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Innovating History Learning through a STEAM-Based E-Module: Enhancing Students' Historical Understanding

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Abstract. This study examines the development of history teaching materials in the form of e-modules based on the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach to improve students' understanding of history. This study was motivated by the need for innovations in history education that are more interactive, contextual, and capable of encouraging student engagement in a deeper understanding of historical events. The research employed the Research and Development (R&D) method using the ADDIE model, which encompasses the stages of analysis, design, development, implementation, and evaluation. The study was conducted at State Senior High School 3 Ambon and State Senior High School 2 Central Maluku, involving 2 teachers and 132 students. Data collection was conducted through observation, interviews, questionnaires, and tests, while data analysis used qualitative and quantitative approaches. Effectiveness tests were performed using the Wilcoxon, Mann-Whitney U, and N-Gain tests with the assistance of IBM SPSS Statistics 31. The research results indicate that the STEAM-based history e-module has a very high level of feasibility based on validation by subject matter experts (4.77) and media experts (4.80). In terms of practicality, teachers gave an average rating of 4.66 and students gave an average rating of 4.58, both falling into the "very practical" category. The findings also indicate that the use of STEAM-based e-modules is effective in enhancing students' historical understanding, as evidenced by the results of the Wilcoxon and Mann-Whitney U tests, which showed a significance level of 0.000 (<0.05). Furthermore, the N-Gain test results showed a higher increase in the experimental class (0.7152; high category) compared to the control class (0.3021; moderate category). This study contributes to the development of digital-based history learning innovations through the integration of the STEAM approach to strengthen students' historical understanding.

Keywords: *teaching materials, e-module, STEAM, historical understanding*

Abbreviations: STEAM ; An integrated learning approach based on science, technology, engineering, the arts, and mathematics.

INTRODUCTION

The 21st century has brought significant advances in educational technology innovation, which have transformed traditional teaching and learning methods. One such innovation in 21st-century education is the development of digital instructional materials relevant to the Fourth Industrial Revolution [1], [2]. Digital learning materials, such as electronic modules (E-Modules), are increasingly being used to develop critical thinking and problem-solving skills [3]. Through E-Modules, learning can be delivered in a digital format that makes it easier for students to study course material efficiently and flexibly. Advances in educational technology have also introduced interdisciplinary learning approaches such as STEAM (Science, Technology, Engineering, Arts, and Mathematics). STEAM is a learning approach that aims to develop knowledge, motivation, communication skills, and creativity by integrating multiple disciplines through project-based learning activities [4]. Combining digital instructional materials such as E-Modules with the STEAM learning approach creates an educational innovation that can be applied across various subjects, including history.

History, as an academic discipline that is required at various levels of education, plays a strategic role in enhancing and developing students' ability to think historically—logically, inspiring, creatively, and innovatively [5]. Indicators of historical understanding are the primary goal of the learning process—not merely to know facts about the past, but to interpret and analyze historical events [6]. Key components in shaping historical understanding in the digital age include the integration of technology and a multidisciplinary approach [7]. The use of digital technology in history education helps develop students' digital literacy, which is essential for navigating and understanding historical content in the digital age [8], [9]. Meanwhile, a multidisciplinary approach to teaching history involves integrating various academic disciplines to provide a more comprehensive understanding of historical events and contexts through project-based learning [10].

The STEM (Science, Technology, Engineering, and Mathematics) approach was originally developed to strengthen students' logical thinking, problem-solving, and technological literacy skills [11]. In line with the

demands of 21st-century learning, the STEM approach has evolved into STEAM by adding the Arts to strengthen creativity, expression, and the meaningfulness of learning. Integrating the arts into STEM allows students to interpret learning on a personal level and fosters deeper engagement and motivation in learning [12]. In history education, the STEAM approach offers a solution to the challenges of history learning, which tends to be rote memorization, lacks context, and involves minimal student engagement. Through the integration of STEAM elements, history education not only emphasizes mastery of facts but also encourages the analysis of evidence, critical interpretation, and the interpretation of historical events. For example, when studying the history of Indonesia during the Hindu–Buddhist period, students often struggle to understand abstract concepts such as the process by which Hindu–Buddhist influences took root, the chronology of kingdoms, and the symbolic significance of historical artifacts.

The STEAM approach offers a solution by integrating the analysis of historical evidence through digital maps and inscriptions (Science and Technology), the reconstruction of trade routes and royal centers (Engineering), the interpretation of cultural symbols and values through visuals and creative narratives (Arts), and the chronological analysis of a kingdom's development (Mathematics). The integration of STEAM into history education can be achieved through project-based learning, which helps students understand historical material through a holistic learning experience [13]. Nevertheless, the implementation of the STEAM approach in history education has not yet been optimal because it has not been systematically integrated into teaching resources, particularly instructional materials. As a result, instruction has not yet been fully able to guide students to integrate analysis, creativity, and the interpretation of history.

The development of e-modules for history represents an innovation in the effort to transform learning into a digital format, marking the transition from print teaching materials to digital platforms. This situation stems from the continued dominance of print textbooks as teaching materials, which tend to limit interaction, exploration, and in-depth understanding of historical content. The pedagogical aspects of traditional teaching approaches and methods, such as lectures, also contribute to a decline in the quality of history education [14]. Observations conducted at State Senior High School 3 in Central Maluku show that students' average scores remain below the minimum passing score (KKM) or ≤ 70 , indicating a low level of historical understanding among students. An interview with one of the teachers revealed that textbooks are still the primary teaching material, even though PowerPoint presentations are used to deliver content in class. This is not enough, because in reality, students' use of textbook-based learning materials is limited to the school environment, thereby restricting the flexibility of learning. This is a weakness of conventional teaching materials; therefore, the need for flexible teaching materials that students can access anytime and anywhere is a solution to overcome this weakness.

E-modules as digital teaching materials for history instruction have yielded positive results in several previous development studies. Research by Sa'adah & Sapto [15] developed a multimedia e-module based on a flip PDF format covering the National Revolution in Malang (1945–1949), using Sugiyono's 10-step development model. The results showed that the e-module, as a history teaching material, achieved a 96% validation score from subject matter experts, an 86% score from instructional design experts, a 96% score in the teacher practicality test, and in pilot tests with students, a score of 85% in the small group and 87% in the large group—indicating a 2% improvement. These results demonstrate that the E-Module, as a digital teaching material, is valid and suitable for use in history education.. Further research by Swastika & Jati [16] developing Canva-based e-module instructional materials on early humans in Indonesia using Sugiyono's 10-step development model. The research results show that the e-module, as a history teaching material, achieved a validation score of 97.91% from subject matter experts and 90.06% from instructional design experts; pilot testing with students in a small group yielded a score of 93.98%, and with a large group, a score of 93.02%. These results indicate that the e-module teaching materials are highly effective for use in the classroom.

In addition to studies reporting on innovations in the development of E-Modules as teaching materials, there are other studies that report on the application of STEAM in history education. Study on STEAM in history education, reported that STEAM has been used and implemented in history education; moreover, STEAM elements are present in the history material presented to students [17]. With the STEAM approach, students can learn effectively, enjoy the process, participate in learning that integrates multiple subjects, and collaborate in groups. Furthermore, there is research by sumardi [18], on the implementation of RBL-STEAM in enhancing historical thinking skills. This study employed a mixed-methods approach with a non-equivalent group design (control and experimental groups) using pre- and post-tests, in which the two groups

received different interventions. The results showed that the independent samples t-test yielded a significant Sig value of 0.015 (<0.05), indicating a statistically significant difference in historical thinking skills scores between the experimental and control groups, with the experimental group demonstrating better results.

Based on an analysis of previous research, there are several research gaps that have not yet been explored and present opportunities for innovation in this study. First, research on the development of digital history modules tends to merely transfer content from print teaching materials to a digital format without incorporating a learning approach that promotes a deeper understanding of history. Second, research related to STEAM in history education has not yet been integrated into teaching materials. Based on these two research gaps, this study offers a novelty in the development of digital history e-module teaching materials specifically designed to systematically integrate the STEAM approach as an integral part of the e-module into learning activities within the history e-module to enhance students' understanding of history. This study also demonstrates that the STEAM approach—which has traditionally been perceived as focused on science subjects—can also be applied in the field of social science education, such as history education, through the integration of technological innovations in digital E-Module instructional materials.

This study aims to develop digital instructional materials—specifically, E-Modules—that incorporate the STEAM approach as part of learning activities to enhance students' understanding of history. The urgency of this research lies in the need for digital teaching materials that are efficient, practical, and flexible—accessible anytime and anywhere—and that support the vision of 21st-century learning, which emphasizes the 4Cs (Critical Thinking, Creativity, Communication, and Collaboration) as well as digital literacy. This research is also expected to produce an E-Module that can be used by teachers and students in history classes, as well as to contribute academically to the field of knowledge, particularly regarding innovations in learning technology and history education.

METHODS

Study area

This study employs a research and development (R&D) approach, which aims to develop new products or improve existing ones. The development model used is the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model stages were used in this study to develop a STEAM-based history e-module aimed at improving students' understanding of history. To measure the effectiveness of the e-module in enhancing historical understanding, a quasi-experimental design was employed, featuring pre-tests and post-tests in an experimental class that used the STEAM-based history e-module and a control class that used conventional teaching materials.

This study was conducted at State Senior High School 3 in Ambon and State Senior High School 2 in Central Maluku. The selection of these two schools as research sites was based on the real need for innovation in digital teaching materials for history instruction. History instruction at both schools is still dominated by conventional teaching materials, while the use of STEAM-based educational technology has not yet been optimized. On the other hand, both schools possess basic ICT infrastructure and adequate teacher support, thereby enabling the implementation and testing of the STEAM-based e-modules. The subjects of this study were 2 history teachers and 128 students, divided into an experimental class ($n = 64$) and a control class ($n = 64$). The research stages using the ADDIE model are shown in Figure 1 below.

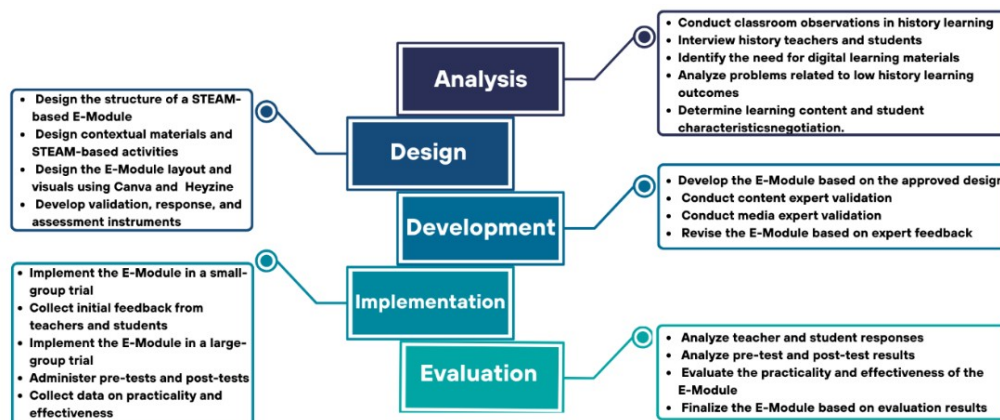


Figure 1. Stages of the ADDIE Research Model

Procedures

The development process for this E-Module follows a development procedure adapted from the ADDIE model. The development process using the ADDIE model consists of five steps: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation.

Analysis

At this stage, researchers conduct an in-depth study to ensure that the product being developed meets the needs. The analysis includes:

a. Needs Analysis

The analysis was conducted with a focus on the needs of teachers and students regarding instructional materials. The results of a preliminary study, for example, showed that students need instructional materials that are interactive, easily accessible, and combine text, images, videos, and HOTS-based exercises. Teachers also need resources that can help facilitate 21st-century learning.

b. Content Analysis

Examining the core competencies, indicators, and scope of history content relevant to the application of the STEAM approach. Content was selected based on its connection to science, technology, engineering, art, and mathematics. Based on interviews with teachers at Maluku State High School 2 and an analysis of the syllabus used, the researcher decided to select the topic “The Development of Hinduism and Buddhism in Indonesia” for this study.

c. Analysis of Student Characteristics

Identifying the background of students in Central Maluku, including their age (early adolescents), learning styles (visual, auditory, kinesthetic), level of digital literacy, motivation to learn, and their basic ability to understand historical events. This analysis is important to ensure that the STEAM-based e-modules are tailored to the students’ characteristics.

Design

During the design phase, the STEAM-based history E-Module was developed based on the results of a needs analysis and an assessment of student characteristics, using the Canva and Heyzine Flipbook applications. The design includes a systematic structure for the E-Module, covering learning objectives, concept maps, contextual materials, STEAM-based activities, and assessments. Additionally, research instruments were developed, including an expert validation form to ensure the suitability of content and media, teacher and student response forms to assess practicality, and a test instrument to assess historical understanding prior to the development phase.

Development

At this stage, the design that has been developed is realized in the form of an E-Module. Development is carried out using digital applications to support the interactive presentation of the material. The resulting content consists not only of text but is also supplemented with relevant images, animations, and videos. The integration of STEAM activities takes the form of simple projects, experiments, and creative assignments that connect historical material with other academic disciplines.

The next step in the development phase is product validation. Product validation is an evaluation process conducted by experts to ensure that the developed product meets standards of quality in terms of content, presentation, language, and usability. The purpose of this validation is to gather feedback and make improvements so that the product becomes more effective and suitable for use in learning. Once the e-module has been fully developed, it undergoes validation by experts, including subject matter experts, media specialists, and education practitioners. The results of this validation are used to revise and refine the e-module before it is pilot-tested.

Implementation

The next stage is implementation, which involves applying the revised e-module—based on expert validity assessments and practicality survey results—through pilot testing with a small group. Once the product is deemed suitable for use, implementation is carried out with a broader group. The purpose of this implementation stage is to determine the effectiveness of the developed e-module in a broader, real-world learning context. In addition, the implementation phase also aims to assess the extent to which the e-module can improve students’ historical understanding of the learning material, as well as to identify any obstacles that may arise during classroom implementation.

Before the e-module product is implemented in a large group, a pre-test is first administered to the students. This pre-test aims to assess students’ initial proficiency regarding the material to be studied, thereby serving as a baseline for measuring improvements in learning outcomes following the use of the e-module.

During the implementation phase, students are divided into two groups: an experimental class and a control class. The experimental class is the group that is given the treatment of using the e-module in the learning process, while the control class does not use the e-module and continues to use the conventional learning methods typically applied by teachers.

Evaluation

The evaluation phase was conducted after implementation to assess the effectiveness of the e-module in improving students' understanding of history. The research design used in the evaluation phase was a pretest-posttest control group design. In this design, the research subjects were divided into two groups: the experimental class and the control class. Both classes took a pretest to determine the students' initial abilities before the intervention. Next, the experimental class received the treatment in the form of the e-module, while the control class used conventional instruction. After the treatment was completed, both classes took a posttest to measure improvements in learning outcomes. The experimental design can be illustrated as follows:

Table 1. Group Experimental Design

Group	Pre Test	Perlakuan	Post Test
Exsperiment	O1	X	O2
Controll	O3	-	O4

Notes:

O1: Pre-test experimental class

O2: Post-test experimental class

O3: Pre-test control class

O4: Post-test control class

X: Instruction using the E-Module

- : Instruction without the E-Module

Data analysis in this study employed both quantitative and qualitative approaches to assess the validity, practicality, and effectiveness of STEAM-based e-modules in history education. Quantitative data from teacher and student questionnaires, as well as the results of validation by subject matter experts and media experts, were analyzed using percentage calculations to assess the level of practicality and suitability of the e-modules. The assessment was conducted using a questionnaire instrument with a Likert scale consisting of five rating criteria (Excellent, Good, Fair, Poor, Very Poor), which were then analyzed using the feasibility percentage formula, namely:

$$P = \frac{F}{N} \times 100\%$$

Notes:

P : Percentage

F : Total Score Obtained

N : Maximum Score

[19].

The validity level of a product is determined based on the calculated percentage of scores obtained from evaluations by subject matter experts and media experts. This percentage is then interpreted using the validity criteria in Table 1 to determine the suitability level of the developed product.

Table 2. Eligibility Criteria Based on Percentage Scores (%)

Percentage (%)	Criteria	Notes
81–100	Highly Valid	The product is highly suitable for use without revisions
61–80	Valid	The product is suitable for use with minor revisions
41–60	Moderately Valid	The product is moderately suitable for use with revisions
21–40	Less Valid	The product is less suitable for use and requires major revisions
0–20	Invalid	The product is not suitable for use

Data analysis was conducted quantitatively by comparing the pre-test and post-test results of the experimental and control classes using IBM SPSS 31 statistical software. The initial stage of the analysis used descriptive statistics to determine the mean and standard deviation for each class. Before conducting inferential testing, the post-test data were assessed for normality and homogeneity. If the normality test indicated that the data were normally distributed and the homogeneity test indicated that the variances of the two groups were homogeneous, hypothesis testing proceeded using a parametric statistical test, namely the independent samples t-test; however, if the results of the prerequisite tests indicate that the data are not normally distributed or the variances are not homogeneous, then hypothesis testing is conducted using non-parametric statistical tests. For paired data, such as comparisons of pre-test and post-test scores within a single group, the Wilcoxon test is used. Meanwhile, for two unrelated (independent) groups, the Mann-Whitney test

is used. The decision criteria are based on the significance level (p-value); if $p < 0.05$, this indicates a significant difference between the two groups [20]. To assess improvements in historical understanding, an N-Gain analysis was conducted by comparing the pre-test and post-test scores for each class. The following are the N-Gain calculations.

$$\text{Gain Score} < g > = \frac{X_2 - X_1}{MS - X_1}$$

Notes :

X_2 : Average Post-Test Score

X_1 : Average Pre-Test Score

MS : Maximum Score

An interpretation of the degree of improvement in students' historical understanding based on N-Gain scores can be seen in Table 2 below.

Table 3. Interpretation of the N-gain Value (g)

N-Gain Score (g)	Kategori
$g \geq 0,70$	High
$0,30 \leq g < 0,70$	Medium
$g < 0,30$	Low

Qualitative data analysis was conducted descriptively to reinforce the results of the quantitative analysis. Qualitative data, in the form of suggestions and feedback from subject matter experts and media experts, were used to identify the strengths, weaknesses, and necessary improvements to the E-Module. In addition, open-ended responses from teachers and students were analyzed to describe their learning experiences, perceptions of the module's usefulness, and challenges encountered during the use of the STEAM-based E-Module. The results of the qualitative and quantitative data analyses were then used as the basis for refining the E-Module before its widespread implementation.

RESULTS AND DISCUSSION

Proses Pengembangan Produk Awal

The development of Science, Technology, Engineering, Arts, and Mathematics (STEAM)-based History e-modules began with the analysis phase of the ADDIE model. The analysis was conducted through classroom observations and interviews with History teachers to identify instructional material needs, content characteristics, and student characteristics. The analysis results showed that history instruction is still dominated by the use of textbooks as the primary learning resource. This situation results in instruction that is not yet fully contextual and does not optimally provide opportunities for students to actively engage in the learning process.

These findings indicate a need for instructional materials that not only present historical information but also provide a more interactive and contextual learning experience. The use of e-modules is one such alternative, as they allow history content to be presented through a combination of text, images, videos, links to digital sources, quizzes, and learning activities. The integration of the STEAM approach is further designed to broaden students' learning experiences by linking historical concepts to science, technology, engineering, art, and mathematics. Thus, e-modules serve not only as a source of information but also as a tool that encourages students to explore, connect, and apply their knowledge.

In terms of content, an analysis of the teaching modules used by teachers and the results of discussions indicate that the development of Hindu-Buddhist religion and culture in Indonesia was selected as the subject matter for the e-module for Phase E, 10th-grade students. This selection was based on the nature of the subject matter, which enables students to examine historical artifacts and cultural development from various perspectives. These characteristics provide opportunities to integrate STEAM elements into history learning activities so that the material is not merely understood as a series of facts and events but also as part of the process of interpreting and exploring cultural heritage.

An analysis of student characteristics reveals a tendency toward learning that is visual, digital, and involves hands-on activities. Based on interviews with teachers, students find it easier to understand the material when learning is supported by visual aids and digital media. Their interest in learning also tends to increase when students are engaged in discussions, exploration, and the creation of learning products, compared to learning dominated by lecture-based methods.

These findings served as the basis for determining the characteristics of the product being developed. The e-module was designed by combining written material, visual elements, digital learning resources,

exploratory activities, and activities that enable students to produce learning outcomes. The integration of STEAM into the e-module is thus not only based on the requirement to use technology but is also tailored to students' learning needs and characteristics. The results of this analysis then serve as the foundation for the product design and development phase to ensure that the resulting e-modules are relevant to the history learning needs in schools.

The results of the analysis of learners' needs and characteristics then serve as the foundation for the design phase. At this stage, the e-module is designed as interactive, contextual, and learner-centered digital instructional material by integrating the STEAM approach and project-based learning activities. The product design is organized in the form of a blueprint that includes the e-module's structure, visual presentation, learning content, interactive features, STEAM activities, and assessment tools.

The structure of the e-module is organized systematically, beginning with the introduction, followed by the presentation of content, learning activities, reinforcement, and evaluation. This structure is designed to allow students to follow the learning sequence step by step while also providing them with the opportunity to explore the material independently. The content focuses on the process of the introduction and development of Hindu-Buddhist religion and culture in Indonesia, divided into two learning activities. The first activity discusses historical sources and theories regarding the introduction of Hindu-Buddhist traditions, while the second activity explores the interaction and acculturation of Hindu-Buddhist culture with local cultures, as well as their influence on the lives of the Indonesian people.

Visually, the e-module design features a consistent layout, harmonious color schemes, and typography that distinguishes the hierarchy of information. Blue and white are used as the dominant colors, while different font combinations are applied to differentiate between titles, subtitles, and the main content. The main text uses a highly legible font. In addition, the material is supplemented with relevant images and videos, such as maps of the routes of Hindu-Buddhist influence, key figures and theories regarding the introduction of Hinduism and Buddhism, as well as cultural heritage sites like Prambanan Temple. The use of these visual elements is designed to support learners who tend to rely on visual aids and digital media to understand the material.

Interactivity is one of the key features of this product. The e-module integrates Google Forms for diagnostic tests and evaluations, Quizizz for reinforcement quizzes at the end of each section, and a virtual tour feature to give students the opportunity to visually explore historical sites. The integration of these various media means that the e-module not only serves as a medium for delivering content but also provides activities that allow students to explore and receive feedback throughout the learning process.

The integration of the STEAM approach is realized through the project "Tracing the Routes and Processes of the Introduction of Hinduism and Buddhism in Indonesia." In this project, students are guided to examine maps and historical sources, identify the factors behind the introduction of Hinduism and Buddhism to the Indonesian archipelago, design digital products, and visualize trade routes and the spread of culture. The Science component is applied through the observation and analysis of historical sources; Technology through the use of digital applications; Engineering through the product design process and problem-solving; Arts through the visual design of maps, posters, or videos; while Mathematics is applied through the use of scale, distance, proportion, and spatial representation in the products created.

Table 4. STEAM Activity Plan

STEAM Components	Implementation in e-modules	Student Activities	Competencies Developed
Science	Analysis of historical sources and maps	Identifying evidence and factors related to the introduction of Hinduism and Buddhism	Analysis
Technology	Canva, Google Earth, PowerPoint	Creating digital products	Digital literacy
Engineering	Route/distribution design	Developing solutions and products	Problem solving
Arts	Visual design of maps/infographics/videos	Developing historical representations	Creativity
Mathematics	Scale, distance, proportion	Interpreting spatial data	Reasoning

The project design demonstrates that integrating STEAM into history education can be achieved by linking historical concepts to investigative activities, digital technology, creativity, and problem-solving. Students are not only guided to recall the theories behind the arrival of Hinduism and Buddhism but also to use them to analyze the relationships between trade, cultural interactions, and the spread of religion across the Indonesian archipelago. Thus, the design of activities in the e-module is aimed at fostering students' active engagement while strengthening their understanding of historical processes.

During the design phase, assessment instruments were also developed to evaluate the quality and effectiveness of the product. These included subject matter expert validation sheets, media expert validation sheets, test item validation sheets, usability surveys for teachers and students, and a historical comprehension test. These instruments were prepared as part of the development process to ensure that the resulting e-module

meets the criteria for feasibility, usability, and effectiveness. Thus, the design phase produced an e-module design that integrates three main components: history content, digital technology, and STEAM activities. This design then served as the foundation for realizing the product during the development phase, including the processes of creating, validating, revising, and refining the e-module before its implementation in the classroom.



Figure 2. E-Module Design Layout



Figure 3. Barcode Display for E-modules in Flipbook Format

During the development phase, the e-module designs are further developed into digital learning products that can be used immediately. Once the e-modules are finalized and converted into a digital flipbook format, they are ready to be validated by experts before being pilot-tested with students. The e-modules are distributed via links that can be accessed online, making it easy for students to access the material anytime and anywhere. In addition, the e-modules are also equipped with barcodes (QR codes) that can be scanned using digital devices, making access to the e-modules more practical, fast, and efficient, and accessible via the link. (<https://heyzine.com/flip-book/3005b99bd9.html>).

The e-modules developed were then validated by subject matter experts and media experts to assess the appropriateness of the content, the accuracy of the material presentation, and the quality of the presentation and practicality of the media. The validation results are used as the basis for revising and refining the e-modules before they are implemented in the classroom. Material validation in this study involved a subject-matter expert, namely Prof. Dr. Miftahuddin, M.Hum, a faculty member in the History Education Program at Yogyakarta State University. The subject matter expert was selected based on their expertise in Indonesian history, specifically covering the material addressed in the e-module—namely, the Hindu-Buddhist period of Indonesian history—as evidenced by the courses they teach, the research they have conducted, and their published works. The results of the content validation test, using assessment indicators including Introduction, STEAM Approach, Content, Evaluation, and Conclusion, received a score of 95%. Meanwhile, for the media validation process in this study, the researcher involved a media expert, Alifi Nur Prasetya Nugroho, S.Pd, M.Pd, a lecturer in the History Education Program at Yogyakarta State University. The media expert validator was selected based on the qualifications of the courses taught, research conducted, and published works related to the development of instructional media. Media validation included assessment indicators such as visual appearance, navigation, content, activities, and conclusion. The results of the media validation test, using assessment indicators for visual appearance, navigation, content, activities, and conclusion, yielded a score of 96%. The results of the content and media validation can be seen in the following table.

Table 5. Results of the material validation

Indicator	Number of Items	Score	Average
Introduction	5	25	5,00
STEAM Approach	6	28	4,67
Content	6	28	4,67
Evaluation / Exercises	4	18	4,50
Conclusion	3	15	5,00
$\sum X$		4,77	
Percentage (%)		95%	
Category		Excellent	

Table 6. Hasil Validasi Media

	Indicator	Number of Items	Score	Average
Visual Display	5	23	4,60	
Navigation	6	30	5,00	
Content	6	28	4,67	
Activity	4	19	4,75	
Conclusion	4	20	5,00	
$\sum \frac{X}{n}$	4,80			
Percentage (%)		96%		
Category		Excellent		

During the implementation phase, the e-modules that had been developed and deemed suitable for use were then pilot-tested with students as part of the learning process. The pilot test was first conducted with a small group consisting of 36 students from Class X6 at Ambon State High School 3, 30 students from Class X2 at Central Maluku State High School 2, and two history teachers to assess the practicality of using the e-modules.

Table 7. Partisipan

School	Class	Group	Number
SMA Negeri 3 Ambon	X6	Experiment	36
	X7	Controll	30
SMA Negeri 2 Maluku Tengah	X2	Experiment	36
	X3	Controll	30

A large-scale pilot study was then conducted to determine the effectiveness of the e-module in a broader learning context. The participants in the large-scale pilot study included 132 students from two different schools: Ambon State High School No. 3 and Central Maluku State High School No. 2. These participants were divided into an experimental class, which used the e-module as teaching material, and a control class, which used conventional teaching materials. Before instruction began, students in both groups took a pre-test to assess their initial proficiency. Subsequently, the learning process was conducted using the e-module in the experimental class, which was equipped with interactive features, learning activities, and STEAM-based projects. Meanwhile, the control class participated in learning without using the developed e-module. After the learning process was completed, students took a post-test to measure their learning outcomes. The results from this implementation phase were then used as the basis for evaluating the developed product.

During the evaluation phase, an analysis was conducted on the data collected during the implementation process to assess the quality of the developed e-modules in terms of feasibility, practicality, and effectiveness. The evaluation was conducted comprehensively by analyzing the data from the product pilot test. The analysis included a comparison of pretest and posttest results between the experimental and control groups to ensure that the instruments used met the necessary criteria. Next, normality and homogeneity tests were conducted to determine the appropriate type of hypothesis test to use. Hypothesis testing was performed to identify differences in learning outcomes between the experimental and control classes, using either parametric (t-test) or nonparametric tests, depending on the results of the prerequisite tests. Additionally, an effectiveness analysis using N-gain was conducted to assess the improvement in students' understanding of history following the use of the e-module.

The overall results of the descriptive statistical analysis showed that in the experimental class, the mean pretest score was 60.53, with a minimum score of 40 and a maximum of 75, and a standard deviation of 8.092. After the treatment, the mean posttest score increased to 88.33, with a range of 75 to 100 and a standard deviation of 5.905. This indicates a fairly significant improvement in learning outcomes as well as a more homogeneous distribution of scores following the treatment. Meanwhile, the control class had a pretest mean score of 59.92, with a minimum score of 45 and a maximum of 75, and a standard deviation of 7.869. On the posttest, the mean increased to 71.89, with a score range of 60 to 85 and a standard deviation of 7.058. These descriptive analysis results serve as the basis for further statistical testing.

Table 8. Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pretest Experiment	66	40	75	60,53	8,092
Posttest Experiment	66	75	100	88,33	5,905
Pretest Controll	66	45	75	59,92	7,869
Posttest Controll	66	60	85	71,89	7,058

Descriptive Statistics		
Valid N (listwise)	66	

Prerequisite tests were conducted prior to hypothesis testing to determine the appropriate statistical analysis techniques. The Kolmogorov–Smirnov test for normality indicated that the pretest and posttest data for both the experimental and control groups were not normally distributed. The significance values for each group were, in order, 0.001 for the experimental pretest, 0.001 for the experimental posttest, 0.009 for the control pretest, and 0.000 for the control posttest. All of these values were less than 0.05, so the assumption of normality was not met. Meanwhile, the results of the homogeneity test using Levene’s Test showed a Levene statistic of 1.924 with a significance value of 0.126. This value is greater than 0.05, so the variances of the data across groups are considered homogeneous. Based on the results of these prerequisite tests, hypothesis testing was conducted using nonparametric statistical techniques, namely the Wilcoxon Signed-Rank Test and the Mann–Whitney U Test.

Table 9. Test of Normality

Tests of Normality				
Class		Kolmogorov-Smirnov ^a		
		Statistic	df	Sig.
Result	Pretest Experiment	0,149	66	0,001
	Posttest Experiment	0,199	66	0,001
	Pretest Controll	0,128	66	0,009
	Posttest Controll	0,166	66	0,000
a. Lilliefors Significance Correction				

The results of the Wilcoxon Signed-Rank test indicate a significant difference between the pretest and posttest scores in both groups. In the experimental class, the Z-value was -7.121 with an Asymp. Sig. (2-tailed) of 0.000, while in the control class, the Z-value was -7.213 with an Asymp. Sig. (2-tailed) of 0.000. Both significance values are less than 0.05, indicating a significant difference between pre- and post-instruction learning outcomes in both the experimental and control classes.

Table 10. Wilcoxon rank test

Test Statistics ^a		
	Posttest Eksperimen - Pretest Eksperimen	Posttest Kontrol - Pretest Kontrol
Z	$-7,121^b$	$-7,213^b$
Asymp. Sig. (2-tailed)	0,000	0,000
a. Wilcoxon Signed Ranks Test		
b. Based on negative ranks.		

Furthermore, the results of the Mann–Whitney U test on the posttest scores indicated a significant difference between the experimental class and the control class. The analysis results showed a Mann–Whitney U value of 170.000, $Z = -9.231$, and Asymp. Sig. (2-tailed) = 0.000. With a significance level less than 0.05, it can be concluded that there is a significant difference in learning outcomes between students who participated in the STEAM-based E-Module instruction and those in the control class. These findings indicate that the use of the STEAM-based E-Module yields learning outcomes that are statistically different from those of the control class.

Table 11. Mann – Whitney test

Test Statistics ^a	
	Hasil
Mann-Whitney U	170,000
Wilcoxon W	2381,000
Z	-9,231
Asymp. Sig. (2-tailed)	0,000
a. Grouping Variable: Kelas	

The subsequent analysis utilized the N-Gain analysis. The N-Gain analysis was used to measure the level of improvement in students’ historical understanding following the use of the e-module. Based on the calculations in the table, the average N-Gain score for the experimental class was 0.7152, with a minimum of 0.43 and a maximum of 1.00. This value falls into the high category. Meanwhile, the control class achieved an

average N-Gain score of 0.3021, with a minimum of 0.13 and a maximum of 0.50, which falls into the moderate category.

When expressed as a percentage, the average N-Gain in the experimental class was 71.52%, while in the control class it was 30.21%. This indicates that the improvement in learning outcomes in the experimental class was at a higher level of effectiveness compared to the control class. Thus, it can be concluded that the use of the developed E-Module is effective in improving students' understanding of history, even falling into the high-effectiveness category (≥ 0.70). Meanwhile, learning in the control class showed improvement only in the moderate category. This finding reinforces the results of previous tests that the treatment administered to the experimental class had a more optimal impact on improving learning outcomes.

Table 12. N-Gain score test

	N	Class	Mean	Std. Deviation
N-gain Score	66	Experiment	0,7152	0,012540
	66	Controll	0,3021	0,09154
N-gain Percent	66	Experiment	71,5213	12,53970
	66	Controll	30,2130	9,15350

Discussion

The development process began with an analysis phase that included a needs analysis, a content analysis, and an analysis of student characteristics. The analysis was conducted through the researcher's observations at Ambon State High School No. 3 and Central Maluku State High School No. 2, as well as interviews with two Indonesian history teachers. Based on the analysis results, it was found that the history learning process at both schools still predominantly relied on conventional teaching materials (textbooks), and the teaching approaches used by teachers remained conventional and centered on simple discussion methods; consequently, students were not yet actively engaged in exploratory and contextual learning activities. This situation leads to limitations in learning, as the use of textbooks as teaching materials has limitations in presenting content that requires deeper exploration. This is as stated by Boubcheur [21] the limitations of textbooks lie in their lack of hands-on activities, digital resources, and interactive tools, which make learning history less engaging and relevant for modern students.

History teaching approaches such as simple discussions without any deeper exploratory efforts do not sufficiently encourage students to understand the complexities of history—for example, how historical knowledge is formed through source analysis, interpretation, and acceptance of various perspectives [22]. This statement is supported by Clough's view, which explains that the discussion process tends to focus on basic conversation without involving students in deeper historical thinking processes, such as presenting evidence and developing data-based arguments [23]. Based on these conditions, the researchers suggest a need for flexible instructional materials that can be used anytime and anywhere, are available in digital format to accommodate students' circumstances in the digital age, include in-depth exploratory activities, and employ a learning approach that enables students to analyze historical narratives from various academic perspectives.

Based on an analysis of the problems encountered in the field and the resulting needs, the researcher decided to develop an innovative digital teaching resource—an E-Module—based on the STEAM approach. The researcher chose the E-Module as the product to develop because it allows students to learn anytime and anywhere, and is relevant in the digital age and for 21st-century learning[24]. In addition, Module E supports both online and in-person learning and incorporates technology and interactive media to help students understand abstract concepts [25], [26]. Meanwhile, the STEAM approach was chosen as the learning approach based on previous research indicating that the STEAM approach integrates various disciplines to provide a rich learning experience and is designed to solve real-world problems through methods such as project-based learning (PjBL), gamification, and digital literacy [27], [28].

The next step after identifying the necessary requirements was to analyze the content to be included in the e-module to be developed. Based on the results of interviews with teachers and an analysis of the curriculum for the even semester, it was decided that the content for the e-module would focus on the introduction and development of Hindu-Buddhist religion and culture in Indonesia, which is covered in the 10th-grade curriculum (Phase E) for the even semester. This material was selected because it has a broad scope—it not only discusses historical events but also covers cultural development, belief systems, temple architecture, reliefs, and social interactions during the Hindu-Buddhist period in Indonesia—making it highly relevant for developing into a more contextual and interactive learning experience. Furthermore, this material has strong ties to the STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning approach, which can

be applied through the analysis of historical facts and the process by which Hindu-Buddhist influences entered Indonesia, as well as the use of digital media and educational videos within the E-Module.

Based on an analysis of student characteristics, it is evident that the majority of students still have limited experience learning history. Students have never visited historical sites in person, such as Hindu-Buddhist heritage sites, so their understanding of historical material remains abstract and theoretical. Furthermore, the learning process to date has tended to focus on the use of textbooks as the primary learning resource, without accompanying in-depth exploratory activities. This situation has resulted in students lacking contextual experience in understanding historical relics and being unable to connect the learning material to the cultural and historical realities of their surrounding environment. Therefore, an innovative learning approach is needed that can provide a more interactive, exploratory, and contextual learning experience through the use of STEAM-based e-modules so that students can understand historical material in a deeper and more meaningful way.

The next stage in the development process is to design the e-module product by creating a preliminary design (blueprint) for the e-module. The design is tailored to the findings obtained by the researchers during the analysis stage [29]. The design process begins with designing the structure of the e-module so that it is developed with a systematic flow. The resulting e-module structure includes a cover page, an identification page, a foreword, a table of contents, a glossary, an introduction, a diagnostic test, learning activities, a final assessment, and a closing page. The introduction section includes a detailed description of the e-module's identity, a description of the e-module, instructions for use, learning outcomes, learning objectives, thought-provoking questions, the learning environment, the Pancasila learner profile, media and tools, the learning approach, instructional materials, and a concept map. Each learning activity includes the learning activity objectives, learning steps, material description, material summary, STEAM project, quiz, reflection, and assessment. This e-module structural framework was then developed into an initial draft for further refinement.

After organizing the content structure of the e-module, the next step is to design its visual layout. An engaging and interactive design boosts motivation and interest in learning [30]. From a technical standpoint, the visual presentation consists of layout design, color selection, typography (font size and type), the use of images and videos, and interactive features. The layout of the e-module is designed consistently across every page to facilitate navigation and enhance readability. A clear visual layout and a user-friendly interface make the e-module easily accessible and practical for learning [31]. Color selection significantly affects readability, recall, and trust in e-learning platforms [32]. For this reason, the color scheme is tailored to the theme of the material and takes visual comfort into account. The color palette in the e-module is dominated by blue and white.

Typography—or matters related to font size and type—is an important element in any medium, or in this study, the E-Module. Electronic instructional materials with font sizes that are too small (10 pt) can affect readability for students; therefore, the choice of font size must ensure readability [33]. Meanwhile, interesting font styles can increase students' interest in reading and understanding the text [34]. In the design of the e-module, the researchers selected a font size and type that are easy to read. The Anton font is used on the title page (cover) to create a bold impression and draw attention. Furthermore, the “Archivo Black” font is used for subtitles to clarify the structure of the material and help learners identify key sections within the e-module. Additionally, the “Gagalin” font is used as a supporting element in specific sections—such as to emphasize information or serve as a decorative element—to enhance visual appeal. Meanwhile, the Open Sans font is used for the main text (content) because of its high readability, making it easier for students to understand the learning material. Font sizes are adjusted to distinguish between the title (39), subtitle (34), secondary subtitle (17), and main text (13), thereby helping students understand the structure of the information.

In the visual design of this e-module, the researchers included images and videos to support the content. Images and videos help students better understand the material by presenting information visually, which is easier to remember than text alone [35]. Images used in the e-module include a map illustrating the routes of Hindu-Buddhist transmission, key figures who proposed theories regarding the transmission of Hinduism and Buddhism, and Prambanan Temple as an example of a cultural heritage site. The videos used in the e-module were sourced from YouTube and were carefully selected to align with the course material. Interactive features have also been added to the e-module content through hyperlinks that lead to test questions, quizzes at the end of each section, and virtual tour websites to deepen students' understanding of history. The use of hyperlinks allows users to access additional resources and navigate smoothly within the module, thereby enhancing the depth of learning [36].

In addition to the technical design of the e-module, the researchers also designed the learning materials included in the e-module. The material was then divided into two separate sessions. The first session covered the process of the introduction of Hindu-Buddhist religion and culture in Indonesia, including historical

sources and theories regarding the introduction of Hindu-Buddhist religion. Next, in the second session, the material covered was the development of Hindu-Buddhist religion and culture. This material included topics such as the forms of interaction between Hindu-Buddhist culture and local cultures, their influence on community life, and the forms of acculturation between Hindu-Buddhist culture and local cultures.

The next step in the design process was to develop learning activities. The learning activities in this e-module include STEAM projects to be completed by students. STEAM projects encourage students to actively engage in learning through hands-on and creative activities. Students can create projects that combine elements of history with art and technology, thereby increasing their interest in historical material. In the final stage of the design process, the researcher designed the instruments used in this study, including an expert validation instrument, a questionnaire on the practicality of the e-module for teachers and students, and test questions to measure students' understanding of history. The results of this design then served as the foundation for developing a digital teaching resource during the development phase.

The next stage in the product development process is to transform the designed outcomes into a finished e-module product. To develop the e-module from the initial draft into a finished product for this study, the researcher used the Canva and Heyzine Flipbook applications. Canva was used to design the e-module's interface to make it more engaging, interactive, and easy for students to understand. Canva was used to organize the layout, select colors, position images, icons, typography, and other visual elements so that the e-module's appearance would be more systematic and aesthetically pleasing.

The effectiveness of the STEAM-based e-modules in this study was assessed based on the results of a practicality test conducted by teachers and students, as well as improvements in student learning outcomes as measured by pretest and posttest scores. Based on the results of the practicality test, both teachers and students responded positively to the use of the e-modules in the learning process. The results of the practicality survey administered to teachers and students—covering aspects such as content, media, and language—yielded average scores of 4.66 and 4.58, respectively, placing the e-module's use in the “very good” category. The e-module was rated as easy to use, engaging, interactive, and helpful in enabling students to understand the material on the introduction and development of Hindu-Buddhist religion and culture in Indonesia. Furthermore, the integration of images, videos, STEAM-based learning activities, and a digital flipbook interface made the learning process more engaging and less monotonous compared to the use of conventional teaching materials.

The effectiveness of the e-module is also evident from the improvement in students' learning outcomes. Based on the results of the descriptive analysis, the average pretest score in the experimental class was 60.53, increasing to 88.33 on the posttest. Meanwhile, in the control class, the average pretest score was 59.92, increasing to 71.89 on the posttest. These results indicate that the improvement in student learning outcomes in the experimental class was greater than that in the control class. Furthermore, the results of the Wilcoxon and Mann-Whitney tests revealed a significant difference in student learning outcomes, while the N-Gain test results showed that the experimental class achieved a “high improvement” category with an average score of 0.7152.

The findings of this study indicate that the STEAM-based e-modules developed are effective in improving students' understanding of history. Previous research findings indicate that, based on effectiveness tests, the development of e-modules is capable of improving students' understanding of history [37]. The STEAM approach used in the E-Module helps students understand history by connecting historical material with various aspects of science, technology, art, and culture in a deeper and more meaningful way. Previous research indicates that the STEAM approach can be applied not only to the natural sciences (science) but also to the social sciences (social studies). By applying the STEAM approach, students can engage in learning that integrates multiple subjects and collaborate across groups [38]. The use of educational technology can play an important role in this process, enabling students to become more engaged and develop a deeper understanding of history [39]. The integration of digital instructional materials with this approach significantly enhances students' critical thinking skills and understanding of history [40].

Based on the overall results of the final product evaluation, it can be concluded that the STEAM-based e-modules developed meet the criteria of feasibility, practicality, and effectiveness as digital teaching materials for history education. The developed product not only offers a more engaging and interactive learning experience but also provides a more contextual learning experience through the integration of the STEAM approach into the material covering the introduction and development of Hindu-Buddhist religion and culture in Indonesia. Furthermore, the results of the effectiveness test show that the use of e-modules significantly improves students' understanding of history compared to conventional learning. Thus, these STEAM-based e-modules can be used as an innovative teaching resource that supports more active and creative history learning, in line with the demands of 21st-century education.

CONCLUSION

This study developed a STEAM-based history e-module on the processes of the introduction and development of Hindu-Buddhist religions and cultures in Indonesia using the ADDIE development model. The validation results indicated that the developed e-module was highly feasible, with an average score of 95% from the material expert and 96% from the media expert. In terms of practicality, the e-module received highly positive responses from teachers and students, with respective percentages of 94% and 86%. The effectiveness analysis further demonstrated a substantial improvement in students' historical understanding. The experimental group achieved an average N-Gain score of 0.7152, categorized as high, whereas the control group obtained an average N-Gain score of 0.3021, categorized as moderate. The Wilcoxon Signed-Rank Test and Mann-Whitney U Test both yielded a significance value of 0.000 ($p < 0.05$), indicating statistically significant differences in learning outcomes. These findings suggest that the STEAM-based e-module is feasible, practical, and effective as a digital instructional resource for enhancing students' historical understanding.

Despite these promising findings, several limitations should be acknowledged. First, the development was limited to a specific topic concerning the introduction and development of Hindu-Buddhist religions and cultures in Indonesia; therefore, the findings cannot yet be generalized to other history topics. Second, the study involved students from only two schools, which limits the generalizability of the findings to students with different educational and contextual characteristics. Third, the implementation of the e-module depended on the availability of digital devices and adequate internet connectivity. Fourth, the study primarily examined students' historical understanding and did not investigate the effects of the e-module on other competencies associated with STEAM learning, such as creativity, communication, collaboration, and critical thinking. Finally, the integration of STEAM and interactive features within the e-module remains relatively limited and provides opportunities for further development.

Future research should expand the development of STEAM-based digital learning resources to a wider range of history topics and involve larger and more diverse samples across different schools and educational contexts. Further studies should also develop more sophisticated interactive features and implement STEAM principles more comprehensively within history learning. In addition, future research is encouraged to examine the effects of STEAM-based e-modules on broader learning outcomes, particularly creativity, collaboration, communication, and critical thinking. For practical implementation, teachers and schools should ensure adequate access to digital devices and internet infrastructure to support the effective and sustainable use of digital learning resources.

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REFERENCES

- [1] H. Sikandar, Y. Vaicondam, N. Khan, M. I. Qureshi, and A. Ullah, "Scientific Mapping of Industry 4.0 Research: A Bibliometric Analysis," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 15, no. 18, p. 129, Sep. 2021, doi: 10.3991/ijim.v15i18.25535.
- [2] Setiawati, A. Huda, Ismaniar, and N. Ardi, "Design and Development of Android-Based E-Modul Application to Improve Prosocial Early Children by Family," *International journal of online and biomedical engineering*, vol. 19, no. 12, pp. 111–126, 2023, doi: 10.3991/ijoe.v19i12.40905.
- [3] Widya, D. Maielfi, and Alfiyandri, "Need Analysis for Physics E-Module Based on Creative Problem Solving Integrated 21st Century Skills," *J. Phys. Conf. Ser.*, vol. 1940, no. 1, p. 012110, Jun. 2021, doi: 10.1088/1742-6596/1940/1/012110.
- [4] C. Chow and M. Kordvani, "STEAM Teams," in *International Handbook of Research on STEAM Curriculum and Practice*, New York: Routledge, 2025, pp. 326–344. doi: 10.4324/9781003435488-21.
- [5] A. N. Dhita, A. R. Asmi, M. R. Pahlevi, A. Aderoben, and I. L. Rianda, "Pengembangan buku teks Sejarah lokal Kota Palembang berbasis cronological thinking," *Jurnal Inovasi Teknologi Pendidikan*, vol. 9, no. 3, pp. 328–338, Dec. 2022, doi: 10.21831/jitp.v9i3.48567.
- [6] W. C. Parker, "Backtalk: Teaching historical reasoning helps democracy thrive," *Phi Delta Kappan*, vol. 105, no. 5, pp. 66–67, Feb. 2024, doi: 10.1177/00317217241230791.

- [7] A. Christopoulos, M. Styliou, N. Ntalias, and C. Stylios, "The Impact of Immersive Virtual Reality on Knowledge Acquisition and Adolescent Perceptions in Cultural Education," *Information*, vol. 15, no. 5, p. 261, May 2024, doi: 10.3390/info15050261.
- [8] S. Fatimah, H. Hidayat, S. T. Sulistiyono, Z. Alhadi, and F. Firza, "Digital Literacy toward Historical Knowledge: Implementation of the Bukittinggi City History Website as an Educational Technology," *JOIV : International Journal on Informatics Visualization*, vol. 7, no. 4, p. 2445, Dec. 2023, doi: 10.30630/joiv.7.4.2224.
- [9] M. Issayev and T. Apendiyev, "Teaching history with the help of information and digital technologies," *E-Learning and Digital Media*, Sep. 2025, doi: 10.1177/20427530251379080.
- [10] M. U. Tariq, "Enhancing Students and Learning Achievement as 21st-Century Skills Through Transdisciplinary Approaches," 2024, pp. 220–257. doi: 10.4018/979-8-3693-3699-1.ch007.
- [11] N. S. Utami and A. Nurlaela, "The influence of STEM (science, technology, engineering, and mathematics) learning approach on students' learning outcomes on newton's law concept," *J. Phys. Conf. Ser.*, vol. 1836, no. 1, p. 012066, Mar. 2021, doi: 10.1088/1742-6596/1836/1/012066.
- [12] M. H. Land, "Full STEAM Ahead: The Benefits of Integrating the Arts Into STEM," *Procedia Comput. Sci.*, vol. 20, pp. 547–552, 2013, doi: 10.1016/j.procs.2013.09.317.
- [13] A. D. Mohd Hawari and A. I. Mohd Noor, "Project Based Learning Pedagogical Design in STEAM Art Education," *Asian Journal of University Education*, vol. 16, no. 3, p. 102, Oct. 2020, doi: 10.24191/ajue.v16i3.11072.
- [14] M. J. Jufri, R. Darini, M. Budiman, A. N. Kinanti, I. Z. Aolafasila, and T. H. Darmawan, "Critical Thinking and Historical Understanding in History Learning: A Systematic Literature Review and Bibliometric Analysis," *Jurnal Pendidikan Progresif*, vol. 15, no. 4, pp. 2621–2651, Dec. 2025, doi: 10.23960/jpp.v15i4.pp2621-2651.
- [15] A. Sa'adah and A. Sapto, "PENGEMBANGAN BAHAN AJAR E-MODUL MULTIMEDIA BERBASIS FLIP PDF CORPORATE MATERI REVOLUSI NASIONAL DI MALANG (1945-1949) UNTUK PEMBELAJARAN SEJARAH PESERTA DIDIK KELAS XI SMA PANJURA MALANG," *JPSI*, vol. 8, no. 1, p. 118, 2025.
- [16] A. I. Swastika and S. S. P. Jati, "PENGEMBANGAN BAHAN AJAR E-MODUL BERBASIS CANVA MATERI MANUSIA PURBA INDONESIA UNTUK PEMBELAJARAN SEJARAH KELAS X IPS 5 DI SMAN 1 SUMBERPUCUNG MALANG," *Jurnal Pendidikan Sejarah Indonesia*, vol. 6, no. 2, p. 300, Dec. 2023, doi: 10.17977/um0330v6i2p300-321.
- [17] D. Lestari, N. Ibrahim, and C. Iriani, "STEAM: Science, Technology, Engineering, Art, and Mathematics on History Learning in the 21st Century," *Journal of Education Research and Evaluation*, vol. 7, no. 2, pp. 306–312, May 2023, doi: 10.23887/jere.v7i2.44172.
- [18] Sumardi, Dafik, I. L. Mursyidah, E. S. W. Jannah, and Z. R. Ridlo, "The implementation of RBL-STEAM with pictorial riddle and augmented reality in improving students' historical thinking skill," *Edelweiss Applied Science and Technology*, vol. 8, no. 4, pp. 213–237, May 2024, doi: 10.55214/25768484.v8i4.1163.
- [19] Sugiyono, *Metode Penelitian Kuantitatif Kualitatif dan R&D*, Kedua. Bandung: Alfabeta, 2019.
- [20] S. Arikunto, *Prosedur Penelitian Suatu Pendekatan Praktik*, 15th ed. Jakarta: Rineka Cipta, 2013.
- [21] H. Boubcheur, M. Suiyhi, M. El Qryefy, Y. El Madhi, N. Chahboune, and H. Sfouli, "Evaluation of physical science textbooks in moroccan middle and high schools: Teachers' perspectives," *Multidisciplinary Science Journal*, vol. 8, no. 6, p. 2026381, Nov. 2025, doi: 10.31893/multiscience.2026381.
- [22] M. Kainulainen, M. Puurtinen, and C. A. Chinn, "Regrounding Inquiry-Based Learning in History: A Study of Historians' Epistemic Processes," *Cogn. Instr.*, vol. 43, no. 4, pp. 291–315, Oct. 2025, doi: 10.1080/07370008.2025.2503193.
- [23] C. Clough, "Discussion-Based Instructional Methods," in *Effective Teaching*, New York: Routledge, 2024, pp. 217–234. doi: 10.4324/9781003523956-9.
- [24] A. P. Lubis, E. Ellizar, and R. Zainul, "Preliminary Study of Development of Chemical Equilibrium E-Module Integrated Virtual Laboratory for High School Students," *J. Phys. Conf. Ser.*, vol. 2582, no. 1, p. 012063, Sep. 2023, doi: 10.1088/1742-6596/2582/1/012063.
- [25] W. Azura, A. Silalahi, M. Zubir, and Nurfajriani, "The Science Environment Technology Society (SETS) based e-module development with project based learning model in colloidal learning," *J. Phys. Conf. Ser.*, vol. 2157, no. 1, p. 012046, Jan. 2022, doi: 10.1088/1742-6596/2157/1/012046.
- [26] D. K. R. A. Asih, Sunyono, and D. Yulianti, "Developing steam based e-module to improve creative thinking skill of grade V students on my blood circulation material," 2023, p. 020001. doi: 10.1063/5.0169603.
- [27] F. Roshayati, V. Purnamasari, A. Wijayanti, P. Balqis, and E. S. Setianingsih, "The potential of STEAM (science technology engineering art and mathematics) based learning in curriculum 2013 for 5th of elementary school," 2023, p. 030034. doi: 10.1063/5.0128019.
- [28] A. K. Segarra-Morales and M. Juca-Aulestia, "Strategies and Skills in STEAM Education Systematic Review of the Literature," 2024, pp. 398–411. doi: 10.1007/978-3-031-54235-0_36.
- [29] S. I. Shakeel, M. A. Al Mamun, and M. F. A. Haolader, "Instructional design with ADDIE and rapid prototyping for blended learning: validation and its acceptance in the context of TVET Bangladesh," *Educ. Inf. Technol. (Dordr.)*, vol. 28, no. 6, pp. 7601–7630, Jun. 2023, doi: 10.1007/s10639-022-11471-0.
- [30] Y. N. Dewi et al., "The Development of E-Module English Specific Purpose based on Computer Application for Vocational High School Students," *J. Phys. Conf. Ser.*, vol. 1364, no. 1, p. 012043, Dec. 2019, doi: 10.1088/1742-6596/1364/1/012043.
- [31] R. Alyusfitri, N. Gistituati, and A. Fauzan, "The Effectiveness and Relationship of Student Responses toward Learning Outcomes Using Interactive Multimedia-Based E-Modules in Elementary Schools," *International Electronic Journal of Elementary Education*, Sep. 2024, doi: 10.26822/iejee.2024.354.

- [32] J.-E. Pelet and P. Papadopoulou, "Investigating the Effect of Color on Memorization and Trust in E-Learning," in *Impact of E-Business Technologies on Public and Private Organizations*, IGI Global, 2011, pp. 52–78. doi: 10.4018/978-1-60960-501-8.ch004.
- [33] V. R. Kuchma, N. K. Barsukova, and S. V. Sankov, "Comprehensive approach to the hygienic rating of the use of electronic means for education in children," *Health Care of the Russian Federation*, vol. 64, no. 3, pp. 139–149, Jul. 2020, doi: 10.46563/0044-197X-2020-64-3-139-149.
- [34] M. J. Gardner, R. Wu, and P. R. Todd, "What the Font! The Role of Handwritten Font in Course Interest, Student Inference, and Learning Outcome," *Marketing Education Review*, vol. 34, no. 1, pp. 77–95, Jan. 2024, doi: 10.1080/10528008.2023.2290730.
- [35] S. Dadaşov, "Xarici dil dərində vizual vasitələrin rolu," *SCIENTIFIC WORK*, vol. 19, no. 5, pp. 164–167, Jun. 2025, doi: 10.36719/2663-4619/115/164-167.
- [36] S. Parusheva, B. Bankov, and G. Kasabova, "Interactive Tools in Learning Management Systems – Trends in Their Use," 2026, pp. 411–422. doi: 10.1007/978-981-96-5013-2_25.
- [37] R. N. Ramadhan, "Pengembangan e-modul tentang peristiwa Trikora untuk meningkatkan minat belajar dan pemahaman sejarah siswa kelas XI SMK PGRI 2 Malang," *Masters Thesis*, Universitas Negeri Malang, Malang, 2024.
- [38] D. Lestari, N. Ibrahim, and C. Iriani, "STEAM: Science, Technology, Engineering, Art, and Mathematics on History Learning in the 21st Century," *Journal of Education Research and Evaluation*, vol. 7, no. 2, pp. 306–312, May 2023, doi: 10.23887/jere.v7i2.44172.
- [39] D. Miguel-Revilla, M. Calle-Carracedo, and M. Sánchez-Agustí, "Fostering engagement and historical understanding with a digital learning environment in secondary education," *E-Learning and Digital Media*, vol. 18, no. 4, pp. 344–360, Jul. 2021, doi: 10.1177/2042753020957452.
- [40] S. Sariyatun, L. A. Sutimin, and N. F. Abidin, "Enhancing Historical Thinking and HOTS through Digital Learning Materials: An Inquiry-Based Approach Using Primary Sources for High School Students," *Journal of Curriculum Studies Research*, vol. 7, no. 2, pp. 228–248, Nov. 2025, doi: 10.46303/jcsr.2025.19.