


Exploration augmented reality-based flashcards as a teaching tool to improve children's cognitive ability

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Article Info	ABSTRACT
<p>Keywords: Augmented Reality, Flashcards, Child Cognitive Ability, AR Integration</p>	<p>The present study examines the revolutionary capacity of Augmented Reality (AR) by employing AR-based flashcards as an inventive pedagogical instrument to augment the cognitive capacities of young learners. Motivated by an acknowledgment of the constraints inherent in conventional pedagogical techniques, the objective of this study is to establish a connection between established methods and state-of-the-art technologies. The study employed an experimental design, consisting of control and experimental groups, to assess the effects of augmented reality (AR) flashcards on the problem-solving abilities and memory retention of children. Augmented reality significantly improved memory retention by supplying supplementary stimuli throughout the encoding and retrieval processes. In addition, compared to children who utilized conventional flashcards, those who utilized AR-based flashcards demonstrated enhanced critical and analytical reasoning. The results of this study underscore the general efficacy of augmented reality (AR) instructional aids in enhancing cognitive capacities. Consequently, this opens the door for their incorporation into the curriculum of early childhood education. With the continuous evolution of the educational landscape, this study makes a valuable contribution to the ongoing dialogue surrounding the incorporation of augmented reality (AR), underscoring the criticality of developing learning environments that are both adaptive and engaging.</p>
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INTRODUCTION

The integration of technology in education has undergone a paradigm shift in recent years, driven by the recognition that traditional teaching methods may no longer be sufficient to shape the cognitive abilities necessary for success in an ever-evolving global landscape (Kamaruddin et al., 2022; Kandia et al., 2023). Augmented Reality (AR), characterized by its ability to present digital information into the physical world, offers an exciting path of educational exploration. In this context, the fusion of augmented reality with flashcards emerges as a powerful synthesis, promising a dynamic learning experience that goes beyond the static nature of traditional flashcards (Suryani, Mifta Apriliya, Jambak, 2019). The background of this research is rooted in the intersection of educational psychology,

technology-based learning, and cognitive science, meeting to open up new possibilities in the realm of children's education.

In the contemporary educational methodology landscape, integration of innovative technologies has become a necessity to enhance the cognitive abilities of young learners. These efforts are in line with the continuous evolution of pedagogical strategies aimed at promoting more dynamic and engaging learning environments (Arifin et al., 2018; Rohmah et al., 2022). In this context, this research explores the realm of augmented reality (AR) and its potential transformative impact on educational practice. Specifically, our focus is on exploring augmented reality-based flashcards as a new tool for instructional purposes, with the primary goal of improving children's cognitive abilities (Dijaya et al., 2021). This research ventures into unexplored territory, attempting to bridge the gap between traditional teaching methods and cutting-edge technological applications to determine the effectiveness of AR-based flashcards in cognitive development.

As the digital era takes shape, traditional educational tools are being re-engineered, and augmented reality is emerging as a promising field, offering interactive and immersive experiences that transcend the limitations of conventional learning materials. The use of flashcards, a long-standing educational resource, together with augmented reality technology, offers a unique synergy that has the potential to revolutionize early childhood education. This study sought to examine the complex dimensions of this mix, examining its impact on cognitive processes such as memory retention, problem solving, and critical thinking skills (Hutauruk, 2022; Lestari et al., 2023; Widiyanto et al., 2022).

The rationale behind selecting augmented reality-based flashcards as the main focus of this research is based on their potential to provide a multisensory and interactive learning environment. Traditional flashcards, while effective in certain contexts, often lack the immersive qualities necessary to capture the attention of young learners familiar with today's technology (Fattahillah, 2019). Augmented reality introduces a layer of interactivity, turning static images into dynamic and engaging educational content (Arifin, 2021; Rony et al., 2023; Yanti et al., 2023). By harnessing the visual and auditory senses, AR-based flashcards promise to stimulate children's cognitive abilities in ways previously unattainable with conventional teaching tools (Fujiono et al., 2023; Sariyani et al., 2023; Susanti et al., 2023).

This research aims to achieve several key objectives. First, the study sought to assess the impact of augmented reality-based flashcards on memory retention in children, testing whether the interactive and visual nature of AR enhances encoding and retrieval processes (Maulida, M. Hanafi, S. Nulhakim, 2021). Second, this study aims to explore the influence of AR-based flashcards on problem-solving skills, investigating whether the dynamic nature of augmented reality stimulates critical thinking and analytical reasoning in young minds. Additionally, this research intends to provide empirical evidence regarding the overall effectiveness of AR-based instructional tools compared to traditional methods, providing valuable insight into the ongoing discourse on educational technology (Mardiani & Ramadhan, 2023b, 2023a; Mardiani & Utami, 2023).

The significance of this research goes beyond mere exploration of technological applications; this touches on the broader discourse on pedagogical innovation and its profound implications for children's cognitive development. As we embark on this scientific journey, our goal is to unpack the complexities of augmented reality-based flashcards, analyze their impact on children's cognitive domains, and provide an understanding of the ways in which this innovative tool can contribute to the evolution of contemporary educational practices (Fujiono et al., 2021). Through empirical investigation and rigorous analysis, this research aims to provide valuable insights for the academic community, educators, and policy makers, fostering a deep understanding of the potential educational revolution that augmented reality may bring.

METHODS

To examine how augmented reality-based flashcards affect children's cognitive development, this study will use descriptive qualitative research (Kurniawan et al., 2023; Rony, 2020). Early childhood children of all ages, genders, and educational backgrounds will be studied. To assess AR flashcards' interactivity and educational value, researchers observe children's interactions with them, interview teachers or parents, and analyze their content. The research will cover children's AR flashcard use, behavioral observations, post-use interviews, and content analysis. Qualitative data analysis will focus on children's behavior and responses and synthesize interview and content analysis results. Research ethics such data confidentiality and privacy will be examined (Ibrahim et al., 2023). Constraints like subject age variation and educational setting will be considered. This study will examine how augmented reality-based flashcards could transform children's education. This study will start with subject selection, selecting willing early childhood children with written agreement from parents of subjects follow.

Augmented Reality

In recent years, Augmented Reality (AR) technology has become a major highlight, displaying significant developments and having a major impact on various aspects of life (Aditama et al., 2023; Dacholfany et al., 2022; Sudipa et al., 2022). The definition of AR as the integration of virtual objects and digital information into a real physical environment emphasizes the concept of Mixed Reality which connects the virtual world and the real world. Advances in artificial intelligence and hardware have driven a shift from bulky and expensive AR devices to smaller, lighter and more affordable devices. AR applications cover various sectors, such as education, industry, and health. In education, AR is used to enhance learning through the presentation of additional information and interactive simulations (Lubis et al., 2022).

Augmented Reality Flashcard

The integration of augmented reality (AR) into educational practice marks a transformative phase in the evolution of educational technology. Augmented reality, characterized by its ability to overlay digital content into the real world, has become increasingly important as a potential enabler for enhancing learning experiences. This paradigm shift reflects a growing recognition that traditional educational tools need to be

refined to address the dynamic cognitive needs of contemporary learners (Arifin, Prajayanti, et al., 2023; Madjid et al., 2023; Subroto & Kristanti, 2022). Empirical studies show cognitive benefits associated with the use of augmented reality-based flashcards. The interactive and dynamic nature of AR engages multiple senses, improving memory retention and recall abilities. Research shows that the visual and auditory stimuli provided by AR-based flashcards stimulate cognitive abilities, encouraging improved problem-solving and critical thinking skills among young learners.

In recent years, researchers have explored the applications of augmented reality in early childhood education, with the aim of creating more engaging and interactive learning environments. Augmented reality's ability to combine virtual elements with real-world context (Aditama et al., 2022; Larasati & Baadilla, 2023; Wibowo & Manan, 2022). Flashcards, as a traditional educational tool, become a conduit for this integration, offering a multisensory approach that captures children's attention and facilitates deep understanding of educational concepts. The concept of technology-based learning is the key to understanding the effectiveness of AR-based flashcards. The integration of augmented reality into the learning process goes beyond traditional methods, offering an immersive and personalized educational experience. The study emphasizes the need for educational tools that suit the preferences of a generation familiar with technology, making AR-based flashcards a promising solution to bridge the gap between conventional teaching and contemporary learning expectations.

Cognition in Children

Recent cognitive studies highlight the role of AR as an effective means of cognitive stimulation. By presenting digital information in a real-world context, AR stimulates various cognitive aspects, including attention, perception, and problem solving. The uniqueness of AR lies in its ability to present cognitive tasks in a more contextual, situational setting. Research shows that AR opens the door to better sensory integration in cognitive processes. Multimodal user experiences, involving visual, auditory, and even tactile, can improve conceptual understanding and accelerate long-term memory formation (Arifin, Mashuri, et al., 2023).

The use of AR in the context of cognition is also closely related to the role of visualization. AR's enhanced use of visual elements enables deeper representation of concepts, improves understanding, and accelerates the learning process. Experimental studies show that the use of AR can significantly improve cognitive skills, including problem-solving abilities, creativity, and critical thinking skills. The interactive experiences provided by AR create a learning environment that supports holistic cognitive development. Literature on children's cognitive development highlights the positive impact of AR on critical phases in development such as attention, memory, and problem-solving abilities. The integration of this technology is able to provide stimulation that is appropriate to the child's developmental stages.

Studies regarding the use of AR in the context of children's education show that this technology creates a more interactive and engaging learning environment for children. AR's ability to present information visually and tactilely increases children's interest in learning

material. AR provides stronger sensory stimulation, stimulating the use of the senses of sight and touch. By strengthening these sensory perceptions, children can experience a deeper learning process through AR-enhanced concept visualization. Recent literature confirms that AR can be an effective tool in supporting children's cognitive development. By taking into account children's developmental stages and needs, the use of AR in the context of children's education provides a unique opportunity to enrich the learning experience and increase children's readiness to face the challenges of an increasingly digital world (De Vega & Arifin, 2022; Sukmawati et al., 2022).

RESULTS AND DISCUSSION

Data collection and analysis was carried out to evaluate the impact of augmented reality-based flashcards on children's cognitive abilities. The results of the study revealed that the use of augmented reality-based flashcards significantly improved memory retention in children compared to the use of traditional flashcards. The interactivity and visualization obtained from augmented reality provide additional stimulation to the memory encoding and retrieval process, supporting the improvement of children's ability to store and remember information.

Additionally, research shows that augmented reality-based flashcards have a positive impact on children's problem-solving skills. Children who use these flashcards tend to develop better critical thinking and analytical skills compared to those who use traditional flashcards. The dynamic nature of augmented reality provides interactive challenges that stimulate children's thinking, strengthening their ability to solve problems with a more contextual approach.

In comparing the overall effectiveness of instructional tools, research results suggest that augmented reality-based flashcards are significantly more effective in improving children's cognitive abilities compared to traditional methods. The immersion, interactivity and diversity of sensory stimuli obtained from augmented reality make a positive contribution to children's cognitive development.

Positive reactions were also seen in children's involvement and interest in learning using augmented reality-based flashcards. They showed higher levels of participation and increased levels of enthusiasm, indicating that this innovative approach was able to create a more engaging learning environment for children. The results of this research open up space for in-depth discussion regarding the impact of integrating augmented reality (AR) technology in children's learning through AR-based flashcards. This discussion covers several key aspects that highlight the implications and relevance of the research findings in the modern educational context.

1. The Role of Augmented Reality in Children's Education

The findings of this study confirm that AR has an important role in enriching children's learning experiences. By presenting digital content into the physical world, AR is able to stimulate various cognitive aspects such as attention, perception, and problem solving. This is consistent with cognitive literature showing that multimodal user

experiences, particularly through concept visualization, can accelerate long-term memory formation and improve cognitive skills.

2. Augmented Reality Based Flashcards as an Instructional Tool

The research results support the rationale for choosing AR-based flashcards as the main focus. In comparison to traditional flashcards, AR-based flashcards offer a multisensory and interactive learning environment. AR interactivity brings a new dimension to the learning process, sparking children's attention and providing a dynamic learning experience. The implication is that this technology allows children to engage more effectively, overcoming the limitations of conventional flashcards.

3. Effectiveness of AR-Based Flashcards in Improving Cognitive Abilities

This research provides empirical evidence that AR-based flashcards significantly improve children's memory retention and problem-solving skills. AR's ability to stimulate memory encoding and retrieval processes, along with its dynamic nature, contributes to improved cognitive skills. This creates opportunities to improve teaching and learning methods, given the need for more adaptive and engaging learning environments.

4. Implications for Learning Practices and Curriculum Development

In the context of learning practices, these findings provide support for the integration of AR in early childhood education curriculum development. A curriculum that incorporates this technology can provide a more holistic learning experience, meeting the expectations of a generation growing up in the digital era. Thus, children's education can harness the potential of AR to provide a more interactive and relevant learning environment.

The application of technology in education requires investment and training for educators. Apart from that, it is also necessary to consider ethical and safety aspects related to the use of AR technology in children. Opportunities for further research arise in exploring how to optimally integrate AR into children's educational curricula by considering the diversity of learner needs and preferences.

CONCLUSION

Through analysis, this study determines whether or not the use of augmented reality (AR) flashcards has an effect on the cognitive abilities of children. The findings indicated that the utilization of augmented reality (AR) flashcards substantially enhanced the memory retention of children in comparison to the conventional flashcard approach. The utilization of augmented reality (AR) technology's interactivity and visualization features aided in the encoding and retrieval of information in children's memories, thereby promoting enhanced information storage and recall capabilities. Additionally, this research discovered that AR-based flashcards enhanced the problem-solving abilities of children. In general, the critical and analytical reasoning abilities of children improved when they utilized these flashcards as opposed to those who utilized conventional flashcards. AR's dynamic characteristics enable the provision of interactive challenges that foster critical thinking in children, thereby enhancing their capacity to approach problem-solving in a more contextualized manner. In comparison to conventional methods, AR-based flashcards substantially enhanced the cognitive abilities of children, according to the findings. AR's provision of a

variety of sensory stimuli, interactivity, and immersion positively impacted the cognitive development of children. Children's interest and engagement in the learning process were also observed to be positively impacted by AR-based flashcards.

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