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Optimizing Cultural Awareness Through Augmented Reality: An Analysis of Educational Media Needs in Indonesian Elementary Schools

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Abstract

Indonesia's rich cultural heritage faces challengesdue to globalization and inadequate innovative educational methods. **Objective**: This study analyzes the need for Augmented Reality (AR)-based learning media to enhance cultural awareness in Indonesian elementary schools. **Novelty**: New insights into students' perceptions and expectations towards the use of AR in local cultural learning. **Methods**: Using a quantitative, cross-sectional survey with purposive sampling (N=160, consisting of 150 students and 10 teachers), this study collected perceptions about traditional and AR-based cultural learning. **Results**: Findings from the study showed that 62% of students found traditional cultural learning uninteresting, while 87% expressed strong interest in AR due to its interactivity and ease of use. **Conclusions**: These findings underscore the potential of AR as a transformative tool for cultural education, urging policymakers and educators to adopt immersive technologies. Future studies could explore the long-term impact of AR on cultural retention.

Keywords: Augmented Reality, Cultural Awareness, Learning Media, Elementary Education.

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INTRODUCTION

Indonesia's extraordinary cultural wealth faces significant challenges in preservation and transmission to younger generations. This issue mirrors global concerns about cultural erosion in developing nations undergoing rapid modernization (Fauzan, 2025). Studies across Southeast Asia reveal similar patterns of declining cultural awareness among youth, from Thailand's fading traditional arts (Laochockchaikul & Bhuket, 2024) to Malaysia's weakening indigenous knowledge systems (Samsuddin et al., 2024). In Indonesia specifically, research demonstrates waning interest in cultural preservation among students (Ratminingsih et al., 2020; Sumilat et al., 2022), attributable to globalization (Dharma et al., 2021), foreign cultural influences (Komariah & Asyahidda, 2020), and insufficient cultural education (Nurman et al., 2022). These trends carry serious consequences including diminished national identity (Setyawan & Dopo, 2020), erosion of ethical foundations (Fatmawati, 2021), and cultural displacement (Iasha et al., 2022), potentially leading to social fragmentation and moral crises (Datuk, 2020; Sumantri et al., 2022).

Educational institutions worldwide are increasingly turning to immersive technologies to address these challenges. While schools serve as crucial agents for cultural transmission, current pedagogical approaches remain largely traditional and ineffective (Apriani, 2023; Puspasari et al., 2020). The predominant lecture-based methods (Acesta et al., 2021; Muthmainnah et al., 2022) fail to engage digital-native students, creating an urgent need for innovative solutions. Augmented Reality (AR) emerges as a particularly promising solution, building on successful implementations in other cultural contexts like Mexico's virtual heritage preservation (Salazar Flores, 2023) and China's digital museum initiatives (Hou et al., 2022).

Prior research on technology-enhanced cultural education reveals important foundations yet significant gaps. While Iasha et al. (2022) demonstrated virtual reality's effectiveness for cultural literacy and Wahyuni et al. (2022) established the value of mobile-based cultural content, these studies focused on either different technologies or narrower applications. Notably, existing needs analyses have overlooked AR's unique potential to bridge physical and digital cultural experiences - a critical gap given AR's proven advantages in educational engagement (Lian & Xie, 2024) and cultural heritage interpretation (Boboc et al., 2022). Unlike previous work on VR media or textbook development (Al-Ansi et al., 2023), this study specifically investigates AR's untapped potential for creating contextual, interactive cultural learning experiences.

This study makes three key contributions: First, it extends cultural education theory by empirically testing the Technological Pedagogical Content Knowledge (TPACK) framework in AR-based cultural learning. Second, it provides practical guidelines for developing culturally-responsive AR media through comprehensive needs analysis. Third, it offers cross-cultural insights by adapting global AR implementation models to Indonesia's unique educational context. Our research questions specifically examine: (1) What are students' and teachers' need for AR-based cultural learning media? (2) How can AR technology be optimally designed to enhance cultural awareness? The findings will inform both educational practice and the growing field of cultural preservation technology, with implications for similar cultural contexts worldwide.

METHODS

Research Design

This study adopted an explanatory sequential mixed-methods design to comprehensively evaluate the potential of AR technology for cultural education. The first quantitative phase utilized a cross-sectional survey administered to 160 participants (150 students and 10 teachers) across five elementary schools in Central Java. Structured questionnaires with validated Likert-scale items measured key variables including current learning method effectiveness, technology familiarity, and AR feature preferences. The second qualitative phase involved in-depth interviews with 10 teachers and analysis of open-ended survey responses to contextualize quantitative findings. This phased approach enabled both broad measurement of trends across diverse school environments and deep exploration of implementation challenges and opportunities (Creswell & Creswell, 2017).

Participants

The study used purposive sampling to select 160 participants (150 students and 10 teachers) from five public elementary schools in urban and semi-urban areas of Central Java, Indonesia. Selection criteria included:

- Students: 3rd to 6th graders (ages 8-12) who had completed at least one semester of cultural studies
- Teachers: Minimum 2 years of experience teaching cultural subjects
- Schools: Institutions with basic technological infrastructure but no prior AR implementation

This stratified approach ensured representation across different grade levels, geographic locations, and teaching experiences, enhancing the generalizability of findings (Najoan et al., 2024). The demographic distribution was shown in table 1.

Table 1. Participant Demographics

Category	Subgroup	n (%)
Role	Students	150 (93.75%)
	Teachers	10 (6.25%)
Grade Level*	3rd grade	38 (25.33%)
	4th grade	42 (28.00%)
	5th grade	35 (23.33%)
	6th grade	35 (23.33%)
School Location	Urban	90 (56.25%)
	Semi-urban	70 (43.75%)
Teaching Experience**	2-5 years	4 (40.00%)
	6-10 years	5 (50.00%)
	>10 years	1 (10.00%)

*Percentage of student population (n=150)
**Percentage of teacher population (n=10)

Data Collection

The research utilized a validated 25-item questionnaire divided into four sections: demographic information (5 items), cultural learning experiences (7 items), technology preferences (6 items), and AR expectations (7 items). Instrument development involved content validation by three educational technology experts (CVI = 0.89) and pilot testing with 30 students (Cronbach's α = 0.91), establishing strong reliability and validity. The questionnaire

employed a 5-point Likert scale with clearly defined response anchors to ensure consistent interpretation across respondents.

Data Analysis

The study employed a comprehensive analytical approach combining robust quantitative techniques and rigorous qualitative methods. Quantitative analysis utilized descriptive statistics (frequencies, percentages, means, and standard deviations) to characterize participant demographics and key variables, while inferential analyses, including ANOVA with Tukey post-hoc tests, compared satisfaction levels across learning methods, revealing significant differences between traditional and innovative approaches. Correlation analysis (Pearson's r) explored relationships between technology exposure and learning preferences, and linear regression identified predictive factors for AR acceptance, with all analyses incorporating checks for normality and homogeneity of variance. Complementing this, qualitative data underwent thematic analysis following Braun and Clarke's (2006) framework, with two researchers independently coding open-ended responses and interview transcripts, achieving strong inter-rater reliability (Cohen's $\kappa = 0.83$). The analysis progressed from descriptive coding to interpretive themes through iterative refinement, with emerging patterns constantly compared across data sources and member checking ensuring credibility.

RESULT AND DISCUSSION

Quantitative Findings

The quantitative phase of this study analyzed survey responses from 150 students and 10 teachers across five elementary schools in Central Java. The data focused on three key aspects: (1) the effectiveness of current learning methods, (2) technology familiarity and usage patterns, and (3) preferences for augmented reality (AR) features in cultural education. Statistical analyses, including ANOVA, correlation, and regression, were conducted to identify significant trends and relationships.

Effectiveness of Current Learning Methods

To assess the perceived effectiveness of different instructional approaches, participants evaluated traditional and technology-enhanced learning methods using a 5-point Likert scale (1 = Very Ineffective, 5 = Very Effective). Table 2 presents a comparative analysis of these ratings, including mean scores, standard deviations, and statistical significance tests between different pedagogical approaches. The results reveal striking differences in how students and teachers perceive various teaching methodologies in cultural education.

Table 2. Comparison of Learning Method Effectiveness

Learning Method	Mean Score (Students)	SD	Mean Score (Teachers)	SD	ANOVA (p-value)	Effect Size (η^2)
Textbooks	2.45	0.78	2.60	0.85	<0.01	0.18
Teacher Lectures	2.67	0.82	2.75	0.79	<0.01	0.20
Videos	3.89	0.91	4.10	0.88	0.12 (NS)*	0.05
Field Trips	4.12	0.85	4.30	0.82	0.08 (NS)*	0.07
Digital Games	3.75	0.93	3.90	0.87	0.15 (NS)*	0.04

*NS: Not Significant

The results of the analysis in Table 2 show significant differences in the effectiveness of cultural learning methods in elementary schools. Traditional methods such as textbooks (M = 2.45) and teacher lectures (M = 2.67) obtained the lowest satisfaction scores, with ANOVA significance values of $p < 0.01$ and effect sizes (η^2) ranging from 0.18–0.20, indicating that these methods are less effective in attracting students' interest. In contrast, interactive approaches such as videos (M = 3.89) and field trips (M = 4.12) were considered the most effective, although the differences were not significant between students and teachers ($p > 0.05$). This finding is in line with Radu's (2014) research which states that visual-based learning and direct experience increase student engagement. In addition, teachers tend to give slightly higher scores to interactive methods, indicating awareness of their pedagogical benefits.

Technology Familiarity and Usage

Understanding students' and teachers' access to and familiarity with digital technologies is critical to effectively implementing AR-based learning. This survey examined key indicators of technology readiness, including device ownership, frequency of educational technology use, and self-rated proficiency level. These factors directly impact the feasibility of integrating AR into the classroom environment, particularly in schools with varying levels of technology infrastructure. Table 2 presents a detailed breakdown of technology access and usage patterns among participants, providing important baseline data for planning AR implementation.

Table 3. Technology Access and Usage Patterns

Variable	Students (%)	Teachers (%)	Statistical Test	Significance (p-value)
Smartphone Ownership	92%	100%	Chi-square (χ^2)	00.04
Tablet/Laptop Access	45%	80%	Chi-square (χ^2)	< 0.01
Daily Educational Use	34%	60%	Chi-square (χ^2)	< 0.01
Self-Rated Tech Proficiency (Mean)	3.12 (SD = 0.95)	3.56 (SD = 0.94)	Independent t-test	0.02

The data in Table 2 reveal several important patterns in technology access and use. First, while 92% of students own a smartphone, only 34% use it regularly for educational purposes, indicating a significant gap between device availability and pedagogical applications. This suggests that students are technologically equipped for AR-based learning but may lack guidance in utilizing these tools effectively. Second, teachers reported significantly higher access to laptops or tablets (80%) compared to students (45%), highlighting potential resource disparities that may impact equitable AR implementation. Notably, despite their greater device access, teachers rated their technology proficiency at only 3.56 out of 5 (SD = 0.94), with 60% using digital tools occasionally rather than routinely. This moderate level of proficiency underscores the need for targeted teacher training programs to build confidence in using advanced technologies such as AR. Statistical tests confirmed these observations: chi-square analysis showed a significant difference ($p < 0.05$) in device access between students and teachers, while a positive correlation ($r = 0.42$) between technology exposure and AR acceptance reinforced that familiarity breeds openness to innovation.

Preferred AR Features in Cultural Education

To understand the potential of AR application in cultural education, this study investigated the AR features that are most desired by students and teachers. This preference analysis is crucial in designing AR solutions that truly suit the learning needs of elementary schools. Table 4 reveals the level of acceptance of various AR features.

Table 4. Technology Access and Usage Patterns

AR Feature	Mean (Students)	SD	Mean (Teachers)	SD	ANOVA (p-value)
3D Cultural Artifacts	4.35	0.67	4.40	0.72	0.65 (NS)
Gamified Learning	4.12	0.73	4.00	0.81	0.32 (NS)
Local Language Integration	3.96	0.81	4.20	0.75	0.04
Multiplayer Collaboration	3.75	0.88	3.60	0.85	0.28 (NS)

*NS: Not Significant

Table 4 reveals several key findings regarding AR feature preferences. Both students and teachers showed the strongest agreement on the value of 3D cultural artifacts (Students: M=4.35; Teachers: M=4.40), indicating this as a universally desired core feature for AR cultural education. Gamification learning elements also received high ratings from both groups (Students: M=4.12; Teachers: M=4.00), indicating that game-like interactions can effectively increase engagement. The most significant difference between groups emerged in local language integration (p=0.04), where teachers (M=4.20) rated this feature higher than students (M=3.98), possibly reflecting educators' greater awareness of the need for cultural preservation. Multiplayer collaboration features received the lowest ratings from both groups (Students: M=3.75; Teachers: M=3.60), possibly indicating this may be a lower priority for initial AR implementation. The generally high mean scores (all above 3.5) across all features indicate an overall strong acceptance of AR technology, while the non-significant p-values (NS) for most features indicate alignment between students' and teachers' perspectives regarding the potential of AR applications in cultural education.

Qualitative Findings

Thematic analysis of in-depth interviews and open-ended survey responses revealed three main thematic clusters that provide information about the current state and future potential of AR integration in cultural education.

Current Challenges in Cultural Education Delivery

Educators consistently identified several systemic challenges in traditional cultural education methods. A major concern was the limitations of static learning materials, as expressed by Teacher 4: "Students have difficulty visualizing abstract concepts when we only have flat pictures in textbooks to show puppet characters or traditional house architecture." This visual limitation is compounded by limited access to authentic cultural experiences. Teacher 7 explained, "Even though we are in Central Java, many students have never visited Borobudur or watched a live gamelan performance because field trips are too expensive and complicated to organize." The pedagogical approach itself emerged as another barrier, with Teacher 2 observing that "monotonous teaching reduces interest – when I only explain traditions through lectures, even students who are usually active become disinterested."

Transformative Potential of AR Technology

Participants expressed great enthusiasm about AR's capacity to address these challenges through increased engagement. One Grade 5 student vividly envisioned how "AR could bring shadow puppets to life in our classroom – they could move and tell their stories!" Teachers recognized this potential for active learning, with Teacher 5 noting that "children learn better when they can interact with content rather than just observe." The technology held particular promise for addressing geographic disparities, with semi-urban teachers highlighting AR's

ability to give our students the same exposure to cultural heritage as their urban counterparts. However, this optimism was tempered by pragmatic concerns about implementation readiness. Teacher 9 emphasized that "we need proper workshops before implementing AR – not just on how to use it, but also how to integrate it meaningfully into lessons."

Barriers and Requirements for Implementation

While recognizing the potential of AR, participants identified several significant barriers to successful adoption. Infrastructure limitations were prominent, with many teachers reporting that "some classes do not have tablets or reliable internet for AR applications." Content relevance emerged as another important factor, with requests for "region-specific examples that reflect local Central Javanese traditions rather than general Indonesian culture." Teachers also emphasized the importance of curriculum alignment, noting that "AR content must be clearly connected to national education standards and competency targets." These findings suggest that successful AR implementation requires not only technological solutions but also careful attention to local context, teacher preparation, and curriculum integration to realize its full educational potential.

Discussion

The findings of this study provide strong evidence for augmented reality (AR) as a transformative tool for cultural education in Indonesian elementary schools, while also revealing critical considerations for its implementation. Three main themes emerge from the integration of our quantitative and qualitative findings with existing theoretical frameworks and previous research.

AR as a Solution for Enhanced Cultural Engagement

Our results strongly support the potential of AR to revolutionize cultural learning, corroborating Radu's (2014) findings on how augmented reality creates meaningful learning experiences through enhanced visualization and interaction. The very high preference for 3D cultural artifacts (M=4.35-4.40) and gamification elements aligns with Zhang et al.'s (2025) immersive education framework, which emphasizes that multisensory engagement significantly improves knowledge retention in cultural studies. This effect appears to be particularly pronounced for abstract cultural concepts, overcoming what Sari et al. (2024) identified as the challenge of "cognitive overload" in traditional learning methods. Qualitative data further corroborate this through teacher observations that AR can make cultural artifacts such as wayang kulit more accessible and engaging, supporting Lazaro et al. (2024) dual coding theory by combining visual and verbal information channels. Importantly, our findings extend the current literature by demonstrating these benefits specifically in the context of Indonesian cultural education, where the preservation of intangible heritage presents unique pedagogical challenges.

Navigating Implementation Challenges

While student enthusiasm for AR was evident, our study uncovered implementation barriers that echo those identified in previous educational technology research. Infrastructure limitations and teacher readiness concerns reflect the "second-order digital divide" described by Lin et al. (2023), where even when technology is available, effective integration remains a challenge. This aligns with Ertmer's (1999) distinction between first-order (external) and second-order (internal) barriers to technology adoption. Our findings suggest that a phased implementation approach, combining pre-service teacher training (as recommended by Tondeur et al., 2012) and offline AR solutions, can effectively address these challenges. The demand for local content particularly reflects Kim et al. (2021) TPACK framework, which emphasizes the need for technological solutions that respect local pedagogical and cultural

contexts. In particular, our data extends current understanding by highlighting how these challenges are particularly manifested in Indonesia's semi-urban school settings, where resource gaps are particularly pronounced but often overlooked in the educational technology literature.

Policy Implications and Future Research Directions

The findings of this study have significant implications for the Merdeka Belajar initiative in Indonesia, suggesting that AR integration can operationalize the goals of student-centered and contextualized learning programs. This is in line with Okai-Ugbaje (2022) mobile learning framework that emphasizes "anytime, anywhere" cultural education. The need for local content development supports Park et al. (2022) cultural historical activity theory, which suggests that AR implementations should be co-designed with local communities and cultural experts to ensure authenticity. For future research, we recommend longitudinal studies to assess the impact of AR on cultural knowledge retention, based on Mayer's (2024) cognitive theory of multimedia learning. In addition, research should explore AR's potential to develop what Jayadi et al. (2022) calls "intercultural competence," particularly in Indonesia's diverse cultural landscape. This direction would address the current gap in understanding AR's long-term educational outcomes and its role in cultural preservation efforts.

CONCLUSION

This study demonstrates that augmented reality (AR) has significant potential to enhance cultural education in Indonesian elementary schools by addressing key limitations of traditional teaching methods. The quantitative findings reveal that students and teachers find conventional approaches like textbooks (M=2.45) and lectures (M=2.67) less engaging compared to interactive methods such as videos (M=3.89) and field trips (M=4.12). This preference aligns with the high enthusiasm for AR features, particularly 3D cultural artifacts (M=4.35–4.40) and gamified learning (M=4.00–4.12), which support immersive and multisensory learning experiences. These results corroborate existing theories on multimedia learning, suggesting that AR can bridge the gap between abstract cultural concepts and students' comprehension by providing interactive visualizations.

However, the study also identifies critical challenges that must be addressed for successful AR implementation. While students show strong technological readiness (92% smartphone ownership), only 34% use devices for learning, highlighting a gap in digital literacy. Teachers, despite having better access to devices (80% tablet/laptop ownership), report moderate proficiency (M=3.56/5), emphasizing the need for targeted training programs. Infrastructure limitations, particularly in semi-urban schools, further complicate adoption, necessitating offline AR solutions such as marker-based applications. Additionally, qualitative findings stress the importance of localized content that reflects regional cultural diversity, ensuring relevance and authenticity in AR-based lessons.

To maximize AR's potential, policymakers and educators should adopt a structured implementation strategy. First, teacher professional development must be prioritized to build confidence in using AR pedagogically. Second, curriculum designers should collaborate with cultural experts to develop AR modules that align with national standards while preserving local traditions. Finally, future research should explore scalable and low-cost AR solutions to ensure equitable access across urban and rural schools. Longitudinal studies are also needed to assess AR's long-term impact on cultural knowledge retention and intercultural competence.

In conclusion, AR presents a transformative opportunity to revitalize cultural education in Indonesia, making it more engaging and accessible. However, its success depends on

addressing technological, pedagogical, and logistical barriers through collaborative efforts among educators, technologists, and policymakers.

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