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Effect of AI-Enhanced Learning on Students' History Achievement and Engagement

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ABSTRACT

Learning history helps students understand cultural and social developments, giving them a better view of the world. However, traditional teaching methods often do not engage students enough because they lack interactivity and real-world context. To solve this problem, this study introduces the Artifial Intelligence (AI)-Enhanced History Learning App, which uses interactive maps and a History Agent to make history learning more personal and engaging. This research aims to show how technology can make history lessons more interesting and help students connect better with historical topics. The study involved 67 high school students, divided into two groups. The experimental group (EG) used the app with the History Agent, while the control group (CG) used the app without it. Both groups learned about Yogyakarta's cultural heritage, including pre-historic, Hindu-Buddhist, Islamic, and colonial periods. Over eight weeks, students participated in classroom and outdoor activities supported by their teacher. The results showed that the EG had better learning outcomes, including improved understanding, thinking skills, and engagement. A closer look revealed that using interactive features like the History Agent was linked to better learning progress. Students also said the app was easy to use and made history more interesting. These findings suggest that AI tools can improve history lessons by making them more interactive and tailored to students' needs. This study offers practical ideas for teachers and proves how AI can help make history education more engaging and effective for students.

Keywords:
Artificial Intelligence in Education; Interactive Learning Environment; Educational Technology; History Education; Personalized Learning Systems

1. Introduction

Learning history is important for understanding past events and appreciating the cultural and social developments that shape our world today and in the future [1, 2]. History includes key events, important people, and places that have influenced human civilization [3]. Studying history helps people understand their heritage and traditions, giving them a stronger sense of identity and belonging [4]. It also develops critical thinking by encouraging students to analyze cause-and-effect

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relationships, consider different viewpoints, and engage with historical stories [6–8]. Through this process, students gain empathy and understanding of the lives and decisions of people from different times and cultures [9].

The connection between learning history and cultural heritage is very important. By interacting with artifacts, historical sites, and traditions, students can see history in a real and relatable way [10–12]. This approach turns abstract ideas into clear and meaningful experiences, helping students understand and remember history better [13–16]. Immersive learning environments that include historical elements make the learning process more engaging and emotional, helping students connect to the past in deeper ways [17–19]. However, many educational tools still treat heritage as a static subject instead of making it interactive, missing the chance to improve history education further [20–25].

This study focuses on addressing this issue by introducing the AI-Enhanced History Learning App. The app combines historical content with interactive features like a "History Agent" to give students personalized support during both classroom and outdoor activities. The app covers topics such as Yogyakarta's cultural heritage during the pre-historic, Hindu-Buddhist, Islamic, and colonial periods. This research examines the app's effectiveness in improving learning, increasing engagement, and helping students connect more deeply with history. The study aims to develop a better tools that use AI and heritage to meet the needs of students with different learning styles.

1.1 Historical Learning and Technology Integration

The integration of technology in history education has significantly transformed how students engage with and understand historical content [6]. Over the past few decades, educational technologies have evolved from simple multimedia presentations to sophisticated interactive tools that involve virtual reality, digital archives, and interactive timelines [18]. These technological tools aim to make history more accessible and engaging by presenting complex historical events in a more tangible and relatable manner [6]. Studies have shown that when students interact with history through technology, they often develop a deeper understanding of the subject matter [40]. For instance, digital timelines allow students to visualize time periods and significant events clearly, enhancing their ability to connect various historical episodes and understand their interdependencies [6].

Moreover, the use of technology in teaching history goes beyond just providing information; it also supports critical thinking and analysis [39]. Interactive tools such as virtual tours of historical sites and online databases of historical documents enable students to explore history independently, promoting a more active learning experience [3]. This method encourages students to question, critique, and analyze historical data, fostering critical thinking skills essential in academic and everyday life [25]. For example, virtual reality simulations of historical events can immerse students in past scenarios, allowing them to experience the social and cultural contexts of the times, which deepens their understanding and empathy towards people from those periods [15].

The effectiveness of integrating technology in history education has been supported by numerous studies indicating improvements in student engagement and academic performance [23]. For instance, when students use interactive maps to study geographical changes over time, they tend to retain information longer and develop a better understanding of the causes and consequences of these changes [2]. Educational technologies not only provide visual and interactive aids but also allow for the personalization of learning experiences. Students can learn at their own pace, revisit complex topics, and engage with historical content in ways that suit their learning styles, which is particularly beneficial in diverse educational settings [5].

These advancements underscore the potential of technology to enhance historical learning by making it more interactive, engaging, and adaptable to various learning needs [7]. As educational technologies continue to evolve, they offer promising avenues for further enriching history education, making it a dynamic and continuously developing field [4].

1.2 Artificial Intelligence in Educational Contexts

Artificial Intelligence (AI) has begun to play a transformative role in educational settings, reshaping how subjects are taught and learned across various disciplines [31]. In the context of education, AI tools have been instrumental in creating personalized learning environments, enhancing student interaction with content, and providing real-time feedback [34]. This adaptation of AI in education allows for a tailored approach where students' strengths and weaknesses are continuously assessed, enabling adaptive learning platforms to adjust the complexity of tasks accordingly [33]. This dynamic method not only supports individual learning paces but also addresses diverse educational needs effectively, making education more inclusive and accessible [31].

AI's capabilities extend to facilitating a deeper engagement with educational content [32]. Through the use of intelligent tutoring systems and virtual agents, students receive guidance that is responsive to their interactions [36]. These systems can simulate one-on-one tutoring experiences, which are often not feasible in traditional classroom settings due to resource constraints [40]. Furthermore, AI can automate routine tasks such as grading and providing feedback on assignments, freeing up educators to focus more on teaching and less on administrative duties [38]. Such applications of AI not only enhance learning efficiency but also improve the educational experience by allowing teachers to dedicate more time to address individual student needs and foster a more engaging learning environment [32].

Moreover, AI technologies are particularly effective in making learning interactive and immersive [33]. For example, AI-driven simulations and games can create realistic scenarios that allow students to explore complex topics in a hands-on way [39]. This approach is especially beneficial in history education, where understanding the nuances of historical events can be enhanced through detailed simulations that place students in the midst of historical settings, offering them a vivid understanding of the past [33]. Studies have shown that when students interact with history through AI-enhanced simulations, their historical thinking skills and their ability to empathize with historical figures significantly improve [30]. These tools not only make learning more enjoyable but also more impactful, fostering a deeper appreciation and understanding of the subject matter [33].

As AI continues to evolve, its potential to revolutionize education grows, promising to bring about significant improvements in how knowledge is delivered and absorbed. The ongoing development of AI tools in education suggests a future where learning is not only more customized and interactive but also more effective in equipping students with the skills needed in a rapidly changing world [9].

1.3 The Role of Cultural and Historical Heritage in Education

The role of cultural and historical heritage in education is pivotal for fostering a deep understanding and appreciation of history among students [13]. Engaging with cultural artifacts, historical documents, and heritage sites has been shown to significantly enhance students' historical knowledge and cultural sensitivity [36]. This approach helps students connect with the past in a meaningful way, making historical events and figures more relatable and vivid [29]. Educational strategies that incorporate cultural and historical heritage often lead to enriched learning experiences, as they allow students to explore the textures of history beyond conventional textbooks

[10]. Such immersive learning can transform students' perceptions of history from a collection of dates and facts into a dynamic narrative filled with intriguing stories and insights [10].

Incorporating cultural and historical heritage into education also promotes critical thinking and analytical skills [9]. When students are encouraged to analyze artifacts, interpret historical evidence, and consider the significance of heritage sites, they develop a set of skills that are applicable beyond the history classroom [9]. This method of teaching encourages learners to question and critique sources, understand various perspectives, and develop reasoned arguments about historical interpretations [31]. Moreover, the integration of local and global historical heritage introduces students to a diversity of cultural experiences, fostering a global mindset and an appreciation for cultural diversity [9]. This exposure is crucial in today's interconnected world, where understanding and respecting cultural differences are key to global citizenship [9].

Furthermore, the use of cultural and historical heritage in education has been increasingly supported by digital technologies, which enhance access to and engagement with historical content [14]. Digital archives, virtual tours of museums and heritage sites, and interactive maps are tools that have revolutionized the way educators teach and students learn history [14]. These technologies make it possible for students to explore historical contexts in ways that were previously unimaginable, such as navigating through a 360-degree view of a historical battlefield or examining high-resolution images of ancient manuscripts [14]. By combining traditional approaches with modern technology, educators can provide a more holistic and engaging educational experience that helps students develop a deeper, more comprehensive understanding of history [14].

Overall, the integration of cultural and historical heritage into education not only enhances historical understanding but also enriches students' educational experience by making learning more interactive, engaging, and meaningful. As educational methods continue to evolve, the importance of heritage in teaching and learning history remains a key component in helping students appreciate the complexities and interconnectedness of past and present societies.

2. Methodology

2.1 AI-Enhanced History Learning App

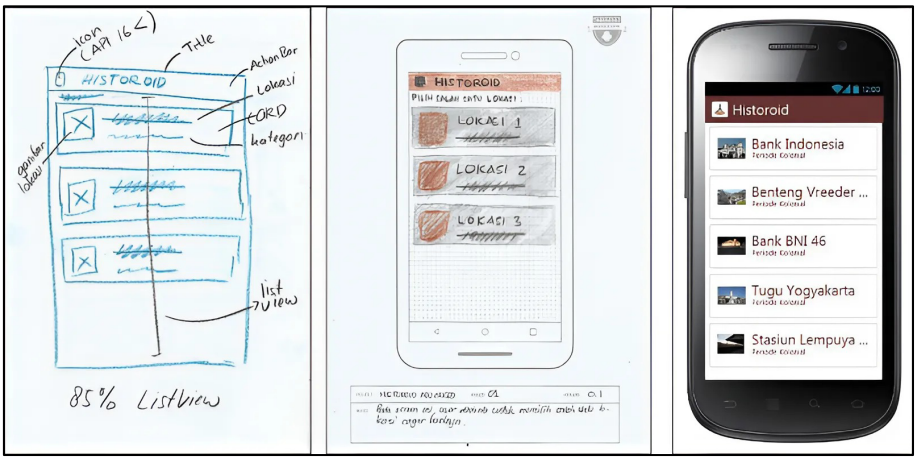

Fig. 1. Early Stage of AI-Enhanced History Learning App Development [32]

The development of the AI-Enhanced History Learning system has been a transformative process from its early stages to its current form as a sophisticated educational tool. Initially, the system was designed using a method known as design thinking, which focused on understanding the specific needs of high school students studying history (Figure 1). This approach was detailed in a study

conducted by Luthfi and Wardani [32]. They started by identifying the challenges students face in learning history, then moved through stages of developing ideas and creating prototypes

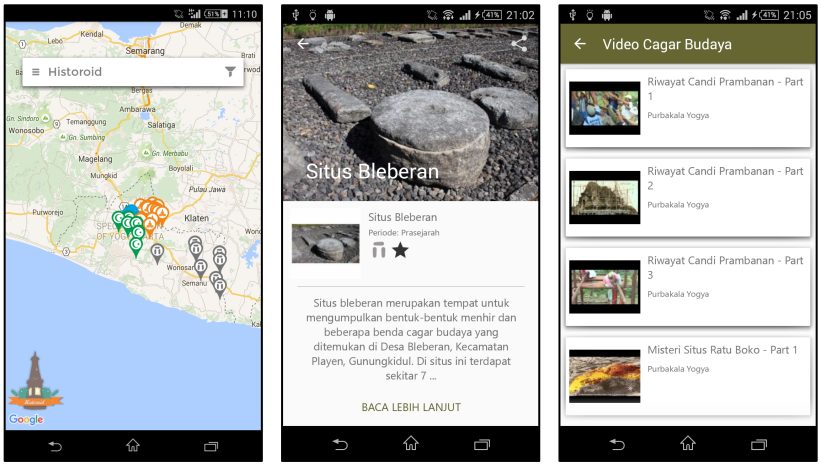

Fig. 2. First Released of AI-Enhanced History Learning App in Android Platform [33]

Following this, an Android-based application was developed to make learning about cultural heritage interactive and engaging (Figure 2). This application provided information about cultural heritage sites in Yogyakarta through an interactive map, combining geographical data with multimedia content to enhance the learning experience. This version of the system, as mentioned by Luthfi *et al.,* [33], aimed to bridge the gap between traditional learning methods and interactive, real-world exploration.

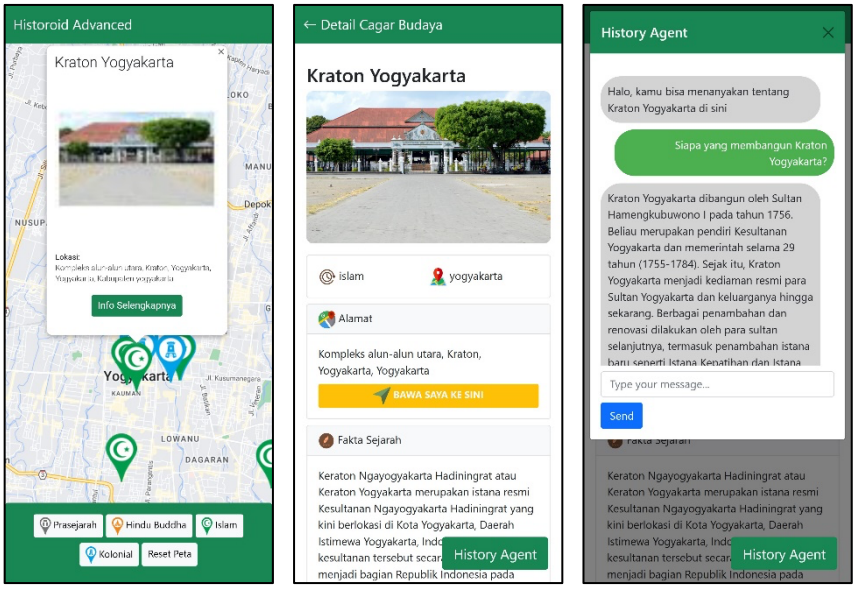

Fig. 3. Latest version of AI-Enhanced History Learning app with History Agent

Building on these earlier versions, the system evolved into a web-based platform with significant enhancements. One of the key features introduced in this version is the History Agent (Figure 3), a chatbot powered by artificial intelligence from the OpenAI platform. This feature allows for personalized interactions, enabling students to ask detailed questions and receive information tailored to their interests as they explore various historical topics and sites. The integration of AI makes the learning experience more engaging and adaptable to individual student needs, making history education more effective and enjoyable.

This progression from a basic instructional tool to an advanced, AI-driven learning platform shows how technology can significantly enhance educational experiences. It highlights the continuous need for innovation in educational technology to meet the changing needs of learners and educators in a digital era. The AI-Enhanced History Learning system not only makes learning history interactive but also deepens students' understanding by connecting them with their cultural and historical heritage in meaningful ways.

2.2 Research Design

The research design of this study was carefully planned to examine how an AI-Enhanced History Learning App influences high school students' understanding of cultural and historical heritage. The study involved 67 second-grade students from the science department of a public high school in Yogyakarta. The students were divided into two groups: EG, which used the AI app, and CG, which studied using the app without AI support. The study lasted for eight weeks, with each week focused on specific activities to support learning and collect data.

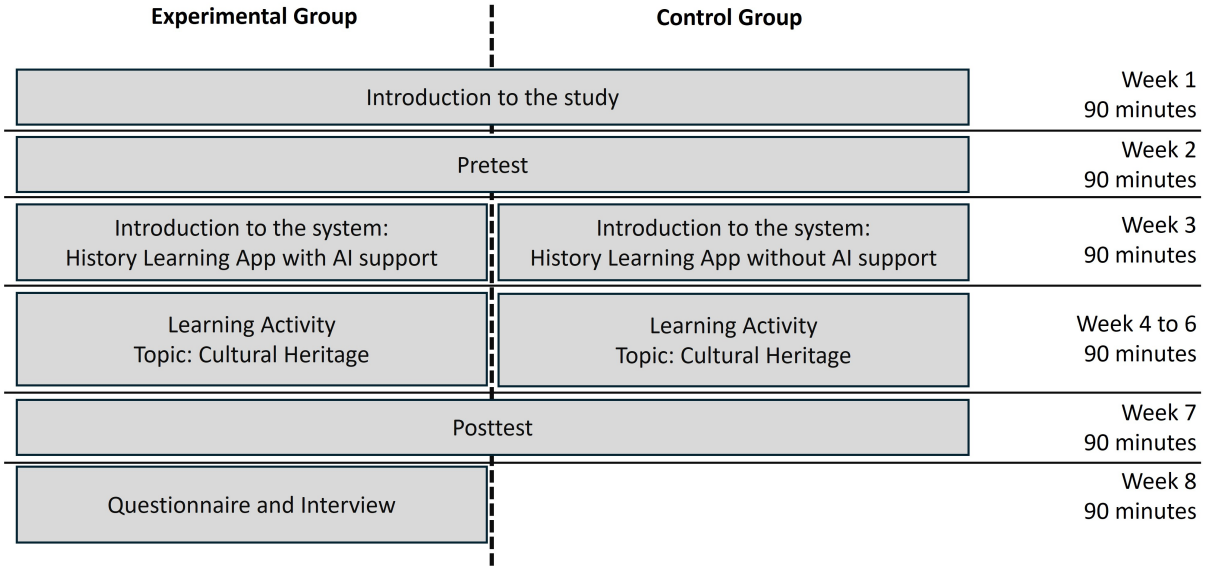

Fig. 4. Research Design of AI-Enhanced Learning on Students' History Achievement and Engagement

As presented in Figure 4, in the first week, a 90-minute introduction was given to all students. This session explained the purpose of the study, the activities, and what was expected of them. In the second week, a pre-test lasting 90 minutes was conducted to measure the student's knowledge of history and culture before the study started. The test included 40 multiple-choice questions created based on the history curriculum.

During the third week, students learned how to use the tools they would work with. The EG used the AI app, which included interactive maps, a History Agent chatbot, and multimedia materials. The CG used the app without AI support to study the same topics with guidance from their teacher. Both groups had 90-minute sessions to ensure equal learning time.

The fourth to sixth weeks were the main study period. Both groups attended three 90-minute sessions per week and used the system to support their learning. For the EG, the system was enhanced with the History Agent feature, which provided personalized guidance and support throughout the activities. The system accompanied students during both in-classroom and out-of-classroom activities, facilitating their learning about cultural heritage topics. These topics included the pre-historic period, Hinduism and Buddhism, the Islamic era, and the colonial period in

Yogyakarta. With teacher support, the CG utilized the system without the History Agent to engage with the same content.

In the seventh week, students completed a post-test, also 90 minutes, which was similar to the pre-test. This allowed the researchers to compare the progress of the two groups. The eighth week was used to collect feedback. Students in the EG completed a questionnaire about their experience using the app, including its ease of use, usefulness, and engagement. Some students from both groups participated in interviews to share their thoughts on the learning process.

This step-by-step process allowed the researchers to compare the learning outcomes of the two groups and understand how effective and engaging the AI-enhanced app was. By combining test results and student feedback, the study showed how technology can improve history education and help develop better learning tools.

2.3 Data Collection and Analysis

This study's data collection and analysis methods were carefully planned to understand how an AI-enhanced learning tool affects students' achievements, behaviors, and perceptions in history education (Table 1). This section explains how data was collected and analyzed in three main areas: students' learning achievements, learning behaviors, and their opinions about the AI-enhanced learning app.

Data about students' learning achievements was collected through a controlled study with two groups: EG and CG (Table 2). Both groups included students from the same school's history class. The EG used the AI-enhanced history learning app, while the CG used history learning app without AI support. Before the study began, both groups took a pre-test to measure their initial knowledge of history. At the end of the study, they took a post-test to measure what they had learned. Each test included 40 questions, such as multiple-choice and short-answer questions, to check six areas of historical learning: Historical Accuracy, Cultural Element Identification, Heritage Terminology Understanding, Preservation Awareness, Cultural Distinction Knowledge, and Historical Impact Recognition. These tests were created with the help of history teachers and tested on other students to ensure they were reliable (Cronbach's alpha = 0.85). The differences between the pre-test and post-test scores showed how much each group improved, and the data was analyzed using statistical tests to check for meaningful differences.

Table 1.
Research Variables and Description

Category	Variable Name	Description
Learning Achievement	Historical Accuracy	Checks how well students can remember and recognize important historical details like dates and events.
	Cultural Element Identification	Looks at how well students can recognize and understand symbols and elements from different cultures.
	Heritage Terminology Understanding	Measures how well students understand special terms related to heritage and history.
	Preservation Awareness	Tests students' knowledge about how to protect and preserve historical sites and information.
	Cultural Distinction Knowledge	Assesses if students can tell the differences between cultural practices or sites from various cultures.
	Historical Impact Recognition	Evaluates how well students can identify the effects of historical events on places and cultures.
Learning Behaviors	Historoid Advanced Usage Time	Notes how many minutes students use the Historoid Advanced feature.

	Total Interaction with Heritage Map	Counts how many times students interact with the heritage map in the app.
	Total Interaction with Heritage Information	Counts how many times students interact with heritage information in the app.
	Total Explored Location	Notes how many different locations students visit within the app.
	Total Unique Explored	Counts how many unique places students visit in the app.
	Total Asking Questions to the History Agent	Measures how often students ask questions to the history agent in the app.
	Total Interaction with History Agent	Tracks how many times students interact with the history agent in the app.
Learning Performance	Learning Gain	Measures how much students' understanding has improved from the start to the end of the study.

To analyze students' learning behaviors and performance, data was collected on how the EG used the AI-enhanced app (Table 3). This included information like how much time they spent using the app, how often they interacted with features like the heritage map, and how many questions they asked the History Agent. The app tracked these details automatically. Researchers used a statistical method called correlation analysis to find relationships between how students used the app and their performance on the post-test. This analysis showed which app features were the most helpful for improving students' learning.

Table 2
Research Tools and Description

Tool Name	Description
Pre-test	A test given before the learning starts to check what students already know.
AI-Enhanced History Learning App	A special app used by the EG to learn history in a new way.
Post-test	A test given after the learning to check what students have learned.
Questionnaire	A list of questions to find out what students think about the app and their learning experience.
Interview Questions	Questions asked in a discussion to get more detailed feedback from students.

To understand students' opinions of the AI-enhanced app, a questionnaire was given to all students in the EG. The questionnaire asked about four things: how easy the app was to use, how useful it was for learning, how students felt about using the app, and whether they wanted to use it again in the future. Students rated their answers on a scale from "strongly disagree" to "strongly agree." The researchers calculated averages and standard deviations to summarize the results. To add more depth to the findings, the researchers interviewed 10 students from the EG—five who performed well and five who performed less well. The semi-structured interviews focused on students' experiences with the app, including what they found helpful, any problems they faced, and how the app supported their learning. The interviews helped explain the results from the quantitative data, such as why students improved in certain areas like Historical Impact Recognition.

Table 3
Analytical Tools and Description

Tool Name	Description
Independent Sample T-Test	A statistical test used to compare two groups and see if there is a big difference between them.
Descriptive Analysis	A way to summarize the survey and test data to see what it tells us.
Pearson Correlation	A method to see if two things are related and how strongly they are connected.
Reliability Analysis	Checks if the questionnaire gives consistent results when used more than once.

3. Result

3.1 Analysis of Students' Learning Achievement

The analysis of pre-test and post-test results presented in Table 4 provides important insights into the effectiveness of the educational strategies for an EG compared to a CG across various aspects of heritage learning. These aspects include Historical Accuracy, Cultural Element Identification, Heritage Terminology Understanding, Preservation Awareness, Cultural Distinction Knowledge, Historical Impact Recognition, and overall scores.

Table 4
Comparative Pre-test and Post-test Results for Heritage Learning Parameters in EG and CG

Groups	Aspect	N	Pre-test				Post-test			
			Mean	SD	t-value	p	Mean	SD	t-value	p
EG	Historical Accuracy	35	2.29	1.725	-1.817	0.074	4.83	0.822	5.776	0.000
	Cultural Element Identification		2.23	1.61	-1.438	0.155	4.06	0.802	3.67	0.001
	Heritage Terminology Understanding		2.49	1.634	1.6	0.114	4.63	0.49	6.12	0.000
	Preservation Awareness		2.46	1.804	-0.471	0.639	4.00	0.84	5.569	0.000
	Cultural Distinction Knowledge		2.66	1.608	0.869	0.388	3.94	0.802	3.534	0.001
	Historical Impact Recognition		2.06	1.474	0.251	0.803	3.6	0.497	6.067	0.000
CG	Historical Accuracy	32	3.16	2.187	-1.798	0.077	2.78	1.845	5.955	0.000
	Cultural Element Identification		2.81	1.712	-1.434	0.156	2.84	1.706	3.778	0.000
	Heritage Terminology Understanding		1.84	1.648	1.599	0.115	2.63	1.792	6.365	0.000
	Preservation Awareness		2.66	1.638	-0.473	0.638	2.28	1.55	5.709	0.000
	Cultural Distinction Knowledge		2.31	1.635	0.869	0.388	2.66	1.911	3.649	0.001
	Historical Impact Recognition		1.97	1.402	0.251	0.802	2.00	1.414	6.286	0.000

Initially, the EG scored lower in Historical Understanding, Cultural Element Identification, and Preservation Awareness, with scores of 2.29, 2.23, and 2.46, respectively, compared to the CG's scores of 3.16, 2.81, and 2.66. However, they scored higher in Heritage Terminology Understanding and Cultural Distinction Knowledge, with scores of 2.49 and 2.66 compared to the CG's scores of 1.84 and 2.31. The scores for Historical Impact Recognition were almost the same between the groups.

The post-test results showed significant improvements in the EG across all aspects. Their Historical Understanding scores increased dramatically to 4.83 from 2.29, with a statistically significant t-value of 5.776 and a p-value below 0.001. Similarly, Heritage Terminology Understanding scores increased to 4.63, supported by a t-value of 6.120 and the same p-value. Preservation Awareness and Cultural Distinction Knowledge scores also saw notable increases to 4.00 and 3.94, up from 2.46 and 2.66, with statistically significant changes indicated by Preservation Awareness's t-value of 5.569 and Cultural Distinction Knowledge's t-value of 3.534, both with p-values below 0.001.

The most impressive improvement was in Historical Impact Recognition, where scores rose to 3.60 from 2.06, highlighted by a t-value of 6.067 and a p-value below 0.001. This demonstrates a strong impact of the educational strategies on students' learning. The EG's total score in the post-test was 25.06, a significant rise from 14.17, marked by the highest statistical change with a t-value of 12.248 and a p-value below 0.001. On the other hand, the CG showed only small improvements;

their Historical Understanding increased slightly to 2.78 from 3.16, and their total score went up marginally to 15.19 from 14.75, showing smaller educational gains.

These findings align with previous studies that highlight the effectiveness of interactive and AI-enhanced learning tools in improving student engagement and knowledge acquisition [43–44]. For instance, YADIMS Enhanced Portal demonstrated how AI tools could personalize learning experiences to yield better academic outcomes [43]. Similarly, research on Fun Al-Quran digital applications showed how interactive tools effectively improve engagement and learning [45]. Furthermore, studies such as Hwang *et al.,* [49] emphasize the role of AI-driven educational tools in enhancing learning outcomes by integrating technology into contextually rich and interactive learning environments.

Moreover, as presented in Table 5, the learning gain analysis for the EG reveals varying degrees of improvement across different heritage learning aspects, measured by comparing pre-test and post-test scores. Historical Accuracy (Historical Understanding) showed an average improvement of 2.54 points, with individual changes ranging from a decrease of 2 points to an increase of 6 points, indicating significant gains in recalling historical facts for some, while others saw declines. Cultural Element Identification experienced an average gain of 1.83 points, with adjustments between a 1-point decrease and a 5-point increase, reflecting general improvements in recognizing cultural symbols. Heritage Terminology Understanding observed an average increase of 2.14 points, with all students showing improvement up to 5 points, suggesting effective educational strategies in enhancing terminology usage. Preservation Awareness and Cultural Distinction Knowledge noted average gains of 1.54 and 1.29 points, respectively, with changes spanning from a 2-point decrease to a 5-point increase, highlighting varied student responses to the learning materials in understanding preservation and cultural distinctions. Historical Impact Recognition also averaged a 1.54-point increase, with gains ranging up to 4 points, though some scores decreased by 1 point, indicating diverse levels of development in analyzing historical impacts.

Table 5
Summary of Average, Minimum, and Maximum Learning Gains for Each Heritage Learning Aspect in the EG

Aspect	Average Learning Gain	Min Learning Gain	Max Learning Gain
Historical Accuracy Gain	2.542857	-2	6
Cultural Element Identification Gain	1.828571	-1	5
Heritage Terminology Understanding Gain	2.142857	0	5
Preservation Awareness Gain	1.542857	-2	5
Cultural Distinction Knowledge Gain	1.285714	-2	5
Historical Impact Recognition	1.542857	-1	4

These results clearly demonstrate that the educational methods used with the EG were highly effective. They significantly improved students' knowledge, understanding, and analytical skills in the context of heritage history learning. Studies on e-learning and AI-based educational interventions further validate these findings, emphasizing the potential of integrating AI and interactive tools into educational practices to improve student learning outcomes [46–47]. Additionally, Hwang *et al.,* [49] highlighted how apps designed for authentic contextual learning positively influence student engagement and comprehension, particularly in areas requiring nuanced understanding like historical heritage. The findings support the effectiveness of these strategies and highlight the need

for further research into what made them successful, potentially guiding future educational practices and curriculum development.

3.2 Analysis of Students' Learning Behavior and Learning Performance

The analysis of students' learning behavior and learning performance reveals significant correlations between various educational interactions and the outcomes measured in terms of test scores and overall learning improvements. The Pearson correlation data presented in Table 6 specifically highlighted several key relationships that suggest how different behaviors and interactions during the learning process affect student performance. One of the most notable findings is the strong correlation between the overall post-test scores and student learning achievement improvement, which is marked with a correlation coefficient ($r = 0.514$) and is significant at the 0.01 level ($p < 0.01$). This strong correlation indicates that students who perform well on the post-test generally show substantial improvements in learning achievement. This finding is consistent with prior studies that emphasize the role of well-structured assessments in reflecting students' overall learning progress [44–45]. Additionally, research by Hwang, *et al.,* [49] supports the importance of integrating technology in educational assessments to capture learning improvements effectively.

Table 6
Summary of Significant Correlations Between Learning Behaviors, Learning Performance and Student Learning Achievement

Variables	Correlation Coefficient (r)	Significance Level
Post Test Score & Student Learning Achievement Improvement	0.514**	$p < 0.01$
Historoid Advanced Usage Time & Post Test Historical Impact Recognition	0.486**	$p < 0.01$
Total Interaction with Heritage Map & Student Learning Achievement Improvement	0.344*	$p < 0.05$
Total Unique Explored Location & Total Explored Location	0.661**	$p < 0.01$

Another significant relationship was observed between the usage time of the Historoid Advanced tool and the scores in Post-Test Historical Impact Recognition ($r = 0.486$, $p < 0.01$). Students who spent more time with the Historoid Advanced tool tended to score higher in recognizing historical impacts, suggesting that the tool is effective in enhancing students' understanding of history's complexities. The engaging nature of the Historoid Advanced, possibly featuring interactive timelines or detailed historical narratives, likely helps students form better connections with the material, thereby improving their ability to analyze and interpret historical events. Previous research also highlights the role of interactive digital tools, like Fun Al-Quran applications, in fostering deeper engagement and learning outcomes through targeted content delivery [42]. Moreover, Liu *et al.,* [48] demonstrated how heuristic evaluation of educational apps can enhance learner engagement, supporting the role of interactivity in improving comprehension and analytical skills. Conversely, aspects like Total Interaction with Heritage Information showed no significant correlation with post-test scores ($r = 0.001$, $p > 0.05$), indicating that simply interacting with heritage information without structured guidance or specific learning objectives might not be sufficient to enhance test performance.

Moreover, the analysis highlighted a significant correlation between the Total Interaction with the Heritage Map and the improvement in student learning achievement ($r = 0.344$, $p < 0.05$). This finding suggests that interactive maps, which often provide spatial and contextual data about

historical sites, enhance students' ability to connect theoretical knowledge with real-world applications, thereby aiding in deeper understanding and retention of information. Tools like these have been shown to be instrumental in helping students visualize complex concepts and relate them to practical contexts [44, 47]. Studies such as Hwang *et al.,* [42] further demonstrate the positive impact of mobile apps in contextual learning, highlighting how spatially aware tools can improve engagement and understanding. This tool seems particularly useful in helping students visualize and contextualize historical events, which can be critical in subjects like history where geographical and spatial awareness is essential. On the other hand, the Total Unique Explored Location showed a very strong correlation with the Total Explored Location ($r = 0.661$, $p < 0.01$), underscoring the idea that exploration diversity enhances the learning experience. Students who explore a variety of unique locations are likely engaging more deeply with the content, demonstrating a proactive learning behavior that positively correlates with higher achievement in other measured aspects.

These results collectively illustrate how different aspects of educational technology and student interaction with learning materials correlate with their performance and understanding. The significant correlations underscore the value of interactive and engaging educational tools in enhancing historical understanding and overall learning achievement. Previous research has demonstrated the positive impact of integrating AI and digital tools into education, highlighting their potential to provide targeted and interactive learning experiences [43, 46]. For example, Liu *et al.,* [48] explored how AI-enhanced video drama-making systems support learners by increasing their engagement and understanding in complex contexts. Meanwhile, the lack of significant correlation in certain areas highlights the importance of purposeful interaction with educational content, suggesting that not all forms of engagement are equally beneficial. The insights gained from these correlations provide valuable guidance for educators in designing more effective learning environments and interventions, aiming to maximize educational outcomes through targeted, interactive, and contextually rich educational experiences.

3.3 Analysis of Students' Perception Toward AI-Enhanced History Learning App

The analysis of students' perceptions toward the AI-Enhanced History Learning App, derived from the descriptive statistics of the survey data presented in Table 7, reveals significant insights into their experience and expectations from the technology. Focusing on four main dimensions—Perceived Ease of Use, Perceived Usefulness, Attitude Toward Using Technology, and Behavioral Intention to Use the Technology—the data points to a moderate acceptance and appreciation of the system among the students. In the Perceived Ease of Use category, the average scores ranged from 2.80 to 3.17, suggesting that while students find the system relatively straightforward to use, there remains room for improving its user-friendliness. Specifically, the lowest average score was for the item "Interacting with this system is uncomplicated" (Mean = 2.80, Standard Deviation = 1.471), indicating some complexities in user-system interactions that could be streamlined. The higher score in "Using this system is easy for me" (Mean = 3.17, Standard Deviation = 1.403) implies that once familiar with the system, students feel more confident in their ability to use it effectively.

Table 7
Descriptive Statistics for Student Perceptions of the AI-Enhanced History Learning App Across Various Dimensions

Dimension & Item	Mean	SD
Perceived Ease of Use 1 (Easy for me)	3.17	1.403
Perceived Ease of Use 2 (Simple operation)	2.89	1.388
Perceived Ease of Use 3 (Skillful use)	2.91	1.442
Perceived Ease of Use 4 (Uncomplicated interaction)	2.80	1.471

Perceived Ease of Use 5 (Little effort)	3.06	1.434
Perceived Usefulness 1 (Improves knowledge)	3.23	1.437
Perceived Usefulness 2 (Enhances knowledge)	2.74	1.462
Perceived Usefulness 3 (Efficient learning)	2.83	1.524
Perceived Usefulness 4 (Helps achieve goals)	2.83	1.424
Perceived Usefulness 5 (Valuable)	2.60	1.311
Attitude Toward Using Tech 1 (Positive attitude)	2.94	1.392
Attitude Toward Using Tech 2 (Favorable benefits)	3.20	1.368
Attitude Toward Using Tech 3 (Good idea)	2.66	1.552
Attitude Toward Using Tech 4 (Positive feeling)	2.97	1.505
Attitude Toward Using Tech 5 (Enthusiastic)	2.83	1.339
Behavioral Intention 1 (Frequent use)	3.14	1.332
Behavioral Intention 2 (Recommended to others)	2.94	1.454
Behavioral Intention 3 (Sought help/training)	2.97	1.382
Behavioral Intention 4 (Explored advanced features)	2.49	1.314
Behavioral Intention 5 (Customizations)	3.06	1.282

In terms of Perceived Usefulness, the scores suggest that students are somewhat skeptical about the direct benefits of the system on their learning outcomes. The scores in this dimension ranged from 2.60 to 3.23, with the lowest being for the belief that the system is valuable in their history learning (Mean = 2.60, Standard Deviation = 1.311). This could be attributed to a lack of clear linkage or immediate recognition of how the system enhances their knowledge acquisition or aids in achieving their educational goals. However, the highest score in this dimension was for the item indicating that the system improves their history knowledge (Mean = 3.23, Standard Deviation = 1.437), suggesting that when the application's utility is directly experienced or observed, students recognize and value the technology's contribution to their learning process. These findings align with previous studies on the role of interactive digital tools in enhancing learning outcomes by making educational content more accessible and engaging [45, 44]. Liu *et al.,* [48] further emphasized how usability improvements and interactive features in educational applications contribute to better learning experiences.

The Attitude Toward Using Technology dimension and the Behavioral Intention to Use the Technology dimension reveal a cautious yet growing interest and willingness to engage with the system. Average scores in these dimensions indicate that while students are generally positive about using the technology, they are not overwhelmingly enthusiastic. The scores for "I have a positive attitude toward using this system" (Mean = 2.94, Standard Deviation = 1.392) and "I feel favorable about the benefits this system offers" (Mean = 3.20, Standard Deviation = 1.368) are moderate, suggesting that students appreciate the system but may not fully embrace all its features or potential benefits yet. In behavioral intentions, the varied responses, particularly in "I use this system frequently in my history learning" (Mean = 3.14, Standard Deviation = 1.332) and "I have explored advanced features or functionalities of this system beyond basic use" (Mean = 2.49, Standard Deviation = 1.314), highlight a divide between routine usage and deeper, more explorative engagement with the technology. These results are consistent with findings from previous research that highlights the importance of ease of use and perceived usefulness in encouraging technology adoption in educational settings [43, 47]. Additionally, Hwang, *et al.,* [42] demonstrated that applications designed with authentic contexts improve students' engagement and willingness to use educational technology effectively.

To explore more deeply the varying effectiveness of the AI-Enhanced History Learning App, interviews were conducted with the students. The interviews revealed that students with high achievement found the app very helpful for enhancing their engagement and understanding of historical content. However, students with lower achievement sometimes had difficulties using the

app effectively or did not see how it helped their studies. These insights mirror findings from studies that emphasize the role of individualized and adaptive learning tools in bridging the gap between students with different levels of achievement [46, 45]. Research by Luthfi and Hwang [49] also underscores the importance of adaptive and heuristic approaches in improving inclusivity and accessibility in educational applications, especially for diverse learners.

Overall, these findings suggest that while some students find the AI-Enhanced History Learning App useful and easy to use, others do not see its benefits as clearly. This difference in perceptions might be due to how different students learn, their comfort with technology, or what they expect from digital learning tools. To improve the app's effectiveness for all users, it is important for developers to tailor the app to meet diverse needs, make it simpler to use, and clearly show how it can be beneficial in educational settings. By doing this, educators and developers can make better use of AI-enhanced learning tools to meet the needs of today's students. Research into similar AI-enhanced tools demonstrates the potential of such applications to provide more inclusive and impactful learning experiences when they are designed with user feedback and diverse needs in mind [45, 44]. Hwang *et al.,* [48] further highlight the effectiveness of integrating AI into learning systems to support both engagement and educational outcomes.

4. Conclusion

This study examined students' learning achievements, behaviors, and perceptions related to an AI-Enhanced History Learning App. The comparison between the EG and CG revealed that the EG, using the AI-enhanced app, achieved significantly higher post-test scores, demonstrating the positive impact of AI integration on learning outcomes in history education.

Significant correlations were found between students' learning behaviors and their achievements. For example, increased usage of interactive tools like the Historoid Advanced tool was strongly linked to higher scores in historical impact recognition. These findings underscore the importance of engaging educational technologies in enhancing student performance.

Student perceptions of the app were mixed. While some students found it useful and easy to use, others felt that improvements were needed. The moderate feedback on ease of use, usefulness, and overall attitude suggests that the app holds potential but requires further refinement to better meet student needs. Ensuring continuous improvement based on student feedback is crucial to maximizing the effectiveness of AI-enhanced learning tools in diverse educational settings.

5.1 Limitation

This study, while providing valuable insights into the effects of AI-enhanced learning tools on student outcomes, has several limitations that should be considered when interpreting the results. Firstly, the sample size was relatively small, comprising only students who participated in the pre-test and post-test sessions, which may limit the generalizability of the findings to a broader population. Secondly, the study was conducted within a single educational setting, which could influence the applicability of the results to other contexts or educational systems. Additionally, the reliance on self-reported data for assessing students' perceptions may introduce bias, as students could overestimate their engagement or satisfaction with the AI tools. Finally, the study focused exclusively on history learning, and the conclusions drawn may not be directly transferable to other subjects where the integration of AI might interact differently with the curriculum content or student engagement.

5.2 Future Study

Future studies could build on the findings of this research by exploring the impact of AI-enhanced learning tools across a broader range of educational settings and with larger, more diverse student populations to enhance the generalizability of the results. It would also be beneficial to conduct longitudinal studies to assess the long-term effects of these technologies on student learning outcomes. Additionally, future research could investigate the use of AI-enhanced tools in other subjects to determine if similar benefits can be observed across different academic disciplines. Including objective measures of student engagement and learning, such as analytics data from the learning platforms, could provide a more comprehensive understanding of how students interact with the technology. Lastly, comparative studies that evaluate different types of AI-enhanced learning tools could offer deeper insights into which features most effectively contribute to improving student learning and engagement.

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