Curriculum-Level Innovation in History Education: Developing a Technology-Integrated and Contextually Adaptive Model for Senior High Schools in Indonesia

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Abstract

This study aimed to develop and evaluate a digital-based history curriculum tailored for Indonesian senior high schools, addressing the pedagogical gap between traditional history instruction and 21st-century learning demands. Employing a Research and Development (R&D) methodology guided by the ADDIE model, the research involved five curriculum and pedagogy experts, ten history teachers, and over 200 students from six public high schools with varying levels of technological infrastructure. The study encompassed a comprehensive needs analysis, expert and teacher validation, guided classroom implementation, and multi-source impact evaluation using interviews, observations, formative assessments, and digital questionnaires. The curriculum was validated with high scores by experts (mean = 4.80) and teachers (mean = 4.60), highlighting its structural coherence, relevance, and ease of implementation. Classroom trials across schools demonstrated consistent effectiveness (mean = 4.60), with no significant variance found through ANOVA analysis ($p > 0.05$). Qualitative results indicated increased student engagement, deeper historical understanding, and development of contextual thinking. The study offers a novel approach to system-level curriculum design where digital media is the backbone of instructional planning. This model contributes to global discourse by presenting a scalable, equitable, and pedagogically resilient solution for integrating digital history education in diverse and resource-limited settings.

Keywords: digital history curriculum, instructional design, senior high school, technology integration, pedagogical innovation.

1. Introduction

History education played a central role in shaping national identity, civic awareness, and critical thinking about the historical dynamics that influenced contemporary society (Domenici, 2023). In Indonesia, the history curriculum has undergone several revisions in response to evolving social, political, and educational policy contexts (Fahruddin & Saefudin, 2025b). However, field realities revealed that the instructional approaches employed in many schools remained conventional, predominantly teacher-centered, and oriented toward rote memorization of chronological events (Widawski & Oleśniewicz, 2023). Such approaches increasingly lost relevance amid the rapid advancement of digital technology and the shifting characteristics of learners, who were more accustomed to visual, interactive, and network-based media. This disconnect generated a significant gap between the existing curriculum design and the pedagogical needs of 21st-century students (Saldanha et al., 2021).

Although various initiatives had been introduced to promote technology-enhanced history instruction, most remained limited to the utilization of specific digital media or applications within classroom activities (Sousa et al., 2022). Few studies systematically addressed the development of a comprehensive curriculum framework that explicitly integrated digital technology into the formal structure of the national history curriculum, including learning

objectives, content organization, and recommended pedagogical activities (Fairless Nicholson, 2023). Consequently, there emerged an urgent need to formulate a curriculum model for secondary-level history education that was technologically adaptive, pedagogically sound, and aligned with Indonesia's national curriculum framework (Efiloğlu Kurt, 2023).

The central problem addressed in this study was the absence of a formal curriculum framework that explicitly and systematically integrated digital technology into secondary-level history education in Indonesia (Camacho-Tamayo & Bernal-Ballen, 2023). While numerous innovations in classroom media use had been documented, these efforts were not guided by any standardized curriculum document, resulting in sporadic, unsustained, and highly individualized practices. To address this issue, the study proposed the design of a structured curriculum development framework that enabled the integration of digital technology within key curriculum components, such as learning objectives, core content, and recommended instructional strategies (Zhang & Chen, 2023). Rather than developing new instructional media, this solution aimed to offer a curricular guide that explicitly supported the meaningful and contextualized use of digital technology in history education, responsive to the learning needs of contemporary students (Darmawan et al., 2025; Isozaki, 2022).

Several findings in the literature indicated a growing positive tendency toward using digital technology in history education. A study by Yulifar & Aman (2023) recommended the development of a history curriculum that supported a blended learning model, in which historical content was combined with digital media such as documentary videos, interactive simulations, and location-based applications. This approach enhanced student engagement and increased instructional flexibility (Darsono et al., 2024). Similarly, research conducted by (Jwai‹ed et al. (2024) introduced an augmented reality (AR) based framework for history learning, which enriched students' spatial understanding of historical contexts. However, both studies focused on the micro-level application of digital tools within classroom instruction without extending their implications to macro-level curriculum design that could serve as a formal reference for policymakers and curriculum developers (Fahruddin et al., 2024).

Beyond media-related innovation, several studies also emphasized the importance of inquiry-based and exploratory pedagogies in implementing digital history learning. For instance, Ghazali et al. (2022) asserted that technology integration should be accompanied by instructional strategies that enable students to access, evaluate, and construct historical narratives independently using digital sources. Nevertheless, such approaches have not yet been operationalized within a structured curriculum document aligned with Indonesia's national education regulatory framework (Assumpção & Castral, 2024). The present study addressed this gap by designing a systematic history curriculum framework that embedded digital technology within its core components—learning objectives, content, and activities—without displacing the disciplinary essence of history education (Pranata et al., 2020). Consequently, the primary focus of this research remained within the domain of curriculum development, rather than the creation of instructional media, devices, or teaching strategies in isolation (Ritzen, 2023).

Previous research on technology integration in history education had concentrated mainly on classroom practice and had not yet advanced toward developing the curriculum as a strategic educational document. For example, Adli & Fatimah (2019) demonstrated the effectiveness of video and animation in enhancing students' historical understanding, but did not explore how these digital elements could be systematically incorporated into a national curriculum framework—similarly, the study by Widiana et al. (2021) explored the use of augmented reality applications at the elementary level, yet failed to propose a scalable and sustainable curriculum model suitable for secondary education. Furthermore, although inquiry-based learning was frequently recommended across the literature, its pedagogical implications had not been sufficiently contextualized within a history curriculum structure that conformed to Indonesia's regulatory, structural, and systemic educational characteristics (Jalil et al., 2024).

This gap served as the foundation for conducting the present study. It called for the development of a history curriculum framework that not only responded to the dynamics of digital technology and modern pedagogical approaches but was also functionally aligned with Indonesia's national curriculum structure at the senior secondary level (Mulyana & Kurniawati, 2020). Accordingly, this research focused on designing a curriculum model that systematically integrated digital technology into the core components of the history curriculum, such as learning objectives, essential content, and instructional activities (Asad et al., 2023). The framework was not intended to evaluate the effectiveness of specific tools or teaching methods but to provide a curricular design that could serve as an implementable reference and be subjected to limited trial implementation in secondary school settings (Borrero, 2023).

The primary objective of this study was to design a curriculum development framework for history education at the senior secondary level in Indonesia that systematically incorporated digital technology into the formal curriculum

structure (Johnston et al., 2024). This design responded to the need for history learning to become more contextualized, engaging, and relevant to the characteristics of 21st-century learners, without altering the foundational principles of the national curriculum (Putra et al., 2020). The proposed framework encompassed essential curricular components—including core competencies, content themes, and sample learning activities—adapted to support digital technology as part of the curriculum implementation strategy. Thus, the research did not aim to develop new instructional media or independent teaching methods but rather to create a curriculum blueprint capable of accommodating available technological resources by practical educational needs (Samuelsson, 2019).

While much of the current literature has focused on classroom-level media usage or digital application development, this study offers a distinct contribution by addressing the curricular architecture itself. Rather than introducing new technology, it systematizes the use of existing tools within a formal curriculum structure—thereby enabling scalable, sustainable, and policy-aligned integration of digital technology (Hutahaean et al., 2024). This approach is particularly significant for developing countries where innovation is often constrained by infrastructure, but where curricular reform offers a powerful avenue for systemic change.

The novelty of this study lay in its integrative approach, which combined analysis of the national curriculum, a synthesis of scholarly literature, and empirical needs from school settings into a single operational curriculum framework for technology-based history education. This approach distinguished the study from previous research, which often focused on the technical aspects of media usage or the effectiveness of specific teaching strategies without addressing the structural dimension of curriculum design. The study also included a limited trial implementation in selected senior high schools to validate the proposed framework and gather empirical insights regarding its feasibility, applicability, and potential for further development. The scope of this research was explicitly limited to the senior secondary level in Indonesia, with an emphasis on curriculum design and initial evaluation through small-scale field trials.

2. Literature Review

2.1 Challenges of the History Curriculum in the Digital Era

The history curriculum is responsible for transmitting knowledge of the past and cultivating historical consciousness, critical thinking skills, and students' contextual understanding of contemporary realities. In the 21st century, the central challenge faced by history curricula was to respond to the changing characteristics of learners who were growing up in digital and fast-paced information environments (Hassan et al., 2024). According to Ofianto et al. (2022) historical understanding was not merely the accumulation of facts but a complex, source-based reasoning process that required students' active participation in reconstructing past narratives. However, in the Indonesian context, the design of the history curriculum continued to emphasize traditional instructional approaches centered on memorization, instead of fostering reflective and exploratory historical thinking (Pratama et al., 2024). This mismatch underscored the misalignment between curriculum design and the competencies required for 21st-century education.

This issue was further exacerbated by the limited explicit technology integration in national history curriculum documents, as shown in studies by Uyun et al. (2024) revealed that, despite general directives encouraging technology use in the 2013 Curriculum and the Merdeka Curriculum, there remained a lack of structured guidance for its implementation in the history subject. As a result, teachers often had to initiate the use of technology independently, without comprehensive curricular support. Consequently, technology-based history learning was fragmented and lacked sustainability (Sahertian, 2024). This created a substantial gap between the direction of digital education policy and the realities of curriculum implementation at the subject level. In other words, the history curriculum in Indonesia had not yet been systematically designed to address the demands of technological integration across its core components—including learning objectives, essential content, and recommended classroom activities (Sakti et al., 2024).

Another structural challenge lay in the absence of digital literacy and technology-oriented pedagogical approaches within the substance of the history curriculum (Hassan et al., 2024). Within the framework of 21st-century literacy, students were not only expected to understand historical narratives but also to critically evaluate digital sources, identify informational bias, and reconstruct historical meaning through accessible digital media (Visuddho et al., 2023). These competencies required a curriculum beyond text-based content by offering explicit guidance on how technology could be used to construct historical understanding. Without a curriculum framework that intentionally integrated technology into both conceptual and pedagogical dimensions, history education risked falling behind the

evolving social and technological landscape (Jwai‹ed et al., 2024) Therefore, developing a technology-integrated history curriculum was not merely a technical innovation but an urgent necessity for substantive reform in history education.

The gap between technological advancement and curriculum design in history education was not solely attributable to implementation-level challenges within individual schools, but also stemmed from the curriculum's failure to transition from a transmissive to a transformative paradigm (Almutairi et al., 2020). Static and fragmented curriculum structures impeded the holistic integration of technological innovation, as they lacked a conceptual framework that supported pedagogical flexibility and adaptation to digital media (Wang, 2024). In the Indonesian context, this issue was further exacerbated by the dominance of syllabi rigidly bound to chronological sequencing and overloaded content, which limited teachers' capacity to explore alternative, technology-based instructional approaches (Idacavage & McAndrews, 2024). This challenge illustrated that the obstacles faced by the history curriculum were not only technical, but also epistemological, raising fundamental questions about how history should be positioned not merely as knowledge to be absorbed, but as a process to be constructed through contextualized and collaborative learning experiences (Sousa et al., 2022).

Furthermore, the absence of explicit guidelines in national curriculum documents regarding integrating technology in history instruction seriously affected educational policy. In practice, many history teachers reported feeling isolated due to the lack of structural and institutional support for developing technology-enhanced instructional designs (Remiswal et al., 2023). This condition contributed to a low level of innovation at the classroom level. It exacerbated school disparities, particularly between those without access to technological infrastructure and training. Such inequality reflected a systemic failure of the curriculum to ensure equity and quality in history education across diverse contexts (A. Stevens & McDonald, 2024). Therefore, the integration of digital technology into the history curriculum could no longer be considered optional, but rather constituted a structural strategy necessary to guarantee equitable access, enhance instructional relevance, and fulfill the learning competencies demanded by 21st-century history education in Indonesia (E. A. Stevens et al., 2022).

2.2 Technology Integration in History Education

The integration of technology into history education has become a critical focus in the development of 21st-century pedagogy. Digital technology offered significant opportunities to reconstruct perspectives on historical events through more interactive, participatory, and multimodal approaches. Several studies demonstrated that technology enabled more authentic and contextualized history learning experiences by providing access to digital primary sources, interactive maps, documentary videos, and event-based simulations (Laine et al., 2023; Setyowati et al., 2023). In this context, technology functioned as an instructional aid and an integral part of the learning process, promoting cognitive engagement and the development of historical thinking skills. Corrales et al. (2024) emphasized that technology could serve as a powerful medium to facilitate historical thinking, particularly in evaluating evidence, comparing perspectives, and constructing historical narratives independently (Domenici, 2023; Temerbayeva et al., 2023).

In the Indonesian context, the application of digital technology in history instruction remained predominantly at the micro level, primarily involving teaching media such as videos, interactive slides, or online quiz applications. While such initiatives were commendable, they often occurred in an ad hoc manner and were not supported by a systematically structured curriculum framework (Brohinsky, 2023; Hay, 2023; Li & Ding, 2022). Consequently, technology integration largely depended on individual teacher initiative and the technological capacity of schools, leading to significant disparities in practice across educational institutions (Fahruddin & Saefudin, 2025b). Moreover, in the absence of a curriculum framework that explicitly guided the objectives, content, and pedagogical strategies of technology-enhanced instruction, integration efforts risked becoming technically focused rather than pedagogically meaningful (Engeness & Gamlem, 2025; Nygren et al., 2019; Sahani & Prakasha, 2024). Hence, a curriculum transformation was required to accommodate and provide a clear structure and direction for the meaningful use of technology in history education.

Recent literature emphasized that the success of technology integration in history education was primarily determined by the extent to which the curriculum provided a supportive pedagogical framework (Ibagón Martín & Miralles Martínez, 2022; Neuhaus & Vogt, 2022). Approaches such as inquiry-based learning and problem-based learning became increasingly relevant when combined with digital technologies, as both promoted independent exploration, collaboration, and critical reflection (Widawski & Oleśniewicz, 2023). Nonetheless, multiple studies also warned that technology was not an automatic solution to educational challenges, particularly when deployed without a strong conceptual foundation (Nygren et al., 2019). Within this framework, it became essential for

curriculum developers to formulate technology integration deliberately and systematically, not as an auxiliary component, but as an integral part of a curricular strategy to foster historically grounded competencies relevant to the contemporary era. This study aligned with such efforts by designing a secondary-level history curriculum that integrated technology at conceptual, pedagogical, and contextual levels (Sahertian, 2024).

Although various technologies had become available and demonstrated potential to enhance interaction in history learning, most of their implementation lacked support from systematically designed curricular structures. A study by Ariani et al. (2022) showed that technology integration in history classrooms often failed to achieve sustainability when not embedded within a curriculum framework that clearly defined pedagogical objectives and coherence among instructional components. In the Indonesian context, technology frequently functioned merely as a substitute for traditional teaching aids rather than a curricular strategy (Uyun et al., 2024). This condition reflected technological bias, where devices were assumed sufficient despite the absence of substantive shifts in curricular thinking. Such circumstances underscored the urgency of transitioning from an instrumentalist approach to a technology-based curricular model that holistically integrates content, competencies, and learning processes (Chen & Yuan, 2022).

Furthermore, the integration of technology in history education needed to be understood as part of an epistemological transformation in how the process of historical learning itself was conceptualized (Mathew & Burgess, 2023). As articulated by Gillate et al., the curriculum was expected to bridge the gap between digital representations of the past and learning processes that required interpretation, analysis, and the development of critical historical understanding. (Gillate et al., 2023) 21st-century historical literacy could not develop optimally without the active engagement of students in accessing, evaluating, and critically utilizing digital historical sources (Utomo & Wasino, 2020). This implied that technology integration should not be limited to media or application selection, but must be embedded within a curricular structure that supports evidence-based, exploratory, and contextually grounded learning experiences (Mars, 2022). By designing curricula that integrated technology at the level of curricular architecture—rather than merely during implementation—it became possible to create history learning environments that were not only responsive to the demands of the digital age but also pedagogically transformative (Rajab et al., 2024; Vestøl, 2024).

3. Methodology

3.1 Research Design

This study employed a Research and Development (R&D) approach using the ADDIE model, which comprises five systematic phases: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE framework was selected for its structured approach in guiding educational product development and its proven effectiveness in curriculum innovation (Serevina et al., 2024). The research aimed to develop a modular, adaptive, and media-integrated digital-based history curriculum for Indonesian senior high schools, adaptable to varying levels of technological readiness and instructional capacity.

3.2 Participants

The study involved three participant groups:

3.2.1 Experts: Five subject-matter experts contributed to curriculum validation. These included two curriculum specialists, two educational technology experts, and one senior lecturer in history education.

3.2.2 Teachers: Ten history teachers from six public high schools in Yogyakarta participated in curriculum feasibility testing and instructional trials.

3.2.3 Students: Approximately 240 Grade XI and XII students engaged in digital learning sessions and formative assessments.

All participants were selected purposively, based on their relevance to the development goals and the diversity of their school contexts.

3.3 Instruments

Several instruments were used to collect both quantitative and qualitative data:

3.3.1 Validation Rubrics: Used by experts and teachers, with eight evaluation indicators scored on a 5-point Likert scale.

3.3.2 Observation Checklists: To monitor the fidelity of instructional implementation and student engagement.

3.3.3 Formative Assessment Sheets: For evaluating student academic achievement. The formative assessment sheets used in this study were specifically designed to measure three key competencies in history learning: (1) conceptual understanding of historical events, (2) analytical skills in evaluating digital historical sources, and (3) the ability to construct historical narratives using digital media. The assessments were administered in the form of digital quizzes comprising multiple-choice questions, source-based analysis items, and short reflective questions. Each assessment was directly aligned with the learning objectives and performance indicators specified in the developed curriculum modules. Automated scoring and immediate feedback features were integrated into the digital platform to enable real-time monitoring of student progress and to support adaptive instructional strategies by teachers.

3.3.4 Student Questionnaires: To gather feedback on digital learning experiences.

3.3.5 Teacher Reflection Forms: To provide qualitative insights into the implementation process.

3.4 Data Collection and Data Analysis

Data collection in this study followed a systematic process aligned with the ADDIE model phases: Analysis, Design, Development, Implementation, and Evaluation. During the analysis phase, the researchers reviewed curriculum documents and conducted interviews with history teachers to identify instructional gaps and the need for digital integration in the learning process. These activities formed the empirical foundation for the curriculum design.

In the design phase, a structured curriculum draft was developed, which included competencies, content, learning strategies, and assessment formats supported by various digital tools such as video narratives, augmented reality (AR), and interactive quizzes. This draft was then evaluated in the development phase by both experts and teachers through rubric-based instruments to assess its validity and feasibility.

The implementation phase involved a six-week trial during which the participating teachers independently delivered two instructional units using the developed digital curriculum. Throughout this phase, researchers collected data through classroom observations, teacher reflections, formative student assessments, and student feedback questionnaires to evaluate how the curriculum performed in real classroom settings.

The formative assessments were systematically developed to align with the core competencies and performance indicators outlined in the curriculum design. Each assessment item was mapped to specific learning objectives to ensure direct alignment between instructional goals, content delivery, and student evaluation. The assessments were conducted at the end of each learning unit using digital quiz platforms that provided instant feedback to students. The results from these assessments served a dual purpose: (1) to measure student mastery of the targeted historical competencies, particularly in digital source analysis and historical thinking, and (2) to inform teachers about areas requiring further instructional emphasis. This formative approach allowed teachers to adjust instructional strategies and provide additional support in a timely manner based on students' real-time performance data.

The evaluation phase triangulated data from these sources to assess the curriculum's usability and its instructional impact. Several instruments were employed to gather comprehensive data, including validation rubrics with eight indicators on a 5-point Likert scale, classroom observation checklists, formative assessment sheets, student response questionnaires, and teacher reflection forms. These instruments provided both quantitative and qualitative data relevant to curriculum feasibility, instructional quality, and student outcomes.

Quantitative data were analyzed using descriptive statistics (mean and standard deviation) to interpret validation scores. Additionally, a one-way ANOVA test was used to examine whether there were significant differences in the effectiveness of curriculum implementation across the six participating schools. The results indicated no statistically significant differences ($p > 0.05$), which suggests that the curriculum could be effectively implemented across different school contexts.

Qualitative data from teacher reflections, classroom observations, and student feedback were subjected to thematic analysis. This analysis helped provide deeper contextual understanding and interpretation of the curriculum's usability and its impact on teaching and learning practices. This methodological combination ensured a rigorous evaluation that balanced empirical validity with contextual responsiveness.

4. Result

4.1 Analysis Stage

The analysis stage in this study served as the empirical foundation for designing a technology-based history curriculum for the senior high school level. The primary focus of this stage was to identify the gap between existing

history teaching practices in schools and the pedagogical demands of the digital era. To obtain comprehensive data, the researcher employed a triangulated methodological approach, which included in-depth interviews with 15 history teachers from six schools, direct observations in 12 classrooms, and a review of national and international literature on history education and educational technology. This combination of methods was chosen to ensure the validity and reliability of the data while enriching the contextual understanding of the challenges and opportunities involved in integrating technology into history curricula in Indonesia (Gläser-Zikuda et al., 2020). Table 1 presents a summary of the findings from the needs analysis.

Table 1. Summary of Needs Analysis for a Technology-Based History Curriculum in Senior High Schools

Assessment Aspect	Key Findings and Implications
Dominant Teaching Approach	Teacher-centered, lecture-based, limited interactivity; 86.7% rely on conventional methods. Highlights the need for pedagogical transformation.
Use of Technology in Instruction	Limited to PowerPoint and video playback; not integrated into curriculum objectives or student activities.
Student Learning Engagement	Low participation in discussions and critical thinking activities. Signals a lack of higher-order cognitive engagement.
Infrastructure and Digital Access	Only 40–60% of students have device access, and 50% of schools lack adequate digital labs. This requires adaptive strategies for implementation in resource-constrained settings.
Teacher Attitudes Toward Technology	93% expressed a strong interest in adopting technology, conditional on training and structured curricular support.
Curriculum-Technology Alignment	No formal integration between digital tools and learning objectives; curriculum documents remain generic and non-operational.
Relevance of Historical Content	Content lacks connection to students' contemporary context; it does not fully reflect local-global linkages.
Availability of Digital Learning Materials	Schools lack structured, interactive materials (e.g., AR, infographics, and digital quizzes), which are needed to support independent and contextualized learning.

The findings revealed a predominant reliance on traditional, teacher-centered instruction, emphasizing rote memorization of historical facts and linear narrative delivery. Approximately 86.7% of teachers reported continuing to use lecture-based methods supported by simple media such as PowerPoint slides or documentary videos, without structured integration of technology into learning objectives or inquiry-based pedagogical strategies. Classroom observations further showed low levels of student engagement and a lack of higher-order thinking activities such as analyzing primary sources, critically evaluating digital historical evidence, and reflecting historical narratives. Students tended to perceive history as a monotonous memorization subject rather than a lens through which to understand social dynamics in context. These findings confirmed that when pedagogically integrated, technology has the potential to transform history learning from an informative model into one that is exploratory and reflective (S. W. Lim et al., 2023).

In addition to pedagogical limitations, digital infrastructure and institutional support emerged as significant structural issues. Three out of six schools studied lacked adequate computer laboratories, and only about 40% to 60% of students had access to personal devices within the school environment. However, it is important to note that 93% of teachers expressed a positive attitude and strong readiness to adopt technology in their teaching, provided that a structured supporting curriculum and relevant training were available. These findings reflect a pressing need to design a history curriculum that is not only adaptive to varying infrastructural realities but also capable of equipping teachers with a systematic and applicable instructional framework. Therefore, the curriculum designed in this study was directed toward addressing three critical dimensions: transforming instructional strategies toward a participatory and exploratory model; integrating contextually relevant digital content; and ensuring structural flexibility to bridge technological disparities across schools.

4.2 Design Stage

Based on the needs analysis, the curriculum design stage focused on developing a systematic framework for integrating digital technology into history instruction at the senior high school level. This design did not merely revise the content and learning objectives and reconstruct key curriculum components—including core competencies, performance indicators, essential subject matter, instructional strategies, and assessment schemes—within a

21st-century pedagogical framework. The curriculum was developed according to the Technological Pedagogical Content Knowledge (TPACK) framework, which emphasizes the integration of historical content, inquiry-based instructional strategies, and the purposeful use of technology as a tool for active learning (Temerbayeva et al., 2023). This approach was intended to meet the cognitive demands of digital-native learners, who require interactivity, visualization, and contextualization to meaningfully understand historical events.

The curriculum design incorporated a variety of interactive digital media into the learning activities, including historical narrative videos, augmented reality (AR) simulations, thematic infographics, and reflective digital quizzes. These media elements were organized into digital teaching modules, each accompanied by step-by-step instructional guides, automated assessment rubrics, and learning tasks that emphasized problem-based learning and source inquiry. The curriculum content was structured thematically and spirally, integrating cross-temporal and cross-local perspectives to help students connect local historical dynamics with global phenomena. The design also emphasized the development of historical thinking skills, such as chronological analysis, source evaluation, and narrative construction, all enhanced through digitally driven exploration.

To ensure implementation flexibility across different school environments, the curriculum was designed in two modes: an individual mode for schools with adequate digital infrastructure and a collaborative mode for schools with limited device access. Each instructional unit was crafted to allow adaptation based on school realities and learner characteristics. The curriculum also included a formative digital assessment component that enabled teachers to monitor student progress in real time and provide automated feedback through the platform. With its modular structure and responsive design, this curriculum aimed not only to support the transformation of history learning but also to serve as a scalable model aligned with national education policy, particularly in the context of the Merdeka Curriculum, which emphasizes differentiated, collaborative, and technology-integrated learning.

To present a clear and concise summary of the curriculum development process, Table 2 illustrates the integration of TPACK, the ADDIE instructional design model, and modular curriculum components that structured the design, implementation, and evaluation of the technology-based history curriculum.

Table 2. Framework of the Technology-Based History Curriculum: Integration of TPACK, ADDIE, and Modular Components

ADDIE Phase	TPACK Integration	Modular Curriculum Components
Analysis	– Content Knowledge (CK) was emphasized to identify the historical learning needs for 21st-century students.	– A needs analysis was conducted involving students, teachers, and school infrastructure readiness.
Design	– Pedagogical Knowledge (PK) and Technological Knowledge (TK) were combined to design appropriate instructional strategies and digital media.	– Core competencies, performance indicators, and thematic learning units were formulated. – Digital learning media such as videos, AR, and interactive infographics were designed. – Instructional scenarios and digital assessments were developed.
Development	– The integration of Technological, Pedagogical, and Content Knowledge (TPACK) was systematically implemented in the curriculum structure.	– Modular digital learning materials were produced. – Automated formative assessments were developed. – Practical tutorials and classroom-based simulations were created.
Implementation	– TPACK-based instructional strategies were applied in various school contexts, with technological adaptation according to infrastructure availability.	– The curriculum was implemented using both individual and collaborative learning modes. – Augmented Reality (AR), videos, and digital quizzes were utilized adaptively.
Evaluation	– The effectiveness of TPACK-based instruction was evaluated through classroom observations and teacher reflections.	– The curriculum impact was assessed based on student participation, historical understanding, and critical thinking skills. – Feedback was used to revise and improve the curriculum framework.

4.3 Development Stage

4.3.1 Expert Validation

The development stage began with a systematic validation of the technology-based history curriculum by five experts from interdisciplinary backgrounds, including curriculum design, history pedagogy, and educational technology. This validation was not merely administrative but was conducted in a substantive and multidimensional manner, targeting the curriculum's structural, content-related, methodological, and implementation feasibility aspects. Each expert was provided with an evaluative rubric constructed based on the principles of curriculum engineering, consisting of eight main indicators: alignment with national standards, technology integration, content relevance, instructional effectiveness, appropriateness of teaching materials, ease of use, digital assessment effectiveness, and potential for cross-school implementation. The evaluation was conducted using a 5-point Likert scale, and the results were averaged to produce an aggregate quantitative score.

Based on the evaluation results, the curriculum design received a very high average score of 4.80 out of a maximum of 5. Two indicators with perfect scores (5.00) stood out: Technology Integration in the Curriculum and Potential for Implementation Across School Contexts. These findings indicated that the experts perceived the design to be not only compatible with 21st-century educational demands but also highly flexible for application across varying school conditions. Other aspects, such as Alignment with National Curriculum Standards, Relevance of Historical Content, and Effectiveness of Technology-Based Instructional Methods, each scored 4.80, demonstrating that the curriculum met both conceptual and pedagogical expectations at a high level. The quantitative results of the expert validation are presented in Table 3 below.

Table 3. Expert Validation Results for the Technology-Based History Curriculum Design

Evaluation Criteria	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Mean Score
Alignment with national education standards	5	4	5	5	5	4.80
Integration of technology within the curriculum	5	5	5	5	5	5.00
Accuracy and relevance of historical content	5	4	5	5	5	4.80
Effectiveness of technology-based instructional methods	5	5	4	5	5	4.80
Relevance of teaching materials to student needs	5	4	5	5	5	4.80
Ease of technology use in instruction	4	4	5	4	5	4.40
Effectiveness of technology-based assessment	4	5	5	4	5	4.60
Potential for wide-scale classroom implementation	5	5	5	5	5	5.00
Overall Average						4.80

Despite the overall high feasibility ratings across all aspects, one dimension received a relatively lower average score, namely the Ease of Technology Use in Learning, which scored 4.40. This indicated that some experts anticipated potential technical barriers during implementation, particularly for teachers unfamiliar with digital platforms or lacking prior training in technology-enhanced instruction. Narrative comments from two experts emphasized that the success of a digital curriculum depends not only on its systemic design but also on the readiness of human resources and the clarity of technical guidance provided in the teaching modules. Therefore, this finding served not only as a reflective insight but also as a rational basis for revising the curriculum's accompanying teacher training instruments and technical documentation. Overall, the expert validation reinforced the assumption that the developed curriculum met key criteria of validity, content reliability, and contextual feasibility. Nevertheless, the findings also highlighted the importance of enhancing the usability aspect, which was subsequently addressed in the development phase by including simulation components and classroom-based operational tutorials.

4.3.2 Teacher Validation of the Technology-Based History Curriculum

Following expert validation, the development phase proceeded with validation by practitioners, specifically, ten history teachers from six partner high schools in the Yogyakarta region. This teacher validation was a strategic step to assess the practical applicability and operational feasibility of the curriculum in real classroom settings and to measure its acceptance by those directly responsible for its implementation. This phase was critical because even a conceptually strong curriculum would only succeed if teachers perceived it as relevant, feasible, and manageable within their instructional context. To that end, the validation instrument for teachers was designed to assess aspects

of applicability, usability, and relevance, considering the real and varied conditions of classroom environments. Teachers were asked to evaluate eight aspects of the curriculum using a 5-point Likert scale, which included alignment with classroom conditions and student characteristics, effectiveness of technology-based instructional methods, comfort in using digital media, and potential for large-scale implementation. The results of this teacher validation are summarized in Table 4 below.

Table 4. Teacher Validation Results of the Technology-Based History Curriculum

Evaluation Aspect	Mean Score
Alignment with classroom conditions	4.60
Feasibility of technology-based instructional methods	4.60
Relevance of content to student learning needs	4.50
Effectiveness of technology in enhancing student engagement	4.60
Ease of technology use by students	4.60
Comfort in using the digital learning platform	4.60
Effectiveness of digital-based assessment	4.50
Potential for large-scale implementation	5.00
Overall Mean Score	4.60

The overall mean score of 4.60 indicated that history teachers generally responded positively to the curriculum and perceived its implementation as realistic within their classroom environments. The highest-rated aspect was the potential for large-scale implementation (5.00), reflecting a high level of optimism among teachers that the curriculum could be adopted across various schools, including those with differing technological readiness levels. In contrast, two aspects received slightly lower—yet still favorable—ratings of 4.50, namely the relevance of content to students' needs and the effectiveness of digital-based assessments. These findings suggest the need to further align the content with local contexts and enhance the flexibility and inclusiveness of digital assessment formats, particularly concerning students' varying levels of digital literacy.

Open-ended feedback from teachers underscored several important points. First, digital instructional media such as historical video narratives and AR simulations were considered highly effective in visualizing abstract historical events. Second, teachers appreciated the curriculum's flexible structure, allowing local contextual adaptation. However, they also emphasized that successful implementation would depend significantly on the availability of initial training and ongoing technical support. As such, the results of this teacher validation served as a critical foundation for the development of accompanying implementation components, including technical tutorials, structured teacher training, and classroom-based usage simulations. With the completion of both expert and teacher validation phases, this study established a strong basis that the developed technology-based history curriculum is not only conceptually and pedagogically valid but also feasible and usable in real-world secondary school settings. The next stage involved a guided implementation trial in six senior high schools to evaluate the curriculum's effectiveness under authentic classroom conditions.

4.3.3 Curriculum Use-Case Simulation

Based on the previous validation results—particularly regarding the ease of technology use in instruction (mean score of 4.40 from experts and 4.60 from teachers)—the researcher acknowledged that the success of curriculum implementation depended not only on the strength of its conceptual design but also on the availability of practical, accessible operational guides for end users, namely teachers and students. Therefore, as an integral part of the development stage, a set of use-case simulations was designed to provide concrete illustrations of how the curriculum could be implemented in real classroom contexts.

The simulations were constructed around thematic learning scenarios that demonstrated curriculum application in specific historical topics such as Resistance to Colonialism, The Asian-African Conference, and National Integration. Each simulation was designed as an end-to-end instructional flow, covering the entire sequence from class introduction, student engagement with digital media, conceptual reinforcement through interactive discussions, to formative assessment using digital quizzes. To enhance accessibility and adaptability, the simulation materials were delivered in three primary formats: demonstrative videos, interactive infographics, and narrative-based step-by-step teaching modules. These formats aimed to accommodate a variety of school conditions and teacher preferences. The

structure and objectives of each simulation type are presented in Table 5 below.

Table 5. Types and Objectives of Curriculum Use-Case Simulations

Type of Simulation	Media Format	Sample Topic	Simulation Objective
Walkthrough of digital module usage	Video & narrative PDF	Resistance to Colonialism	To understand the flow of learning activities using modules and digital tools
AR-based learning activity simulation	Demonstrative video	The Asian-African Conference	To demonstrate the use of AR for historical event visualization and student engagement
Tutorial on automated digital quiz evaluation	Infographic & video tutorial	Dynamics of the New Order Era	To guide teachers in managing assessment via online platforms
Adaptive scenario for low-tech school environments	Narrative text & technical guide	Indonesian National Awakening	To provide collaborative implementation alternatives in low-infrastructure schools

These simulations functioned not only as teacher onboarding tools but also as a curriculum adaptation mechanism for schools with varying levels of technological readiness. Teachers were encouraged to select the simulation format that best matched their school's infrastructure and the characteristics of their students. In addition, each simulation was accompanied by diagnostic assessment instruments and teacher reflection sheets to evaluate the effectiveness of implementation and to identify potential challenges encountered during classroom application.

Within the framework of digital pedagogy, this simulation approach was designed based on the principles of the Universal Design for Learning (UDL), which emphasizes the importance of providing multiple means for teachers and students to access information, actively engage, and express learning outcomes. As such, the curriculum use-case simulations served a dual purpose: as a capacity-building tool for educators and as a practical validation mechanism for the curriculum design itself, ensuring that the curriculum was not only conceptually valid and pedagogically sound but also ready for real-world, context-sensitive implementation.

To further enhance the practical implementation of the curriculum, the teacher training program was designed using a scaffolded structure. The training was delivered through a blended learning approach, combining synchronous sessions for real-time demonstrations with asynchronous modules that teachers could access independently through the digital platform. The training materials were sequenced progressively, beginning with the introduction of the curriculum structure and its digital components, followed by hands-on tutorials for using videos, AR applications, and automated quizzes, and concluding with classroom simulation exercises. This step-by-step design aimed to accommodate teachers with varying technological proficiency and to provide flexible access that supported individual learning paces. By providing both guided and self-paced learning pathways, the training was structured to ensure that teachers could confidently apply the curriculum regardless of their school’s digital infrastructure, thereby strengthening the scalability and adaptability of the model across diverse educational settings.

4.4 Implementation Stage

Before the curriculum implementation, all participating teachers received a structured training program that combined synchronous face-to-face sessions (two sessions of 90 minutes each) with asynchronous, self-paced learning modules accessible through a digital platform. The training adopted a scaffolded approach, gradually building teacher competence starting from the understanding of curriculum concepts, moving to practical use of digital media such as narrative videos, AR tools, and digital quizzes, and culminating in classroom-based simulations that allowed teachers to practice the instructional flow before actual classroom application. This blended and progressive training design aimed to ensure that teachers could comfortably implement the curriculum regardless of their initial digital skill levels or the technological conditions of their schools.

The implementation stage was conducted as a guided field trial to evaluate the effectiveness and practical feasibility of the developed technology-based history curriculum. The trial was carried out in six public senior high schools located in the Yogyakarta Special Region, selected based on their diversity in digital infrastructure, teacher readiness, and student characteristics. The primary objective of this stage was to observe firsthand how the curriculum was applied in real classroom settings by teachers, without direct researcher intervention, and to examine student responses to the use of digital media in learning. The implementation period lasted for six weeks, during which each school applied at least two digital instructional units, with historical topics selected by the respective teachers

according to available time and relevance to the national curriculum.

Before implementation began, all participating teachers received a brief technical training program consisting of two sessions (2 × 90 minutes). The training introduced the curriculum structure, use of digital media (e.g., video, AR, digital quizzes), and strategies for adapting instruction to various classroom contexts. During implementation, teachers conducted the lessons independently using the digital modules, with minimal supervision from the researchers. The success of the implementation was assessed through a combination of classroom observations, teacher reflections, student assessments, and structured questionnaires. To support data-based conclusions, the evaluation results from all six schools were summarized in Table 6 below.

Table 6. Curriculum Implementation Evaluation by Teachers in Six Public Senior High Schools

School	Effectiveness Score (1–5)	Implementation Notes
SMAN 1 Yogyakarta	4.78	Full use of digital media; students were highly active and reflective
SMAN 2 Bantul	4.75	AR was maximally utilized; digital assessment ran smoothly
SMAN 8 Yogyakarta	4.60	Good infrastructure, but limited variety in student interaction
SMAN 1 Kulon Progo	4.53	Positive engagement; limited student access to devices
SMAN 1 Gunungkidul	4.50	Media adapted via group-based projector use
SMAN 2 Ngaglik	4.47	Minimal infrastructure; a collaborative learning strategy was employed
Overall Mean Score	4.60	Curriculum was implemented flexibly and adaptively across school contexts

The average implementation effectiveness score was 4.60, with the highest ratings recorded at schools with moderate to high levels of digital infrastructure, such as SMAN 1 Yogyakarta and SMAN 2 Bantul. Meanwhile, schools with limited device availability managed to adopt collaborative approaches effectively. For instance, implementation at 2 Ngaglik demonstrated that despite the scarcity of student-owned digital devices, teachers were able to manage technology-based instruction using a single classroom projector and group-based reflective discussions supported by historical video content. These findings indicated that the curriculum exhibited a high degree of adaptability and was not exclusive to well-equipped schools.

To examine the consistency of implementation effectiveness across schools, a one-way ANOVA test was conducted on the evaluation scores submitted by teachers. The results showed no statistically significant difference among the schools ($p > 0.05$), suggesting that curriculum performance did not depend on the level of technological infrastructure. Instead, successful implementation appeared to be influenced by factors such as instructional strategy, teacher creativity, and the inherent flexibility of the curriculum design. A summary of the ANOVA results is presented in Table 7 below.

Table 7. One-Way ANOVA Results on Curriculum Implementation Effectiveness

Source of Variation	SS	df	MS	F	p-value
Between Schools	0.067	5	0.013	1.142	0.395
Within Schools	0.410	36	0.011		
Total	0.477	41			

These findings supported the argument that the developed technology-based history curriculum was pedagogically resilient and structurally inclusive. Teachers at schools with limited infrastructure were able to adapt instructional methods without compromising the core learning objectives. This affirmed the curriculum's position as a viable alternative solution suitable for widespread application across Indonesia's secondary education system.

Beyond the quantitative data, teacher reflections and student feedback revealed qualitative shifts in classroom dynamics. Teachers reported increased student participation, the emergence of reflective questioning, and more interactive classroom environments. Most students stated that digital media such as augmented reality (AR) and historical videos made history feel more "real" and "relevant to current life." Some students even connected historical events to contemporary global issues such as colonialism and geopolitics. These responses indicated that the curriculum not only functioned effectively in technical terms, but also fostered higher-order thinking skills and

contextual historical literacy among students. Accordingly, the implementation stage demonstrated that the curriculum had not only passed the design and validation phases but also proved to be pedagogically effective and operationally flexible, making it a strong candidate for replication in the national education system.

Overall, the implementation phase showed that the technology-based history curriculum was practically feasible and effective, with high adaptability and potential for further development. These findings provided a strong foundation for recommending gradual adoption in other schools and encouraging integration of the curriculum into national education policies that promote digital transformation and 21st-century competency-based learning. To visualize the distribution of effectiveness, Figure 1 below presents the trend of implementation scores across the participating schools.

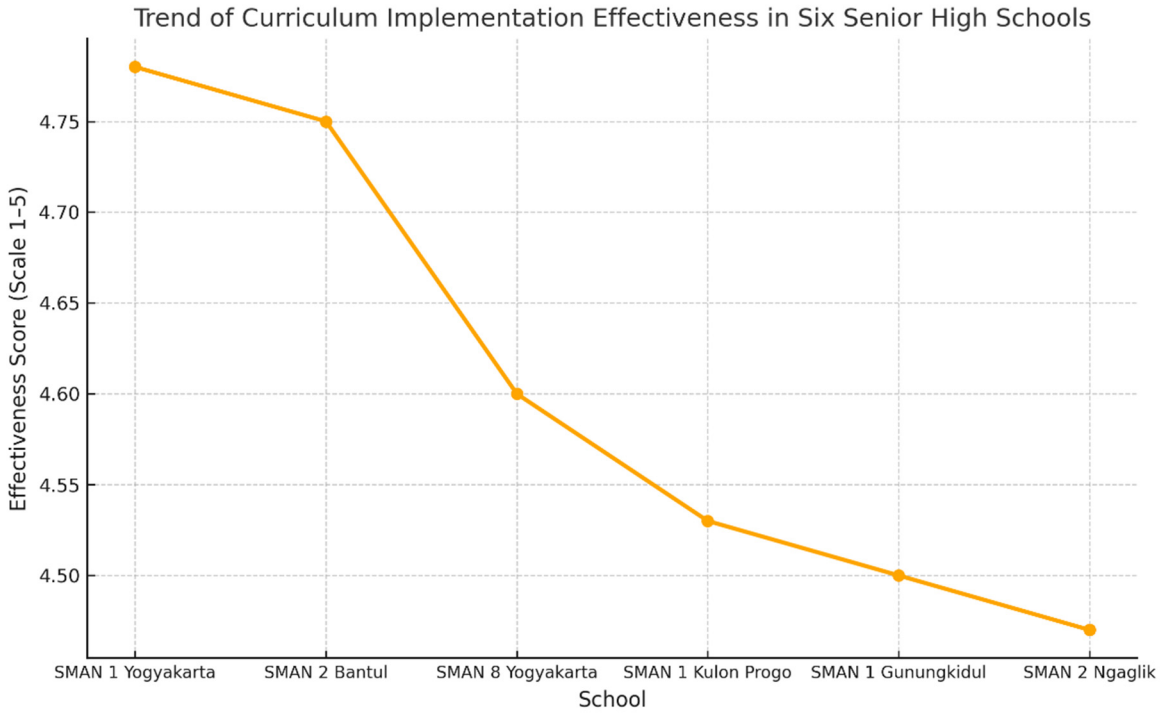

Figure 1. Effectiveness Score Trends Across Participating Schools

The trend chart illustrated a relatively stable distribution of scores, with a gradual decline corresponding to schools with lower levels of digital infrastructure. SMAN 1 Yogyakarta and SMAN 2 Bantul emerged as the top-performing institutions, reflecting a correlation between technological readiness and smooth implementation of digital modules, including AR media and automated assessments. However, it is important to note that the differences in scores across schools were not drastic, and all institutions remained within the high effectiveness category (scores > 4.40). This suggested that teacher adaptability in instructional strategies played a more crucial role in implementation success than the availability of technological facilities alone. The graph reinforced the conclusion that the developed digital history curriculum possessed a high degree of resilience and scalability, making it well-suited for broad replication in the Indonesian secondary education context.

4.5 Evaluation Stage

The evaluation stage was conducted as a comprehensive reflection on the effectiveness of the technology-based history curriculum following its implementation in six senior high schools. This evaluation focused on determining whether the curriculum meaningfully impacted the quality of the instructional process, student engagement, and learning outcomes. Specifically, the formative assessments measured students' understanding of historical concepts, their ability to critically analyze digital historical sources, and their capacity to reconstruct historical narratives using multimedia tools. The assessment process was conducted through digital quizzes at the end of each instructional unit, with immediate feedback provided to both students and teachers. These formative assessments not only tracked student learning progress but also served as a diagnostic tool to help teachers identify learning gaps and adapt their

instructional strategies accordingly. The combination of formative assessment results, classroom observations, teacher reflections, and student feedback questionnaires provided a holistic view of the curriculum's pedagogical impact and its alignment with the intended learning outcomes (X. Wang et al., 2024).

In terms of instructional process, teachers reported a significant change in student participation, particularly during lessons involving digital media such as narrative videos and AR simulations. Approximately 83% of teachers stated that students became more active and reflective during class discussions. This finding was corroborated by researchers' observations, which noted an improvement in the quality of student questions and a shift in classroom dynamics from monologic to dialogic interactions. In terms of learning outcomes, data showed that 71% of students achieved scores above the minimum competency standard (KKM), with an average increase in formative scores of 12.4% compared to previous classes that used conventional teaching methods. These results suggested not only improved content comprehension but also enhanced critical engagement. To provide a clearer overview of the findings, Table 8 below summarizes the key dimensions of the curriculum's impact on both teachers and students.

Table 8. Summary of Curriculum Impact Evaluation on Teachers and Students

Evaluation Dimension	Indicator / Finding	Data Source
Student Participation	83% of teachers reported increased active participation	Teacher Reflections
Student Understanding	76% of teachers stated faster comprehension via digital media	Teacher Reflections
Score Improvement	Average increase in scores: 12.4% over the previous class	Formative Assessment
Students Surpassing KKM	71% of students scored above the minimum competency threshold	Daily Test Results
Classroom Atmosphere	More interactive, an increase in open discussions	Researcher Observations
Student Response: "Learning is more engaging."	Average rating: 4.70 (scale 1–5)	Student Questionnaire
Student Response: "Media helps me understand."	Average rating: 4.65	Student Questionnaire
Student Response: "I feel more active in learning."	Average rating: 4.60	Student Questionnaire

The data presented in the table indicated that the impact of the curriculum was not merely cosmetic or visual, but reached substantive pedagogical dimensions. Teachers reported notable increases in student engagement and intellectual curiosity. Digital media proved to be a catalyst not only for improving content comprehension but also for developing students' historical thinking skills. Furthermore, high student questionnaire scores in dimensions such as engagement and clarity of content demonstrated that media tools—particularly video and augmented reality—provided a more contextualized and meaningful learning experience.

The implications of this evaluation were strategic. The developed technology-based history curriculum demonstrated its ability to address the pedagogical challenges of the digital era by shifting history learning from a chronological and text-based approach to one grounded in exploration, visualization, and meaning construction. This evaluation also validated that the curriculum was ready for national-level replication, provided it was accompanied by structured teacher training, inclusive digital platform integration, and local contextual adaptation. As such, the evaluation stage confirmed that the curriculum was pedagogically effective, contextually flexible, and ready for systemic adoption.

5. Discussion

The findings of this study revealed that the systematic integration of technology into the history curriculum significantly enhanced the effectiveness of learning, both in terms of instructional processes and student learning outcomes. Implementing the curriculum across six schools with varying infrastructure profiles demonstrated its high level of adaptability without compromising its pedagogical essence. This confirmed that the success of

implementation was not solely dependent on the availability of digital devices, but rather on a curriculum structure that enabled methodological flexibility and instructional differentiation. In line with Li & Ding (2022), technology can be transformational when embedded within a curriculum framework that promotes active participation, meaning construction, and contextualized problem-solving in historical learning. Evaluation data showed improvements in student participation, the quality of classroom discussions, and the development of historical thinking skills, collectively marking the curriculum's success in transforming history education from a passive-transmissive model into an active-reflective one (Candel et al., 2024; Fahruddin et al., 2025).

The principal novelty of this study lay in its approach, which not only developed digital learning media for history but also reconstructed the entire curriculum structure to align with technological-pedagogical principles. While most previous research focused on content development, such as video, augmented reality, or mobile applications (Nii Akai Nettey et al., 2024)—This study went further by making technology the foundation of curriculum design. Every component—core competencies, content selection, sequencing of learning activities, and assessment formats—was integratively designed to support exploratory, source-based, and visually driven history learning. Thus, the study did not stop at the level of technology application, but instead demonstrated how technology can drive systemic transformation in the structure and orientation of history education. This approach underscored the significance of curriculum-level innovation, which remains underexplored in the development of digital history curricula, particularly in the Indonesian context (Bures et al., 2022).

In addition to designing the curriculum as a systemic structure, this study introduced a modular curriculum model that was adaptive and ready for implementation without requiring teachers to redesign instructional activities. This distinguishes the study's contribution from most existing research that relies heavily on teacher training models based on the TPACK framework (Bourekkache & Kazar, 2020) Teachers are still expected to create their own lesson plans. In this study, the TPACK principles were operationalized into a modular curriculum that teachers could adopt directly, complete with structured learning scenarios, use-case simulations, and automated assessments. The innovation lay in the curriculum's ability to bridge the gap between theoretical design and classroom practice, positioning it as a ready-to-use instructional product that responded effectively to the challenges of digitalizing history education in secondary schools (Fahruddin & Saefudin, 2025; S. W. Lim et al., 2023).

In the Southeast Asian context, particularly in Malaysia, the development of technology-based history curricula has been part of national strategy through documents such as the Dokumen Standard Kurikulum dan Pentaksiran (DSKP Sejarah) and the Malaysia Education Blueprint 2013–2025 (D. Lim et al., 2024). However, previous studies indicated that the application of digitalization in Malaysian history curricula has largely followed an additive approach—that is, adding technology as a supplementary tool rather than embedding it as a structural component of the curriculum (Inayatillah et al., 2022; Saefudin et al., 2024). This approach relied heavily on individual teacher initiatives and failed to drive systemic changes in instructional structure. Although ICT training programs for teachers were available, the lack of integration between technology, historical content, and pedagogical goals meant that digital history instruction in Malaysia remained fragmented and sporadic (Candel et al., 2024; Muangchan & Yanhua, 2025).

This study positioned itself as a novel contribution by offering a more instructional and systemic approach to curriculum development. Unlike the Malaysian framework, which treated technology as an auxiliary teaching tool, the curriculum in this study constructed a digital history learning system from the ground up—beginning with the design of competencies, the development of digital narratives, and the integration of automated assessments (Ghazali et al., 2020; D. Lim et al., 2024; Vinco et al., 2019). Technology was no longer a peripheral component in this framework but became the backbone of the entire instructional process (Muangchan & Yanhua, 2025). Furthermore, the curriculum offered a ready-to-use modular model, not merely a pedagogical guideline, allowing immediate implementation without requiring extensive teacher redesign. In this regard, the technology-based history curriculum developed in the Indonesian context could serve as a new benchmark for digital curriculum development in Southeast Asia, particularly in aligning educational policy, curriculum design, and classroom practice in response to the challenges of digitalization in education (Sopacua et al., 2020; Stracqualursi & Agati, 2024).

This study also made a global contribution to the discourse on digital curriculum development, particularly in history education, by demonstrating that curriculum innovation does not have to rely on high-end technologies, but rather on contextualized, modular instructional design replicable across diverse educational cultures. The curriculum model developed in this study presented a systemic approach to technology integration, which could serve as a reference for developing countries facing similar challenges in infrastructure, teacher training, and digital literacy. In contrast to many models in developed countries, which often require high technological readiness and substantial resources, this

study adopted a design grounded in the principles of technological equity and pedagogical resilience, making it more inclusive and applicable on a global scale (Granado-Peinado & Huertas, 2023; Setiawan et al., 2020; Takenaka & Soga, 2019). Thus, the research was nationally relevant and expanded the global horizon of digital pedagogy, particularly in strengthening collaborative, reflective, and source-based digital history learning.

6. Conclusion

This study demonstrated that the systematic integration of technology into the history curriculum significantly transformed both the learning process and student outcomes at the senior secondary level. Developed through the ADDIE model, the curriculum proved to be conceptually valid, practically feasible, and pedagogically effective, as reflected by high expert validation scores (mean 4.80), teacher validation (mean 4.60), and implementation results across six schools with varied infrastructure profiles (mean effectiveness score 4.60). A one-way ANOVA test revealed no significant difference in effectiveness between schools ($p = 0.395$), indicating that successful implementation was driven more by curriculum flexibility and teacher strategies than infrastructure availability. Qualitative data also revealed a substantial shift in classroom dynamics: students became more engaged, reflective, and capable of linking historical content to contemporary global issues. High student response scores (average 4.65–4.70) further confirmed that digital media—especially AR and narrative videos—enhanced content comprehension, historical thinking skills, and digital literacy. Accordingly, this curriculum was deemed effective in design and implementation and replicable at scale, aligning with the pedagogical demands of the digital age.

7. Suggestions

Based on the findings and limitations, this study formulated several strategic recommendations for future development. First, broader-scale implementation across geographically and demographically diverse schools—including underdeveloped and remote areas—is necessary to test the curriculum's scalability and cultural adaptability. Second, a modular digital training platform should be developed using microlearning and interactive simulation to build teacher competence progressively and reduce reliance on traditional workshops. Third, this curriculum should be integrated into national education policies—such as Indonesia's *Kurikulum Merdeka*—to transition from academic experimentation to system-level adoption. Fourth, longitudinal studies are required to assess the curriculum's long-term impact on students' 21st-century skills, including historical digital literacy, critical reasoning, and democratic engagement. Finally, the curriculum model offers a replicable reference for other developing countries facing similar constraints—limited infrastructure but a growing need for inclusive and transformative digital curriculum innovation.

8. Limitations

Despite its positive outcomes, this study faced several methodological and practical limitations. First, the field trial was limited to six schools in a single province, which, although diverse in infrastructure, did not sufficiently represent the full range of Indonesia's geographic, cultural, and institutional diversity. Second, the effectiveness evaluation was conducted over a short-term period (six weeks), limiting conclusions about long-term impacts on historical retention, value internalization, or digital citizenship development. Third, the reliance on teacher reflections and student questionnaires—administered shortly after implementation—may have introduced response bias due to initial enthusiasm. Fourth, technologies such as AR and automated assessments remained contingent upon device availability, connectivity, and baseline digital literacy, which varied across schools. Furthermore, teacher training was only tested in a basic format and has not yet been explored across different durations or online learning models. Therefore, the findings should be interpreted as early-stage trial results, not as final validation.

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Authors contributions

Zulkarnain and Fahruddin were responsible for analyzing the research problem and conducting data analysis. Salamah, Loso Judijanto, and Darsono contributed by developing data collection instruments and conducting field data collection. The curriculum design and manuscript preparation were collaboratively carried out by all authors, complementing each other's contributions.

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