to show what they know. Augmented reality can be integrated into the classroom in all grades and across the curriculum—possibilities range from exploring space to learning about animals and continents to creating book reviews or historical settings. Some students may not have many opportunities to visit historical landmarks, but they can do so virtually. AR also allows students to view models of things we can't see without a microscope and creates opportunity to see and interact with plants and animals, and sea creatures that live on the ocean floor. As educators, we can provide our students with opportunities and experiences they might not otherwise have that will be vital to their future.

Higgins (2022) in Augmented Reality in Elementary School Environment mentions that t applying AR as an additional "multimedia source" into existing curricula can already lead to improved retention, attention and satisfaction and increased academic achievement compared to traditional learning methods, increased concentration and the enabling of teachers to convey

concepts faster and with more clarity through demonstration of connections between concepts and principles. Notably, while significant differences can be observed for all levels of education, the largest effect size of learning benefits is observed for students of elementary level. As success factors for AR deployment, user experience, stability, adaptability, and independent self-learning capabilities have been identified. Technology acceptance models (TAM) applied to potential AR trainings in educational contexts show that students perceive the technology as useful, easy to use [16] and teachers attitudes imply their intention to utilize AR. Moreover, AR-based training is independent of the availability of the teacher, and thus in principle time independent. Whether it is place independent depends on the required context objects: expensive special purpose devices might only be available in laboratories or special training facilities and thus restrict spatial flexibility. To provide maximum spatial flexibility, AR applications can, however, provide alternative virtual proxy environments and context objects in cases the physical ones are not accessible.

Han et al. (2023) in Examining Young Children's Perception toward Augmented Reality-Infused Dramatic Play assert that regarding the AR application, the abovementioned types of data can reveal the degree of context immersion in AR environments, such as involvement, engagement, motivation, mobility, reality or parameters associated with psychology, including self-efficacy, self-esteem, situational interest, or general information about overall user experience, satisfaction and course interactivity. AR involves multiple senses and requires simultaneous tasks from students, which may overload their attention, affecting the usability of AR systems. Therefore, it is important to consider design strategies that favor the usability of AR applications to ensure that they can be easily implemented in any educational context. Additionally, it is important to identify how new deployment technologies can improve AR systems' usability, to help overcome this challenge of AR in education. On the other hand, application-based AR requires a process of downloading and installation that takes additional time and effort. This causes users to often delete the application after a few uses to save space on their devices and other potential users do not bother to download it at all. Therefore, to improve dissemination, it is necessary to reduce the number of obstacles the end user faces to access the AR experience, which can be achieved by eliminating the need to download or update AR applications.

4. Results and Discussion

Augmented Reality (AR) refers to a direct or an indirect view of a physical, real environment that has been enhanced by adding virtual computer-generated information. AR is interactive and is used to combine real as well as virtual objects in the three-dimensional space. While Virtual Reality (VR) technology completely immerses the user in a synthetic world without the ability to see the real world, AR technology in contrast expands the sense of reality by superimposing virtual objects and cues on the real world in real time. AR enhances the user's perception of and interaction with the real world and aims to simplify or improve the user's

experience by bringing virtual information not only into their immediate environment, but also into any indirect view of the real environment. The use of Augmented Reality technology for basic education students can have a positive impact and a negative impact. The use of Augmented Reality in elementary school students still has to consider the needs and readiness of students, as well as existing readiness such as facilities and teacher abilities. From a pedagogical point of view, Augmented Reality technology is very supportive for the implementation of learning activities, it can create student learning experiences directly. However, students still have to consider the concept of the difference between the real world and the virtual world.

Based on what researchers found and discussed above, AR technology AR technology can empower four dimensions of pedagogic perspective of elementary school education: multiple senses involvement, retention and attention improvement, concentration and engagement increment and seamless interaction between real and virtual environments. Moreover, such technology application in pedagogic perspective of elementary school education demands three prerequisites for teachers or trainers: AR technology acquaintance, downloading and installing processes, and spatial-temporal flexibility.

These four dimensions and three prerequisites are shown in figure 2.
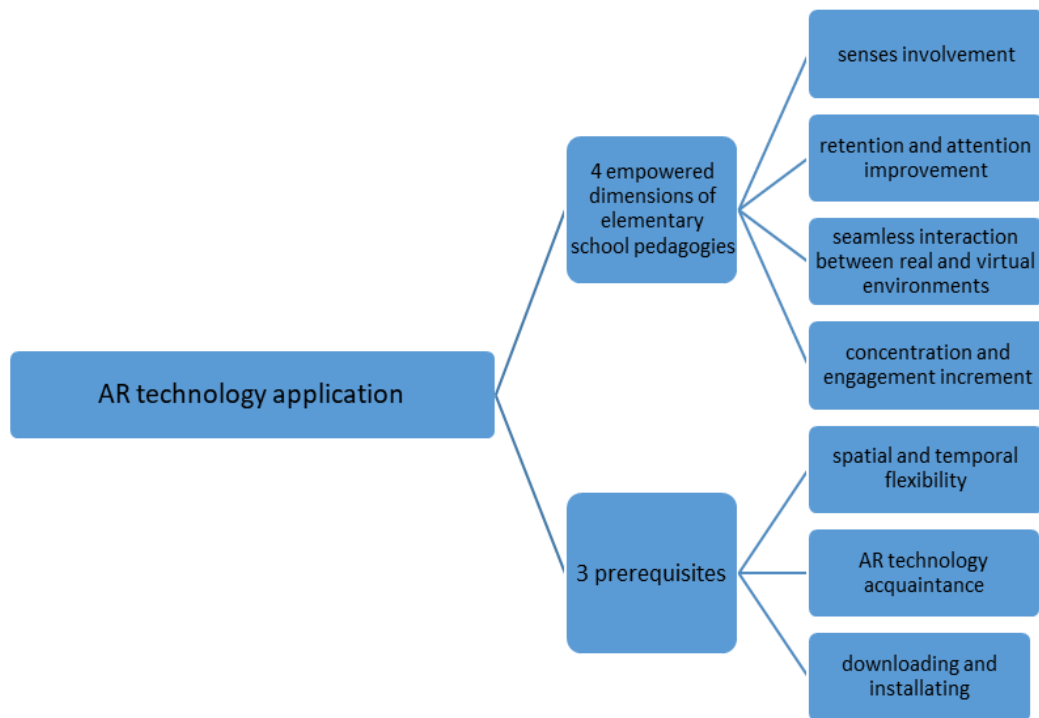
Figure 2: The Four Empowered Dimensions of Pedagogic Perspective of Elementary School Education and Three Prerequisites of AR Technology.

5. Conclusions

The purpose of this article was the study of application of augmented reality technology in pedagogic perspective of elementary school education with literature review research methodology. Using qualitative content analysis, in this study 9 articles were synthesized for the last decade. The results showed that the four dimensions of pedagogic perspective of elementary school education can be empowered through AR technology. Moreover, such technology application needs three prerequisites for teachers or trainers.

The main limitation of this study was the contradictory results of researches about the application of AR technology in elementary school education. Furthermore, the type and characteristics of such technologies were not discussed anymore for further information and better comparison.

The empirical findings to date on AR in the elementary school education sector are very promising, but overall and specifically for the education sector there are still numerous research gaps. "In conclusion, although most of the previous studies showed a positive impact and encouraging results, it is advisable to focus also on pedagogical and learning theory when implementing and developing the AR application since the educational value of AR is not solely based on its features". Hence, it is suggested to view the application of AR technology in pedagogic perspective of elementary school education in line with spatial and temporal atmospheres. Besides, it is better for elementary school teachers and trainers to get acquaintance with AR technologies to be applied in their classes.

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