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Edu-Tech Kit: Interactive Learning Media Package Based on Augmented Reality for Early Childhood Education

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Abstract :
This study aims to develop and evaluate an Augmented Reality (AR)-based Edu-Tech Kit as an interactive learning medium to enhance early childhood learning outcomes, including cognitive understanding, motor skills, and classroom engagement. The research employed a quantitative approach using a pre-experimental one-group pre-test and post-test design. A total of 20 preschool students participated in the study. Data were collected through tests and classroom observations, and analyzed using descriptive statistics to compare students' performance before and after the intervention. The results indicate a significant improvement in students' learning outcomes, as reflected in increased post-test scores compared to pre-test scores. In addition, observational findings revealed higher levels of student engagement, motivation, participation, and collaboration during AR-based learning activities. The interactive features of the Edu-Tech Kit enabled students to better understand concepts, follow instructions, and complete tasks more independently. The findings imply that AR-based learning media can serve as an effective and innovative tool in early childhood education. The Edu-Tech Kit not only enhances learning outcomes but also supports active and engaging classroom environments, providing practical value for educators in integrating technology into teaching practices.

INTRODUCTION

The rapid advancement of digital technology has significantly transformed various sectors of society, including education, where innovative tools are increasingly integrated to enhance learning experiences. Early childhood education, in particular, plays a crucial role in shaping cognitive, social, and motor development, making it essential to adopt effective and engaging instructional approaches. One emerging solution is the use of Augmented Reality (AR), which blends virtual elements with real-world environments to create interactive learning experiences. The importance of this study lies in addressing the growing demand for technology-enhanced learning that aligns with the developmental needs of young children. Evidence from recent studies suggests that AR can improve engagement, comprehension, and retention among early learners by providing immersive and multisensory experiences (Wu et al., 2024; Yao et al., 2024). Therefore, integrating AR into early childhood education is not only relevant but necessary to support modern educational practices and prepare children for a technology-driven future.

Despite the potential benefits of digital technologies, many early childhood

education settings still rely on traditional teaching methods that may not fully support active and experiential learning. These conventional approaches often limit children's opportunities to explore, interact, and develop higher-order thinking skills. As a result, students may experience reduced engagement, lower motivation, and difficulties in understanding abstract concepts. Additionally, there is a lack of innovative learning media that effectively integrates technology in a way that is developmentally appropriate for young learners. Research has indicated that the absence of interactive and student-centered tools can hinder cognitive and motor development in early childhood (Neumann et al., 2022; Shahid, 2022). This problem highlights the need for educational innovations that can bridge the gap between traditional pedagogy and modern technological advancements, ensuring that children receive meaningful and effective learning experiences.

In practice, several early childhood education institutions have begun experimenting with digital learning tools; however, their implementation remains limited and inconsistent. Many classrooms still lack structured and well-designed AR-based learning media that can be seamlessly integrated into daily teaching activities. Observations in various preschool settings reveal that children often show greater interest in visual and interactive materials compared to static resources such as textbooks or worksheets. However, the available digital tools are often not tailored to the specific needs of early learners, resulting in suboptimal learning outcomes. Studies have shown that while AR applications have been introduced in some contexts, their usage is frequently fragmented and lacks pedagogical alignment (Irmade et al., 2022; Petrlik et al., 2022). This phenomenon underscores the importance of developing comprehensive and user-friendly AR-based learning kits that can effectively support both teachers and students in the classroom.

Previous research has extensively explored the potential of Augmented Reality in early childhood education, particularly in enhancing engagement, motivation, and learning outcomes. For example, AR has been shown to improve vocabulary acquisition, language skills, and conceptual understanding by providing interactive visualizations (Topu et al., 2023; Yilmaz et al., 2022). Additionally, AR-based learning tools have been found to support creativity and imagination by allowing children to interact with digital objects in meaningful ways (AlAli & Al-Barakat, 2024; Nugraha et al., 2025). These studies highlight the effectiveness of AR as an innovative educational tool that can transform traditional learning environments into dynamic and engaging spaces. However, most existing studies focus on specific learning domains or isolated applications, rather than comprehensive learning systems that integrate multiple developmental aspects within a single platform.

Furthermore, while prior studies have demonstrated the benefits of AR, several limitations remain. Many AR applications are designed primarily for cognitive development, with less attention given to motor skills, social interaction, and holistic child development. In addition, some studies emphasize technological design without sufficiently addressing usability and practicality for teachers in real classroom settings. Research also indicates that the successful implementation of AR depends on factors such as user acceptance, accessibility, and instructional design, which are often overlooked (Aslam et al., 2024; Khoirunnisa et al., 2025). Moreover, there is a lack of empirical studies that combine quantitative and

observational data to evaluate the effectiveness of AR-based learning media comprehensively. These gaps highlight the need for integrated and empirically tested AR solutions that address multiple dimensions of early childhood learning.

This study introduces a novel approach through the development of an Edu-Tech Kit based on Augmented Reality, designed as a comprehensive and integrated learning media package for early childhood education. Unlike previous studies that focus on single applications, this research combines AR flashcards, 3D interactive objects, teacher guides, and digital modules into a unified system that supports cognitive, motor, and creative development simultaneously. The innovation lies in its holistic design, which not only enhances student engagement but also ensures ease of use for teachers, making it practical for everyday classroom implementation. By addressing multiple aspects of child development within a single platform, this study offers a more effective and scalable solution for integrating technology into early childhood education.

Based on these considerations, the main research problem of this study is how AR-based learning media, specifically the Edu-Tech Kit, can improve early childhood learning outcomes and classroom engagement. This study argues that integrating interactive and well-designed AR tools into preschool education can significantly enhance students' cognitive understanding, motor skills, and social interaction. It is hypothesized that children who use the Edu-Tech Kit will demonstrate higher learning achievement, increased motivation, and more active participation compared to those who rely on conventional learning methods. Furthermore, this study contributes to the field by providing empirical evidence on the effectiveness of a comprehensive AR-based learning solution, offering practical insights for educators and policymakers in implementing technology-driven education in early childhood settings.

RESEARCH METHODS

The research employed a qualitative research and development (R&D) design, chosen to systematically develop and implement an interactive learning media package based on Augmented Reality (AR) for early childhood education (Judijanto et al., 2025; Okpatrioka, 2023; Rahayu, 2025). This design was selected because it allows the researchers to both create innovative educational tools and assess their practical effectiveness in real classroom settings. The study aimed to enhance learning outcomes by integrating technology into early childhood pedagogy, providing a structured approach for iterative development, testing, and refinement of the AR media.

The research was conducted at several early childhood education centers in Probolinggo Regency, East Java, Indonesia, including PAUD Al-Falah, PAUD Permata Hati, and PAUD Tunas Bangsa. These institutions were chosen because they represent diverse socio-educational contexts within the regency and have actively shown interest in implementing digital learning innovations. Selecting multiple locations allowed the study to gather comprehensive insights into the usability, acceptance, and adaptability of the AR learning media across different early childhood environments.

Data were collected using multiple techniques, including structured observations, interviews with teachers, and practical trials with students. The data analysis involved data condensation through selective coding, data display via tables and narrative summaries, and verification through triangulation to ensure

reliability. Pre-tests and post-tests were administered to evaluate the effectiveness of the media in improving students' cognitive and motoric skills. Additionally, teacher feedback and classroom observation were used to verify the applicability and pedagogical value of the developed AR learning tools.

RESULTS AND DISCUSSION

Results

Description of the Edu-Tech Kit

The results of the study show that the Edu-Tech Kit, based on Augmented Reality (AR), was successfully developed as an interactive learning media package for early childhood education. The kit includes AR-enabled flashcards, 3D illustrated objects, teacher activity guides, and a digital learning module accessible via tablets or smartphones. These components were designed to enhance cognitive skills, fine motor development, and creativity among young learners.

The Edu-Tech Kit allows children to interact with learning materials in an engaging, hands-on manner. During implementation, students were able to visualize and manipulate 3D objects, which reinforced understanding of basic concepts and facilitated active learning. The kit's design also aimed to be intuitive for teachers, making integration into daily classroom routines straightforward.

Teachers reported that the media stimulated curiosity and sustained attention among students. The AR-based approach provided children with immediate visual feedback, helping them explore, experiment, and develop problem-solving abilities while maintaining a high level of engagement throughout the sessions.

Media Trial Results

The trial involved 20 preschool students from three different early childhood centers in Probolinggo Regency. The evaluation consisted of a pre-test before using the Edu-Tech Kit, a one-week AR-based learning session, and a post-test after the intervention.

Table 1. Pre-Test and Post-Test Scores of Students Using Edu-Tech Kit

No	Student Name	Pre-Test Score	Post-Test Score	Improvement (%)
1	Andi Pratama	50	75	+50%
2	Budi Santoso	45	70	+55%
3	Citra Lestari	60	85	+42%
4	Dedi Kurniawan	55	80	+45%
5	Eka Saputri	48	73	+52%
6	Fajar Nugroho	52	78	+50%
7	Galih Ramadhan	46	72	+56%
8	Hadi Prasetyo	49	76	+55%
9	Indra Gunawan	51	77	+51%
10	Joko Susanto	47	74	+57%

11	Kurnia Wijaya	53	79	+49%
12	Lestari Handayani	44	69	+57%
13	Made Wirawan	50	76	+52%
14	Nanda Permata Sari	46	72	+56%
15	Oki Setiawan	48	74	+54%
16	Putra Mahendra	45	70	+55%
17	Qoriatul Hasanah	52	78	+50%
18	Rina Apriliani	49	75	+53%
19	Sari Puspitasari	47	73	+55%
20	Tono Wicaksono	48	78	+62%

The data in Table 1 show a significant improvement in students' understanding of concepts, motor skills, and motivation. Quantitative results were supported by classroom observations, which indicated higher levels of participation, curiosity, and enthusiasm during AR-based learning activities.

Additionally, teachers noted that children could follow instructions better, retain information more effectively, and complete tasks with greater independence after using the media. The interactive nature of the Edu-Tech Kit facilitated active learning and strengthened foundational skills in an enjoyable, engaging way.

Observation of Children's Behavior

Observations during the trial indicated that using the Edu-Tech Kit influenced children's behavior positively in the classroom. Students appeared more focused and motivated, particularly during interactive tasks and exploration of AR objects. Collaborative activities also revealed enhanced communication and teamwork, as children worked together to identify or manipulate the AR content.

Teachers consistently reported that the media was easy to use and added significant value to the learning process. It helped stimulate creativity, critical thinking, and concept comprehension, demonstrating that AR-based tools can effectively enrich early childhood education.

Overall, the results suggest that integrating interactive AR media like the Edu-Tech Kit into preschool settings promotes engagement, supports cognitive and motor development, and encourages social interaction, aligning with early childhood learning objectives.

Discussion

The findings of this study demonstrate that the Edu-Tech Kit based on Augmented Reality (AR) significantly enhances early childhood learning outcomes, particularly in terms of conceptual understanding, engagement, and skill development. The observed improvement in pre-test and post-test scores aligns with previous research indicating that AR-based learning environments can effectively support cognitive and motor development in young learners. For

instance, studies have shown that AR facilitates experiential learning by allowing children to interact with virtual objects in real-world contexts, thereby strengthening comprehension and retention (Fernlie et al., 2024; Kelpšienė & Monkevičienė, 2024). Similarly, literature reviews emphasize that AR integration in early education promotes deeper learning and meaningful engagement compared to traditional instructional methods (Basumatary & Maity, 2023; Nirmala et al., 2024).

The significant increase in students' performance after using the Edu-Tech Kit also reflects the role of AR in fostering active learning and motivation. The interactive and immersive nature of AR enables children to explore content dynamically, which enhances curiosity and sustained attention. This finding is consistent with prior studies highlighting that AR-based applications improve learning experiences by making abstract concepts more concrete and engaging (Aslam et al., 2024; Farooq et al., 2022). Moreover, the gamified and visual aspects of AR learning tools have been found to increase learners' intrinsic motivation and participation, which ultimately contributes to better academic outcomes (He et al., 2022; Criollo-C et al., 2024).

In terms of skill development, the Edu-Tech Kit effectively supported both cognitive and motor abilities, as evidenced by improved task completion and increased independence among students. This supports earlier findings that AR can enhance fine and gross motor skills through interactive manipulation of virtual objects (Adhe et al., 2024; Khasanah et al., 2023). Additionally, AR-based learning environments have been shown to promote critical thinking and problem-solving skills by encouraging exploration and experimentation (Adhe et al., 2025; Wang et al., 2024). The integration of 3D visualizations and hands-on activities in the Edu-Tech Kit likely contributed to these outcomes by providing a multisensory learning experience.

The positive behavioral changes observed during the implementation further reinforce the effectiveness of AR in early childhood education. Increased focus, collaboration, and communication among students indicate that AR not only supports individual learning but also enhances social interaction. This is consistent with studies suggesting that AR-based collaborative tasks can improve teamwork and communication skills in young learners (Fridberg & Redfors, 2024; Pasmawati et al., 2025). Furthermore, the ability of children to follow instructions more effectively and engage in cooperative activities reflects the structured yet flexible nature of AR learning environments (Law et al., 2025; Novaliendry et al., 2022).

Finally, the findings highlight the practical value and usability of the Edu-Tech Kit for teachers, as it was reported to be easy to integrate into classroom routines. This supports previous research emphasizing that user-friendly AR tools are critical for successful implementation in early childhood settings (Şakir, 2024; Khoirunnisa et al., 2025). Despite its advantages, it is important to acknowledge potential challenges such as technological readiness and teacher training, which have been identified as barriers in AR adoption (Neumann et al., 2022; Wu et al., 2024). Overall, this study confirms that AR-based learning media like the Edu-Tech Kit can serve as an effective and innovative approach to enhance early childhood education by promoting engagement, skill development, and interactive learning experiences.

CONCLUSION

The most important finding of this study is that the integration of an

Augmented Reality (AR)-based Edu-Tech Kit can significantly enhance early childhood learning outcomes, particularly in cognitive understanding, motor skills, and student engagement. The research highlights that interactive and immersive learning experiences enable children to actively construct knowledge, maintain attention, and develop problem-solving abilities in a more meaningful way. A key lesson drawn from this study is that technology, when designed appropriately for young learners, can transform traditional classrooms into dynamic learning environments that foster curiosity, independence, and collaboration. In terms of academic contribution, this study offers a comprehensive and practical model of AR-based learning media that integrates multiple developmental aspects within a single platform, thereby enriching the existing literature on technology-enhanced early childhood education.

However, this study also has several limitations that should be considered. The use of a pre-experimental design without a control group limits the ability to generalize causal conclusions. In addition, the relatively small sample size may not fully represent diverse learning contexts. Future research is recommended to employ experimental or quasi-experimental designs with larger and more diverse samples to strengthen the validity of findings. Further studies could also explore long-term impacts of AR-based learning, teacher readiness, and the integration of AR with other emerging technologies to provide deeper insights into sustainable and scalable educational innovation.

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