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# Development of Augmented Reality-Based History Card Media to Strengthen Chronological Thinking Skills

Brilliantoro Yusuf ervanda,[1*] Rhoma Dwi Aria Yuliantri,[1] Awanis Akalili[1]

[1]Universitas Negeri Yogyakarta, Indonesia

[*]brilliantoroyusuf.2025@student.uny.ac.id

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**Abstract:** Chronological thinking skills are an important foundation in historical thinking skills because they help students understand the relationships between historical events in a coherent, logical, and meaningful manner. However, the results of a needs analysis at SMAN 2 Klaten indicate that students still experience difficulties understanding the sequence of events in the material "Efforts to Maintain Indonesian Independence." In addition, the learning media used are still dominated by textual materials, while students want more interactive, visual media that align with the development of digital technology. The purpose of this study is to develop Augmented Reality-based History Card learning media to strengthen students' chronological thinking skills in the material Efforts to Maintain Indonesian Independence. The study used the Research and Development (R&D) method, with the Borg and Gall model comprising 10 development stages. The resulting product is a history card integrated with an Android-based Augmented Reality application that includes AR-scanning features, visualisation of historical events, location maps, learning materials, and evaluation quizzes. Based on the validation results, the material experts assigned a feasibility score of 88% to the developed media, 92.8% to media experts, and 90% to history teachers. All assessment results were classified as very feasible. The media's feasibility rate was 82.3% in a small-group trial with six students and 81% in a large-group trial with 30 students. The media's effectiveness was tested through pretests and posttests, which demonstrated an increase in student performance after using the developed learning media. These findings indicate that the developed media meets the criteria of validity, practicality, and effectiveness, making it suitable for use in strengthening students' chronological thinking skills in history learning.

**Keywords:** augmented reality; chronological thinking; history cards; history learning

**Abstrak:** Kemampuan berpikir kronologis merupakan fondasi penting dalam keterampilan berpikir historis karena membantu murid memahami hubungan antarkeja¬dian sejarah secara runtut, logis, dan bermakna. Namun, hasil analisis kebutuhan di SMAN 2 Klaten menunjukkan bahwa murid masih mengalami kesulitan dalam memahami urutan peristiwa pada materi Usaha Mempertahankan Kemerdekaan Indonesia. Selain itu, media pembelajaran yang digunakan masih didominasi bahan ajar tekstual, sementara murid menginginkan media yang lebih interaktif, visual, dan sesuai dengan perkembangan teknologi digital. Tujuan penelitian ini adalah untuk mengembangkan media pembelajaran Kartu Sejarah berbasis Augmented Reality guna menguatkan kemampuan berpikir kronologis murid pada materi Usaha Mempertahankan Kemerdekaan Indonesia. Penelitian menggunakan metode Research and Development (R&D) dengan model Borg and Gall yang terdiri atas sepuluh tahap pengembangan. Produk yang dihasilkan berupa kartu sejarah yang terintegrasi dengan aplikasi Augmented Reality berbasis Android yang dilengkapi fitur pemindai AR, visualisasi peristiwa sejarah, peta lokasi, materi pembelajaran, dan kuis evaluasi. Berdasarkan hasil validasi, ahli materi memberikan skor kelayakan sebesar 88% untuk media yang dikembangkan, 92,8% dari ahli media, dan 90% dari guru sejarah. Seluruh hasil penilaian tersebut diklasifikasikan sangat layak. Tingkat kelayakan

media adalah 82,3% dalam uji coba kelompok kecil dengan enam murid dan 81% dalam uji coba kelompok besar dengan tiga puluh murid. Efektivitas media diuji melalui pelaksanaan pretest dan posttest yang menunjukkan adanya peningkatan kemampuan murid setelah menggunakan media pembelajaran yang dikembangkan. Temuan tersebut menunjukkan bahwa media yang dibuat memenuhi kriteria valid, praktis, dan efektif sehingga layak digunakan untuk menguatkan kemampuan berpikir kronologis murid dalam pembelajaran sejarah.

**Keywords:** augmented reality; berpikir kronologis; kartu sejarah; pembelajaran sejarah



## Introduction

History learning plays a crucial role in shaping students' identity, character, and national awareness. Through history learning, students not only learn about past events but also understand the values of struggle, nationalism, and wisdom that can serve as guidelines for their lives today and in the future. Hasan (2012) emphasized that history learning serves as a means to build historical awareness and national character through an understanding of society's collective experiences in the past. Therefore, history learning should not stop at mastering historical facts but should also develop thinking skills that enable students to understand the meaning behind historical events.

A key challenge of 21st-century education is that history learning requires students to develop various skills, such as critical thinking, creativity, collaboration, communication, and digital literacy. The goal of studying history should be to develop higher-order thinking skills, enabling students to critically analyze, interpret, and evaluate various historical phenomena. However, the practice of history learning in schools still faces various challenges, such as presenting learning in an attractive, essential, and contextual way for students (Mulyasa, 2014). Learning is often teacher-centered and oriented toward conveying information in the form of names of figures, dates, and historical events that must be memorized. This condition results in history being viewed as a boring, uninteresting subject, and synonymous with memorization (Pangestu & Kurniawati, 2019).

This phenomenon aligns with Wineburg's (2011) view, which states that history instruction often emphasizes mastering names, dates, and stories rather than developing the thought structures necessary for a deeper understanding of the past. As a result, students learn various historical facts but fail to grasp the relationships, context, or meaning contained within them. However, according to Wineburg (2010), understanding history requires not only the ability to memorize information but also historical thinking skills, which include analyzing evidence, interpreting sources, understanding context, and critically connecting various historical events.

One of the basic skills in historical thinking is chronological thinking. Seixas & Morton (2013) explain that chronological thinking is the ability to understand the chronological sequence, change, continuity, and relationships between events within a historical event. This ability is the main foundation for developing historical thinking because it helps students understand the logical connections between one event and another. With good chronological thinking skills, students not only know what happened but also understand why an event occurred, how it developed, and its impact on society.

Various studies have demonstrated the importance of chronological thinking skills in history learning. Helsa et al. (2024) stated that chronological thinking skills are a fundamental skill in history learning, enabling students to reconstruct historical events sequentially and

meaningfully. This study demonstrated that the use of timeline-based e-booklets effectively improved students' chronological thinking skills. Ananda (2024) also emphasized that chronological thinking is the initial stage in mastering historical thinking skills and serves as the foundation for a more comprehensive understanding of history. Meanwhile, research by Putri et al. (2025) showed that the use of timeline media significantly improved students' historical thinking skills. These findings demonstrate that chronological thinking skills are an important competency that needs to be developed through appropriate learning media.

Despite this, various studies still indicate that students' chronological thinking skills are quite low. Helsa et al. (2024) found that students still struggle to understand the chronology of historical events and connect events sequentially. Research by Ananda (2024) also showed that students have difficulty identifying periodization, sequencing historical events, and interpreting events in chronological order. This condition tends to lead students to understand history only partially and to be less able to build a comprehensive historical understanding.

Similar findings were obtained from a needs assessment conducted at SMAN 2 Klaten through classroom observations, interviews with history teachers, and questionnaires. The analysis revealed that the school had provided learning resources in the form of main textbooks and supplementary history books. However, most students did not bring these books to school because they were quite bulky and considered impractical to carry every day. As a result, students relied more on teacher explanations during the learning process. Furthermore, the learning media used was still dominated by text-based presentations, making it less effective in visualizing the relationships between historical events engagingly and interactively. The survey results also showed that students desired more modern, visual, and interactive learning media accessible via the smartphones they use daily.

This issue becomes even more complex in the material on Efforts to Defend Indonesian Independence. This material contains a series of events that unfolded continuously, involving various figures, regions, and interconnected dynamics of the struggle. Understanding this material requires students to connect national events with the local context of their surroundings, understand cause-and-effect relationships, and sequence events chronologically. However, observations indicate that students still struggle to understand the sequence of events and connect the interrelationships between them. This situation impacts students' low ability to reconstruct historical events in a comprehensive and meaningful way.

The development of digital technology opens up new opportunities to address these challenges. One technology that has great potential for application in history learning is Augmented Reality (AR). AR technology allows virtual objects to be displayed and interact with the real environment in real time, creating a more engaging, interactive, and contextual learning experience. Ibáñez & Delgado-Kloos (2018) explained that the use of Augmented Reality in learning has been proven to increase student motivation, engagement, conceptual visualization skills, and overall interactivity compared to conventional information presentations. In history learning, AR technology has the potential to help students visualize historical figures, locations, and sequences of events more concretely, thus facilitating their understanding of the chronological relationships between events.

Although extensive research has been conducted on history learning media, there are still research gaps that require further study. Research by Helsa et al. (2024) developed a timeline-based e-booklet to improve students' chronological thinking skills. Research by Ananda (2024) utilized a digital history timeline to improve chronological thinking skills in history learning. Meanwhile, Putri et al. (2025) examined the effect of timeline media on students' historical thinking skills. All three studies demonstrated that timeline-based media is effective in helping students understand the sequence of historical events. However, the media developed are still

limited to e-booklets and digital timelines and have not integrated Augmented Reality technology into a comprehensive learning system (Radianti et al., 2020). Furthermore, these studies have not specifically developed media that combine physical cards, AR visualizations, historical narrative videos, concise materials, event location maps, and interactive quizzes in a platform specifically designed to strengthen chronological thinking skills.

Based on these conditions, this study developed Augmented Reality-Based History Card Learning Media for the material Efforts to Maintain Indonesian Independence. This media is designed as physical cards that function as markers to display digital visualizations through AR technology. Each card is equipped with visualizations of historical events, narrative videos, location maps, summary materials, and interactive quizzes that can be accessed via smartphones. The advantage of this media lies in its ability to present historical events in a coherent, visual, interactive, and contextual manner, so it is expected to strengthen students' chronological thinking skills. Therefore, this study aims to develop valid, practical, and effective learning media to strengthen students' chronological thinking skills on the material Efforts to Maintain Indonesian Independence while supporting the study of history in a more meaningful and relevant way to meet the demands of the 21st century.

## Research Methods

The approach applied in this study is Research and Development (R&D). According to Sugiyono (2019), the R&D method is a research approach oriented toward creating a specific product while simultaneously testing its effectiveness upon implementation. The researcher chose this method because it is considered highly aligned with the primary research organization, which focuses on product design, particularly in the realm of learning media.

The primary focus of this research lies in the creation and testing of the effectiveness of the History Card media integrated with Augmented Reality (AR) on the topic of efforts to maintain Indonesian independence. The media reconstruction process is based on the ten-stage research and development (R&D) model of Borg and Gall in Sugiyono (2019). Systematically, this research applies ten development stages: (1) identifying potential and problems, (2) gathering relevant information, (3) developing a product plan, (4) validating the design, (5) correcting plan deficiencies, (6) testing a product prototype, (7) revising the product, (8) implementing the product in a large-scale trial, (9) preparing the final product, and (10) conducting mass production. The operational details of the flow are explained as follows.

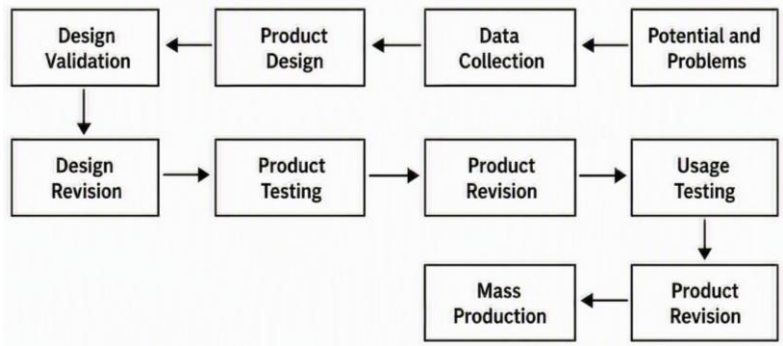


**Figure 1.** Step-by-Step Procedure Diagram
Research and Development Methodology of the Borg and Gall Model
Source: Sugiyono, 2019

According to Sugiyono (2019), the research and development (R&D) method chosen for this study was based on its systematic procedures. The ten stages of the R&D model were used as a reference in developing Augmented Reality-based History Cards to support students' chronological thinking skills and maintain Indonesian independence. This development model was deemed appropriate because it encompassed the entire learning media development process, from problem identification to product refinement. Furthermore, the stages of the Borg and Gall model proposed by Sugiyono are structured sequentially and allow for three gradual revisions. With this revision process, the developed Augmented Reality-based History Cards are expected to produce more optimal results and meet learning needs.

Before being implemented in history lessons, the completed product must undergo a testing phase to measure its validity, feasibility, and effectiveness. Evaluation of these three parameters is carried out through a series of validity, feasibility, and product effectiveness tests. Specifically, for validity, subject matter experts and learning media experts serve as validators. Material validation was conducted by Ms. Ayu Bella Rusita Purwanti, S.Pd., Gr., to assess the suitability and accuracy of the Augmented Reality-based History Cards, specifically for the topic of defending Indonesian independence. Meanwhile, media validation was conducted by Mr. Kardilah Rohmat Hidayat, M.Kom., an IT expert, to assess the feasibility of the media design and the technical aspects of the developed software. In addition to expert validation, an assessment was also conducted by Ms. Siti Nur Anisa, S.Pd., a history teacher teaching Grade 12 history at SMAN 2 Klaten. This practitioner assessment aimed to obtain input regarding the use of the media in learning. With this input, the product could be refined and perfected before being tested with students.

The effectiveness and feasibility testing phase was implemented through two experimental phases: a small-group product trial and a large-group usage trial. The subjects involved in both phases were grade 12-B students at SMAN 2 Klaten. In the small-group phase, the sample consisted of six students recruited using a purposive sampling technique. The sampling criteria were based on variations in learning achievement—covering high, medium, and low categories—so that the population characteristics could be adequately represented. After the treatment was administered, the six students were asked to complete an assessment questionnaire related to the Augmented Reality (AR) History Card media on the topic of the struggle for Indonesian independence. Feedback data, including responses, criticisms, and suggestions from this questionnaire, were used as a basis for product evaluation and improvement before moving on to the next stage. Next, a large-group trial involved 30 remaining students from grade XII-B of SMAN 2 Klaten, including the 36 students who had not participated in the initial phase.

Data collection in this research and development (R&D) relied on several key instruments, including an expert assessment questionnaire, teacher and student response questionnaires, effectiveness test questions, an interview guide, and activity documentation. The questionnaire was constructed on a Likert scale with five answer choices (5, 4, 3, 2, and 1). The standardization of these score intervals is based on the validity and effectiveness percentage formulas for expert groups and audiences, as formulated by Akbar (2013) in his book, "Learning Device Instruments." All of these instruments are designed to support a combination of quantitative and qualitative data analysis techniques to obtain comprehensive evaluation results. Through questionnaires completed by material validators, media validators, subject teachers, and students, quantitative data was obtained to test the feasibility and effectiveness of the History Card media. Meanwhile, qualitative data, including input, suggestions for improvement, and constructive feedback from experts and users, was used specifically as reference material for product improvements.

## Research Results

### Research Data

The development of History Card media with Augmented Reality (AR) technology on the topic of efforts to defend Indonesia's independence aligns with the Phase F Learning Achievement (CP) target in the Independent Curriculum or National Curriculum. In terms of conceptual understanding, this instrument is designed so that students can identify and explain the crucial phases of national history, which span from the era of Western colonialism, local resistance, national awakening, the Japanese occupation period, proclamation, physical revolution to defend independence, the Old Order (Sukarno's government), the New Order (Suharto's government), to the Reformation era. More than that, this media is used to familiarize students with applying historical reasoning, enriching literacy, conducting research, and fostering historical awareness through an inquiry approach. Students are also directed to evaluate historical values and reflect them in the current context. Meanwhile, in the realm of process skills, this product is oriented to hone specific skills in historical studies. This includes the ability to think diachronically (chronologically) and synchronically, understand events in context, sharpen analysis and interpretation, expand research and literacy skills, solve historical issues, make decisions, and discover the meaning behind a historical event.

The media developed in this research is Augmented Reality-based History Cards, which can be accessed for free and installed on Android devices. This media is designed to support chronological history learning, especially regarding local historical events that played a role in efforts to maintain Indonesian independence. This Augmented Reality-based History Card is equipped with learning videos, simplified material, and multiple-choice practice questions. The presentation aims to make it easier for students to understand the material being studied. This is in line with Kartika & Zakir's (2022) argument that learning media act as a tool, method, or technique for connecting communication between teachers and students to increase learning effectiveness. Therefore, media preparation must prioritize clarity of language and writing so that students can receive the learning messages conveyed well.

Suitability to learning objectives, ease and flexibility of use, ease of operation by instructors, suitability to student characteristics, and availability of supporting facilities are some of the main requirements for effective learning media (Dina et al., 2018). These criteria can be understood through the three main characteristics of learning media, namely fixative, manipulative, and distributive characteristics, which indicate the media's ability to record, process, and disseminate learning information (Hasan et al., 2021). Therefore, the design of the History Card media with Augmented Reality (AR) technology in this study was realized by comprehensively integrating various parameters and characteristics of educational media. The orientation of this strategic consideration is to ensure that the product produced not only passes the feasibility test from a technical perspective, but also serves as an efficient alternative solution to instructional problems in optimizing students' chronological thinking skills on the topic of the struggle to defend Indonesian independence.

The design of educational media in the form of historical cards with Augmented Reality (AR) technology in this study was realized by referring to the material substance of the struggle to defend Indonesian independence as the foundation for compiling the content and systematics of the product. This instrument was developed not only to transfer historical data but also to serve as an adaptive medium that helps students construct the flow of historical events systematically and chronologically. Each history card contains important events arranged systematically based on time sequence, making it easier for students to reconstruct the flow of history. The content in this media is organized into several main sub-materials that reflect important stages in efforts to defend Indonesia's independence, such as the background of the

conflict, events of the struggle, and the impacts they had. Each sub-material is then developed into interconnected learning units, thus forming a complete and continuous historical narrative flow.

The advantage of this media lies in the integration of Augmented Reality features through the AR scan menu. Each card functions as a marker that, when scanned, displays video documentation and historical narratives. The application also includes a map of the event's location and explanatory text to support student understanding. Furthermore, this media is equipped with interactive practice questions designed to test and strengthen students' chronological thinking skills. This structured, technology-based presentation is expected to provide a more concrete, engaging, and meaningful learning experience in understanding the events of the struggle to maintain Indonesian independence.

The material presented in this history card media consists of several main subtopics, including: (1) the condition of Indonesia after the proclamation of independence, (2) the Dutch military aggression and its impact on the Yogyakarta region and its surroundings, and (3) the series of struggles of the people and the Indonesian National Armed Forces (TNI) leading up to the General Offensive of March 1, 1949. These three subtopics are then elaborated on in a series of cards arranged chronologically.

Each card presents an important event, such as the crash of a Dakota VT-CLA aircraft in Jatikarang Village, Tamanan Subdistrict, Bantul Regency, due to a sudden attack by a Dutch Kitty Hawk P-40 aircraft (Subdisjarah Diswatpersau, 2004). Then, on the next card, the material displayed is about the MBKD Kepurun Monument; this card will discuss the movement of AH Nasution's troops after returning from East Java in December 1948. After learning that Maguwo had fallen into Dutch hands, AH Nasution ordered the entire group to head north to the slopes of Mount Merapi. From there, AH Nasution was taken to the residence of the Kepurun village head because Jogja had fallen into Dutch hands. Finally, Kepurun Village was used as a location to prepare an attack, with several fighters commanded at the Magelang and Jogja Posts (Pusat Sejarah TNI, 2014). The third card will discuss the Plataran Monument; the main material displayed is a series of guerrilla attacks by the Indonesian National Army (TNI) and the people's militia in the Yogyakarta region, especially Sleman, as a reaction to the Dutch Military Aggression II from December 19, 1948 until the General Offensive of March 1, 1949. This material includes various attacks on Dutch headquarters and communication lines, such as in Maguwoharjo, Godean, Kaliurang, Pakem, and Ngemplak, as well as the battle in Plataran Village in February 1949, which marked the intensity of resistance and sacrifice of fighters, including Young Officers, Cadets, Student Soldiers, and residents in facing Dutch troops (Moehkardi, 2019).

Then on the fourth card, the main material displayed is the Death Ghost Monument, which shows the role of the people's army in the Yogyakarta region in supporting the armed struggle after the Second Dutch Military Aggression until the General Offensive of March 1, 1949. This material includes the formation of the Death Ghost Army by GBPH Poedjokoesoemo, the merger with the Dark Samber Army, as well as various struggle activities such as the capture of spies, support for TNI military operations, and cooperation with the Military Academy in strengthening war strategies in the Yogyakarta region (Hardjowidjono, 1985). On the fifth card discussing the March 1 General Offensive Monument, the main material presented is the March 1 General Offensive event as a military strategy to show the existence of the Republic of Indonesia in the eyes of the international world. This attack was initiated by Sri Sultan Hamengkubuwono IX and carried out by the TNI under the coordination of various regional commanders, including Lieutenant Colonel Soeharto. The attack was carried out in a coordinated manner in various sectors of Yogyakarta City and succeeded in controlling the city

for six hours. This event was then immortalized in the March 1, 1949 General Attack Monument located in the center of Yogyakarta City as a symbol of the nation's collective struggle (Hutagalung, 2010; Nugraha et al., 2018).

The sixth card discusses the AURI PC-2 Radio Monument. The main topic presented is the role of the AURI "PC-2" radio station in Playen, Gunungkidul, in the struggle for Indonesian independence. This radio station was secretly moved from Yogyakarta after the Second Dutch Military Aggression in 1948 and used to disseminate information about the struggle. Through covert broadcasts, PC-2 successfully spread news of the success of the March 1, 1949, General Offensive internationally. This information played a crucial role in countering Dutch propaganda and strengthening Indonesia's position in global diplomacy. This event demonstrated the importance of communication in the struggle for independence. To commemorate this service, the AURI "PC-2" Radio Monument was built in Banaran, Playen (Boediarjo, 1993; Subdisjarah Dispen AU, 2007).

The learning media developed consisted of history cards integrated with an Augmented Reality (AR)-based application. This media was tailored to student needs based on potential and problem analysis. The development of this media aims to provide a more interactive, contextual, and engaging history learning innovation, helping students understand the chronological sequence of historical events. The history cards serve as the primary media. When scanned through the application, they display digital content in the form of video narratives and visualizations, such as archives, photo documents, and videos relevant to the historical event. This integration provides a more concrete and immersive learning experience, allowing students not only to read but also to see and hear representations of historical events. Furthermore, the application is equipped with various supporting features, such as readable material information, event location maps to reinforce spatial context, and practice questions for learning evaluation. By combining physical cards and the digital application, this media can create more flexible learning and encourage active student engagement in the history learning process.

The Augmented Reality-based History Card learning media was developed using a graphic design application (Adobe Illustrator) and an augmented reality platform (Vuforia). In the initial stage, researchers developed the material flow and sequence of historical events to determine the card content, visual appearance, and material to be presented through the Augmented Reality-based History Card learning media. Prior to the media development process, researchers first created a storyboard containing the arrangement of images, narrative text, markers, and video displays of objects on each history card as a basis for systematic and chronological media development.

During the media creation process, the history card designs were created using a graphic design application (Adobe Illustrator), paying attention to the appropriateness of colors, text layout, images, and markers for easy scanning by students' devices. Once the card designs were complete, the markers were integrated into an augmented reality application so that when the card was scanned using a smartphone, a visualization in the form of a historical narrative video related to the Efforts to Maintain Indonesian Independence appeared. The development process concluded with testing the marker function, the appearance of the augmented reality application objects, media navigation, and the appropriateness of the content so that the media could be used practically, systematically, and engagingly in history learning both in and outside the classroom.


**Figure 2.** History Card Display
Source: Research Data, 2025

An Augmented Reality-based History Card display that can be scanned using a smartphone. After successfully scanning, students will see a visualization of a narrative video and historical information related to the material on "Efforts to Maintain Indonesian Independence." Students can view each visualization sequentially. Furthermore, a navigation menu allows students to easily repeat the visual display, supporting interactive and engaging history learning.


**Figure 3.** Initial App View after Installing on a Smartphone
Source: Research Data, 2025

After successfully installing the Augmented Reality History Card app on a smartphone, the main page is simple and easy for students to use. The main menu features several features that support interactive history learning, including an AR scan menu (for scanning history cards), an app description, maps of historical event locations, learning materials, and practice questions.

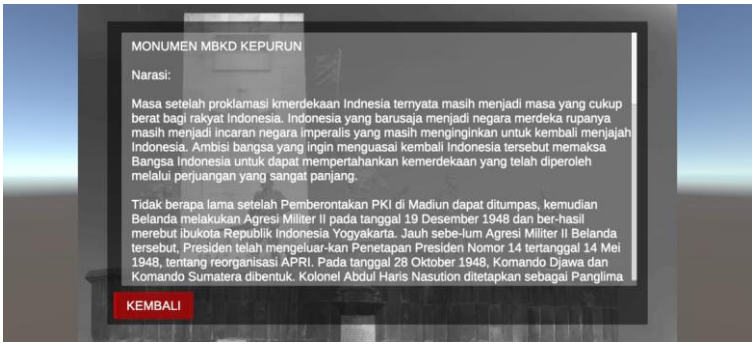


**Figure 4.** Learning Materials Menu Display
Source: Research Data, 2025

In the materials menu, students can read a chronological and sequential explanation of the struggle for independence. This section features a navigation menu that makes it easy for students to review the material repeatedly at their own pace

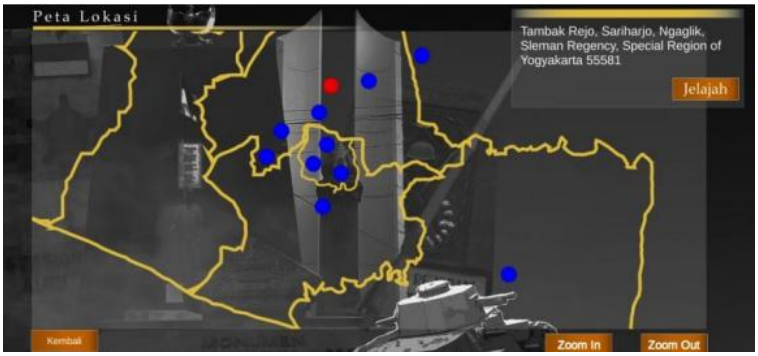


**Figure 5.** Location Map Menu Display
Source: Research Data, 2025

In the location map section, students can see the location directly. Then, through this menu, students can also search for the location using GPS without typing the name of the place. Students can press the location button and be directed to GPS if they want to search for it directly.

**Figure 6.** Students trial using applications and history cards
Source: Research Data, 2025

The AR-based History Card media that has been developed must undergo a testing phase before being applied to learning. This testing assesses the product's feasibility, validity, and effectiveness through a series of relevant trials. The validity test involves subject matter experts and media experts as examiners to evaluate the quality of the material and the design of the learning media.

The assessment of the validity of the material in the Augmented Reality-Based History Card media, specifically Efforts to Maintain Indonesian Independence, was conducted by Ms. Ayu Bella Rusita Purwanti, S.Pd., Gr., as the subject matter expert. The validation aimed to assess the material's suitability to learning outcomes, the accuracy of historical concepts, the presentation of the material, the use of language, and the material's relevance to strengthening students' chronological thinking skills. The validation results are presented in Table 1.

**Table 1.** Material Substance Validation Results

| No | Assessment Aspect | Score Obtained | Maximum Score | Percentage | Category |
|---|---|---|---|---|---|
| 1 | Material Suitability | 19 | 20 | 95,0% | Very Feasible |
| 2 | Material Presentation | 17 | 20 | 85,0% | Very Feasible |
| 3 | Strengthening Chronological Thinking Skills | 18 | 20 | 90,0% | Very Feasible |
| 4 | Language | 12 | 15 | 80,0% | Feasible |
| Total | | 66 | 75 | 88% | Very Feasible |

Source: Research Data, 2025

Based on Table 1, the media received a score of 66 out of 75 (88%) and was categorized as very suitable. The aspects with the highest scores were material suitability and strengthening chronological thinking skills, while the language aspect received the lowest score, although still in the suitable category. Overall, the validation results indicate that the material presented aligns with learning outcomes, has good historical accuracy, is structured chronologically, and supports the development of students' chronological thinking skills, making it suitable for use in the trial phase.

The validity assessment of the Augmented Reality-Based History Card media was conducted by Mr. Kardilah Rohmat Hidayat, M.Kom., a media expert. The validation aimed to assess the media's quality in terms of visual appearance, software engineering, usability, and the functionality of the Augmented Reality features integrated into the learning media. The results of the media expert validation are presented in Table 2.

**Table 2.** Media Expert Validation Results

| No | Assessment Aspect | Score Obtained | Maximum Score | Percentage | Category |
|---|---|---|---|---|---|
| 1 | Visual Appearance | 28 | 30 | 93,3% | Very Feasible |
| 2 | Software Engineering | 28 | 30 | 93,3% | Very Feasible |
| 3 | Ease of Use | 23 | 25 | 92,0% | Very Feasible |
| 4 | Augmented Reality Functionality | 37 | 40 | 92,5% | Very Feasible |
| Total | | 116 | 125 | 92,8% | Very Feasible |

Source: Research Data, 2025

Based on Table 2, the Augmented Reality History Cards media received a score of 116 out of 125 (92.8%), indicating it is highly feasible. The visual appearance and software

engineering aspects received the highest scores, while the ease of use and Augmented Reality functionality also ranked very highly. Overall, the validation results indicate that the media has an attractive interface design, easy-to-understand navigation, good application performance, and Augmented Reality features that function optimally to support the delivery of historical material. Therefore, the media was declared suitable for use in the trial phase with students.

The assessment of the practicality and feasibility of using the Augmented Reality History Cards media in learning was conducted by Ms. Siti Nur Anisa, S.Pd., a Grade XII History teacher at SMAN 2 Klaten. The practitioner validation aimed to assess the media's suitability for the classroom learning process, ease of use, quality of material presentation, and its potential to support strengthening students' chronological thinking skills. The results of the practitioner assessment are presented in Table 3.

**Table 3.** Practitioner Assessment Results

| No | Assessment Aspect | Score Obtained | Maximum Score | Percentage | Category |
|---|---|---|---|---|---|
| 1 | Media Suitability for Learning | 14 | 15 | 93,3% | Very Feasible |
| 2 | Ease of Use | 14 | 15 | 93,3% | Very Feasible |
| 3 | Presentation Quality | 14 | 15 | 93,3% | Very Feasible |
| 4 | Learning Implementation | 12 | 15 | 80,0% | Feasible |
| Total | | 54 | 60 | 90% | Very Feasible |

Source: Research Data, 2025

Based on Table 3, the Augmented Reality-Based History Cards media received a score of 54 out of a maximum of 60, equivalent to 90%, making it categorized as very suitable. The media's suitability for learning, ease of use, and presentation quality received very good ratings, while the learning implementation aspect was categorized as suitable. These results indicate that the media is easy to implement in history learning, captures students' attention, and supports a more systematic delivery of material through the integration of history cards, the Augmented Reality scanning feature, reading materials, maps of historical locations, and practice questions. Based on the practitioner's assessment, the media was deemed suitable for use in learning activities and is ready to be piloted with students.

**Table 4.** Descriptive Statistics of Pretest and Posttest Results

| Group | N | Mean Pretest | Mean Posttest | Improvement | Pretest Std. Deviation | Posttest Std. Deviation |
|---|---|---|---|---|---|---|
| Small Group | 6 | 44,17 | 90,83 | 46,66 | 4,44 | 2,93 |
| Large Group | 30 | 42,33 | 90,56 | 48,23 | 5,41 | 4,02 |

Source: Research Data, 2025

Descriptive statistics were used to provide an overview of student learning outcomes before and after using the Augmented Reality History Cards. According to Table 4, the average pretest score for the small group was 44.17, then increased to 90.83 in the posttest, representing a 46.66-point increase. Meanwhile, for the large group, the average pretest score of 42.33 increased to 90.56 in the posttest, representing a 48.23-point increase. In addition to the increase in average scores, the standard deviations for both groups also decreased, indicating that student abilities after using the media became more homogeneous compared to before the treatment. These results indicate that the developed media is able to improve student learning outcomes descriptively.

**Table 5.** Results of the Pretest Data Normality Test

| Variable | Shapiro-Wilk Statistic | df | Sig. | Remarks |
|---|---|---|---|---|
| Pretest | 0,891 | 6 | 0,322 | Normal |
| Posttest | 0,920 | 6 | 0,506 | Normal |

Source: Research Data, 2025

**Table 6.** Results of the Posttest Data Normality Test

| Variable | Shapiro-Wilk Statistic | df | Sig. | Remarks |
|---|---|---|---|---|
| Pretest | 0,922 | 30 | 0,030 | Not Normal |
| Posttest | 0,914 | 30 | 0,019 | Not Normal |

Source: Research Data, 2025

Normality tests were conducted using the Shapiro–Wilk test because the sample size for both groups was less than 50 students. Based on Table 5, the pretest and posttest data for the small group had significance values of 0.322 and 0.506, respectively, indicating normal distributions (Sig. > 0.05). Conversely, the large group obtained significance values of 0.030 for the pretest and 0.019 for the posttest, indicating non-normality (Sig. < 0.05). Therefore, hypothesis testing was conducted using the Paired Sample t-test for the small group and the Wilcoxon Signed Rank Test for the large group.

**Table 7.** Results of the Paired Sample t-test for the Small Group

| Group | Comparison | Mean Difference | t | df | Sig. (2-tailed) | Remarks |
|---|---|---|---|---|---|---|
| Small Group | Pretest - Posttest | -46,67 | -54,195 | 5 | <0,001 | Significant |

Source: Research Data, 2025

The results of the paired sample t-test in the small group showed a significance value of <0.001, indicating a significant difference between the pretest and posttest scores. The mean difference of -46.67 indicates an improvement in student learning outcomes after using the Augmented Reality History Cards. Therefore, the developed media significantly improved student learning outcomes during the small group trial phase.

**Table 8.** Summary of Ranks

| Comparison | Negative Ranks (N) | Positive Ranks (N) | Ties (N) | Total (N) |
|---|---|---|---|---|
| Posttest - Pretest | 0 | 30 | 0 | 30 |

Source: Research Data, 2025

**Table 9.** Wilcoxon Test Results

| Group | Comparison | Z | Sig. (2-tailed) | Remarks |
|---|---|---|---|---|
| Large Group | Posttest - Pretest | -4,79* | <0,001 | Significant |

Source: Research Data, 2025

Because the data in the large group did not meet the assumption of normality, hypothesis testing was conducted using the Wilcoxon Signed Rank Test. Based on Table 7a, all 30 students achieved higher posttest scores than their pretest scores; thus, there were no negative ranks or

ties. Furthermore, Table 7b shows a significance value of <0.001, indicating a significant difference between the pretest and posttest scores. This finding indicates that the use of Augmented Reality History Cards significantly improved learning outcomes in the large group.

**Table 10.** N-Gain Analysis Results

| Group | N | Mean N-Gain Score | Std. Deviation | Minimum | Maximum | Category |
|---|---|---|---|---|---|---|
| Small Group | 6 | 0,8383 | 0,04207 | 0,78 | 0,90 | Tinggi |
| Large Group | 30 | 0,8411 | 0,05558 | 0,75 | 0,93 | Tinggi |

Source: Research Data, 2025

An N-Gain analysis was conducted to determine the media's effectiveness in improving student learning outcomes. Based on Table 8, the small group achieved an average N-Gain of 0.8383, while the large group achieved 0.8411. Both values are in the high category ($g \geq 0.70$), indicating that the Augmented Reality-Based History Cards media is highly effective in improving student learning outcomes on the topic "Efforts to Maintain Indonesian Independence." Although the large group had a slightly higher average N-Gain than the small group, the difference was relatively small, indicating that both demonstrated a similar level of effectiveness.

**Discussion**

The development of the Augmented Reality-Based History Cards media was based on the results of a needs analysis, which showed that students still experience difficulty understanding the sequence of events, cause-and-effect relationships, and the interconnectedness of space and time in history learning. These findings indicate that history learning remains oriented toward mastering facts, thereby not optimally developing chronological thinking skills, one of the main dimensions of historical thinking. This situation aligns with the views of Wineburg (2011) and Seixas & Morton (2013), who emphasized that the goal of history learning is not simply memorizing facts, but rather developing the ability to understand chronology, continuity, change, and causal relationships between historical events.

The developed media integrates history cards, Augmented Reality scanning features, narrative videos, maps of historical locations, chronologically organized materials, and practice questions into a single learning experience. This design is supported by the Cognitive Theory of Multimedia Learning (Mayer) and Dual Coding Theory (Clark & Paivio), which explain that presenting information through simultaneous visual and verbal representations helps students develop deeper conceptual understanding. Therefore, the use of Augmented Reality in this study serves not only as a technological innovation but also as a pedagogical strategy that facilitates students in constructing temporal and causal relationships between historical events.

The high validation results indicate that the media meets the requirements of material feasibility, media quality, and practicality, making it suitable for implementation in learning. Furthermore, the improvement in learning outcomes on the effectiveness test indicates that integrating history cards, Augmented Reality visualizations, location maps, chronological materials, and evaluative exercises can help students understand the relationships among space, time, and cause and effect more systematically. This finding is consistent with research by Rachim et al. (2024), Helsa et al. (2024), Septiana et al. (2026), Ibáñez & Delgado-Kloos (2018), and Radianti et al. (2020), which show that Augmented Reality-based digital media can improve learning quality. However, unlike these studies, which focus more on learning

motivation, engagement, or conceptual understanding, this study positions Augmented Reality as part of a learning design specifically aimed at strengthening chronological thinking skills by integrating physical and digital media. Thus, this study not only produces valid and effective media but also provides a conceptual contribution to the development of Augmented Reality-based history learning oriented towards strengthening historical thinking in accordance with the demands of 21st-century learning.

## Conclusion

Through a research and development (R&D) approach, this study successfully created educational media in the form of Augmented Reality-Based History Cards. This media, which highlights the struggle to maintain Indonesian independence, is specifically designed for practical access via Android devices. The learning media was developed by combining history cards and augmented reality technology, enabling a more interactive, engaging, and systematic presentation of historical material. This media is equipped with an AR scanning feature, application descriptions, maps of historical locations, learning materials, and practice questions to support the history learning process by strengthening students' chronological thinking skills.

Based on the results of validity, effectiveness, and feasibility tests, this AR-based History Card media was declared valid, effective, and highly suitable for use in history learning. This product has been proven to help students understand the subject matter more easily, coherently, and engagingly. Furthermore, this media can be an innovative media option to support the implementation of an interactive, contextual, and meaningful history learning process.

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