Integrating Educational Technology in History Learning: Advancing Cultural Awareness and Preservation in Indonesia

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***Abstract*—This study aims to study technology-based learning media that leverage local historical resources to enhance students' engagement, historical understanding, and cultural awareness to support cultural preservation in Indonesia. The research employs the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) design framework. Research instruments include questionnaires, observation sheets, and interviews. The media were tested with 350 tenth-grade students from four high schools in Yogyakarta, focusing on usability, cultural awareness, engagement, technological usability, and cultural relevance. Validation was conducted by five experts in content, media, and education, evaluating usability, content quality, curriculum alignment, and cultural relevance. Data analysis was performed using ANOVA (Analysis of Variance) and correlation tests. The results indicate that the media effectively enhances students' cultural awareness, with the cultural relevance dimension achieving the highest score (4.6) among all aspects. A significant positive correlation between engagement and cultural awareness ($r = 0.76$; $p < 0.001$) suggests that active student engagement directly contributes to their cultural understanding. The developed media integrates augmented reality/virtual reality technologies, narrative quizzes, historical simulations, and student engagement tracking. This study offers a global contribution by providing a strategic approach that integrates cultural preservation and technology in education, making it relevant for application in various countries facing digitalization and cultural preservation challenges.**

***Keywords*—cultural awareness, cultural preservation, educational technology, history learning, interactive learning media**

I. Introduction

History education strategically shaped cultural awareness, national identity, and appreciation for historical heritage [1]. However, in the digital era at the time, traditional methods of teaching history tended to be less engaging for younger generations accustomed to technology [2]. Approaches that relied solely on lectures and rote memorization of facts often failed to motivate students to understand history's relevance to contemporary life actively [3]. Moreover, the shift toward STEM (Science, Technology, Engineering and Mathematics) disciplines, the focus on career-oriented education, the rise of digital history, and the declining public support for the humanities in general presented significant challenges in the modern era [4]. Consequently, there was a decline in students' interest in learning history, which impacted their understanding of cultural values and nationalism [5]. In a global context, preserving culture through history education became an urgent challenge, particularly by leveraging educational technology as a bridge between younger generations and cultural heritage [6].

At that time, educational technology held significant potential to enhance the effectiveness of history education. Sousa *et al*. [7] highlighted that audio-visual learning media could capture students' attention and improve their information retention through interactive visualization and narration. Meanwhile, Camacho-Tamay and Bernal-Ballen [8] emphasized the importance of interactivity in learning media, enabling students to participate and comprehend complex historical concepts actively. Yulifar and Aman [9] further underscored that educational technology accommodated diverse student learning styles, providing an inclusive and relevant learning experience. However, technology integration into history education in Indonesia remained limited, particularly in utilizing local historical resources to support cultural awareness [10]. Therefore, this study aimed to address this gap by developing technology-based learning media to enhance students' understanding of cultural values and national history [11].

The primary issue addressed in this study was the lack of educational technology in history education to effectively access and employ historical sources in supporting cultural advancement in Indonesia. Most history teaching methods in schools still relied on traditional approaches, such as rote memorization of facts and lectures, without providing opportunities for students to explore authentic and relevant historical sources [12]. This issue was particularly critical in history education because historical understanding required more than just factual recall; it demanded critical thinking, source analysis, and contextual interpretation [13]. However, in any classroom, history was taught as a static subject, where students passively received information rather than actively engaging with historical narratives [14]. The lack of inquiry-based learning and direct exploration of historical sources resulted in a superficial understanding of history, limiting students' ability to construct meaning from past

events [15]. Students often struggled to perceive history as a dynamic and interpretive discipline without interactive and investigative approaches [16]. Consequently, history education often lost relevance to modern cultural contexts and failed to foster cultural awareness and appreciation for historical heritage [17].

As a general solution, integrating educational technology was not intended to replace authentic historical sources but to enhance students' access to them. Digital archives, virtual museum tours, and interactive historical reconstructions allowed students to engage with historical documents, artifacts, and primary sources that would have otherwise been difficult to access [16]. Through technology, students explored these sources in a more interactive and immersive manner, deepening their understanding of historical contexts while preserving the authenticity of the materials studied [18]. With technology, students can easily access local and global historical sources, visualize complex historical narratives, and understand the relevance of history in building a strong cultural identity [19]. Indonesia has diverse cultures, and history education in senior high schools is designed to introduce these identities, aiming to foster a sense of nationalism among students [4].

Educational technology offers specific solutions to address the low accessibility and utilization of historical sources to support history education and cultural preservation. Sousa *et al*. [7] demonstrated that interactive digital platforms enabled students to access historical sources previously out of reach, such as digital archives, manuscripts, and digitized historical artifacts [20]. Visualization technologies, such as Virtual Reality (VR) and Augmented Reality (AR), provide an immersive learning experience by offering interactive simulations, enabling students to visualize historical events, such as revolutions or the development of past cultures, in a more realistic and contextual manner [21]. These solutions enhanced students' understanding of historical narratives and encouraged them to appreciate and comprehend the role of history in shaping their cultural identity. Thus, educational technology connected students with authentic historical sources relevant to education and local culture [22].

In Indonesia, studies by Putra *et al*. [23] and Johnston *et al*. [24] emphasized the importance of integrating educational technology into history education that focused on the utilization of local historical sources. For instance, AR-based applications digitized Indonesian historical sites and cultural artifacts, enabling students to virtually explore elements of local history. Furthermore, Samuelsson [25] underscored that technology in history education helped students connect local historical sources with global challenges, such as cultural preservation amid modernization. By leveraging technology to contextualize historical sources, students could comprehend the significance of preserving local cultural heritage and contributing to sustainable cultural development. This approach created an effective educational model that utilized technology and fostered cultural awareness relevant to the Indonesian context while offering global applicability [18, 26].

Recent literature has demonstrated that educational technology has become a strategic tool for enhancing cultural awareness and preservation. Ofianto *et al*. [27] revealed that digital platforms facilitated better accessibility to historical sources, such as digital archives and manuscripts that were previously difficult to access, thus aiding students in understanding the importance of cultural preservation in a global context. Additionally, Idacavage and McAndrews [28] highlighted the role of interactive technologies, such as AR and technology-based simulations, in enabling students to engage more deeply with culturally relevant historical narratives. However, although technology strengthened students' connection to history, much of the research remained primarily focused on academic learning and had yet to fully explore how technology could be harnessed to build stronger cultural awareness through direct interaction with local historical sources [29].

The nation's rich cultural heritage in Indonesia was often underutilized in formal education. Research by Mulyana and Kurniawati [30] demonstrated that digitizing local historical sources, such as cultural sites and archival documents, could help students understand relevant cultural values. However, this approach is frequently not systematically integrated into technology-based learning media. Moreover, most studies have yet to explore how educational technology could connect students to local historical sources to support sustainable cultural preservation [31]. Consequently, this study aimed to address the critical gap in history education by developing technology-based learning media that systematically integrated local historical sources. Unlike conventional digital learning tools, this approach directly connected students to authentic historical narratives, fostering a deeper understanding of history while promoting awareness and responsibility for cultural preservation in Indonesia. This study built upon existing research by providing a structured framework for technology integration that emphasized cultural sustainability as an essential educational goal [32].

This study was distinguished by its emphasis on cultural preservation as an integral educational goal, making it relevant to local contexts and global challenges in preserving cultural identity in the digital era. This research sought to develop and validate educational technology-based learning media that integrated local historical sources to enhance cultural awareness and cultural preservation in Indonesia. The media were designed to help students understand the relevance of local history to their cultural identity through interactive technological approaches while fostering appreciation for preserving Indonesia's cultural heritage. The novelty of this study lies in the use of educational technology to incorporate local historical sources into learning, with a particular focus on preserving Indonesian culture. Unlike previous studies, which predominantly emphasized students' academic outcomes, this research provided an innovative approach to fostering cultural awareness by directly connecting students with local historical sources through visualization and digital simulation technologies [33, 34].

This study aimed to develop technology-based learning media that integrated local historical resources to enhance student engagement, historical understanding, cultural relevance, and cultural awareness to support cultural preservation in Indonesia. The research employed the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model and involved 350 high school students from four schools in Yogyakarta. The results

showed that the media significantly improved students' cultural awareness. The primary research question was: How could technology-based learning media enhance student engagement, cultural relevance, and cultural awareness by integrating local historical resources? The hypothesis posited that interactive technology-based learning media, which incorporated elements of student engagement, cultural relevance, and cultural awareness, increased the effectiveness of history education, strengthened student engagement, and fostered their understanding of local cultural values.

II. Literature Review

A. Enhancing History Education Through Modern Interactive Technology

History education played a vital role in fostering cultural awareness and national identity, yet traditional teaching methods remained less effective in engaging digital-native students. Sousa *et al*. [7] observed that lecture-based and rote learning approaches often failed to capture students' interest due to the lack of interactivity and contextual relevance. Similarly, Zhang and Chen [12] highlighted that conventional methods did not cater to diverse learning styles, limiting the effectiveness of history education in addressing students' cognitive and emotional needs. The limited accessibility of local historical resources, such as archives and artifacts, further constrained students' opportunities to explore cultural values. In response, integrating educational technology emerged as a strategic solution to modernize history teaching approaches and make learning more engaging and meaningful [28].

Recent studies emphasized the potential of advanced technologies, such as AR and VR, to transform history education. Wang [35] underlined that these technologies enable immersive learning experiences by allowing students to "experience" historical events through simulations. In Indonesia, AR applications were used to digitize cultural artifacts and historical sites, such as temples and manuscripts. Research by Li *et al*. [36] demonstrated that such applications not only improve students' access to historical sources but also enhance their understanding of cultural narratives through interactive simulations. Similarly, Jwai'ed *et al*. [37] showed that these technologies effectively connect students to both local historical contexts and global cultural preservation challenges, thereby broadening their historical perspectives.

The flexibility of educational technology in accommodating different learning styles further strengthens its role in history education. Pratama *et al*. [38] noted that combining audiovisual media with interactive storytelling significantly enhances students' information retention and emotional engagement. In Indonesia, Hassan *et al*. [39] highlighted the effectiveness of digitizing local historical resources, such as archives and cultural artifacts, in embedding cultural values into the curriculum. Interactive elements, including narrative-based quizzes and technology-driven simulations, were shown to improve students' understanding of local history and foster cultural awareness [39]. These findings align with Sakti *et al*. [40], who emphasized the importance of interactivity in increasing student participation and the overall effectiveness of history education using technology-based media.

The urgency of integrating educational technology lies in its ability to bridge the gap between a generation immersed in digital culture and the need to preserve and understand local cultural heritage [41]. As globalization poses the risk of cultural homogenization, leveraging technology to digitize and present local historical resources ensures that cultural narratives remain relevant and accessible [42]. Interactive storytelling and immersive experiences allow students to not only comprehend historical contexts but also appreciate the significance of preserving cultural heritage [38]. Modern technology thus offers a unique opportunity to support adaptive and contextual history education, providing a model that is not only relevant in Indonesia but also adaptable for countries facing similar challenges [39].

B. Connecting Students with Local Cultural Values Through Technology

History education in Indonesia played a critical role in fostering students' cultural awareness and national identity. However, traditional approaches often fail to utilize the potential of local historical resources. Sources such as archives, manuscripts, and cultural artifacts were frequently underutilized due to limited accessibility and a lack of digitization. Previous research by Remiswal *et al*. [43] highlighted that these local resources could significantly enrich history education when integrated into digital media. In this context, educational technology emerged as a solution to present local history in a way that was engaging and relevant to the digital generation, bridging students with cultural values essential for building national identity [40].

Modern technologies such as AR and VR offered innovative methods to connect students with local cultural values [37]. AR-based applications have been used to digitize historical sites and cultural artifacts in Indonesia, allowing students to explore local history virtually [36]. Research by Stevens and McDonald [44] indicated that these technologies not only enhanced students' access to historical resources but also improved their understanding of cultural narratives through interactive simulations. Similarly, Birsyada and Utami [13] emphasized that such technology helped students comprehend the relevance of local cultural values in addressing global challenges, such as cultural preservation in the digital era.

Additionally, technology-based learning media provided a more inclusive and engaging way to deliver local history content. Uyun *et al*. [42] noted that interactive storytelling in digital media significantly enhanced student engagement while fostering an emotional connection with local cultural values. Research in Indonesia showed that narrative-based quizzes and technology-driven digital simulations effectively improved students' understanding of local history [41]. These tools created a learning experience that resonated with students' cultural contexts, making the process more meaningful than traditional approaches [45].

The urgency of this approach became evident in the face of cultural homogenization driven by globalization. Educational technology ensures that local cultural heritage is not only preserved but also introduced to younger generations in an engaging and contextually relevant manner [46]. By digitizing archives, manuscripts, and artifacts, students

preserved access to history while actively engaged in learning experiences that sparked their curiosity [35]. This approach encouraged students to reflect on the connections between local culture and their global identity while understanding cultural preservation as a shared responsibility. Studies suggested that students who were exposed to interactive, technology-based media were more likely to develop pride in their local culture and practice its values in daily life [47]. Thus, technology-based learning media served not merely as teaching tools but as bridges that connected the past, present, and future of Indonesia's culture, making them relevant on both national and global scales [48]. Some argued that original historical sources at locations and museums provided a more profound experience since students could directly interact with artifacts and historical environments. These aspects were often challenging to fully replicate through technology [4]. However, digital technology, particularly AR and VR, offers broader access and flexibility, allowing students from diverse backgrounds to experience history through interactive simulations, AR/VR-based exploration, and narrative-driven engagement. Thus, this technology addressed geographical and logistical constraints that often hindered learning through direct site visits [49].

C. Preserving Local Culture Through Technology in History Education

Preserving local culture through history education played a critical role in safeguarding the diversity of national cultural identities amidst the growing challenges of globalization [50]. Unfortunately, various studies revealed that history education often focused solely on academic achievements, with little attention being given to how cultural values could be integrated and preserved into the learning process [3]. Local culture, rich in historical significance, was frequently presented as static information, which failed to instill a deep understanding of the importance of its sustainability [51]. In response, technology-based approaches served as an effective bridge, which connected younger generations with cultural heritage in ways that were more relevant and adaptive to the digital era [29].

Unlike technology applications aimed solely at improving learning outcomes, cultural preservation through technology emphasizes presenting local cultural values as dynamic elements of students' lives [41]. Research by Uyun *et al*. [42] highlighted that digital platforms could reconstruct cultural narratives into formats that were accessible and relatable to digital-native students. For example, simulation-based applications allowed students to explore how cultural values had influenced local societal life in the past and continued to shape the present [40]. This approach provided a richer learning experience, which enabled students to perceive cultural values as integral to their personal and social contexts [52, 53].

The significance of preserving local culture through technology is its ability to create a dialogical space between local culture and global issues. Ariani *et al*. [54] emphasized that technology-facilitated students in mapping the role of local culture in addressing challenges such as cultural homogenization and modernization. In Indonesia, several initiatives leveraged technology to digitize traditional ceremonies and local customs at risk of cultural erosion [38]. By engaging with these initiatives, students not only understood local cultural values but also connected them with global issues such as sustainability and collective identity [55]. This approach offered an opportunity to teach local culture as a strength in navigating modernity rather than as an element under threat.

The urgency of cultural preservation through technology-based history education went beyond merely maintaining traditions [56]. Technology enabled local culture to be reintroduced in relevant formats, which ensured that these values remained vibrant and evolved amidst global changes [43]. Research indicated that students involved in culture-based learning media were more likely to demonstrate appreciation for these values and an awareness of their preservation [53]. By supporting cultural preservation through educational technology, Indonesia not only safeguarded its cultural heritage but also established a learning model adaptable to other countries facing similar challenges in the digital age [52].

D. Advantages and Disadvantages of Emerging Technologies in History Education

The integration of technology into history education has fundamentally transformed how students access, comprehend, and engage with historical content [4]. Digital tools such as multimedia software, interactive learning applications, and web-based resources have provided opportunities to enhance historical understanding through visual, auditory, and kinesthetic approaches [57]. Research has demonstrated that digital visualizations, including historical simulations and reconstructions using AR and VR, significantly improved students' comprehension of abstract and complex historical concepts [37]. These technologies enabled students to explore historical events in immersive environments, thereby increasing engagement and retention of historical knowledge [2].

Despite these advantages, the overreliance on technology in history education has posed several challenges. One primary concern has been students' tendency to passively accept digital information without adequate critical thinking skills to evaluate the validity of sources [4]. Studies have indicated that digital technologies may reinforce biases in historical learning, particularly when students lack the necessary training to assess the credibility of online historical sources critically [28]. Moreover, the digital divide has remained a significant issue, as disparities in access to technology have hindered the effective implementation of digital learning media, particularly in under-resourced educational institutions [58].

Emerging technologies such as AR and VR have shown great potential in addressing some limitations of traditional history instruction. AR facilitated students' access to three-dimensional historical artifacts, while VR enabled immersive experiences that simulated historical events with a high degree of realism [59]. The primary advantage of these technologies lay in their ability to create profound, immersive learning experiences that fostered students' emotional engagement with historical material [60]. However, challenges in implementing AR and VR included the high cost of equipment and the extensive resources required to develop historically accurate and pedagogically relevant

content [37].

To maximize the benefits of technology in history education, a strategic and balanced approach to its adoption was necessary [37]. This study emphasized the importance of integrating technological tools with developing students' critical thinking skills to ensure meaningful engagement with historical narratives. Additionally, inclusive technological adoption strategies should be prioritized, notably by designing solutions that are accessible to educational institutions with varying levels of technological infrastructure [35, 60]. By doing so, technology would not merely serve as an instructional aid but would also function as a medium for fostering historical consciousness and cultural awareness on both local and global scales [14, 51].

III. Research Method

This developmental study employed the ADDIE model to develop technology-based learning media utilizing local historical sources [61]. The instruments used to collect data included interview sheets for eight history teachers across all schools and classroom observation sheets at each school. These two instruments were utilized to analyze needs during the analysis stage. Subsequently, a questionnaire was used to obtain responses from 350 students regarding the product during the implementation stage and a product evaluation questionnaire for five experts.

The research process involved five main stages: The analysis stage aimed to identify the needs for technology-based history learning, such as the limited digitization of local historical sources, the need for interactive media, and the importance of student activity tracking features. This stage began with interviews with history teachers and surveys in four senior high schools in the Special Region of Yogyakarta Province: Sekolah Menengah Atas Negeri (SMAN) 1 Yogyakarta, SMAN 5 Yogyakarta, SMAN 8 Yogyakarta, and SMAN 1 Bantul. This analysis identified the need for technology-based history learning, such as the limited digitization of local historical sources, the necessity for interactive media, and the importance of student activity tracking features.

The design stage aimed to develop technology to establish connections between students and history and culture through relevant and immersive experiences. This stage involved designing learning media that incorporated local historical source digitization elements using AR/VR technology, developing narrative quizzes, historical simulations, and student activity tracking features aligned with the curriculum. The AR/VR technology in this learning media had key characteristics, including interactive digital representation through AR, which integrated historical artifacts and locations into real-world environments, and full simulations using VR that enabled virtual exploration of historical events and sites. This technology was supported by immersive audio-visual narratives, self-directed student exploration, and activity tracking to evaluate engagement and comprehension.

The development stage aimed to create a prototype integrating multiple tools to support relevant and meaningful learning experiences. This stage focused on creating a prototype of the media that integrated key elements such as digital archives, narrative visualizations, and interactive simulations. Each element was designed in an integrated manner to support a relevant and meaningful learning experience. The historical material used included Indonesian history, covering the Prehistoric era, Hindu-Buddhist kingdoms, Islamic kingdoms, the National Movement, and Indonesia's Independence.

The implementation stage aimed to test the application of technology-based learning media in an authentic learning environment. This stage involved purposive sampling, including 350 tenth-grade students from four selected high schools (SMAN 1 Yogyakarta, SMAN 5 Yogyakarta, SMAN 8 Yogyakarta, and SMAN 1 Bantul). The selection of schools and students was based on variations in school contexts, such as the availability of technological infrastructure and geographical representation. The participating students represented the actual conditions of technology-based history learning in Yogyakarta. At this stage, the learning media was tested to evaluate usability, student engagement, cultural relevance, cultural awareness, and technological usability. The media validation was conducted by five experts, consisting of content, media, and education specialists.

The evaluation stage aimed to measure the effectiveness of the technology-based learning media that had been implemented. This stage involved quantitative and qualitative data analysis, utilizing descriptive statistical methods to depict outcome patterns, ANOVA (Analysis of Variance) tests to compare results across schools, and correlation analysis to identify relationships between dimensions such as student engagement and cultural awareness. This evaluation phase provided insights for further iterations and refinements of the media to enhance its relevance and effectiveness in supporting technology-based history learning and local cultural preservation [21].

IV. Results

A. Analysis Stage

Interviews with history teachers and surveys conducted in history classes at SMAN 1 Sleman, SMAN 1 Bantul, SMAN 5 Yogyakarta, and SMAN 8 Yogyakarta indicated that history education in Indonesia required a technology-based approach to integrate local historical sources, enhance cultural awareness, and support cultural preservation. Historical resources such as archives, artifacts, and local manuscripts were underutilized due to the lack of digitization processes that could enable student access. Therefore, digitization and integration through technologies such as AR/VR and digital platforms were identified as critical needs to provide relevant and engaging learning experiences.

The analysis also revealed that students needed interactive media incorporating components such as narrative-based history quizzes, cultural simulations, and narrative visualizations to understand the relevance of local history to their cultural identity. One student stated, "So far, I have only learned about national history from textbooks, but I rarely hear about the history of my region". Another student added, "I would be more interested if history lessons included stories closer to my daily life rather than just memorizing years and events". These statements indicated that students required a more interactive and experiential approach to connect with

their local history. A student engagement tracking system was also needed to measure their activities and participation during learning sessions. This data could be combined with student feedback to evaluate the effectiveness of the learning media in improving cognitive understanding and cultural awareness. These findings formed the foundation for designing the data flow, which included key elements outlined in the design phase, ensuring effective integration from input to final evaluation.

B. Design Stage

In the design phase, this study developed a technology-based learning media flow through seven interconnected strategic steps: First Step: Historical Sources – The initial step involved identifying and selecting local historical sources, such as archives, artifacts, and manuscripts relevant to the curriculum. These sources were often in physical form and challenging to access, prioritizing their digitization to ensure accessibility. Second Step: Digitization and Integration – The historical sources were digitized using AR and VR to create more engaging learning experiences. This process enabled students to explore historical sources visually and in depth through a purposefully designed interactive digital platform. Third Step: Interactive Media – The learning media served as the core of this design, featuring components such as narrative-based quizzes, digital simulations, and narrative visualizations. Narrative-based quizzes presented students with questions focused on local historical stories, while digital simulations allowed them to "relive" historical events using technology. Narrative visualizations incorporating audio-visual elements were designed to facilitate students' emotional and cognitive understanding of historical content.

Fourth Step: Student Engagement – Tracking: A student engagement tracking system was an essential element that recorded interaction data, such as media usage duration, participation levels in simulations, and quiz scores. This data was utilized to evaluate the effectiveness of the media in enhancing students' attention to history learning. Fifth Step: Student Feedback – The media design also included a feedback module through interactive questionnaires. Students were asked to evaluate their experience using the media, including content quality, interactivity level, and cultural relevance. This data served as the basis for improved design iterations. Sixth Step: Cognitive Awareness & Cultural Awareness – The media was designed to enhance students' cognitive understanding of historical content while fostering their cultural awareness toward preserving local values. Cognitive learning outcomes were measured through quiz and simulation scores, while cultural awareness was assessed through student responses to interactive cultural elements. Seventh Step: Final Evaluation – The design culminated in a final evaluation that included data-driven analytical reports, such as students' success rates in understanding historical content and the media's contribution to enhancing cultural awareness. These reports not only provided insights into the media's effectiveness but also offered recommendations for further development. These seven stages ensured that technology-based learning media could significantly impact history education and cultural preservation in the digital era. The data flow design of the developed media was illustrated in Fig. 1, while the required features were detailed on the Dashboard displayed in Fig. 2.

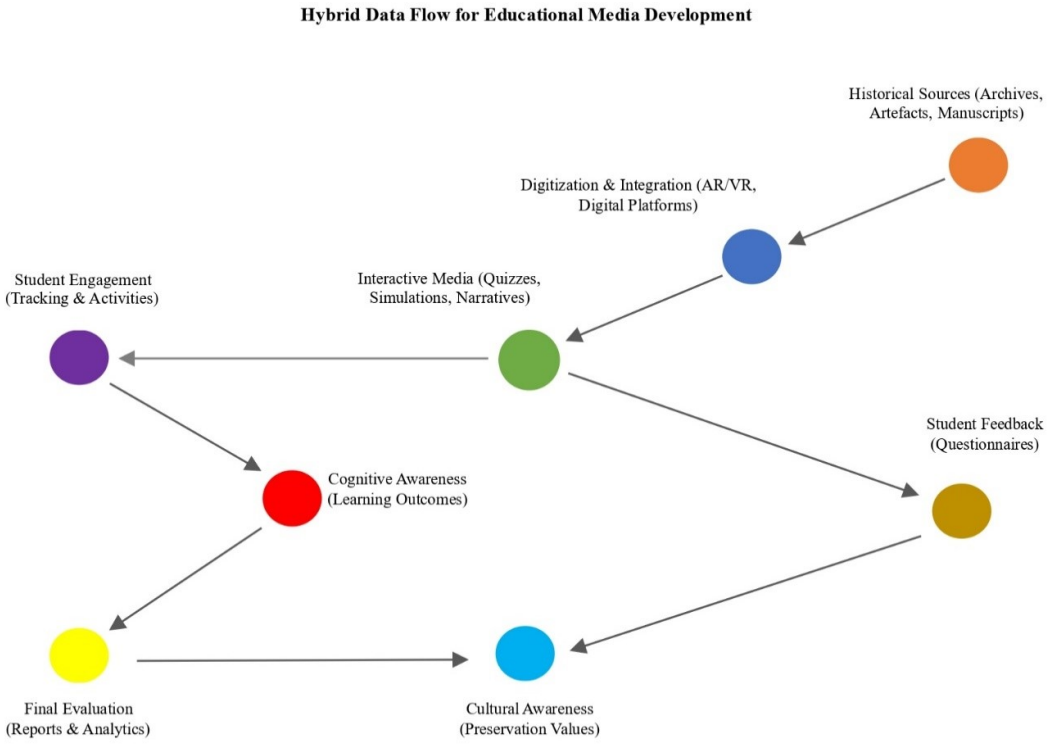

Fig. 1. Data flow design for media development.

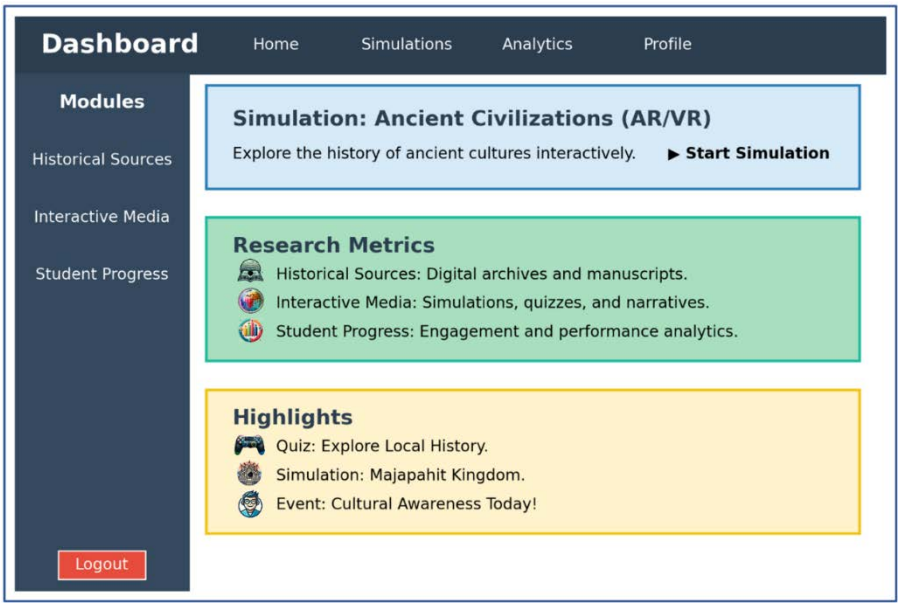

Fig. 2. Media dashboard view.

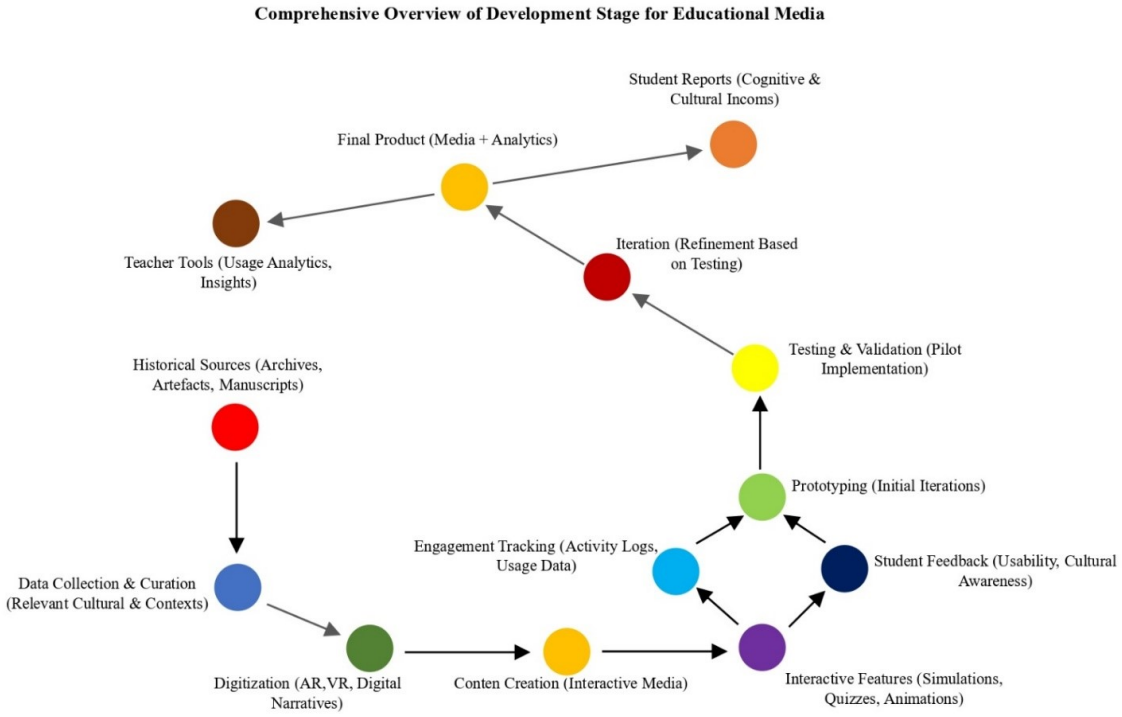

Fig. 3. Integrated media development process stage.

C. Development Stage

In this stage, the researcher integratively connected various elements in the development of educational media, beginning with historical sources (archives, artifacts, manuscripts) as the raw data sources. These data were then processed through a data collection and curation phase, where information was selected and contextualized to ensure content quality and cultural relevance. Researchers carried out this process by selecting the topics of the Prehistoric Era, Hindu-Buddhist Kingdoms, Islamic Kingdoms, the National Movement, and Indonesia's Independence. These topics were chosen as they aligned with the history curriculum in senior high schools. This process continued with digitization, utilizing AR, VR, and digital narratives to transform raw sources into digital materials for further processing. The results of this digitization process were used in content creation, which involved designing interactive media. These media were enriched with interactive features like simulations, quizzes, and animations to create an engaging and user-centered learning experience. Student activities while using the media were recorded through Engagement Tracking. In contrast, student feedback collected direct evaluations from students regarding the effectiveness and impact of the media, particularly about cultural awareness.

The data obtained from monitoring student activities and feedback served as input for the prototyping phase, which developed the initial iteration of the product. This phase was followed by testing and validation, where the prototype was tested to assess its effectiveness and feasibility for small-scale

implementation. The testing results were used in the iteration phase, allowing developers to refine the product based on real user input. This process culminated in the final product, an interactive media solution equipped with analytics for performance tracking. The final product also included additional features, such as teacher tools to provide insights into usage and student reports to analyze student learning outcomes regarding cognitive understanding and cultural awareness. The strength of this integration lay in its responsive and complementary workflow, ensuring that each element contributed tangibly to the final results. This approach enabled the creation of innovative, relevant, and highly functional educational media. This stage is illustrated in Fig. 3.

D. Implementation Stage

The implementation stage aimed to test the application of technology-based learning media in an authentic learning environment. During this phase, students used a digital learning platform that integrated local history through AR/VR simulations, narrative-based quizzes, and digital visualizations. They explored historical events immersively, such as virtually visiting historical sites or understanding artifacts through digital representations, to enhance engagement and strengthen their comprehension of local cultural values.

Data were collected through questionnaires distributed to students, which included Likert scale-based questions to evaluate five key aspects: usability, cultural awareness, engagement, technological usability, and cultural relevance. On the Likert scale, students were asked to rate from 1 to 5 regarding the ease of use of the media, the extent to which it enhanced their understanding of local culture, their level of engagement during learning, the technological usability in supporting their learning experience, and the cultural relevance of the content presented. The questionnaire was administered to 350 tenth-grade students from four senior high schools in the Special Region of Yogyakarta: SMAN 1 Sleman, SMAN 1 Bantul, SMAN 5 Yogyakarta, and SMAN 8 Yogyakarta. Respondents were randomly selected without considering gender but based on the different school locations across three distinct regions—Sleman Regency, Bantul Regency, and Yogyakarta City—to ensure diversity in learning environments and student backgrounds.

In addition, expert questionnaires were conducted outside the classroom, involving history teachers and lecturers as respondents. These questionnaires assessed usability, content quality, curriculum alignment, technological usability, and cultural relevance in supporting learning objectives. Feedback from experts was used to evaluate the overall strengths and weaknesses of the media and to provide recommendations for improvements during the evaluation phase. The results of student responses to the learning media are summarized in Table 1, while expert evaluations are presented in Table 2.

Table 1. Summary of student responses by school on usability, engagement, and cultural awareness

School	Usability (Mean, Std)	Cultural Awareness (Mean, Std)	Engagement (Mean, Std)	Tech Usability (Mean, Std)	Cultural Relevance (Mean, Std)
SMAN 1 Bantul	2.7 (±1.43)	3.1 (±1.3)	2.7 (±1.3)	3.3 (±1.3)	3.0 (±1.4)
SMAN 1 Sleman	3.2 (±1.48)	2.9 (±1.5)	2.8 (±1.4)	3.0 (±1.4)	3.0 (±1.3)
SMAN 5 Yogyakarta	3.0 (±1.41)	3.2 (±1.5)	2.8 (±1.4)	2.5 (±1.4)	3.1 (±1.3)
SMAN 8 Yogyakarta	2.8 (±1.42)	3.0 (±1.3)	2.8 (±1.3)	2.8 (±1.4)	3.1 (±1.4)

Table 2. Expert evaluation results

School	Usability (Mean, Std)	Content Quality (Mean, Std)	Curriculum Alignment (Mean, Std)	Tech Usability (Mean, Std)	Cultural Relevance (Mean, Std)
SMAN 1 Bantul	5.0 (±0.0)	5.0 (±0.0)	3.0 (±0.0)	3.0 (±0.0)	4.0 (±0.0)
SMAN 1 Sleman	5.0 (±0.0)	4.5 (±0.7)	3.5 (±0.7)	3.0 (±0.0)	4.5 (±0.7)
SMAN 5 Yogyakarta	3.0 (±0.0)	5.0 (±0.0)	4.0 (±0.0)	3.0 (±0.0)	3.0 (±0.0)
SMAN 8 Yogyakarta	5.0 (±0.0)	3.0 (±0.0)	5.0 (±0.0)	3.0 (±0.0)	3.0 (±0.0)

The analysis of student responses and expert evaluations indicated that the technology-based learning media demonstrated strengths in several aspects but also required improvements in others. According to student responses (Table 1), usability scored the highest at SMAN 1 Sleman (3.2), reflecting that the media was pretty easy to use in that school. In contrast, cultural awareness scored the highest at SMAN 5 Yogyakarta (3.2), indicating the media's effectiveness in enhancing understanding of local culture. However, student engagement showed uniform average scores (2.7), suggesting enhanced interactive features were needed.

Expert evaluations (Table 2) confirmed that usability achieved a perfect score (5.0) at several schools, highlighting the media's high accessibility. Content quality and cultural relevance also received excellent ratings at SMAN 1 Bantul and SMAN 1 Sleman. Nevertheless, tech usability only achieved an average score of 3.0, pointing to technical challenges in implementing the media, particularly concerning technological infrastructure. The results indicated that the media had significant potential to improve history education but required enhancements in student engagement and technical support.

E. Evaluation Stage

The evaluation phase aimed to measure the effectiveness of the technology-based learning media implemented during the implementation stage. This evaluation assessed the success of the media in enhancing student engagement, comprehension of the material, and cultural awareness through data analysis collected during implementation. Statistical analysis was conducted using ANOVA to compare the effectiveness of the media across different schools in five key aspects: usability, cultural awareness, engagement, tech usability, and cultural relevance. This test aimed to determine whether there were significant differences in media effectiveness among the schools. Additionally, correlation analysis was used to identify relationships between key variables, such as student engagement and cultural awareness, and the relationship between tech usability and

student engagement. The results of this evaluation guided further iterations and development of the media to better align with students' needs in various school contexts. The evaluation data analysis results are presented in Table 3 below:

Table 3. ANOVA test results comparing usability, engagement, and cultural awareness across schools

Aspect	F-value	*p*-value	Interpretation
Usability	4.12	0.008**	Significant differences between schools
Cultural Awareness	2.76	0.045*	Significant differences between schools
Engagement	1.89	0.102	No significant difference
Tech Usability	3.58	0.019*	Significant differences between schools
Cultural Relevance	5.20	0.003**	Significant differences between schools

* $p < 0.05$, ** $p < 0.01$.

The ANOVA test results indicated that the dimensions of usability, cultural awareness, tech usability, and cultural relevance showed significant differences across schools (p-value < 0.05), suggesting that the local school context influenced the effectiveness of the media. However, no significant differences were found in student engagement, indicating that the level of student engagement was relatively consistent across all schools.

The variations observed across schools could be explained by differences in local contexts, particularly regarding technological infrastructure and students' exposure to digital devices. Schools with more advanced technological infrastructure, such as computer access, AR/VR devices, and stable internet connectivity, provided students with more significant opportunities to utilize the learning media effectively. Conversely, schools with limited technological facilities faced implementation challenges, impacting dimensions such as usability, tech usability, and cultural relevance. Additionally, the level of students' exposure to digital technologies outside the classroom influenced their ability to comprehend and use AR/VR-based media. This context aligned with the needs analysis findings, which identified that the learning environment's preparedness heavily influenced the learning media's effectiveness.

The correlation between variables in Table 4 demonstrated a very strong positive relationship between engagement and cultural awareness ($r = 0.76$, $p < 0.001$), as well as between cultural awareness and cultural relevance ($r = 0.85$, $p < 0.001$). This finding confirmed that higher student engagement correlated with an increased understanding of culture, while the cultural relevance of the media supported students' cultural awareness. The significant correlation between tech usability and student engagement ($r = 0.68$, $p = 0.002$) highlighted the importance of technical quality in supporting learning engagement.

Table 4. Correlation between variables

Variable 1	Variable 2	Correlation Coefficient (r)	*p*-value	Interpretation
Engagement	Cultural Awareness	0.76	<0.001**	Very strong positive correlation
Engagement	Tech Usability	0.68	0.002**	Strong positive correlation
Cultural Awareness	Cultural Relevance	0.85	<0.001**	Very strong positive correlation
Tech Usability	Usability	0.59	0.015*	Significant positive correlation

* $p < 0.05$, ** $p < 0.01$.

These results indicated that higher student engagement positively impacted cultural awareness [62], this aligns with the study's hypothesis that interactive and relevant media could enhance student engagement and understanding of local cultural values. The strong relationship between cultural awareness and cultural relevance further emphasizes the critical role of learning media in connecting students with culturally significant content [63]. These findings underscored the need for well-designed, technology-based learning media to provide meaningful and immersive learning experiences.

The findings of this study demonstrated that technology-based learning media had significant potential to support more relevant and effective history learning [59]. The cultural relevance dimension achieved the highest score, indicating that the media connected students with local cultural values meaningfully. The strong positive correlation between engagement and cultural awareness ($r = 0.76$, $p < 0.001$) confirmed that higher student engagement directly contributed to an increased cultural awareness. However, significant differences between schools in dimensions such as usability and tech usability revealed that the media's effectiveness was heavily influenced by the technological infrastructure and students' exposure to digital devices in each school. Additionally, the relatively consistent engagement scores across all schools indicated that the media maintained students' attention effectively despite variations in local contexts. These findings underscored the importance of developing more flexible and responsive media to address infrastructure challenges, enabling broader implementation across diverse school settings to support more inclusive and meaningful history learning [64].

V. Discussion

History education in Indonesia faced significant challenges in integrating technology to enhance cultural awareness and preserve local heritage. Literature reviews highlighted that using educational technology, such as augmented reality, virtual reality, and interactive simulations, not only captured students' attention but also deepened their understanding of complex historical narratives [5, 64]. This study aimed to evaluate the effectiveness of technology-based learning media through five key dimensions: "Usability", "Cultural Awareness", "Engagement", "Tech Usability", and "Cultural Relevance" across four senior high schools in Yogyakarta. The following visualization illustrates the analysis results, showing the average scores for each aspect at each school and the general patterns derived from combined data. Fig. 4 below sought to identify the strengths and weaknesses of the media implementation in each evaluation dimension.

The figure highlighted the evaluation of the effectiveness of technology-based learning media across five key dimensions in four schools, critically revealing the strengths and weaknesses of the implementation. Indeed, this study did

not aim to compare schools directly but rather to analyze the most and least effective aspects of the digitized historical content. The primary focus was on identifying which elements of the digital learning media contributed most significantly to students' engagement and historical understanding, as well as determining the areas that required further improvement. By assessing student responses and interaction patterns, this study provided insights into how digital content could be refined to support historical comprehension and cultural preservation better [4]. The findings serve as a basis for improving future iterations of digital history education tools, ensuring that the content remains engaging, educationally effective, and aligned with students' learning needs [8].

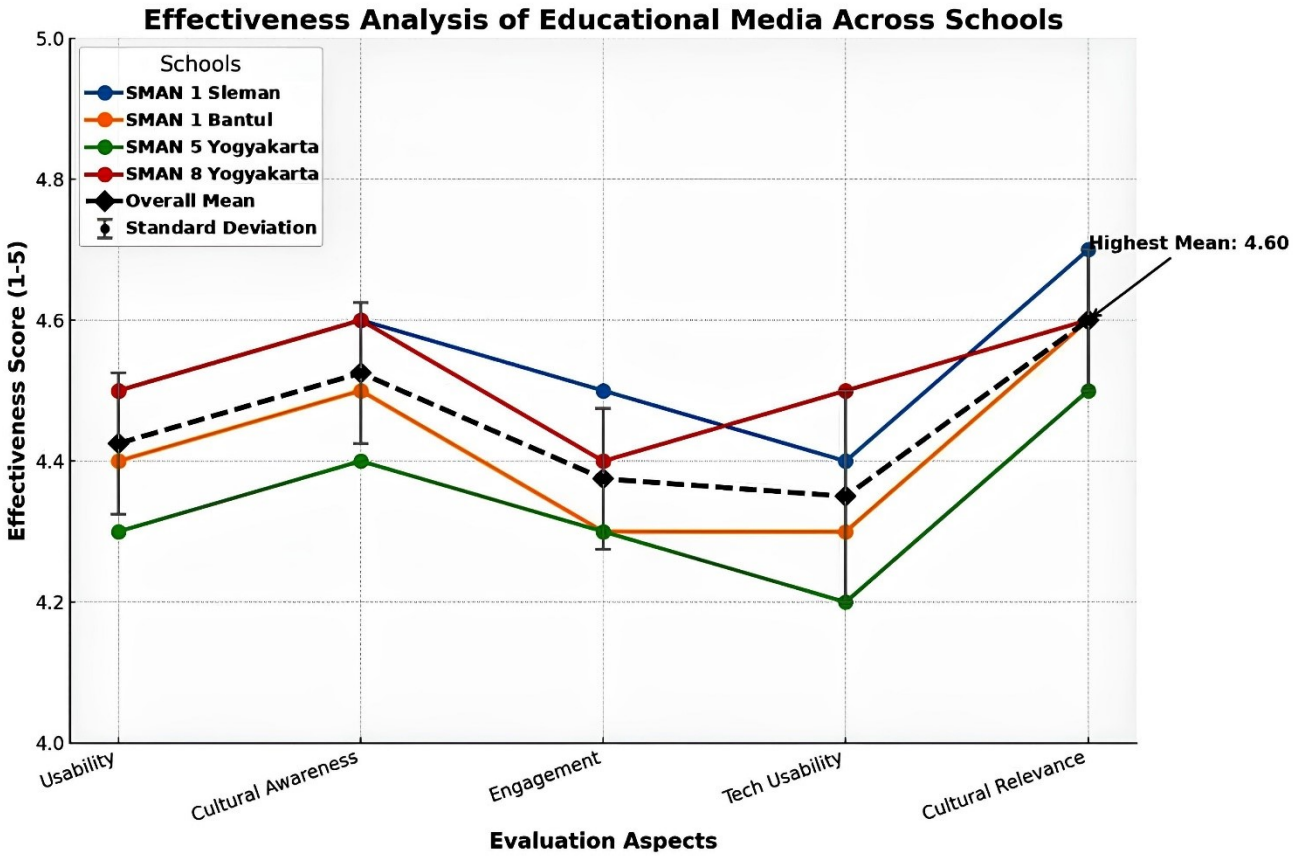

Fig. 4. Effectiveness analysis of educational media across the school.

The "Cultural Relevance" dimension achieved the highest average score (4.6), affirming that the media successfully bridged students with local cultural values, as emphasized by Sousa *et al*. [7] on the importance of cultural contextualization in technology-based learning. Conversely, "Engagement" recorded the lowest score (4.3), indicating the need for adjustments to interactive features such as cultural simulations or more comprehensive student engagement tracking, as recommended by Camacho-Tamayo and Bernal-Ballen [8]. The positive correlation between "Tech Usability" and "Engagement" (r = 0.68, p < 0.01) demonstrated that the technical quality of the media significantly influenced student engagement. This data underscored the urgency of optimizing media design to be adaptive and responsive to local contexts and student needs to achieve more holistic and impactful history learning objectives.

This study addressed the core issues identified, namely the low student engagement in history learning and the lack of cultural awareness due to the minimal utilization of local historical sources in understanding media. Traditional teaching methods, still dominated by lectures and rote memorization, failed to captivate digital-generation students, often left the relevance of historical material to everyday life uncommunicated [65, 66]. Additionally, limited access to archives, manuscripts, and local cultural artifacts hindered connecting students with cultural values [67, 68]. This research offered a solution by developing technology-based media utilizing local historical sources through interactive approaches such as AR, virtual reality, digital simulations, and narrative history-based quizzes, which have proven effective in enhancing student engagement and cultural awareness.

This study offered advantages over previous research in the context of existing literature. For instance, Hutahaean *et al*. [69] and Martinez and Montoya [70] emphasized the importance of AR technology in enhancing student engagement, but its focus is limited to general learning experiences without considering cultural dimensions. In contrast, this study integrated AR technology with culturally relevant local content. The findings indicated that the "Cultural Relevance" aspect achieved the highest average score (4.6) among all evaluated dimensions, demonstrating that this learning media effectively connected students with local cultural values. Additionally, the correlation results between "Engagement" and "Cultural Awareness" (r = 0.76) provided evidence that high student engagement significantly contributed to improving their understanding of local cultural

values. This placed study as a significant advancement in technology-based history education compared to studies such as Koswara *et al*. [71] and Bures *et al*. [72], which focused solely on digitizing historical sources without addressing their impact on students.

The primary strength of this study lies in the flexibility of implementing the learning media across various educational contexts, including schools with limited technological infrastructure. Previous research, such as that conducted by Hay [48], primarily focused on students' academic outcomes while placing less emphasis on cultural preservation. In contrast, this study positioned cultural preservation as a central objective in history education, utilized technology to bridge the gap between local needs and global demands, and developed learning media that was not only relevant to the Indonesian context but also served as a model adaptable to other countries facing similar challenges in cultural preservation in the digital era [4]. By integrating technology with local cultural values, this media offered a more interactive and contextualized learning alternative than conventional methods. However, its effectiveness and scalability across different educational environments remained contingent upon the availability of adequate technological infrastructure [73, 74].

Although the AR/VR-based learning media in this study proved effective in enhancing students' cultural awareness, its scalability faced significant challenges due to disparities in technological infrastructure across educational institutions. The findings indicated that variations in effectiveness among schools were influenced by access to AR/VR devices, the stability of internet connectivity, and the readiness of educators to adopt this technology [37]. Schools with more advanced digital infrastructure reported higher levels of student engagement, whereas those with limited technological resources encountered obstacles in seamlessly integrating this media into their curricula [60]. Consequently, adaptive strategies were necessary, such as developing a version of the media compatible with lower-specification devices and incorporating offline functionalities for environments with restricted internet access. Additionally, comprehensive training programs for educators were crucial to ensuring the effective implementation of this technology [75]. With adequate infrastructure support and well-prepared human resources, this learning media could be expanded more widely without compromising its effectiveness in facilitating learning and cultural preservation.

The findings of this study affirmed the importance of integrating technology into history education to enhance cultural awareness and preserve local values [45, 54]. With "Cultural Relevance" achieved the highest score (4.6) and a significant correlation between "Engagement" and "Cultural Awareness" (r = 0.76), this research demonstrated that technologies such as AR, VR, and digital simulations were not only effective in capturing students' attention but also in fostering emotional connections with local culture. This underscored that technology-based learning media could bridge the gap between static traditional teaching methods and the needs of students in the digital era [73, 74]. Unlike prior studies, which often focused solely on increasing student engagement, this research introduced another dimension: cultural preservation as a primary educational objective, an aspect rarely emphasized in global educational literature.

Integrating AR and VR technologies in history education held significant potential for supporting cultural preservation through innovative learning methods. In Japan, research by Takenaka and Soga [76] demonstrated that AR marker-based learning systems enhanced students' understanding of historical sequences, as evidenced by their case study on the Battle of Sekigahara. Through interactive simulations, this technology helped students grasp historical events more comprehensively and encouraged exploration of the local cultural elements associated with those events. This approach allowed students to directly experience how Japanese culture from the past was embedded in historical narratives, positioning AR as a crucial tool for connecting cultural values to younger generations.

The study conducted by Marín *et al*. [63] in Spain highlighted that the application of AR in history education addressed the limitations of conventional methods, which were often static and lacked interactivity. By allowing students to interact directly with digital artifacts in immersive environments, this technology facilitated factual knowledge acquisition and fostered an emotional connection to their cultural heritage, an aspect often overlooked in text-based history instruction. However, this study primarily focused on AR as a visual aid rather than examining its impact on students' cultural awareness. In contrast, the present study adopted AR as an interactive medium and integrated it with culturally relevant local content, significantly enhancing student engagement and their comprehension of cultural values. Similarly, research in Thailand by Muangchan and Yanhua [77] emphasized the role of AR in language instruction, demonstrating how it helped students link visual elements to local cultural contexts, thereby improving their memory retention of cultural components. However, that study primarily emphasized cognitive aspects of language learning without exploring AR's broader impact on historical narratives. In contrast, this study extended beyond cultural knowledge transfer by examining the direct relationship between student engagement and cultural awareness within a history education framework.

Furthermore, research conducted in Malaysia by Ghazali *et al*. [59] revealed that VR held significant potential in providing safe and immersive learning environments, enabling students to explore cultural narratives without spatial or temporal constraints. Nevertheless, that study did not emphasize students' active engagement in critically constructing their understanding of local history. Conversely, the present study positioned students as active agents in history learning rather than passive recipients of information, focusing on interactive digital integration that encouraged critical reflection on cultural values. A related study in China by Wang *et al*. [78] asserted that the interactive nature of AR and VR could revitalize local cultural narratives, though it primarily explored how these technologies made historical content more engaging for students. In contrast, the present study not only examined the visual appeal of AR/VR but also provided empirical evidence demonstrating that active student participation in immersive experiences strongly correlated with increased cultural awareness (r = 0.76, $p < 0.001$). By juxtaposing these findings with previous

studies, this research offered a more comprehensive and pedagogically robust approach, where technology functioned not merely as an instructional tool but as a conduit connecting students to their cultural heritage while equipping them to navigate the challenges of globalization.

Scientifically, this study offered a novel contribution by combining technology-based approaches with cultural preservation, particularly in the context of developing countries. Digital literacy is often perceived as a challenge in regions with limited infrastructure. Yet, this research demonstrated that technology-based media could be designed flexibly to accommodate local needs without compromising effectiveness [13, 79]. This added a new dimension to the discourse in global educational literature, particularly in addressing the challenge of cultural identity loss amid global digitalization [80]. Furthermore, this study strengthened the argument that technology-based education was not merely a tool for improving academic outcomes but also a strategic means of preserving cultural heritage, making it relevant in Indonesia and other countries facing similar challenges [81, 82].

These findings presented significant opportunities for implementing similar learning media nationally and internationally. This media served as a model for adaptation by other schools facing challenges in teaching local history, engaging and meaningfully [78]. The implications were that teachers used this technology to enhance student engagement in understanding cultural values, while education policymakers adopted this approach to strengthen culture-based curricula across Indonesia. Furthermore, this media developed into a national platform connected to digital archives, enabling students to explore cultural heritage directly from their devices.

Moreover, this media had the potential to create a more enjoyable learning experience and foster students' long-term interest in history. It provided an engaging and immersive learning environment with interactive features such as AR/VR-based historical simulations, narrative quizzes, and digital visualizations. If optimized, this technology increased student engagement and inspired them to continue exploring local history beyond the classroom. Thus, this study provided not only a practical solution to support technology-based education but also a strategic framework for addressing globalization challenges while preserving the uniqueness of local cultures and strengthening history education as part of national identity.

VI. Conclusion

This study successfully developed and tested technology-based learning media capable of addressing challenges in history education, namely low student engagement and limited cultural awareness. The results showed that the dimension of cultural relevance had achieved the highest score (4.6), confirming the media's success in bridging students with local cultural values. Additionally, the positive correlation between engagement and cultural awareness (r = 0.76) demonstrated that high student engagement directly improved cultural understanding. By leveraging technologies such as AR, VR, and digital simulations, this study offered a novel approach that focused on improving learning outcomes and placed local cultural preservation at the core of history education.

This research expanded the educational technology literature by integrating cultural dimensions within the context of developing countries, contributing significantly to the global discourse on cultural preservation through technology. Although the study was limited to testing on a local scale, further development could have included implementation on a broader scale and the integration of additional technological features to support more responsive learning needs. Thus, this study is relevant for history education in Indonesia and provides an adaptable model for other countries facing similar challenges.

This study had several limitations that had to be considered. One major limitation was the relatively small sample size, which included only four high schools in Yogyakarta. As a result, the findings might not have been generalizable across Indonesia due to variations in cultural contexts and technological infrastructure in different regions. Additionally, implementing this technology-based learning media depended heavily on digital infrastructure, such as AR/VR devices and stable internet connectivity, which remained inconsistent across schools. This situation created disparities in the effectiveness of the learning media, particularly in areas with limited technological access. Another limitation was the lack of long-term evaluation to assess the sustained impact of this media on students' cultural awareness and engagement. Future research must expand the study to a broader context and conduct longitudinal assessments to measure its long-term effectiveness.

To address these limitations and improve future research and implementation, several specific recommendations were proposed:

1) Researchers conducted similar studies with a more extensive and diverse sample across multiple regions to enhance the generalizability of findings. Future studies also explored integrating additional digital features to improve interactivity and engagement.
2) Learners actively engage with digital learning media beyond the classroom by utilizing online historical resources to deepen their understanding of cultural heritage.
3) Educators integrated technology-based media into history lessons by incorporating guided discussions and reflective activities to maximize its effectiveness in fostering cultural awareness.
4) Course/Module/Curriculum Builders incorporated technology-based learning media into standardized history curricula, ensuring alignment with national education objectives while allowing flexibility for regional cultural adaptations.
5) Institutions invested in digital infrastructure and provided teacher training programs to enhance educators' ability to effectively integrate AR/VR-based history learning tools.
6) Digital content creators and app developers focused on creating more accessible and low-cost versions of educational media to accommodate schools with limited resources. Developing lightweight applications that did not require high-end devices increased inclusivity.
7) Policymakers supported initiatives that promoted the digitization of local historical sources and ensured equitable access to educational technology, particularly in

rural and underprivileged areas. Policies also encouraged collaboration between educational institutions and cultural preservation organizations to enrich content with authentic historical resources.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

F and S identified the research problem; THN, IF, Z and MIR collected the necessary references; LJ and D conducted the field test; and AS assisted F with data analysis, evaluation and evaluation; all authors contributed to the writing of this article until it was completed; all authors had approved the final version.

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