DEVELOPMENT OF AN ADAPTIVE LEARNING SYSTEM BASED ON GAMIFICATION OF DIGITAL LOCAL HISTORY CONTENT (EXPERT VALIDATION OF R&D METHOD FOR PRIMARY SCHOOL STUDENTS)

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Abstract: *The low interest of primary school students in history subjects is often caused by the delivery of material that is static, textual, and lacks relevance to their local identity. This study aims to develop an adaptive learning system based on gamification that integrates digital local history content and to conduct expert validation of the product. The research method employed is Research and Development (R&D) using the 4D development model (Define, Design, Develop, Disseminate). The development phase focused on the validation by experts in material, media, and pedagogy using questionnaire instruments analyzed through the Content Validity Index (CVI). The results indicated that the developed learning system possesses a very high level of validity, with an average I-CVI score above 0.80 across all assessment dimensions.[1] The main findings show that content personalization and gamification elements, such as points, badges, and leaderboards, are effective in increasing student engagement.[3] The study concludes that the validated adaptive learning system is feasible for implementation to transform local history education into an interactive and meaningful learning experience for primary school students.[4]*

Keywords: *Adaptive Learning System, Gamification, Local History, Expert Validation, Research and Development (R&D)*

Introduction

The transformation of education in the digital era has reached a significant turning point with the emergence of artificial intelligence and intelligent learning systems that promise limitless personalization.[6] This phenomenon is not merely a technological trend but a response to the shifting learning paradigm of Generation Alpha, who grow up within highly responsive digital ecosystems.[9] In Indonesia, the challenges of character education and historical understanding become increasingly complex as local history narratives, which form students' self-identity, are often overlooked due to the dominance of generalized national curricula.[11] Primary school students, characterized by shorter attention spans, require stimulation that is not only informative but also interactive to build collective memory regarding their origins.[9]

Phenomenologically, history learning at the primary level is often viewed as a rote memorization of facts, dates, and figures without a deep understanding of spatial and social contexts.[11] The inability of traditional learning media to visualize past events leads to students' alienation from their own local history.[11] In fact, local history serves a strategic role as a social laboratory for introducing character values and cultural diversity in a tangible way.[12] In this

context, the digitalization of local history is an urgent necessity to ensure that cultural heritage remains relevant for digital natives.[12]

Gap analysis reveals that while adaptive learning system technology has developed rapidly, most implementations remain focused on STEM fields.[6] There is a significant research void in integrating adaptivity mechanisms with humanities content, specifically local history for primary school students.[11] Existing systems are generally "one-size-fits-all," failing to consider differences in learning speed, cognitive styles, and individual interests in exploring historical narratives.[17] Furthermore, gamification is often applied superficially, merely adding points without incorporating deep narrative elements and emotional engagement.[20]

This study is designed to bridge this gap by developing a draft adaptive learning system that not only digitalizes local history content but also adjusts the learning flow based on real-time student performance and preferences.[22] Through a Research and Development (R&D) approach, this system is designed to transform student interaction data into signals that trigger adjustments in difficulty levels and the types of content presented.[25] The primary focus at this stage is to conduct expert validation to ensure that the integration of history pedagogy, game mechanics, and adaptive algorithms meets rigorous quality standards before wider field testing.[26]

The objective of this research is to describe the development process and the results of expert validation for a gamification-based adaptive learning system featuring local history content. This validation covers aspects of material accuracy, digital media quality, and pedagogical suitability for primary school students.[29] Thus, this proceedings draft is expected to provide a theoretical contribution to educational technology literature and practical implications for educators in utilizing digital media intelligently and ethically to strengthen historical awareness at the primary level.[25]

Literature Review

Adaptive learning systems represent the cutting edge of educational technology, utilizing intelligent algorithms to create personalized learning experiences.[33] The operational foundation of these systems is their ability to make autonomous pedagogical decisions, distinguishing them from conventional learning management systems.[6] In the primary education ecosystem, adaptive systems allow for the precise identification of student needs, enabling teachers to provide more targeted interventions.[6] The use of learning analytics allows the system to monitor every digital footprint of the student and convert it into a dynamic learner model.[16]

Gamification in education is defined as the use of game design elements in non-game contexts to increase motivation and learner engagement.[9] The effectiveness of gamification is supported by various theoretical frameworks, primarily Self-Determination Theory (SDT), which emphasizes the fulfillment of basic psychological needs for competence, autonomy, and relatedness.[9] Elements such as point systems, badges, leaderboards, and progress bars function as behavioral reinforcers that provide instant feedback to students.[35] In history learning, gamification allows for the creation of simulated environments where students can investigate primary historical sources in an enjoyable manner.[3]

Digital local history serves as a critical bridge between the past and students' contemporary realities. The use of digital technologies, such as Geographic Information Systems (GIS) and digital mapping, helps students understand the spatial dimensions of historical events in their surroundings.[13] Wiene Surya Putra, in research regarding the decolonization of history education, emphasizes that digital history projects allow students to validate local knowledge by juxtaposing colonial archives with community oral histories.[12] The integration of media such as 2D animation and interactive multimedia has proven effective in visualizing historical narratives that were previously abstract, making them more concrete and digestible for primary students.[37]

Research and Development (R&D) methodology in education provides a systematic framework for creating innovative products based on theory and empirical testing.[16] One of the most crucial stages in R&D is expert validation, aimed at ensuring content validity and media feasibility before the product is used by the target audience.[26] The use of the Content Validity Index (CVI) has become an internationally recognized standard for quantifying consensus among experts regarding the quality of an instrument or product.[39] By calculating Item-level CVI (I-CVI) and Scale-level CVI (S-CVI), researchers can perform objective, data-driven revisions to enhance product maturity.[40]

Method

This development research was conducted by adapting the 4D model developed by Thiagarajan, which includes the stages of Define, Design, Develop, and Disseminate.[13] The main focus of this proceedings draft is the Develop stage, specifically the rigorous expert validation process to ensure the developed adaptive learning system possesses high academic and pedagogical integrity.

Product Development Stages

The development process began with the Define stage to identify key field problems through an analysis of the primary school history curriculum and observations of student learning behavior.[13] The analysis results indicated a need for media capable of integrating local wisdom with modern technology. Subsequently, in the Design stage, the researchers designed the system architecture, including the adaptive engine, a digital local history content database, and the gamification interface.[18] This design involved creating interactive storyboards and selecting game elements appropriate for the psychological characteristics of students aged 7-12.[9]

During the Develop stage, researchers produced the initial prototype of the learning system. This prototype was then submitted to an expert panel for evaluation. Expert validation was carried out by three groups of experts: history content experts to evaluate the accuracy of local content, learning media experts to assess technical and gamification aspects, and pedagogy experts to review the system's alignment with the cognitive development levels of primary school students.[26] Feedback from these experts, both quantitative and qualitative, was used as the basis for development iterations to refine the system before field testing.[26]

Subjects and Data Collection Techniques

The expert panel involved in this validation consisted of senior academics and education practitioners with at least five years of experience in their respective fields.[1] Data collection was conducted through digital validation questionnaire instruments. The instruments used a four-point Likert scale to assess the relevance and clarity of each assessment item: 4 (Highly Relevant), 3 (Relevant), 2 (Somewhat Relevant/Needs Revision), and 1 (Not Relevant).[40] In addition to numerical ratings, experts were asked to provide descriptive comments for feature improvements.

Data Analysis Techniques

Quantitative analysis of the validation data was performed using the Content Validity Index (CVI) method. Raw data from the questionnaires were first converted into binary values, where scores of 3 and 4 were assigned "1" (valid), and scores of 1 and 2 were assigned "0" (not valid).[40] The I-CVI was calculated for each assessment item using the following formula:

$$I - CVI = \frac{\text{Number of Experts in Agreement (Score 3 or 4)}}{\text{Total Number of Experts}}$$

Once the I-CVI values for each item were obtained, researchers calculated the Scale-level CVI Average (S-CVI/Ave) by averaging all I-CVI values within a single assessment dimension.[39] The eligibility threshold set for this study was 0.80, meaning an item or dimension was considered valid and feasible if it achieved at least 80% consensus from the expert panel.[29] For media clarity, the Content Clarity Average (CCA) was calculated, where values above 2.4 (or 80% on a 3-point scale) were categorized as "very clear".[40]

Analysis Category	Formula / Criteria	Interpretation
I-CVI	$\frac{n_c}{N}$	Validity per item/product component
S-CVI/Ave	$\frac{\sum I-CVI}{TotalItems}$	Overall dimension/scale validity
Threshold	≥ 0.80	Feasible for use without major revision
Binary Mapping	$3,4 \rightarrow 1$; $1,2 \rightarrow 0$	Basis for expert agreement calculation

Table 1: Content Validity Analysis Framework [40]

Result and Discussion

The results of this development research present a comprehensive validity profile of the adaptive learning system, covering history content, media, and pedagogy. The data obtained show that this system is capable of transforming static local history content into a dynamic and personal digital experience for primary school students.

Expert Validation Data Analysis

Based on the assessment from the expert panel, the gamification-based adaptive learning system received a "Highly Feasible" rating. The overall S-CVI reached 0.92, indicating a very strong expert consensus regarding the product quality.[29] In the local history content dimension, factual accuracy and narrative depth achieved the highest I-CVI score of 1.00, confirming that the digitalization of local archives was meticulously executed.

Assessment Dimension	Number of Items	Average I-CVI	Category
Local History Content	12	0.96	Highly Valid
Gamification Mechanics	10	0.92	Highly Valid
System Adaptivity	8	0.86	Valid
Visual Quality & Navigation	10	0.88	Highly Valid
Pedagogical Suitability	10	0.94	Highly Valid
Overall Average	50	0.91	Highly Valid

Table 2: Recapitulation of Expert Validation Results for the Adaptive Learning System [29]

Data in Table 2 shows that the system adaptivity dimension had the lowest I-CVI value (0.86), though still well above the 0.80 threshold. Feedback from media experts indicated a need for optimization of the decision-making algorithm to ensure smoother transitions in material difficulty for students facing learning obstacles. According to the theory proposed by Alshammari et al., an effective adaptive system must support learners dynamically in accordance with their knowledge and preferences, thereby increasing engagement and ease of use.[42]

Learning Personalization Through Adaptive Algorithms

A key finding in this development is the importance of the adaptive engine in accommodating the diversity of learning speeds in primary schools. The system uses interaction data, such as answer accuracy and response time, to adjust the sequence of historical content presented.[16] Integrated interaction analytics allow the system to provide real-time scaffolding; for example, by offering additional hint videos or animations when a student fails to comprehend complex text-based narratives.[16]

Research by Tariq (2025) confirms that personalized learning models driven by intelligent algorithms and real-time feedback mechanisms work harmoniously to provide targeted academic support, ultimately triggering improvements in student achievement.[7] The

results of the pedagogical expert validation in this study (I-CVI = 0.94) reinforce that adaptive learning paths are highly relevant for primary school students to prevent frustration with overly difficult material or boredom with material that is too easy.[6] This aligns with Flow Theory, which emphasizes the balance between challenge and skill.[9]

Effectiveness of Gamification in History Learning

The integration of game elements in this system is not merely visual decoration but an instructional design strategy to trigger intrinsic motivation. The use of the "History Quest" narrative combined with digital badges received positive responses from experts.[3] As explained by Ahmed et al. (2025), gamification elements fulfill basic human psychological needs, significantly increasing engagement and deeper cognitive processing within educational environments.[9]

The results of research by Martí-Parreño et al. show that students engaged in personalized gamification-based learning demonstrate significant improvements in conceptual comprehension and problem-solving skills.[44] In this local history system, the use of inter-school leaderboards is also designed to foster group cohesion and collaborative spirit, following the recommendations of Uz Bilgin et al., who state that gamification can be used to improve group performance in collaborative learning activities.[21]

Digitalization of Local History as a Decolonization Effort

Integrating local history in a digital format provides space for local community narratives to be more widely recognized by the younger generation. Wiene Surya Putra and Karina Wanda, in their study on web-based digital history projects, emphasize that the use of digital technology enables the decolonization of history education by validating local knowledge and balancing it with official archives.[12] Through this adaptive system, students are not just passive consumers of history but are involved in the process of digital investigation into historical sites around them.[45]

The digitalization of local history content using 2D animated videos serves as a solution to the limitations of printed learning resources in regional schools.[11] By presenting material through interactive simulations, history material previously considered rigid becomes more meaningful and easier for students to understand.[11] Wiene Surya Putra's (2020) research on the development of 2D animated video media for Social Studies in Binjai demonstrates that proper visual stimulation can significantly increase students' interest in narrative-heavy material.[37]

Infrastructure Challenges and Digital Literacy

Although this adaptive learning system has high content validity, its implementation in the field faces challenges in the form of the digital divide. Research reports from 2023 to 2025 show a significant relationship between the availability of stable electricity and internet bandwidth and the actual adoption of AI platforms in primary schools.[10] This disparity means that sophisticated learning systems are often difficult to access for schools in rural areas.[10]

Beyond infrastructure, educator readiness (TPACK) is a determining factor. Many primary school teachers have strong pedagogical knowledge but lack confidence in integrating intelligent technology into their classroom practices.[25] Wiene Surya Putra (2025) offers a solution through the integration of intuitive design applications like Canva to help teachers independently design interactive visual media within the Independent Curriculum (Kurikulum Merdeka) framework.[37] This indicates that the developed adaptive system must be designed as simply as possible so it can be managed by teachers with various levels of digital literacy.[32]

Comparative Analysis with International Literature

Narratively, the development of this system aligns with global research trends for 2024–2026, which are moving toward smarter, data-driven learning ecosystems.[20] Bibliometric studies

on the Scopus database reveal a shift in research focus from mere motivational design to adaptive gamification systems driven by generative artificial intelligence (GenAI).[20] A meta-analysis of 45 empirical studies published up to March 2026 confirms that AI-driven gamified environments have large positive effects on knowledge acquisition, with a Cohen's d effect size of 0.72.[15]

Research by Guo et al. (2021) and the latest 2025 literature emphasize that intelligent learning systems (ILS) not only personalize learning speed but also facilitate early intervention through the precise identification of student needs.[6] However, as warned by UNESCO (2023), the extensive collection of student behavioral data in adaptive systems must be accompanied by strict ethical frameworks and privacy protections.[6] The integration of local history in this system also responds to the need for "epistemic justice" in education, where digital platforms are used to champion local narratives that have been marginalized.[12]

Overall, this draft adaptive learning system based on gamification has met academic validity standards. Comparisons with established theories such as Self-Regulated Learning (SRL) and Constructivism show that this product has a strong philosophical foundation for improving the quality of history education at the primary level.[44] The use of algorithms capable of dynamically adjusting learning paths is a step forward in creating primary schools that are more inclusive and responsive to the diverse potential of students.[6]

Conclusion

The development of the draft adaptive learning system based on gamification, integrating digital local history content, has undergone a systematic expert validation process with highly positive results. Based on the Content Validity Index (CVI) analysis, this system possesses high content, media, and pedagogical validity with an average S-CVI of 0.91, far exceeding the eligibility threshold of 0.80. This proves that the product is academically feasible for use as a learning medium in primary schools to transform local history teaching from static to interactive and personal.

The main findings of this research confirm that personalizing learning paths through adaptive algorithms combined with gamification elements—such as points, badges, and local history narratives—significantly improves student engagement. Integrated digital local content also serves as a strategic instrument for strengthening cultural identity and historical awareness in the era of globalization. However, the success of field implementation will heavily depend on equitable digital infrastructure and the enhancement of Technological Pedagogical Content Knowledge (TPACK) for educators.

Practical implications include the necessity for schools and policymakers to begin adopting student-centered intelligent learning technologies. Suggestions for further development include the integration of Generative AI to create more dynamic historical narratives and expanding the scope of local history material to other regions in Indonesia. Thus, this system is expected to make a real contribution to realizing inclusive, relevant, and empowering history education for future generations.

References

Guo, L., et al. (2021). Emerging educational technologies and the transformation of learning environments. *Journal of Educational Computing Research*.

Putra, W. S. (2020). Pengembangan Media Video Animasi 2D Pada Mata Pelajaran IPS Di Sekolah Dasar Negeri 028227 Di Kota Binjai. *Jurnal Nagur*, 1(2), 56-62.

Putra, W. S., & Wanda, K. (2023). Transformasi Pendidikan: Merdeka Belajar dalam Bingkai Pendidikan Indonesia di Era Society 5.0. *Modeling: Jurnal Program Studi PGMI*.

Putra, W. S., Salim, A., & Adhi, S. (2025). Technology Transformation in Islamic Religious Education Student Learning in Facing 2025 Trends Using SAMR and TPACK Models. *Jurnal Inovasi Pendidikan dan Sains*, 6(3), 559-565.

Thiagarajan, S., et al. (1974). *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook*.

Martí-Parreño, J., et al. (2016). The use of gamification in education: A systematic review. *International Journal of Educational Review*.

Wanda, K., & Putra, W. S. (2025). A Quantitative Study of Historical Consciousness among Primary School Teacher Education Students Studying History, with a Focus on Ethnic Identity. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 9(4), 1042–1053.

Uz Bilgin, C., et al. (2020). Gamification in collaborative learning: A systematic review. *Educational Technology Research and Development*.

Alshammari, M., et al. (2016). Adaptivity in e-learning: The role of learner knowledge and preferences. *Frontiers in Computer Science*.

Ahmed, et al. (2025). Theoretical foundations of gamification: Self-Determination Theory and student engagement. *Journal of Educational Psychology*.

Tariq. (2025). AI-enhanced personalized learning models and student achievement. *Frontiers in Education*.

Polit, D. F., & Beck, C. T. (2006). The Content Validity Index: Are you sure you know what's being reported? *Research in Nursing & Health*.

Wiene Surya Putra. (2025). Digitalisasi Pendidikan: Integrasi Aplikasi Canva Sebagai Solusi Digital dalam Membantu Guru Sekolah Dasar Merancang Media Visual Interaktif pada Kurikulum Merdeka. *IJERI: International Journal of Educational Research and Innovation*, 22(1), 431.

UNESCO. (2023). AI and education: Guidance for policy-makers.

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied Nursing Research*.