

Development of a Virtual Ecomuseum Based on Local Wisdom for Sustainable Historical Literacy

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ABSTRACT

This study aims to develop a virtual ecomuseum based on the local wisdom of the *Kasepuhan Adat Sinar Resmi* community as a pedagogical innovation in history education to strengthen *sustainable historical literacy* among high school students. The research method employed was *research and development* (R&D) using a modified ADDIE model, encompassing needs analysis, design, development, implementation, and evaluation. Data were collected through field observations, ethnographic studies, in-depth interviews with traditional leaders, and pilot learning sessions with high school students in Bandung. The research results indicate that the developed virtual ecomuseum comprising digital artifacts, indigenous-based historical narratives, 3D models of cultural spaces, and interactive tours effectively enhances the three main dimensions of sustainable historical literacy: understanding of historical context, ecological-cultural awareness, and reflective ability in linking local wisdom values with future sustainability. The pretest posttest results indicated improved sustainable historical literacy scores in the experimental group compared with the control group. These findings confirm that integrating traditional knowledge into digital heritage through a virtual ecomuseum not only enriches the history learning experience but also contributes to fostering sustainability awareness and cultural preservation among the younger generation. The findings suggest that virtual ecomuseums can support contextual, immersive, and sustainability-oriented history learning when combined with validated learning activities and teacher facilitation. This study recommends the further development of regional-scale virtual eco-museums as adaptive, local wisdom-based history learning media in the era of digital transformation.

Keywords: *kasepuhan adat sinar resmi, sustainable history literacy, virtual ecomuseum*

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INTRODUCTION

Education, by its very nature, is a fundamental tool for understanding the dynamics of life. In the 21st century, a new focus has gained significance: the environment and climate change have become central concerns, alongside growing anxieties about the future caused by environmental, social, and economic crises ([Riva et al., 2022](#)). The escalating severity of these crises has created an urgent need for the implementation of sustainable development models, participation, and subsidiarity ([Riva & Gnessi, 2021](#)). In responding to these ecological challenges, Hawkey ([2014](#)) notes the need to evaluate how school subjects address questions regarding environmental change. Consequently, the use of new spatial scales in historical studies and the incorporation of environmental and planetary perspectives have become increasingly significant. Concurrently, the rapid transformation of education in the digital age has created an urgent need to reassess the relevance of history teaching methods ([Firmansyah & Atmaja, 2025](#)). This is crucial given that history education serves to affirm national and local identities that are increasingly eroded by the tide of globalization. Therefore, there is a need to strengthen historical literacy that explores the meaning and relevance of historical events so they can be understood contextually ([Aristiawan, 2025](#)).

As an operational response to this need for contextualization, the ecomuseum serves as a bridge between people and their environment, functioning to improve the quality of life for local communities and preserve cultural identity amidst modernization ([Malek & Miličić, 2024](#)). In its dynamics, the ecomuseum plays a dual role as it serves as a stage for collective cultural representation and a medium for individual self-expression ([Ruoyue et al., 2025](#)). This function of cultural representation is well-suited to strengthening historical literacy, which aims to safeguard and preserve national values and identity, ensuring that younger generations maintain a strong cultural foundation and values in the face of global social and cultural changes ([Aristiawan, 2025](#)). To support sustainable historical literacy in the digital age, Malek & Miličić ([2024](#)) have contributed a theoretical review of the roles of ecomuseums, cultural heritage institutions, and media in documenting, popularizing, and preserving traditional culture.

In line with this strategic role, it appears to foster awareness of the urgency of digital access to cultural heritage as an effort to maintain the existence and relevance of ecomuseums in the contemporary era ([Malek & Miličić, 2024](#)). In this new ecosystem, ICT and digitization are being promoted as vital components in preserving the cultural landscape and enhancing community participation ([Vedoà, 2021](#)). This transformation demonstrates that the integration of technology into cultural heritage has provided broader accessibility, as well as new perspectives and forms of presentation ([Šojat-Bikić, 2011](#)). Therefore, the role of new media is crucial in cultural heritage preservation, as Babic & Vekic (in [Malek & Miličić, 2024](#)) demonstrate that media such as the internet and film are beneficial for the transmission and popularization of cultural heritage. This technological dimension is further emphasized by Palumbo et al. ([2022](#)), who state that ICT has been used to advance and enhance the effectiveness of ecomuseums in achieving the preservation of local culture. They highlight several benefits of ecomuseum digitization: *first*, it facilitates the recontextualization of ecomuseums within a cyber-physical environment; *second*, ecomuseum digitization offers sustainable cultural preservation; *third*, the digitization of ecomuseums enhances cultural experiences and the virtualization of ecomuseum services; *fourth*, the digitization of ecomuseums supports cultural heritage literacy, which is crucial for visitor engagement in value creation and the management of ecomuseums. Support for cultural heritage literacy demonstrates the integration of digital technology into cultural heritage as an opportunity for future learning development ([Aristiawan, 2025](#)).

Exploration of these future opportunities has begun to emerge through the application of digital technology to cultural heritage, as initiated by researchers; for example, Šojat-Bikić's ([2011](#)) study identified opportunities to utilize the web for narrating intangible heritage. This documentation initiative became increasingly concrete when Malek & Miličić ([2024](#)) presented two *e-scapbook* projects dedicated to the digital recording and presentation of Bistra oral literature. Moving beyond mere presentation, the dimension of participation began to be emphasized by Cai & Ch'ng ([2025](#)), who actively involved local communities in the

reconstruction of cultural heritage and the technical processes of VR. A more massive scale of implementation can be seen in Italy; over the past two decades, the approaches applied in the development of ICT for cultural heritage have been implemented both *top-down* and *bottom-up*. In this regional context, Italian stakeholders have developed a Cultural Heritage GIS (CHGIS), web maps, and catalogs to collect and document cultural heritage. This digital ecosystem has continued to grow thanks to contributions from local governments, associations, private entities, and citizen groups that organize projects and develop ICT to enhance the local landscape ([Vedoà, 2021](#)). Vrettakis et al. ([2023](#)) have contributed to the creation of the Pros-Eleusis digital ecomuseum application to help visitors discover a region's tangible and intangible cultural heritage through the identification of *Points of Interest* (POI). Overall, the success of various developments in digital ecomuseums holds significant importance for the implementation of subsidiarity in addressing the polycrisis ([Riva et al., 2022](#)).

In addition to digital technology development, another key finding is highlighted by Palumbo et al. ([2022](#)), who conclude that managerialization and professionalization have positive implications for the digitalization of ecomuseums. Nevertheless, the urgency of this management approach has not yet been fully realized across all sectors; for instance, Borrelli et al. ([2024](#)) highlight the discourse on food governance, where the role of eco-museums has not been sufficiently considered. Yet, the involvement of eco-museums in this context is crucial for defining food governance strategies that impact systems related to sustainable transformation. Beyond these sectoral challenges, the socio-technological dimension demonstrates significant success, as Riva & Gnessi ([2021](#)) state that virtual connections have successfully created meaningful narratives and connections, as well as digital connections to promote social inclusion and participation. To ensure the technical sustainability of such inclusion, system integration is essential; however, existing developments and findings indicate that landscape evaluation protocols and services remain partial. Consequently, highlights that the study by Brumana et al. ([2015](#)) offers an innovative approach specifically, components designed to enable interoperability that links heterogeneous data sources.

Few studies have examined the development and classroom implementation of virtual ecomuseums for formal history education. Existing studies primarily focus on cultural preservation, tourism, community participation, or digital heritage documentation, while their pedagogical application in history learning remains underexplored ([Lestari & Suyanto, 2024](#)). This study contributes by integrating indigenous ecological knowledge, digital heritage visualization, and sustainable historical literacy into an ADDIE-based history learning product. The integration is particularly relevant because technology-based history learning can encourage more active, interactive, and contextual learning experiences ([Firmansyah & Atmaja, 2025](#)).

A concrete manifestation of this digital transformation optimization is the development of a virtual ecomuseum in this study, aimed at strengthening sustainable historical literacy. This focus is highly relevant because field data indicates that historical literacy remains low in Indonesia ([Armiyati & Purwanta, 2024](#)). Within this intervention framework, the three main dimensions of sustainable historical literacy that this study seeks to strengthen include an understanding of historical context, ecological-cultural awareness, and the reflective ability to connect local wisdom values with future sustainability. To achieve these dimensions, the development of a virtual ecomuseum focuses on creating digital artifacts, traditional-based historical narratives, 3D models of cultural spaces, and interactive tours. This comprehensive design, which integrates visuals and storytelling, is implemented because culture cannot be fully explained by merely viewing objects accompanied by descriptions; rather, it requires narrative storytelling ([Šojat-Bikić, 2011](#)). In addition to the depth of content, reach is also a crucial consideration; cultural knowledge from communities needs to be supported by a platform capable of widespread dissemination, as it is easily lost due to generational gaps ([Bruttini et al., 2017](#)).

This study seeks to address the challenges of cultural heritage preservation by establishing *Kasepuhan Adat Sinar Resmi* as an ideal ecomuseum model for history learning. Pedagogically, *Kasepuhan Adat Sinar Resmi* is relevant for sustainable historical literacy because it integrates historical traditions, ecological conservation, and local wisdom in everyday community life.

The philosophy of life embraced by its community is not merely an abstract ethos but is embodied in a highly structured and holistic traditional natural resource management system, where territorial zoning is managed with strict conservation discipline (Prabowo & Sudrajat, 2021). Therefore, based on the above description, this study aims to develop a virtual ecomuseum based on the local wisdom of the *Kasepuhan Adat Sinar Resmi* as a pedagogical innovation in history education to strengthen sustainable historical literacy among high school students.

METHOD

This study employs a *research and development* (R&D) design, guided by the ADDIE model, to develop a learning model. The objective is to enhance sustainable historical literacy through a living history approach based on a virtual ecomuseum. This study employs both qualitative and quantitative methods. The research procedures follow the ADDIE model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation. This model was selected due to its structured yet adaptable approach, making it highly suitable for the development and validation of learning innovations in education. Each phase of the research was conducted systematically to ensure the relevance, utility, and effectiveness of the learning model. Figure 1 illustrates the overall research flow based on the ADDIE framework. This study follows the ADDIE instructional design model, which consists of five main stages: Needs Analysis, Design, Development, Implementation, and Evaluation (Zou et al., 2024). Data were collected through field observations, ethnographic studies, in-depth interviews with traditional leaders, and learning trials with high school students in Bandung. The research flow is shown in Figure 1.

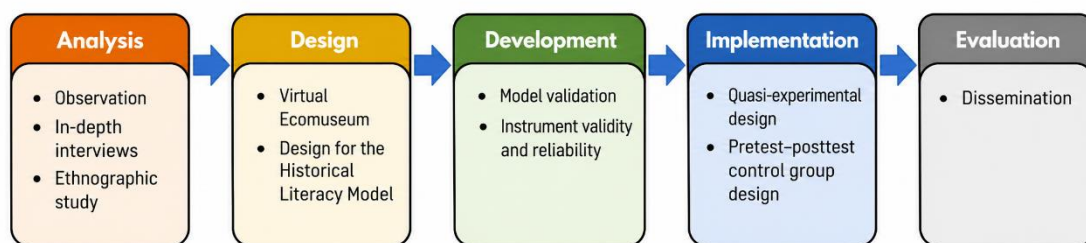


Figure 1. The ADDIE Model

The research location and subjects were selected in stages to support the validity of the developed learning model. This research took place at a State Senior High School (SMAN) in Bandung City, involving history teachers and 11th-grade students. In the preliminary study phase, the location and subjects were selected randomly (random sampling) to gather initial data on the actual conditions of history learning and teachers' responses to the initial draft of the model. Subsequently, in the development trial phase, the sample was shifted using a purposive sampling technique. This phase consisted of two parts: a limited trial (preliminary field test) conducted at one selected school, and a broad trial (main field test) covering four schools that had previously been the objects of initial observation. Finally, in the effectiveness test phase, this study determined subjects through purposive sampling, selecting two classes from two schools. From these two schools, the experimental class implementing the virtual ecomuseum and the control or conventional class were grouped based on pretest results, with the class with the lower average score designated as the experimental class.

The selection of SMAN in Bandung City as the locus for all sampling stages was based on rational considerations related to equivalence of school characteristics and readiness for digital subjects. The impact of the zoning system on new student admissions has transformed the education landscape by eliminating school groupings based on superior clusters, so that all high schools in Bandung City now have a standard ecosystem and relatively equal academic input to

produce a representative sample. Furthermore, because the product developed is an immersive virtual ecomuseum technology, the aspect of technological mastery is a very crucial instrument. Schools in Bandung City were chosen because their teachers and students already have high adaptability and digital literacy in their daily activities, so that technical biases such as technological stuttering can be minimized when the model intervention is implemented. As illustrated, the research flow used consists of four main stages.

Analysis Phase, In this initial phase, the researcher conducts a needs analysis through (1) field observations, (2) in-depth interviews, (3) ethnographic studies. These insights then form the basis for the design of the subsequent learning model.

Design Phase, based on the exploration, a virtual ecomuseum prototype for sustainable historical literacy was developed, integrating the three dimensions of sustainable historical literacy: understanding of historical context, ecological-cultural awareness, and the reflective ability to connect local wisdom values with future sustainability. The virtual ecomuseum model includes digital artifacts, traditional-based historical narratives, 3D models of cultural spaces, and interactive tours. This prototype then underwent expert validation. Experts assessed the model's feasibility using a structured validation form. Their feedback was then used to refine the learning materials and activities prior to implementation.

Development Stage. Based on input from experts, the prototype was revised. Validity and reliability testing of the research instrument were also conducted at this stage. At this stage, the initial draft of the virtual ecomuseum prototype, along with supporting tools such as the Lesson Plan (RPP), materials, Student Worksheets (LKPD), and assessment sheets, was comprehensively developed. The prototype then underwent a design and product validation process conducted by expert lecturers and history teachers as field practitioners. Validation focused on the appropriateness of the content (content validation) and construct (construct validation), particularly the functionality of the model syntax. Input and suggestions for improvement from the validators were analyzed qualitatively as the basis for revisions to ensure the product met validity criteria before being tested. The test instrument measuring continuous historical literacy was then reviewed by the supervising lecturer, three experts, and the history teacher to ensure the accuracy of the outline and test items, ensuring validity and reliability before being used in the effectiveness testing stage.

Implementation and Evaluation Stage. In the final stage, the model was tested using a quasi-experimental pretest-posttest control group design involving high school students in Bandung City. Testing was conducted by administering the same test instrument at the beginning (pretest) to measure students' basic abilities, and at the end (posttest) to measure the effectiveness of the model after the treatment was administered. Pretests and posttests on sustainable historical literacy were administered. The experimental group implemented a virtual ecomuseum model based on sustainable historical literacy with digital resources, while the control group received conventional learning, namely a standard history learning model typically implemented by teachers in the classroom, using expository methods, without the intervention of the developed virtual ecomuseum media. Data were analyzed using SPSS to assess the effectiveness of the model. Data collection instruments and tools included a validation rubric (Development Phase), observation sheets, and a sustainable historical literacy test (Implementation Phase).

All quantitative data obtained from pretest and posttest scores were statistically processed using SPSS software. The first statistical test used was the Kolmogorov-Smirnov Normality Test as a prerequisite analysis. Because the prerequisite test results showed that the data were not normally distributed, the analysis was continued using non-parametric statistics through the Mann-Whitney U Test. This test was used for two purposes: first, to test the equality of students' initial abilities (pretest), and second, to test the hypothesis of differences in learning outcomes (posttest) between the experimental class and the control class. Finally, the N-Gain Score Test was used to calculate the level of effectiveness of the virtual ecomuseum media in improving student learning outcomes.

RESULT AND DISCUSSION

The virtual ecomuseum product developed in this research is an innovative history learning medium based on 3D Virtual Reality (VR) technology with a 360° viewing angle. This medium integrates landscape visualizations, digital artifacts, oral traditions, traditional ceremonies, and the philosophical values of the local wisdom of the Sinar Resmi Kasepuhan Adat into an immersive digital platform. Using an edutainment approach, the product is packaged as an interactive virtual tour equipped with self-contained information panels to immerse students in a real-life cultural heritage site exploration from within the classroom, thereby stimulating their critical and imaginative abilities. This concrete product is realized in a unified learning toolkit that includes a visual ecomuseum application, local wisdom-based learning modules, digital teaching materials, Student Worksheets (LKPD), and assessment instruments for attitude, cognitive, and psychomotor aspects.

This virtual ecomuseum was then implemented in the field. The findings of this study confirm that the development of the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum is an effective pedagogical tool for strengthening students' *sustainable historical literacy*. This effectiveness aligns theoretically with Supriatna's (2019) perspective on the importance of developing historical imagination as the key to creative history learning in the 21st century. In this context, the virtual ecomuseum serves as an immersive space that enables students to engage in an imaginative process to understand and experience the atmosphere of indigenous community life which may feel geographically and culturally distant from their own reality. This imaginative process is not abstract but stems from the integration of Sinar Resmi's local wisdom values, presented through digital artifacts and historical narratives. Consequently, students are able to internalize the philosophy of sustainability embraced by these indigenous communities. Observations during implementation demonstrate that stimulating imagination through this immersive medium successfully transforms how students interact with historical narratives, ultimately fostering more critical, consistent, and reflective historical literacy behaviors (see [Figure 2](#)).

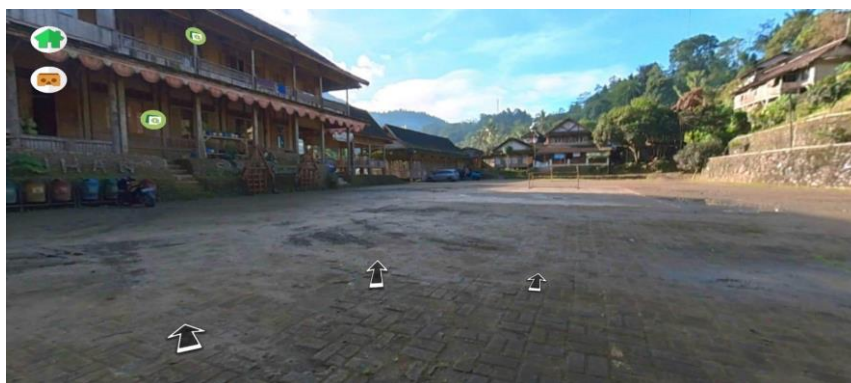


Figure 2. The virtual ecomuseum interface display in the main field area, which functions as a tool to stimulate students' historical imagination through navigation features

It appears that the development of historical imagination through this virtual ecomuseum is also aligned with the dimensions of historical thinking. Ethical dimensions and the significance of history are deeply embedded in the development of this concept. The *Kasepuhan Adat Sinar Resmi* virtual ecomuseum does not merely present data from the past. This concept aims to encourage students to assess the significance of traditional values in a contemporary context. This is made possible by the sense of presence generated by *virtual reality* technology. This concept of *presence* is key because when students experience the sensation of being in the Sinar Resmi Traditional Village, psychological barriers toward distant historical objects will dissolve. This then triggers deep historical empathy (see [Figure 3](#)).



Figure 3. A wide-angle visualization of the *Kasepuhan Adat Sinar Resmi* landscape designed to build students' sense of presence

The success of this technology in bridging local narratives to the classroom in Bandung also reinforces the findings of Riva et al. (2022) regarding the ecomuseum as a landscape of connections that builds *possible futures*. Traditional knowledge from Sinar Resmi transforms into a living laboratory for students to reflect on eco-social transitions and environmental sustainability. It is this interconnectedness between historical imagination, digital presence, and ethical reflection that empirically drives students' historical literacy processes to a higher level. The effectiveness of this theoretical synergy is confirmed by field observation results showing the consistent emergence of sustainable historical literacy behaviors across all sample schools (see Table 1).

Table 1. Achievements in sustainable history literacy among high school students in Bandung

School Name	Average
Bandung 1 Public High School	3.25 – 3.58
Bandung State High School 4	2.87 – 3.44
Bandung State High School 7	2.75 – 3.44
Bandung State High School 10	3.19 – 3.81

Source: Researcher's Data

Overall, the implementation of the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum at four high schools in Bandung City demonstrated a significant positive impact on strengthening students' sustainable historical literacy. Observation data indicates that the majority of historical literacy behavioral indicators fall within an average score range of 3.1 to 3.8. This signifies that the use of immersive technology is capable of transforming local knowledge into concrete learning experiences that transcend the boundaries of conventional classrooms.

SMAN 10 Bandung emerged as the school with the highest achievement. Its average score reached 3.81. This achievement indicates that the sense of *presence* generated by the virtual ecomuseum is functioning optimally at this school. The high score indicates that students at SMAN 10 do not merely view digital artifacts. They successfully engage in a higher-order imaginative process to project the values of Kasepuhan Sinar Resmi. This success reinforces the argument that the stronger the sense of digital presence felt by students, the deeper their ethical reflection and connection to the cultural heritage of indigenous communities.

On the other hand, SMAN 4 and SMAN 7 Bandung show interesting data dynamics with a score range between 2.75 and 3.44. Although some indicators are at 2.75 or in a transitional phase, the scores at both schools still show a stable trend. This balance in the data indicates that the virtual ecomuseum possesses high adaptability. Even when implemented in schools with diverse student characteristics, this medium is capable of fostering historical and ecological awareness. These score variations provide a realistic picture of the intuitive process through which students understand the complexity of local wisdom narratives.

In-Depth Analysis of Sustainable Historical Literacy (By Dimension)

The effectiveness of the virtual ecomuseum's development was then analyzed through the alignment of field research instruments with a conceptual framework structured across three main dimensions. This process involved grouping the seven sub-dimensions of sustainable historical literacy behavior into more comprehensive units of analysis to systematically map the trajectory of students' cognitive, affective, and reflective transformations. The dimensions serving as the framework for these sub-dimensions are the dimension of historical context understanding, the dimension of ecological-cultural awareness, and the dimension of reflective ability and future orientation.

Dimension of Historical Context Understanding

The implementation of the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum positions the historical context understanding dimension as a crucial bridge within students' thought structures. This dimension does not merely serve as an entry point for recognizing historical facts. It acts as a connector enabling students to transcend temporal boundaries and comprehend the interconnections among various elements of life (Miskawi et al., 2024). This is where the strategic role of *virtual reality* media lies. This medium transforms linear historical narratives into a holistic ecosystem of knowledge.

Through virtual media, students are invited not merely to view the *Kasepuhan Sinar Resmi* as remnants of the past. They are asked to interpret this tradition as a living continuity. This immersive experience sparks students' temporal awareness, enabling them to connect how past traditions such as rice-farming patterns and reverence for nature remain relevant and are practiced to this day. Students' ability to view history as a process of continuity demonstrates that their understanding has moved beyond rote memorization of events. They then progress toward an understanding of the meaning behind the continuity of a cultural identity.

An understanding of historical context has also bridged students' ability to map systemic causality (Miskawi et al., 2024). In the virtual ecomuseum, students do not view historical objects in isolation. Instead, they can identify a culture as the result of a strong social system and a high sense of responsibility (see Table 2).

Table 2. Comparison of historical context understanding

School	Temporal Awareness	Systemic Causality	Average
Bandung 1 Public High School	3.50	3.58	3.54
Bandung State High School 4	3.44	3.13	3.28
Bandung State High School 7	2.81	3.25	3.03
Bandung State High School 10	3.63	3.63	3.63

Source: Researcher's Data

Across all schools, the dimension of historical conceptual understanding appears to show a positive trend. This phenomenon demonstrates that students are beginning to move away from single or simplistic explanations of historical phenomena. They are beginning to understand that the social order in *Kasepuhan Sinar Resmi* is the result of a complex network of cause and effect. Thus, this understanding of historical context serves as a foundation for students to advance to higher levels of literacy. Students will more easily develop an awareness of the importance of balancing tradition and sustainability in the future.

Dimension of Ecological-Cultural Awareness

The ecological-cultural awareness dimension within the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum serves as the core of students' internalization of values and empathy toward local wisdom. While the previous dimension builds a cognitive foundation, this dimension seeks to engage students' affective and ethical aspects (Sudarto et al., 2025). Here, *virtual reality* media

functions as a dialogic space that enables students to become critical participants in interpreting the narratives of indigenous communities. This medium transforms digital information into an inner experience that connects students' personal identities with local cultural identities.

Through critical and ethical source literacy, students are encouraged to analyze the authenticity and biases of every piece of digital information presented in the ecomuseum ([Palumbo et al., 2022](#)). This medium challenges students to seek historical evidence from the local Sinar Resmi perspective, which is often marginalized in dominant historical narratives. This process builds students' ability to acknowledge diverse perspectives. History is not viewed as a single story but as a mosaic of comprehensive local events ([Bowersock, 2006](#)). This immersive experience fosters strong historical empathy ([Logston, 2006](#)). Students begin to feel and appreciate the indigenous communities' perspectives on their environment.

This ecological-cultural awareness ultimately leads to deep ethical reflection and social responsibility. Students do not merely view cultural objects as mere displays. They see culture as a symbol of humanity's responsibility toward nature. In the virtual ecomuseum, the dilemma of preserving traditions and the challenges of modernity are presented vividly. This encourages students to use history as a moral compass. This understanding demonstrates that sustainable historical literacy has successfully guided students toward a concern for social justice and ecosystem balance (see [Table 3](#)).

Table 3. Comparison of ecological-cultural awareness

School	Source Literacy	Multi-Perspective	Ethical Reflection	On average
Bandung 1 High School	3.25	3.33	3.00	3.19
Bandung State High School 4	2.88	3.19	3.44	3.17
Bandung State High School 7	3.31	2.88	3.44	3.21
Bandung 10 High School	3.19	3.38	3.63	3.40

Source: Researcher's Data

Across the entire sample, the dimension of ecological-cultural awareness showed a positive and consistent trend across all schools. This phenomenon demonstrates that students are beginning to internalize the values of local wisdom as a living ethical and moral system. They are beginning to understand that every artifact and narrative in *Kasepuhan Sinar Resmi* contains a perspective that demands empathy and reflection regarding the relationship between humans and nature. Thus, ecological-cultural awareness serves as the foundation for students to break down geographical and sociological boundaries. This explains why the values of the Sinar Resmi indigenous community remain deeply accepted and internalized by students living in urban environments such as Bandung.

The Dimension of Reflective Ability and Future Orientation

The dimension of reflective ability in linking local wisdom values with future sustainability represents the culmination of students' knowledge transformation process following their interaction with the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum. While the previous dimensions focused on cognitive and affective foundations, this dimension assesses to what extent students can reflect on past values to formulate solutions and concrete actions for the future. In this process, the virtual ecomuseum functions not merely as a visual medium. It serves as a catalyst for students' predictive thinking. The experiences gained through *virtual reality* technology stimulate students' critical thinking, encouraging them to go beyond mere cultural understanding. They are invited to actively engage as citizens who are aware of their historical roots and their responsibility for sustainability.

Through a history-based future orientation, students are encouraged to use the collective experiences of the Sinar Resmi indigenous community as a reference for designing solutions to

current global challenges. This medium successfully stimulates students' reflective imagination to view history as a navigational tool for the future. Aspects of critical civic participation begin to take shape when students are able to bring indigenous historical narratives into public discourse and argue based on historical evidence. Thus, this reflective ability demonstrates that sustainable historical literacy has equipped students with the competencies to act as agents of change through adaptive local wisdom values (see [Table 4](#)).

Table 4. Comparison of reflective abilities

School	Future Orientation	Civic Participation	Average
Bandung 1 Public High School	3.58	3.33	3.46
Bandung State High School 4	3.44	3.19	3.32
Bandung State High School 7	2.75	3.31	3.03
Bandung State High School 10	3.81	3.31	3.56

Source: Researcher's Data

From the overall school sample, it was found that the dimension of reflective ability showed a positive trend and indicated the depth of students' thinking. This phenomenon proves that students are beginning to transcend the limits of textual understanding toward practical thinking. They are beginning to understand the values of local wisdom in *Kasepuhan Sinar Resmi* not merely as something to admire, but as a foundation for designing a sustainable future. Thus, this reflective ability serves as tangible evidence of the successful integration of traditional knowledge into digital media. This reaffirms that sustainable historical literacy has empowered urban students to connect the values of Sinar Resmi's local wisdom with real-world solutions to future environmental and cultural sustainability challenges.

The Virtual Ecomuseum as a Pedagogical Tool

The selection of the *Kasepuhan Adat Sinar Resmi* virtual ecomuseum as a learning medium stems from its ability to transform how students interact with historical sources. This medium emerges as a technological solution that brings the cultural reality of indigenous communities into the classroom in an immersive way. The success of this approach is driven by the integration of technological features that work in tandem with students' cognitive needs.

The *virtual reality* and 3D modeling features in this ecomuseum play a crucial role as a bridge that overcomes the geographical distance between students in Bandung and the *Kasepuhan Sinar Resmi* in Sukabumi. This directly creates the sensation of being in another place without having to physically travel there ([Popat, 2016](#)). 3D models of examples such as the leuit and other cultural spaces allow students to conduct in-depth observations from various angles. This phenomenon would certainly be impossible to achieve through two-dimensional images or textbooks alone. With this sense of presence, students' psychological barriers toward historically significant objects located far away geographically can be minimized. Students no longer feel alienated from the lives of indigenous communities, but rather feel like they are part of the narrative they are exploring. Technology serves as a tool for students to accurately reconstruct the past and present contexts of indigenous communities through the stimulation of historical imagination ([Supriatna, 2019](#)).



Figure 4. A detailed visualization of the *leuit*, equipped with *interactive information points* to facilitate independent and in-depth observation by students.

In addition to its immersive aspects, the effectiveness of this medium is also evident in the ease of data access or *accessibility* it offers compared to conventional lecture methods. In conventional methods, historical information is often linear and relies entirely on the teacher's narration, which is frequently limited to superficial facts ([Gardner, 2003](#)). In contrast, the virtual ecomuseum provides a rich data ecosystem, ranging from digital artifacts and historical documents to recordings of interviews with traditional leaders, all of which students can access independently.

This ease of access enables a student-centered learning process. Students have full control to explore the information they need. They can revisit visualizations they haven't fully understood and conduct direct source analysis. Compared to lecture-based methods, which tend to be passive, virtual ecomuseums offer a new approach through digital laboratories that make historical data more accessible ([Grammalidis & Pavlis, 2025](#)). This aligns with findings that the availability of interactive digital learning resources significantly enhances students' engagement and critical thinking skills in analyzing the values of local wisdom.

Integrating Sinar Resmi Local Wisdom into Sustainable Historical Literacy

The integration of the local wisdom of the *Kasepuhan Adat Sinar Resmi* into the history curriculum provides a new dimension in viewing the past as an instrument of sustainability. The specific content of this indigenous community is not merely supplementary material. This concept is a living model demonstrating how a community can endure across the ages by maintaining a balance between human needs and environmental conservation. This is what makes Sinar Resmi a real-world laboratory for teaching the concept of sustainability, a concept that is often difficult for students to grasp when taught solely through theory.



Figure 5. Infographic mapping the cultural landscape of the Sinar Resmi Traditional Community as a tool for sustainable navigation based on local wisdom.

As in the example of the agricultural philosophy in the Sinar Resmi Traditional Village, reflected in the rice planting cycle and the Leuit system. This system is a concrete manifestation of future management. Students are encouraged to understand that for the Sinar Resmi community, rice is not merely an economic commodity. Rice is symbolized as a form of life and resilience that must be preserved for future generations ([Prabowo & Sudrajat, 2021](#)). The practice of storing a portion of the harvest for decades to come is a highly strategic form of historical literacy. This phenomenon reflects an awareness that today's actions determine humanity's existence in the future.

The community's social structure, rooted in solidarity and adherence to customary law in safeguarding entrusted forests and cover forests, is also highly relevant material. This teaches students that sustainability requires not only technology but also an ethical social order. By studying this structure through a virtual eco-museum, students can observe how local wisdom values such as Panca Waluya are practiced in collective decision-making to preserve ecosystems.

This integration is closely linked to *Green History* and critical literacy. Referring to Supriatna's ([2019](#)) perspective, history education must be able to transform students' awareness so they develop ecological responsibility. The Sinar Resmi content provides an applicable example of this theory. This concept shifts the cognitive nature of *historical thinking* into the reflective nature of *historical action*.

The data obtained from this study indicate the ineffectiveness of this integration. The high scores on ethical reflection and future orientation in schools like SMAN 10 and SMAN 1 demonstrate that Sinar Resmi's specific content successfully triggers these higher-order thinking processes. These figures suggest that when students are exposed to content relevant to global issues through the lens of local wisdom, they are more likely to critically evaluate current world conditions.

The success of integrating Sinar Resmi's local wisdom proves that historical literacy need not always focus on grand national narratives but can be grounded in local narratives that hold universal value. Specific content on how the Sinar Resmi community manages its natural and social environments serves as a bridge for urban students to rediscover their connection to the environment. Thus, this virtual ecomuseum has successfully fulfilled its role as a medium that not only preserves the past but also sows the seeds of sustainability for the future.

The success of the virtual ecomuseum in enhancing sustainable historical literacy demonstrates that history education must shift from past-oriented narratives toward the development of critical-reflective competencies relevant to future challenges. In general, this study provides evidence that integrating local wisdom into digital formats does more than simply enrich instructional materials. Local wisdom is also capable of fostering students' ecological and ethical awareness. This implies the need for a redesign of the history curriculum that is more adaptive to global sustainability issues through the lens of local wisdom.

The distinguishing feature of the *Kasepuhan Adat Sinar Resmi* virtual eco-museum compared to other digital history media lies in its underlying philosophy. While most digital history media tend to present artifacts as static and isolated objects, this virtual eco-museum functions as a *living heritage*. This study aims to position *Kasepuhan Adat Sinar Resmi* as a digital medium that serves as a landscape of connections linking three main pillars: indigenous communities, the natural environment, and historical evidence. Thus, this concept not only offers a visual tour but also provides a framework that helps students think systemically and ethically. Thus, this study seeks to fill a gap in the literature on history learning media, which has so far rarely addressed the aspect of sustainability specifically through the integration of holistic traditional knowledge.

CONCLUSION

The findings indicate that the virtual ecomuseum contributed to improving students' sustainable historical literacy through the integration of immersive virtual reality technology and local wisdom. The product was developed using the ADDIE model, which included the stages of analysis, design, development, implementation, and evaluation. In its development process, the virtual ecomuseum integrated digital artifacts, local historical narratives, 3D models of cultural

spaces, and interactive tours to support contextual and engaging history learning experiences. Expert validation results indicated that the product was feasible for use in history learning. Furthermore, the implementation results across several schools showed an improvement in students' sustainable historical literacy, particularly in understanding historical context, ecological-cultural awareness, and reflective thinking toward sustainability issues. However, this study has several limitations. The implementation was conducted within a limited number of schools and focused specifically on the cultural context of Kasepuhan Adat Sinar Resmi, which may limit the broader generalizability of the findings. In addition, the study primarily examined short-term learning outcomes and did not explore the long-term impact of the virtual ecomuseum on students' attitudes and behaviors. Future research is recommended to involve broader participant groups, examine long-term impacts on students' historical and environmental awareness, and explore the adaptation of virtual ecomuseum models in different cultural and educational contexts. Further studies may also investigate the integration of emerging technologies, such as augmented reality and artificial intelligence, to enhance interactive history learning experiences.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

Conceptualization, I.Y. and N.S.; methodology, I.Y. and E.W.; validation, I.Y., N.S., E.W., W.D.; formal analysis, I.Y.; investigation, I.Y. and N.S.; writing, original draft preparation, I.A.; writing, review and editing, I.Y. and J.S.; supervision, I.A. All authors have read and approved the final version of the manuscript.

AI DISCLOSURE STATEMENT

The authors declare that no artificial intelligence (AI) tools or services were used in the preparation, writing, analysis, or development of this manuscript. The manuscript was prepared and reviewed entirely by the authors, who take full responsibility for its content and accuracy.

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