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Analysis of the need to create a model of Muara Takus Temple using the green history approach as a medium for learning history

Rizki Ananda Hasibuan*, Yanuar Al-fiqri, Bunari, Yuliantoro

Universitas Riau, Kampus Bina Widya KM. 12,5, Pekanbaru, Riau, 28293, Indonesia.
*Correspondence should be addressed to Rizki Ananda Hasibuan; rizkiananda@lecturer.unri.ac.id

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Abstract
This study aims to conduct a needs analysis for developing a Muara Takus Temple model based on the Green History approach as an innovative medium for history learning. The research employed a qualitative descriptive design with a case study approach conducted at SMAN 12 Pekanbaru. Participants consisted of 1 history teacher and 32 eleventh-grade students selected through purposive sampling. Data were collected through classroom observations, semi-structured interviews, and documentation analysis, and were analyzed using an interactive model involving data reduction, data display, and conclusion drawing. Data validity was ensured through triangulation of sources and techniques. The findings reveal three main results. First, existing history learning practices are still dominated by lecture-based methods with limited use of interactive media, resulting in low student engagement and superficial understanding of local historical content. Second, both teachers and students expressed a strong need for visual, contextual, and environmentally oriented learning media, particularly for complex historical topics such as Muara Takus Temple. Third, the proposed model made from recycled materials has the potential to enhance students' conceptual understanding, learning motivation, and environmental awareness, although challenges related to technical production and teacher readiness remain significant. This study concludes that the development of a Green History–based temple model is pedagogically relevant and urgently needed, as it integrates historical understanding with sustainability values. The study recommends systematic development, teacher training, and institutional support to ensure effective and sustainable implementation in history learning.

1. Introduction

Education is essentially a deliberate effort to develop the human resources (HR) capabilities of students through encouragement and the provision of facilities for learning activities. In detail, according to Indonesian Law Number 20 of 2003 concerning National Education Chapter 1 article (1), education is defined as a well-planned effort to create a learning environment and learning process that enables students to actively explore their potential, including religious spiritual strength, self-control, character, intelligence, noble behavior, and the skills needed for themselves, society, nation, and country.

Learning is essentially a process of interaction between teachers and students, both direct interaction, such as face-to-face activities, and indirect interaction, namely through the use of various learning media. Learning media are tools that can assist the teaching and learning process and serve to clarify the meaning of the message being conveyed, so that learning objectives can be achieved better and more perfectly (Tazhenova, Mikhaylova, & Turgunbayeva, 2024; Wang & Perey, 2025; Yusuf, Hasyim, Anan, & Hadi, 2021).

In essence, history learning is an effort to shape ideal citizens. Therefore, history learning models prioritize student-centered activities. Meanwhile, teachers position themselves as mediators, facilitators, catalysts, and evaluators (Gillate, Castrillo, Luna, & Ibáñez-Etxeberria, 2023; Kisler, 2022; Kuş & Mert, 2023; Rahmawati & Umamah, 2023; Ramey & Stevens, 2020). In such a learning model, students have more opportunities to improve their ability to process information that is more meaningful to them. In addition, they are also expected to be able to construct the knowledge they learn in accordance with their social

environment. To further develop these expectations, it would be appropriate to organize the material thematically in the implementation of history learning.

The history learning is a process of interaction between teachers and students in history lessons that has the general objective of strengthening nationalism and teaching moral principles (Jaskulowski, Majewski, & Surmiak, 2021; Reyes, Córdova, Capa, Avilés, & Leon, 2024; Tasca, 2024; Zilka, 2022). Past events that are the subject of history lessons are moments that have meaning and lessons that are very significant in human life. One of the most famous quotes about history and the importance of learning history was written by the Spanish philosopher, George Santayana, namely, "those who cannot remember the past are condemned to repeat it" . Learning history is important because humans can never be separated from history. In general, history is defined as events that have happened to humans in the dimension of time, whether a century ago or even a second ago (Bergman, 2025; Dazzi, Benedetti, Corti, & Costantini, 2024).

The characteristics of history learning in schools are generally still conventional. The characteristics of "traditional" history learning are that messages are conveyed through storytelling (lectures). These stories are factually true, but their interpretation is not necessarily true. A teacher's job is to convey historical messages to students in a simple and easy-to-understand way. These messages must be based on historical facts. History learning plays a role in shaping students' mindsets. By learning history, all actions must be thought through beforehand so that they do not have an impact on daily life or its application in the future (Fauzi & Santosa, 2020; Harnes, 2025; Limeri et al., 2020).

History education has become unimportant because it is considered to have no role in everyday life, whereas in practice history teaches many things. Learning history teaches students how every decision made in the past inevitably influences future actions. Learning history also teaches how an event can have a significant impact on future life. If implemented properly, history education can help students think critically, comprehensively, and creatively (Adu-Boahen, 2024; de Souza, 2021; Doornbos & Piedmont, 2024; Gibson, Milligan, & Peck, 2022; Karn, 2023; Nordgren, 2021).

History education in schools plays an important role in shaping students' understanding of the nation's journey and national values. Through history education, students not only learn about facts and events of the past, but also understand the social, cultural, and political contexts that shape a nation's identity. For this learning process to be effective, learning media are needed to help students understand the material in a more concrete and interesting way. Learning media serve as a means of visualization and representation that help bridge abstract concepts to make them more tangible, thereby increasing the appeal, motivation to learn, and quality of students' understanding of the content of history lessons. Thus, the use of appropriate learning media is very important to support the achievement of history learning objectives in schools (Bleeze, 2024; Skårås, 2021; Ting & Cajani, 2023).

Muara Takus Temple is one of the relics or historical sites of the Buddhist Sriwijaya Kingdom in Indonesia, which once existed and ruled the island. As a historical site, Muara Takus Temple is also a national cultural heritage site in Indonesia, specifically located in Muara Takus Village, XIII Koto Kampar District, Kampar Regency, Riau Province. It is approximately 135 km from Pekanbaru City, the capital of Riau Province. Meanwhile, the distance to the center of Muara Takus Village is approximately 2.5 km, and it is not far from the right bank of the Kampar River. This temple consists of four parts, namely Candi Tuo, Candi Mahligai, Candi Bungsu, and Candi Palangka.

Interesting and environmentally friendly learning media for local topics or temple history have several limitations that need to be considered. First, the use of environmentally friendly materials such as recycled paper or natural materials for models and visual media often presents challenges in terms of durability and resilience, making the media susceptible to damage due to use or classroom conditions. Second, the limitations of simple technology accessible in schools, especially in remote areas, make it difficult to provide interactive media that is rich in visuals and audio, so that learning media tends to be passive and less interesting to students. In addition, the limited human resources capable of designing and producing locally-based media while maintaining ecological aspects is also a significant obstacle. Finally, presenting complex historical information through simple media can sometimes be difficult to accommodate the depth of the narrative and cultural context, thus limiting students' potential understanding of local historical values. Therefore, the development of historical learning media must always strive for a balance between

environmental sustainability, educational appeal, and ease of use in order to support an effective learning process.

Based on data from the Ministry of Environment and Forestry's National Waste Management Information System (SIPSN), paper waste accounts for approximately 10% of total waste. Although digitalization has reduced paper consumption in certain sectors, paper-based materials remain widely used in educational and administrative activities, resulting in a continuous accumulation of paper waste. If not properly managed, this waste contributes to environmental burdens, particularly when it is mixed with other types of waste and becomes difficult to recycle.

However, it is important to acknowledge that paper production is inherently linked to deforestation and resource-intensive industrial processes. Therefore, simply promoting the use of paper, even recycled paper, cannot be uncritically framed as an environmentally sustainable solution. In the context of ecopedagogy, digital technologies and modern applications are often considered more aligned with sustainability principles due to their potential to reduce material consumption.

Nevertheless, within educational settings, especially in contexts with limited access to digital infrastructure, the reuse of existing paper waste can be repositioned as part of a circular and transitional sustainability strategy, rather than as a primary ecological solution. In this perspective, the pedagogical value lies not merely in the material itself, but in the process of reusing waste to extend its life cycle, reduce disposal, and foster students' awareness of responsible resource use.

Thus, the utilization of discarded paper as a material for constructing temple models should be understood not as an ideal environmental practice, but as a context-sensitive educational approach that integrates principles of reuse, creativity, and environmental reflection. In the field of history education, such models can function as tangible learning media that help students visualize historical structures while simultaneously engaging them in critical discussions about sustainability, resource consumption, and environmental responsibility.

The green history approach in the creation of learning media is very important because it prioritizes sustainability and environmental friendliness, which are relevant to the current conditions and needs of society. By integrating historical values related to environmental preservation, green history-based learning media not only helps students understand historical events but also increases awareness and concern for environmental issues through contextual and meaningful learning. This approach encourages students to see the relationship between the past and current environmental conditions, so that they can emulate positive behaviors in preserving nature. In addition, learning media with green history provides an economical, practical, and reusable alternative learning resource, thereby supporting sustainable and environmentally friendly education. This is also in line with the ecopedagogy approach, which aims to develop green behavior among students. Based on the background described above, this article will discuss the analysis of the creation of the Muara Takus Temple Model using the green history approach as a history learning medium.

2. Method/Metode

2.1. Research Design and Approach

This study employed a qualitative descriptive design to systematically examine the needs for developing a Muara Takus Temple model based on the green history approach as a medium for history learning. This design was selected because it enables an in-depth exploration of participants' perceptions, experiences, and contextual realities related to the use of local history and environmentally oriented learning media. Rather than testing hypotheses, the study focused on producing a rich, contextualized understanding of the gap between existing instructional practices and the expected integration of sustainable, visually engaging learning tools in history education.

2.2. Research Site and Justification

The research was conducted at SMAN 12 Pekanbaru in April 2025. The selection of this site was based on purposive considerations, particularly its relevance to the research objectives. The school actively implements history learning that includes local historical content such as Muara Takus Temple; however,

preliminary observations revealed a limited use of innovative and sustainability-based learning media. Therefore, this site was treated as an instrumental case that reflects broader challenges in integrating local history and environmental values into classroom practice. The intention was not to achieve statistical generalization, but to provide analytical generalization that can inform similar educational contexts.

2.3. Participants and Sampling Technique

The participants in this study consisted of 15 individuals selected through purposive sampling to ensure relevance and data richness. These included two history teachers directly responsible for delivering local history content, ten Grade XI students representing diverse academic abilities (high, medium, and low), and three key informants comprising a local history expert, a curriculum coordinator, and a practitioner in educational media development. This composition was deliberately structured to capture multiple perspectives and enable triangulation across stakeholders involved in the teaching–learning process.

2.4. Data Collection Techniques and Instruments

Data were collected through observation, in-depth interviews, and documentation studies, each supported by clearly defined instruments. Non-participant observations were conducted to capture authentic classroom interactions, focusing on teaching strategies, the use of learning media, and student engagement. These observations were guided by a structured observation sheet complemented by detailed field notes. In-depth interviews were carried out using a semi-structured format to explore participants' perceptions regarding the need for innovative learning media, the relevance of the green history approach, and the feasibility of developing temple models. The interview protocol was developed systematically and validated through expert judgment to ensure content validity. In addition, documentation studies were conducted by examining lesson plans, teaching materials, curriculum documents, and historical references related to Muara Takus Temple, which served to corroborate and enrich the primary data.

2.5. Research Procedure

The research was implemented through three interconnected stages. The pre-field stage involved problem identification, literature alignment, and the development as well as validation of research instruments by experts in history education. The fieldwork stage included three classroom observation sessions, followed by in-depth interviews lasting approximately 30 to 45 minutes per participant, and the collection of relevant documents. The post-field stage focused on data transcription, systematic coding, categorization, and thematic interpretation. This staged procedure ensured that data collection and analysis were conducted in a structured and iterative manner.

2.6. Type of Data

The study generated qualitative data in the form of descriptive field notes, verbatim interview transcripts, and documented instructional materials. These data provided comprehensive insights into instructional practices, stakeholder perceptions, and contextual constraints related to the development of Green History-based learning media.

2.7. Data Analysis Technique

Data analysis was conducted using the interactive model of Miles, Huberman, and Saldaña, which involves data reduction, data display, and conclusion drawing/verification. In the data reduction phase, raw data were coded and organized into meaningful categories aligned with the research focus. The data display phase involved presenting findings in narrative and tabular forms to facilitate pattern recognition and interpretation. Finally, conclusions were drawn through an iterative process of verification, ensuring that emerging themes were consistently supported by empirical evidence. This analytical approach allowed for a systematic and transparent interpretation of complex qualitative data.

2.8. Validity and Trustworthiness

To ensure the credibility and trustworthiness of the findings, several validation strategies were applied. Source triangulation was conducted by comparing data obtained from teachers, students, and expert informants, while technique triangulation involved cross-verifying data from observations, interviews, and documentation. Member checking was carried out by returning interview summaries to participants for confirmation, thereby reducing misinterpretation. In addition, peer debriefing was conducted with fellow

researchers to critically examine analytical processes and findings. An audit trail documenting all stages of the research process was also maintained to enhance transparency and replicability

2.9. Researcher's Role

In qualitative inquiry, the researcher functions as the primary instrument responsible for data collection, interpretation, and validation. In this study, the researcher actively engaged in the field while maintaining reflexivity to minimize subjective bias. Continuous reflection and methodological awareness were applied to ensure that interpretations remained grounded in empirical data rather than personal assumptions.

3. Results and Discussion

Results can be presented in graphical, tabular, or descriptive form. Tables and figures should only contain essential information about the research results. It is necessary to analyze and interpret these results before discussing them.

3.1. The Reality of History Learning

History learning in schools is currently undergoing a transformation towards a more contextual and interactive learning approach, especially for local history topics such as Muara Takus Temple. Material about this temple is usually taught in the context of the history of kingdoms in Sumatra and the surrounding islands, which highlights cultural values and archaeological relics as part of a historical heritage that must be preserved. However, in practice, teaching local temple history still faces challenges, including limited teaching media capable of effectively visualizing the complexity and local wisdom contained within.

In some schools, especially at SMAN 12 Pekanbaru, material about Muara Takus Temple is mostly delivered through lectures and textbooks that are uninteresting and fail to stimulate students' interest. This results in students' understanding of the historical value and importance of preserving the site often being less than optimal. In addition, access to learning resources directly related to the temple, such as models or other visualization media, is still very limited. As a result, history lessons tend to be abstract and difficult to connect with students' everyday lives. These conditions can be seen in the results of the observation analysis of the history learning process in Grade XI, as presented in Table 1.

Table 1. Results of the Observation Analysis of the History Learning Process in Grade XI

No.	Problem Identification	Analysis Results
1.	Student enthusiasm in participating in learning	Students feel less motivated to participate in the learning process because the lessons seem boring. Students are more focused on their own activities and do not pay attention to the teacher when explaining the material.
2.	Learning media used	The media used is not very diverse and is still monotonous, usually in the form of image-based visual media.
3.	Teachers' methods of delivering material	The method used by teachers is the conventional method, which causes students to feel bored and tired when the teacher explains the material. Students tend to be more interested in chatting with friends than listening to the teacher's explanation.
4.	Student interest in media	Students are more interested in visual learning media such as the Muara Takus temple model. Students also prefer unique learning media because it motivates them to learn and makes it easier for them to understand the subject matter ( ).
5.	Obstacles encountered during the learning process	The lack of facilities that support the learning process has resulted in some obstacles to the learning process.

Observations show that the use of learning media at SMAN 12 Pekanbaru is limited and lacks diversity, highlighting the need for innovative approaches. Students often become disengaged in class and focus on unrelated activities. Introducing engaging and appropriate learning media increases student motivation and helps them better understand the subject matter.

In the context of the 2025 curriculum, there is a push to strengthen history learning through more innovative approaches such as the use of interactive and thematic learning media, including the integration of sustainability concepts such as green history. This approach is expected to enrich the learning experience of students by linking the local historical value of Muara Takus Temple with environmental and cultural preservation issues, thereby not only improving cognitive understanding but also attitudes and awareness of

sustainability aspects. Thus, history lessons about Muara Takus Temple have great potential to be developed into more interesting, relevant, and meaningful lessons for students in this modern era.

3.2. Limitations of History Learning Media

The limitations of historical learning media identified in this study are grounded in empirical findings obtained from classroom observations, interviews, and document analysis conducted at SMAN 12 Pekanbaru. Observation data indicate that the learning media used in history classes are predominantly limited to textbooks and static visual images, with minimal variation or interactivity. During three observed sessions, students showed low engagement, as reflected in their passive participation and tendency to divert attention to non-learning activities. This finding is consistent with interview data from students, who reported that “history lessons are mostly explanation-based and difficult to imagine”, particularly when discussing local historical sites such as Muara Takus Temple.

From the teachers’ perspective, interview results reveal that the use of innovative and contextual learning media is constrained by limited availability and practical challenges in implementation. Teachers acknowledged that existing media “do not adequately represent local historical objects in a concrete way”, making it difficult to deliver material that requires spatial and visual understanding. Furthermore, documentation analysis of lesson plans (RPP) shows that although local history content is included, there is no integration of media that supports sustainability-oriented or green history-based learning.

In relation to environmental aspects, both observational and interview data confirm that learning media used in the classroom have not yet incorporated ecological considerations. Teachers reported that they had “never used environmentally friendly media or materials” in history learning, primarily due to a lack of guidance and examples of applicable models. This indicates that the concept of sustainability remains at the level of discourse and has not been operationalized into instructional practice.

Another critical finding concerns teachers’ capacity and access to resources. Interviews with teachers and the curriculum coordinator highlight that the development or adoption of innovative media, particularly those integrating technology or sustainability values is hindered by limited training and institutional support. Although digital media are recognized as potentially beneficial, their application remains sporadic and not specifically oriented toward local history or environmental themes.

Taken together, these findings demonstrate that the limitations of historical learning media are not merely conceptual but are empirically evident in classroom practice. The lack of interactive, contextual, and sustainability-oriented media directly affects students’ engagement and understanding of local history. These conditions underscore the need for developing learning media that are not only pedagogically effective but also capable of integrating environmental values, such as a green history-based model of Muara Takus Temple.

3.3. Students' Level of Understanding and Interest in the History of the Temple Before Using the Model

The level of students' understanding and interest in the history of Muara Takus Temple before the use of models was still relatively low and needed to be improved. Most students know Muara Takus Temple only as one of the historical sites in Indonesia, but their knowledge is more general and limited to basic information provided through textbooks and lectures in class. Because the material presented tends to be abstract and lacks visual or hands-on experience, students' interest in exploring the history and cultural significance of this temple is still not optimal (Ahmad, 2021; Chen, Su, & Lo, 2025; Strand, 2025; Van Doorsselaere, 2025).

In addition, the complexity of the history of Muara Takus Temple, which is a relic of the Sriwijaya Kingdom, and the Buddhist cultural elements inherent in the temple are often difficult to understand without adequate learning media. Students need media that can help them see the physical form of the temple, understand the functions of the building in a historical and religious context, and relate it to the values of local wisdom and environmental preservation. The absence of learning media capable of displaying these dimensions makes learning about the history of Muara Takus Temple feel less lively and less stimulating to students' curiosity.

Given these conditions, the use of models as visual and practical media is very important to improve students' understanding and increase their interest in local history, especially Muara Takus Temple. Models can provide a more concrete, interactive, and in-depth learning experience, making it easier for students to internalize historical values and the relationship between cultural and environmental aspects contained in the temple site. Thus, history learning becomes more interesting and meaningful for students.

3.4. The Need to Createa Model of Muara Takus Temple

3.4.1. Identification of Teachers' and Students' Needs Related to Representative Learning Media

Based on the identified needs, teachers require learning media that are not only economical and flexible but also technically feasible within classroom constraints. In this context, the use of recycled paper-based materials is positioned not as a simplistic solution, but as a guided, structured, and scalable classroom activity. The term “wastepaper” in this study specifically refers to reusable materials such as cardboard (corrugated boxes), used duplex paper, and thick paperboard, which possess sufficient rigidity and durability for model construction. To ensure practicality, the model is designed at a moderate scale (approximately 40–60 cm in length), allowing it to be produced collaboratively in small student groups rather than individually by teachers. This collaborative approach reduces technical burden while maintaining pedagogical value.

From a technical standpoint, the construction of the Muara Takus Temple model does not aim to replicate architectural precision at a professional or archaeological level. Instead, the model adopts a simplified geometric approximation, where complex elements such as curves and relief structures are represented through layering, folding, and modular assembly techniques. This design strategy ensures that the model remains pedagogically functional and achievable within school settings, without requiring advanced craftsmanship skills. Furthermore, the implementation is supported by step-by-step instructional guidelines, enabling teachers and students to follow a structured production process.

From the students’ perspective, the primary need is not merely accuracy of form, but conceptual clarity and experiential engagement. The model serves as a didactic representation, allowing students to visualize spatial structures, identify key architectural components, and connect them with historical narratives. Through hands-on involvement in the construction process, students engage in active learning, which enhances both cognitive understanding and affective engagement. At the same time, the use of recycled materials is framed within a critical sustainability perspective, emphasizing responsible reuse rather than unreflective material substitution.

Importantly, the practicality of this model lies in its integration into project-based learning scenarios, where the process of constructing the model becomes part of the instructional strategy rather than an additional task. This shifts the role of the model from a finished product to a learning process, aligning with constructivist and experiential learning principles. In this sense, the model is not intended to compete with high-precision digital or industrial media, but to provide an accessible, low-cost, and pedagogically meaningful alternative that can be implemented in resource-limited educational contexts.

By aligning material selection, scale, and construction techniques with classroom realities, the development of the Muara Takus Temple model demonstrates a balance between feasibility, educational function, and sustainability values. Consequently, the model should be understood not as a technically perfect replica, but as a representational learning medium that effectively bridges abstract historical concepts with tangible student experiences, while still promoting environmental awareness in a realistic and implementable manner.

3.4.2. Expectations for the Muara Takus Temple Model as a Medium Capable of Improving Visual and Contextual Understanding

The model, as a physical representation of the temple, is expected to provide a more concrete picture than simply reading text or looking at two-dimensional images in a book. With the model, students can directly see the architectural form, structure, and important details of the temple that reflect the culture and history of the Sriwijaya Kingdom, thereby deepening their understanding and integrating it more comprehensively.

In addition, the model is also expected to facilitate contextual learning, where students not only learn about history from a factual perspective, but also understand the social and cultural functions and meanings contained within the temple site. Through this more interactive and visual learning experience, students can relate historical knowledge to the reality of the environment and sustainability as part of the value of green history. Therefore, models are an effective medium for increasing students' interest in learning and raising awareness of the importance of preserving cultural heritage and the surrounding environment.

The use of models as a learning medium not only provides added value in terms of visualization but also fosters an active and critical attitude in students when studying history. With models, students can explore directly, discuss, and ask questions, making learning livelier and more meaningful. This expectation positions models as a medium that is not only a teaching aid, but also a learning tool that can connect the theoretical aspects of history with real experiences that can be felt directly by students.

3.4.3. Functional Needs of Models as Interactive, Educational, and Environmentally Friendly Learning Aids

The Muara Takus Temple model as a learning aid must meet important functional requirements to be interactive, educational, and environmentally friendly. As an interactive aid, the model should encourage students to participate directly in learning, for example, with features that allow exploration or observation of the temple's structure in detail. This provides a more immersive experience than conventional text-based or static image-based learning, increasing student engagement and motivation.

From an educational perspective, the model should be informative and representative, accurately depicting the main aspects of Muara Takus Temple, such as its architecture, function, and historical and cultural values. This model serves as a concrete medium that helps students understand abstract historical concepts through visual and practical reinforcement. Thus, the model is not just a display tool, but also a learning resource that encourages critical thinking and deeper historical reflection.

Environmental friendliness is also an important requirement in creating models. Using wastepaper as the main material aligns with sustainability and the green history approach. Learning media made from recycled materials reduce waste and ecological impact and teach students the importance of maintaining environmental balance and practicing eco-friendly values. By meeting these requirements, the Muara Takus Temple model is expected to be an effective, innovative, and environmentally conscious learning tool in history education.

3.5. Application of the Green History Approach in Model Making

3.5.1. Understanding and Principles of Green History as a Foundation for Media Creation Learning

Green history represents a pedagogical approach in history education that situates past events within environmental and sustainability frameworks. This perspective embeds ecological principles and conservation values into historical narratives, enabling students to move beyond the acquisition of factual knowledge toward a deeper understanding of how historical processes have shaped, and been shaped by, environmental conditions. Central to the green history framework are the development of ecological consciousness, the cultivation of environmentally responsible attitudes, and the articulation of historical experiences with contemporary environmental challenges that are closely related to learners' everyday contexts. Through this integration, history instruction gains greater relevance and depth by linking interpretations of the past with present environmental realities and future sustainability concerns (Borah, 2023; Ishaque & Ansari, 2025; Lahmidi & Youssef, 2025).

As a foundational principle for the development of instructional media, green history requires learning resources to function not merely as vehicles for historical content delivery but also as instruments that actively support environmental sustainability. Media grounded in green history principles should prioritize the use of eco-friendly, recyclable, and reusable materials in order to minimize ecological footprints. Moreover, such media need to be pedagogically designed to stimulate critical reflection on human–nature relationships, thereby fostering learners' awareness of environmental preservation through historically informed perspectives (Bond et al., 2022; Saripudin & Darmawan, 2018; Xue, Li, & Wen, 2023).

The practical implementation of green history in learning media further underscores the significance of embedding educational messages that explicitly connect historical values with environmental issues. By presenting historical events alongside their environmental consequences through structured modules or instructional models, students are encouraged to recognize the long-term ecological implications of human actions across time. In this way, history education transcends its retrospective function and becomes a formative medium for shaping environmentally conscious attitudes and behaviors, contributing to the development of learners who demonstrate greater ecological responsibility.

3.5.2. The Relationship Between Environmental Conservation and Understanding Local History Integrated through Models

Environmental conservation is closely connected to the study of local history through the use of instructional media, including physical models. Scale representations of historical sites, such as Muara Takus Temple, offer concrete illustrations of both historical and cultural significance and underscore the necessity of conserving the surrounding environment. These models help students understand that heritage sites are not merely cultural artefacts but also essential elements of broader ecological systems, whose preservation relies on sustainable management.

Engagement with these models encourages learners to examine the interdependence between the physical integrity of historical structures and their natural environments, as well as the threats posed by environmental degradation. This integrated perspective emphasizes that the protection of cultural heritage is fundamentally linked to environmental conservation, both of which are necessary for maintaining historical authenticity and ensuring long-term sustainability. As a result, history education encompasses not only the transmission of past events but also critical reflection on the social and ecological responsibilities inherent in heritage preservation.

Moreover, constructing learning models from environmentally friendly materials, such as recycled paper, exemplifies the practical application of conservation principles within history education. This method illustrates how sustainable practices can be incorporated into both educational activities and cultural preservation initiatives. Thus, these models serve a dual pedagogical purpose by fostering historical understanding and environmental awareness, while also promoting a comprehensive appreciation for the integrated preservation of cultural and natural heritage.

3.5.3. Efforts to Use Environmentally Friendly Materials and Production Processes with Minimal Ecological Impact in Model Making

The use of environmentally friendly materials in model making is very important for supporting sustainability and minimizing the ecological impact of the production process. One of the most popular materials is wastepaper or used cardboard, which is easily available, inexpensive, and recyclable. The use of these materials helps reduce waste going to landfills, while also educating students about the importance of applying the principles of reduce, reuse, and recycle (3R) in their daily lives. In addition, cardboard and paper require simple production processes and can be processed with basic tools, making them energy-efficient and more environmentally friendly.

In addition to material selection, the model's production process is designed to minimize environmental impacts. This can be achieved by using water-based glues that do not contain harmful chemicals, selecting environmentally friendly acrylic paints for coloring, and reducing the use of plastics or synthetic materials that are difficult to decompose. This clean and efficient production process not only protects the environment but also creates safer working conditions for model makers.

By utilizing environmentally friendly materials and implementing production processes with minimal ecological impact, the models not only serve as effective and educational learning media but also become concrete examples of the application of sustainability values. This aligns with the green history principle, which encourages students to learn about history while recognizing the importance of protecting and caring for the environment for a better future (Borah, 2023). This effort is expected to foster ecological awareness and green behavior among students from an early age through fun, meaningful learning activities. The use of environmentally friendly materials in model manufacturing is crucial to supporting sustainability and minimizing the ecological impact of the production process. One of the most popular materials is wastepaper

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3.5.4. Analysis of Models as a Support for the History Learning Process with the Green History Thematic Approach

Models can support the history learning process through a thematic Green History approach by addressing several important aspects. Visually, models provide a concrete picture of historical sites such as Muara Takus Temple, helping students better understand their physical structures and cultural elements. Thus, students not only learn historical facts, but also see the relationship between humans and their environment, which is the main focus of Green History. This allows students to examine history from a more holistic perspective, seeing how human activities in the past have affected environmental conditions and how conservation efforts are integral to understanding history.

In addition to the visual aspect, models also facilitate more interactive, context-based learning. Students can touch, observe, and discuss the models directly, thereby increasing their engagement and understanding. This approach is very much in line with the principles of green history, which promote ecological intelligence and green behavior, as models can serve as a medium to link local historical values with ecological awareness (Kalungwizi, Krogh, Gjøtterud, & Mattee, 2020; Rombot, Doringin, & Ariesta, 2018; Ruiz-Corro et al., 2024). For example, students can be encouraged to understand how environmental conservation around the Muara Takus Temple supports the preservation of the site, while also fostering their concern for the environment today.

Furthermore, models as a thematic learning medium for green history enable the integration of sustainability values into history learning. By using environmentally friendly materials, this medium provides concrete examples of sustainability principles that students are expected to internalize. The learning process through models also encourages students to reflect on their role in protecting the environment and preserving cultural values. Thus, models become a strategic tool in realizing history learning that is not only informative but also encourages positive changes in attitudes and actions towards environmental and cultural preservation.

3.5.5. Positive Impact on Students' Environmental Awareness through Direct Interaction with Model Media

Engaging students with models during history lessons increases their awareness of environmental issues. The use of models provides hands-on experiences, facilitating a deeper understanding of the relationship between historical events and environmental protection. Through direct interaction with models, students gain insight into the value of sustainability and recognize the significance of environmental preservation in maintaining cultural heritage.

Incorporating eco-friendly materials, such as wastepaper, into model construction educates students about the importance of environmentally responsible choices in daily life. This approach fosters a greater

sense of environmental stewardship by demonstrating practical ways to reuse waste. Engaging with models also promotes critical discussion and reflection on the impact of human activities on the environment, thereby enhancing students' understanding of the consequences of their actions and the importance of conservation.

Additionally, learning experiences involving models foster positive attitudes and behaviors toward the environment, such as responsibility, care, and awareness. This educational approach motivates students to participate in conservation activities both at school and within their communities. The intended outcome is that increased environmental awareness will translate into concrete actions, establishing model-based education as an effective way to teach sustainability and conservation from an early age.

3.5.6. Implications for the Development of Sustainable and Educational History Learning Media

The development of sustainable and educational history learning media can enhance the quality of history education and foster greater student awareness of cultural and environmental values. When learning media are designed with sustainability as a core principle, they prioritize not only effective content delivery but also environmental responsibility, resource efficiency, and long-term durability. Achieving these objectives requires selecting materials and production methods that minimize waste and incorporate recycled or eco-friendly components, thereby reducing the environmental impact of educational media.

In addition to environmental considerations, educational learning media should address students' cognitive, emotional, and physical needs through engaging, interactive, and contextually relevant designs. For instance, green history-themed models offer innovative ways to connect historical theory with real-world experiences, thereby deepening students' understanding and appreciation of history. The development of such media enhances the relevance and significance of history education within students' social and environmental contexts, which can increase motivation and reinforce the perception of history as integral to both present and future societal development (Berg & Stolare, 2024; Katyalova, Shukurova, & Hajiyeva, 2024; Nugroho & Gunawati, 2024; Su & Zhao, 2023).

The development of sustainable history learning media also facilitates collaboration among educators, media creators, and communities to produce resources that reflect local cultures and values. Such collaborative efforts promote continuous innovation in history education, enabling adaptation to evolving circumstances while maintaining respect for tradition. These educational tools extend beyond information dissemination by shaping students' character and fostering a sense of responsibility toward history and the environment, thereby cultivating a generation that values both cultural heritage and environmental stewardship.

3.6. Obstacles and Challenges

Technical and material constraints constitute major challenges in the production of environmentally friendly models, particularly the limited availability of sustainable raw materials that are both easily accessible and sufficiently durable for model construction (Abera, 2024). Common substitute materials such as recycled paper or cardboard often exhibit inconsistent quality, which complicates efforts to achieve models with satisfactory visual appeal and structural resilience. Moreover, transforming these materials into functional and aesthetically acceptable models requires specialized processing techniques to ensure strength and attractiveness without generating additional environmental impacts.

Further challenges stem from the technical requirements of the production process, including the need for specific tools and competencies to manipulate eco-friendly materials in accordance with educational and aesthetic standards (Kumar & Devadula, 2024). Efforts to reduce the use of hazardous substances such as replacing conventional adhesives and paints with environmentally benign alternatives and to implement efficient cutting and assembly procedures demand careful planning and targeted skill development (Altassan, 2023). These challenges are intensified by the necessity to minimize secondary waste and to safeguard the health and safety of producers, who often operate under constraints related to limited infrastructure and human resources.

In addition to technical considerations, cost and time limitations also pose significant barriers. High-quality sustainable materials are generally more costly than synthetic alternatives, while environmentally responsible production processes tend to be more time-intensive due to the need for meticulous handling and processing stages. Such conditions can be prohibitive for educational institutions or learning media developers with restricted budgets and tight schedules (Tafida, Alaloul, Zawawi, & Musarat, 2024). Consequently, addressing these challenges requires innovative production strategies and collaborative efforts among stakeholders to ensure that environmentally friendly model development can be implemented effectively and contribute meaningfully to history education.

3.7. Challenges in Integrating Model Learning Media in the Classroom that must be Adjusted to the Curriculum

Integrating model-based learning media into classroom practice in alignment with curricular demands presents multifaceted challenges encompassing technical, pedagogical, and resource-related dimensions (Lai & Hu, 2025). A primary concern lies in ensuring congruence between the instructional models and the learning objectives as well as core competencies stipulated in the curriculum (Rahmah, 2025). Learning models must therefore be carefully designed not merely for visual appeal, but to function as accurate and effective representations of historical content that conform to curricular standards (Joyce & Calhoun, 2024). Misalignment between model content and prescribed competencies may disrupt instructional coherence and diminish the pedagogical value of the media.

From a technical and instructional perspective, the successful use of models also depends heavily on teachers' readiness and capacity to incorporate them into their teaching practices (Abildinova, Abdykerimova, & Assainova, 2024). Effective implementation requires educators to possess adequate pedagogical competence and practical skills in utilizing models as interactive learning tools (Firmansyah & Atmaja, 2025). This often necessitates targeted professional development to enhance teachers' familiarity with the instructional potential of such media. In the absence of sufficient training and conceptual understanding, models risk being underutilized or perceived as an additional instructional burden rather than as facilitators of learning.

Constraints related to school infrastructure and resource availability further complicate the adoption of model-based media (Firmansyah & Atmaja, 2025). Many educational institutions lack appropriate classroom layouts or secure storage facilities needed to preserve and maintain physical models (Mahyudin, Rosman, & Haron, 2024). Moreover, the production and maintenance costs of environmentally sustainable models may exceed those of conventional instructional materials, posing financial challenges for schools operating under limited budgets and restricting large-scale implementation.

Beyond technical and logistical issues, socio-cultural factors also influence the integration of models into classroom learning (Birsyada & Wibowo, 2025). Teachers and students who are accustomed to traditional instructional approaches may initially exhibit resistance toward non-conventional media. Consequently, systematic efforts in familiarization, capacity building, and institutional socialization are required to foster acceptance. Gradual implementation strategies, supported by school-level policies and educational authorities, play a crucial role in mitigating resistance and facilitating effective curricular integration (Birsyada & Wibowo, 2025). When these challenges are adequately addressed, model-based learning media can contribute meaningfully to enhancing the quality and effectiveness of history education.

3.8. Factors Affecting the Long-Term Sustainability of the Use of Models and the Response of Education Stakeholders

The long-term viability of models as instructional media is shaped by interrelated factors encompassing durability, curricular relevance, and institutional support (Li & Wang, 2026). From a technical standpoint, models should be constructed using robust materials, supported by sound design principles that allow for repeated use, straightforward repair, and sustained instructional quality over extended periods. Such characteristics ensure that the time, effort, and resources invested in their development yield lasting pedagogical value rather than short-term utility (Ansari, 2025).

Sustainability is further influenced by the capacity of schools and educators to embed models within diverse and contextually meaningful learning activities that evolve alongside curriculum changes (El-

Hamamsy, Monnier, & Avry, 2024). As learning demands become increasingly dynamic, instructional models must be adaptable and periodically refined to prevent obsolescence (Boustani, Mourtajji, & Arts-Chiss, 2025). In this respect, teachers' pedagogical competence and creativity play a decisive role, as innovative instructional strategies enable models to remain engaging, effective, and responsive to students' learning needs.

Equally important is the commitment of educational stakeholders, including teachers, school leaders, curriculum designers, and policymakers. Structured professional development, adequate budgetary provision for the development and upkeep of learning media, and policies that actively promote pedagogical innovation collectively reinforce the sustained use of models in schools (El-Hamamsy et al., 2024). Beyond formal institutions, the participation of parents and local communities contributes to broader appreciation of the educational, historical, and environmental values conveyed through such media, thereby strengthening their long-term relevance.

Through coordinated support and shared responsibility among these stakeholders, models can function as more than temporary teaching aids. Instead, they become enduring educational resources that foster students' historical understanding and environmental awareness, while contributing positively to the preservation of cultural values and sustainable educational practices over time.

4. Conclusion

Developing the Muara Takus Temple model as a history learning medium offers significant advantages by providing tangible visualizations of architectural and cultural elements that are hard to convey through text or two-dimensional images. This approach bridges students' understanding through realistic and interactive experiences. Incorporating the green history approach in model design encourages the use of environmentally sustainable materials and processes, fostering both historical knowledge and ecological awareness. Models made from recycled paper offer an economical and accessible solution that aligns with sustainability principles, serving as interactive, educational, and eco-friendly tools that show the relationship between cultural heritage and environmental conservation. Besides improving student engagement and comprehension, this model-based, green history–oriented pedagogy cultivates deeper environmental consciousness through direct interaction, positively influencing students' attitudes and behaviours regarding sustainability. However, challenges such as limited access to quality eco-friendly materials and the need for teacher proficiency in curriculum integration require targeted professional development and infrastructure support. Continued support from educational stakeholders, including teachers, school leaders, curriculum designers, and government authorities, is crucial to ensure the long-term effectiveness and sustainability of this innovative, environmentally focused teaching tool.

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The author declares that there is no conflict of interest in the preparation and publication of this article, either financial or non-financial.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript. AI were used only to improve readability and language under strict human oversight; no content, ideas, analyses, or conclusions were generated by AI.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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