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The Role of Indigenous Culture-Based Augmented Reality Media in Improving Cultural Understanding in Elementary Schools

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Abstract
Cultural learning in elementary schools (SD) has an important role in building national identity and instilling local wisdom values from an early age. However, students' low interest in cultural learning is a challenge for educators. The development of digital technology, especially Augmented Reality (AR), offers innovative solutions in enhancing a more interactive and engaging learning experience. This research aims to explore the role of local Indonesian indigenous culture-based AR media, particularly related to Javanese cultural elements, in improving the cultural understanding of elementary school students. A qualitative method was employed, involving semi-structured interviews with three elementary school teachers from Taman, Buduran, and Candi Districts in Sidoarjo Regency. The findings indicate that teachers are aware of the importance of cultural learning but face challenges in making the content appealing to students. AR is perceived as a promising tool to increase engagement by visualizing cultural objects such as traditional houses, clothing, and folklore through interactive media. However, barriers such as limited digital infrastructure, insufficient teacher training, and lack of localized AR content remain significant obstacles. In conclusion, while AR technology has strong potential to enhance cultural learning in Indonesian elementary schools, its success depends on cross-sectoral collaboration in content development, ongoing teacher professional development, and improved access to supporting technologies.

INTRODUCTION

Cultural learning from an early age has a crucial role in shaping the character and identity of students. Culture is a heritage that must be preserved so that it does not disappear with the times. In the era of globalization, the younger generation tends to be more familiar with popular culture than the local culture inherited from ancestors (N. Sari et al., 2024). Lack of cultural understanding can lead to the fading of local values that are part of the nation's identity (Pringadhi & Najicha, 2023). Therefore, education at the elementary school (SD) level needs to integrate cultural materials so that students have awareness of their own cultural richness. Interesting and relevant cultural learning is needed so that students do not feel bored in understanding the local culture. One of the innovations that can be applied in cultural learning is the use of Augmented Reality (AR) technology. To address these challenges, innovative learning approaches must be aligned with the developmental characteristics of young learners and rooted in culturally relevant pedagogy.

AR technology is a digital medium that allows users to interact with virtual objects in a real environment directly. AR provides a more immersive and interactive learning experience than conventional methods such as lectures or textbooks (Dendodi et al., 2024). In the context of cultural learning, AR can display digital representations of cultural artifacts, traditional dances, and folklore in attractive visual form. The use of AR in education has been proven to increase student engagement

and deepen understanding of the material being taught. In addition, this technology can also bridge the gap between the younger generation and local culture that may feel foreign to them (D. K. Sari et al., 2024). Thus, AR has great potential in strengthening cultural learning, especially for elementary school students. Moreover, AR aligns with constructivist learning theory, which emphasizes the active role of learners in constructing knowledge through experience (Piaget, 1973; Vygotsky, 1978). Through interactive exploration, students can engage in contextual learning that enhances both retention and cultural empathy.

In Indonesia, the use of technology in education continues to grow as part of efforts to improve the quality of learning. The Independent Curriculum also encourages the use of technology in project-based learning that is relevant to daily life. However, the implementation of technology in cultural learning is still relatively minimal, especially at the basic education level (Novitandari et al., 2023). Many schools still use traditional methods such as reading books and memorizing without an interactive learning experience. This causes students to be less interested in learning about local culture and more likely to adopt foreign cultures (Oktaviasary & Sutini, 2024). Therefore, the integration of AR in cultural learning in elementary schools needs to be studied further in order to provide maximum benefits for students. Global research also supports the use of AR in cultural and heritage education to foster intercultural awareness, identity formation, and critical thinking (Bakhov et al., 2024). However, localized studies that examine these effects within Indonesian elementary contexts are still limited.

Some research shows that AR can increase students' interest in learning because it provides a more real and immersive experience. In a cultural context, AR can be used to display 3D animations of traditional houses, traditional clothing, to regional musical instruments (Ronal et al., 2023). This technology can also be integrated with folklore visualized in an interactive form, making it easier for students to understand the meaning and values contained in it. In addition, AR also allows for exploration-based learning, where students can explore different aspects of culture through digital applications (Mukhid, 2023). Another advantage is the flexibility of AR that can be used on various devices, such as tablets and smartphones, making it easier for students and teachers to access (Fauziyah et al., 2024). Thus, the use of AR in cultural learning can be an innovative solution in improving students' understanding of local cultural heritage. This experiential learning approach not only increases engagement but also develops 21st-century competencies such as digital literacy, creativity, and collaboration.

Despite its many advantages, the implementation of AR in cultural learning also faces various challenges. One of them is the limited technology infrastructure in some schools, especially in remote areas. Not all teachers have the technical skills to develop and operate AR media in the learning process (Oktavia, 2022). In addition, the development of local culture-based AR content requires collaboration between cultural experts, technology developers, and educators so that the material presented remains authentic and in accordance with local values (Juliawan et al., 2024). Another obstacle is the lack of policies that specifically encourage the use of AR in cultural education at the elementary level (Lembong et al., 2023). Therefore, there is a need for training for teachers as well as support from the government and related parties to ensure that AR can be applied effectively in cultural learning. Moreover, institutional support and curriculum alignment are essential to ensure that AR is not perceived as a temporary trend but integrated as part of long-term educational innovation.

In addition to technical challenges, the pedagogical aspect in the use of AR also needs to be considered so that learning remains in accordance with the needs of elementary school students. AR-based learning should be designed with a fun approach that is easy for children to understand. AR content that is too complex can confuse students and actually reduce the effectiveness of learning. Therefore, the design of AR applications for cultural learning must consider the visual, interactive, and active aspects of students in exploring the material. In addition, AR should not replace traditional learning methods entirely, but rather serve as a tool that complements students' learning experiences. Thus, a balanced approach between technology and conventional methods can provide optimal results

in cultural learning in elementary school. Instructional design frameworks such as Clark & Mayer (2023) can help guide the development of effective AR content by ensuring it supports student attention, reduces cognitive overload, and promotes meaningful learning.

The integration of AR in cultural education can increase students' awareness of cultural diversity in Indonesia. Through more immersive and interactive experiences, students can better understand the cultural values that exist around them (Januardi et al., 2024). In addition, AR can also be an effective medium in supporting character education, such as instilling an attitude of respect and preserving the nation's cultural heritage. The proper use of AR in cultural learning can help build a sense of pride in local cultural identity among the younger generation (Minsih et al., 2024). Therefore, it is important for schools to start considering the use of AR as part of innovative cultural learning strategies. With support from various parties, AR can be an effective educational medium in strengthening cultural understanding from an early age.

This research aims to explore the role of indigenous culture-based Augmented Reality media in improving cultural understanding in elementary schools. Specifically, it seeks to: (1) investigate the effect of AR on student engagement and comprehension in cultural learning; (2) identify challenges faced by teachers and schools in implementing AR; and (3) examine the opportunities for integrating AR into culturally responsive teaching practices. By addressing these objectives, this study contributes to a growing body of literature that advocates for the meaningful integration of emerging technologies into foundational education.

METHODS

This study uses a qualitative approach with the interview method as the main data collection technique. The qualitative approach was chosen because this study aims to deeply understand teachers' experiences and perceptions regarding the use of indigenous *culture-based* Augmented Reality *(AR)* media in cultural learning in elementary schools (SD). Interviews allow researchers to explore information more flexibly and in-depth, so as to understand the views and challenges faced by teachers in integrating AR technology in cultural learning. In addition, this method also provides space for teachers to express their opinions and reflections on the effectiveness and obstacles to the implementation of AR in their respective schools. This approach is consistent with the nature of exploratory research, where rich, contextual insights are prioritized over generalization.

The research subjects consisted of three elementary school teachers from three different sub-districts in Sidoarjo Regency, namely Taman, Buduran, and Candi Districts. The selection of informants was carried out purposively, with the criterion that the interviewed teacher must have experience in teaching subjects related to the local culture or have tried to apply technology in learning. The teachers involved in this study came from schools with different backgrounds, both in terms of facilities and the level of application of technology in the teaching and learning process. Thus, the variety of experiences from teachers is expected to provide a more comprehensive picture of the potential and challenges of the application of AR in cultural learning in elementary schools. Although the number of participants is limited, the diversity of school contexts was intentionally considered to represent different levels of technological readiness. Future studies may include broader samples to enhance generalizability.

The interviews were conducted face-to-face with a semi-structured approach, where the researcher used a pre-arranged list of questions, but still provided room for the informants to develop their answers freely. The questions in the interview were focused on several main aspects, namely (1) teachers' perceptions of the importance of cultural learning in elementary school, (2) teachers' understanding of AR technology and its potential in cultural learning, (3) teachers' experience in using or seeing the application of technology in learning, (4) obstacles faced in the integration of technology, especially AR, in cultural learning, and (5) recommendations from teachers on effective ways to implement AR in learning. Cultural Studies in Elementary School. The interview protocol was

reviewed by two qualitative education experts to ensure the clarity and relevance of the guiding questions.

During the interview, the researcher recorded and recorded the conversation to ensure the accuracy of the data. The data obtained from the interview results were then transcribed and analyzed using thematic analysis methods. The analysis was carried out by identifying the main themes that emerged from the teachers' answers, such as the benefits of AR in cultural learning, the technical challenges faced, and solutions that can be applied to increase the effectiveness of the use of AR. This approach allows researchers to understand the teacher's mindset and provide recommendations based on real-life experiences in the field. Data coding was performed using NVivo software to assist in theme categorization, improve traceability, and enhance analytical rigor.

To ensure the validity of the data, triangulation was carried out by comparing the answers of the three teachers interviewed and relating them to relevant literature and previous research. In addition to respondent triangulation, researcher triangulation was employed by involving two independent coders to review and cross-check the identified themes. Discrepancies were resolved through discussion to achieve intersubjective agreement. In addition, confirmation or member checking is also carried out by giving informants the opportunity to review the results of the interview transcript to ensure that the researcher's interpretation is in accordance with the intent of their answers. This approach aims to increase the credibility of research results and avoid bias in data analysis. These combined validation strategies help to ensure trustworthiness in accordance with the criteria of credibility, transferability, dependability, and confirmability.

RESULTS AND DISCUSSION

Research Results

This research aims to explore the role of *indigenous culture-based* Augmented Reality *(AR) media* in improving cultural understanding in elementary schools (SD). The data was obtained through interviews with three teachers from elementary schools in Taman, Buduran, and Candi Districts, Sidoarjo Regency. The results of the interviews were analyzed thematically to identify key patterns and findings related to the use of AR in cultural learning. From the results of the analysis, there are several main themes that emerge, namely teachers' perceptions of cultural learning, understanding of AR technology, experience in the use of technology in learning, challenges in implementing AR, and recommendations for the application of AR in cultural learning in elementary schools. Thematic analysis was used not only to identify recurring patterns, but also to explore the contradictions and underlying pedagogical beliefs of the teachers.

1. Teachers' Perception of Cultural Learning in Elementary School

The three teachers interviewed agreed that cultural learning is an important aspect of basic education. They consider that understanding culture from an early age can help students recognize and love ancestral heritage, as well as build national identity. However, they also acknowledged that students' interest in cultural learning is declining because it is considered less interesting compared to digital and popular cultural content from abroad. One teacher from Candi District expressed, *"Nowadays, children are more excited about Korean dramas and mobile games than about learning about batik or wayang stories."* This aligns with previous studies which show that conventional cultural education often fails to compete with digital entertainment in capturing students' attention. The declining appeal of cultural subjects highlights a mismatch between traditional teaching methods and student expectations in a digital age.

2. Teachers' Understanding of AR Technology in Learning

When asked about AR technology, teachers have varying levels of understanding. Teachers from Taman District have been familiar with the concept of AR and have seen its implementation in digital learning applications. A teacher from Buduran stated, "*We use slides and sometimes YouTube videos, but AR sounds too advanced for us right now*." Meanwhile, teachers from Buduran and Candi Districts have not yet had a deep understanding of AR, even though they have heard of this

technology. A teacher from Buduran admitted, "I've seen AR used in science apps before, but I wouldn't know how to apply it to culture unless there's a specific guide." They argue that AR can be an exciting innovation in learning, but it requires guidance and training for teachers to use it effectively. One of the teachers revealed that although this technology sounds interesting, there are still many teachers who are not familiar with how to use it in the learning process.

3. Teachers' Experience in Using Technology in Learning

The three teachers acknowledged that the use of technology in learning has increased in recent years, especially since the digitalization of education policy. However, the application of technology still focuses more on the use of videos, interactive presentations, and application-based educational games. A teacher from Buduran District said that his school had tried to use a 3D-based educational application, but had not specifically used AR. Meanwhile, a teacher from Taman District revealed that the use of technology in cultural learning is still limited, so many students feel that cultural learning is less interesting compared to other subjects that have been supported by more interactive digital media.

4. Challenges in the Implementation of AR in Cultural Learning

Although teachers see great potential of AR in increasing students' interest in local culture, they also reveal some challenges in its implementation. One of the main challenges is the limited facilities and infrastructure in schools. A teacher from Candi shared, "*Even for basic computer use, we often have to take turns with limited devices — let alone AR that requires specific specs*." Teachers from Candi District revealed that not all schools have devices that support AR technology, such as tablets or smartphones with high specifications. In addition, the lack of training for teachers is another obstacle. Teachers from Buduran District stated that many teachers still have difficulty adapting technology in learning, so special training is needed so that they can develop and operate AR media properly. In addition, the limitation of AR content relevant to the local culture is also a barrier, as most of the available apps focus more on science and math material than on culture.

5. Teachers' Recommendations for the Application of AR in Cultural Learning

To overcome these challenges, the teachers provided several recommendations so that AR technology can be implemented effectively in cultural learning. First, training is needed for teachers so that they can understand and utilize AR optimally. One teacher emphasized, *"We need real workshops — not just theories, but hands-on sessions where we actually try to create or run AR apps in class."* Second, the government and schools are expected to provide adequate infrastructure support, including technological devices that can be used by students and teachers in AR-based learning. Third, collaboration between technology developers and cultural experts is needed to create AR content that is based on local culture, so that students can learn about their local culture in a more interactive way. Teachers from Buduran District suggested that AR not only display 3D images, but also integrate elements of stories and educational games to make it more attractive to students. This aligns with the principle of experiential learning, which holds that deeper understanding occurs when learners are actively involved in authentic, engaging activities

Overall, the findings indicate that while AR holds considerable promise for revitalizing cultural learning in elementary schools, its successful implementation depends heavily on systemic support, content development, and teacher preparedness. The insights from teachers reveal both the excitement and apprehension that come with adopting new technology, reflecting global trends in AR integration in primary education. Future research could expand the participant pool and explore student perspectives to gain a more holistic understanding of AR's impact on cultural learning.

Discussion

Cultural learning in elementary schools (SD) has an important role in instilling local wisdom values and building students' national identity from an early age. However, the challenge faced in the cultural learning process is the low interest of students due to learning methods that tend to be conventional and less interactive. The development of digital technology offers various innovative

solutions to improve the learning experience, one of which is the use of *Augmented Reality* (AR) technology. AR can provide a more real and engaging learning experience for students through the integration of digital objects in a real-world environment (Aditia, 2024). In the context of cultural learning, AR can be used to present cultural artifacts, traditional clothing, traditional houses, and folklore in visual and interactive forms that are easier for students to understand. This is consistent with global research showing that AR enhances learners' cultural empathy and contextual understanding through sensory immersion.

The results of interviews with teachers from three schools in Sidoarjo Regency show that they are aware of the importance of cultural learning, but have difficulty in making it attractive to students. One of the teachers stated that students are more interested in digital content such as games and videos than reading books about local culture. This is in line with the findings of Wanda (2023) who stated that the current young generation accesses more information through digital devices than print media. Therefore, innovations in cultural learning that integrate modern technology are needed to be more relevant to today's student learning styles. AR is one of the solutions that can bridge this need by providing a more immersive and immersive learning experience (Dendodi et al., 2024). However, it is important to note a contradiction: while students may prefer digital content, cultural depth and value transmission require structured pedagogical design, which is sometimes absent in off-the-shelf AR applications (Sultan, 2023). This points to a need for teacher mediation in the integration process.

Despite its great potential, teachers' understanding of AR technology is still limited. Only one in three teachers interviewed were familiar with AR and saw its application in the world of education. The other two teachers admitted that they are still unfamiliar with this technology, even though they are interested in using it in cultural learning. These findings show that there is still a knowledge gap between the development of educational technology and teachers' readiness to adopt it (Solihin et al., 2024). This shows the need for training and mentoring for teachers so that they can understand and integrate AR in learning effectively (Ambiyar et al., 2024). Moreover, research by Demircioglu et al. (2023) emphasized that professional development for AR use must go beyond technical instruction it must include critical reflection on pedagogical goals and cultural relevance.

In terms of experience using technology in learning, teachers have utilized various digital media such as videos and 3D-based educational applications. However, the use of technology is still limited to several subjects such as science and mathematics. Cultural learning is still often done in conventional ways such as reading books and listening to stories from teachers. In fact, previous research has shown that the integration of technology in cultural learning can increase student engagement and strengthen their understanding of the material being taught (Azhar et al., 2024). A similar study by Rachmawati et al. (2023) found that students were more able to articulate and internalize cultural values when using AR narratives compared to traditional lectures, especially in early-grade classrooms. Therefore, the application of AR in cultural learning not only serves as a technological innovation, but also as a strategy to increase learning effectiveness.

The main challenge in the implementation of AR in cultural learning in elementary schools is the limited facilities and technological infrastructure in schools. Teachers from Candi District said that not all schools have devices that support AR, such as tablets or smartphones with high specifications. This is in accordance with research by Wahyudi & Jatun (2024) which found that the digitalization of education is still experiencing obstacles due to infrastructure gaps in various regions. In addition, the factor of teachers' technical skills is also a challenge, because many teachers have not received training in the use of AR. Therefore, support from the government and educational institutions is needed to provide access to tools and training for teachers so that this technology can be applied optimally. This situation reflects the digital divide not only between urban and rural schools but also within individual districts, creating equity challenges in the adoption of educational technology.

Another obstacle is the availability of AR content based on local culture. Most of the AR apps available today focus more on science and technology subjects, while content about local culture is still very limited. Teachers from Buduran District said that although they were interested in using AR

in cultural learning, they had not found an application that could specifically display the culture of the Sidoarjo area. This is echoed in a meta-review by Papakostas et al. (2021), which found that cultural heritage AR content is often Eurocentric and lacks representation from the Global South, including Southeast Asia. This shows that collaboration is needed between technology developers, academics, and cultural experts to create AR content that suits the needs of cultural learning in Indonesia (Juliawan et al., 2024).

One of the main recommendations from teachers is the need for more practical training in the use of AR. Teachers from Taman District emphasized that training must not only be theoretical, but also provide hands-on experience in using AR applications in learning. This finding is supported by research by Wahyuni et al. (2022) who stated that the effectiveness of educational technology is highly dependent on teachers' readiness to use it. In addition, Joylitha et al. (2024) recommend that teacher training for AR should be continuous, collaborative, and embedded within real school contexts—moving beyond one-off workshops. Thus, a comprehensive and ongoing training program needs to be organized to ensure that teachers can effectively integrate AR in the cultural learning curriculum. In addition to training, the integration of AR in cultural learning also requires policy support from the government and educational institutions. Currently, the Independent Curriculum has provided flexibility for schools to implement project-based and technology-based learning methods (Kurniati et al., 2022). This can be an opportunity for schools to start exploring the use of AR in cultural learning. However, to ensure its sustainability, the government needs to provide incentives and assistance in the form of providing devices and developing AR content that is relevant to local culture. Policy alignment with local content development is crucial to avoid homogenized AR applications that ignore the richness of Indonesia's cultural diversity.

The success of the implementation of AR in cultural learning also depends on the involvement of students in the learning process. Research by Aminudin & Mutmainah (2024) shows that AR-based learning is more effective if students are given the opportunity to actively interact and explore the material. Therefore, AR content developed should not only display cultural objects in visual form, but also engage students in activities that stimulate their understanding, such as educational games, interactive simulations, or mixed reality-based experiences. Furthermore, attention must be paid to students' cognitive load and learning styles AR should be designed with intuitive navigation, age-appropriate interactions, and narrative elements that evoke curiosity and reflection. This ensures that AR use not only excites, but also educates in meaningful ways.

CONCLUSION

This research reveals that the application *of Augmented Reality* (AR) based on *indigenous culture* has significant potential in improving the cultural understanding of elementary school students through a more interactive and immersive learning experience. However, the implementation of this technology still faces various challenges, including limited infrastructure, lack of teacher competence in the use of AR, and lack of availability of local culture-based content. The results of the interviews show that students are more interested in digital media compared to conventional learning methods, so AR can be an innovative solution to increase their involvement in cultural learning. However, not all educators have adequate understanding and skills in integrating AR into the curriculum, so continuous training and mentoring are needed. In addition, the limitation of supporting devices and the lack of AR applications that showcase local culture are the main obstacles in the application of this technology. Therefore, synergy is needed between the government, technology developers, and academics in providing infrastructure, improving teacher competence, and developing content based on local culture. With supportive education policies, such as the Independent Curriculum, AR has the potential to become an effective learning medium in introducing, understanding, and preserving local culture in the midst of globalization dynamics.

Despite the promising findings, this study is limited by its small sample size (only three teachers) and narrow geographical scope (limited to Sidoarjo Regency). As a result, the conclusions

drawn cannot be generalized to all elementary school contexts in Indonesia. Moreover, the study relies solely on teacher perceptions without triangulating with student data or classroom observations, which limits the depth of its analysis. Future research should involve a larger and more diverse group of participants, including students and education policymakers, to gain a more holistic understanding of AR integration in cultural learning. Experimental or quasi-experimental studies could also be conducted to measure the actual impact of AR media on students' cultural knowledge acquisition, engagement levels, and character development over time. In addition, interdisciplinary collaborations between educational technologists, cultural experts, and curriculum designers are needed to co-develop culturally authentic and pedagogically sound AR content. By addressing these limitations and expanding the scope of inquiry, future studies can contribute more robustly to the discourse on digital innovation in cultural education and help shape more inclusive, locally grounded, and future-ready learning environments.

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