

Transforming Traditional Knowledge Preservation through a Project-Based Lontar Digitization Learning Model in Higher Education

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Abstract: The preservation of Balinese Lontar manuscripts requires innovative educational approaches that integrate digital technology, cultural awareness, and community engagement. However, limited research has developed and examined a higher-education learning model that explicitly integrates project-based learning with authentic community-based Lontar digitization, particularly through a university–community partnership, to simultaneously address student learning and traditional knowledge preservation. This study aimed to analyze the implementation and contribution of the Project-Based Lontar Digitization Learning Model in higher education. The study employed a qualitative descriptive research design to examine the implementation and outcomes of the learning model, which served as the pedagogical intervention. The research was conducted at STKIP Agama Hindu Amlapura, Karangasem, Bali, involving eight students from the Bali Language Education Study Program in collaboration with the local Lontar community. Data were collected through classroom and field observations, project documentation, performance assessment, and field activity reports, and were analyzed using thematic analysis and descriptive evaluation. The findings indicate that the learning model guided students through systematic stages of manuscript identification, conservation, digitization, metadata preparation, documentation, and project presentation. Evidence from the project documentation and field activity reports showed that students successfully produced digital archives of two Balinese Lontar manuscripts, Kakawin Arjuna Wiwaha and Kakawin Partha Karma, supported by structured metadata. As an educational outcome, students demonstrated active participation and developed digital, cultural, collaborative, and community-engagement competencies through direct involvement in the digitization process. As a community-development outcome, the partnership produced accessible digital documentation of two traditional manuscripts and strengthened the involvement of the Lontar community in preserving local knowledge. The principal novelty of the study lies in positioning the university–community partnership as an integral component of the learning model, rather than treating community engagement as a supplementary learning activity. The study therefore contributes a specific community-based instructional framework that operationalizes

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university–community collaboration through authentic Lontar digitization projects, linking student competency development with the sustainable digital preservation of Balinese traditional knowledge.

Keywords: Balinese manuscript, cultural heritage, digital preservation, Lontar digitization, project-based learning, traditional knowledge.

Introduction

The rapid advancement of digital technology has transformed the preservation of cultural heritage by enabling more systematic documentation, digital archiving, and knowledge dissemination. In the context of traditional knowledge, however, digital preservation is not merely a technological process of creating digital copies; it also involves ensuring that culturally significant knowledge remains documented, accessible, interpretable, and connected to the communities that maintain it. Beyond creating digital copies of cultural artifacts, digital preservation has evolved into a comprehensive strategy for safeguarding traditional and indigenous knowledge, promoting cultural sustainability, and improving public accessibility to valuable heritage resources. Recent studies emphasize that the effectiveness of digital preservation depends not only on technological capacity but also on educational innovation, cultural responsiveness, and community participation in the preservation process ([Sarasvananda et al., 2024](#); [Burgos-Ayala et al., 2020](#); [Druker-Ibáñez & Cáceres-Jensen., 2022](#)). Traditional knowledge represents an essential intellectual and cultural asset accumulated through generations of interaction between indigenous communities and their surrounding environments. Such knowledge encompasses religious beliefs, philosophy, literature, environmental ethics, traditional medicine, customary law, and local ecological practices that collectively shape community identity. However, globalization, environmental degradation, and declining intergenerational transmission have placed many indigenous knowledge systems at risk of disappearing. The vulnerability is particularly evident when traditional knowledge is preserved in physical manuscripts that remain dependent on the knowledge, resources, and preservation practices of individual families, temples, traditional villages, and local collectors. In such settings, preservation may be constrained by limited technical knowledge of conservation and digitization, the absence of systematic metadata and cataloguing, restricted access to appropriate digitization equipment, and the lack of procedures for maintaining and disseminating digital copies. Consequently, integrating digital technology with culturally responsive educational practices has become an increasingly important strategy for ensuring the sustainability of traditional knowledge while strengthening cultural identity among younger generations ([Boakye-Yiadom et al., 2025](#)).

In Indonesia, Balinese Lontar manuscripts constitute one of the richest repositories of traditional and indigenous knowledge in Southeast Asia. Beyond serving as historical records, previous studies have recognized Lontar manuscripts as educational resources that facilitate the transmission of Hindu philosophy, moral values, local wisdom, and traditional knowledge across generations ([Jatiyasa et al., 2024](#)). Written on processed palm leaves using Balinese script, these manuscripts contain diverse knowledge related to Hindu philosophy, ritual traditions, ethics, traditional medicine, architecture, agriculture, astronomy, literature, and environmental management. The physical characteristics of palm-leaf manuscripts make them particularly dependent on appropriate conservation, documentation, and storage practices, while their cultural value requires preservation practices that respect the ownership, meaning, and knowledge of the communities that maintain them. Nevertheless, many Lontar manuscripts remain privately owned by families, temples, traditional villages, and local collectors, making their long-term preservation dependent on the availability of appropriate conservation practices and the willingness and capacity of owners to document and share them. Environmental factors, limited documentation, and inadequate digital management may therefore increase the risk of physical deterioration, loss of manuscript information, and reduced access to traditional knowledge. ([Sarasvananda et al., 2024](#)) demonstrated that semantic-based digital restoration significantly improves the documentation and preservation of Balinese Lontar manuscripts while facilitating future digital access and knowledge management. However, technological restoration and digital archiving alone do not necessarily address the educational and participatory dimensions of preservation, particularly when manuscripts are dispersed among community owners and collectors. This limitation highlights an important distinction between institutional digitization and community-based preservation. Institutional initiatives may provide technological infrastructure, expertise, or digital repositories, but they do not automatically ensure that community-owned manuscripts are systematically identified, documented, digitized, catalogued, and connected to younger generations through meaningful learning experiences. For community-owned collections, therefore, preservation requires a collaborative mechanism through which manuscript owners contribute access, contextual knowledge, and cultural authority, while universities contribute pedagogical expertise, digital skills, documentation procedures, and student resources. University–community collaboration is consequently not only a mechanism for accessing manuscript collections but also a strategy for ensuring that digitization activities respond to community preservation needs while generating educational value for students. Higher education institutions have a strategic responsibility to prepare graduates capable of responding to these challenges through innovative learning approaches that integrate digital competence, cultural literacy, and community engagement. Previous studies have also emphasized that Balinese manuscript-based learning provides authentic opportunities for

strengthening students' cultural literacy while promoting the preservation of traditional knowledge ([Jatiyasa et al., 2024](#)). Among contemporary pedagogical approaches, Project-Based Learning (PjBL) has consistently demonstrated positive impacts on students' critical thinking, collaboration, creativity, and authentic problem-solving. More importantly, recent studies indicate that integrating indigenous knowledge into project-based learning strengthens students' cultural awareness while simultaneously contributing to community empowerment and heritage preservation ([Boakye-Yiadom et al., 2025](#); [Widyaswari et al., 2026](#); [Purbosari et al., 2025](#)). These characteristics make PjBL particularly relevant to Lontar preservation because students can learn through an authentic process in which knowledge acquisition, technical practice, cultural interpretation, and community interaction occur within a single project. The concept of Ethno-Project-Based Learning introduced by [Widyaswari et al. \(2026\)](#) further demonstrates that community-based projects rooted in local cultural values effectively enhance students' learning experiences while preserving cultural heritage. Likewise, recent bibliometric studies reveal a rapidly growing international interest in integrating indigenous knowledge, ethnoscience, and project-based learning into higher education as an approach to achieving culturally responsive and sustainable education ([Kurdiati et al., 2026](#); [Minarni et al., 2026](#)). Nevertheless, these approaches do not specifically address the procedural requirements of Lontar digitization, such as manuscript identification, physical conservation, digital imaging, metadata preparation, cataloguing, and community validation of the resulting digital documentation. Despite these important contributions, three related gaps remain. First, studies of Balinese Lontar digitization have predominantly emphasized technological aspects, including digital restoration, documentation, and access, rather than treating digitization as an integrated learning experience involving students and manuscript-owning communities ([Sarasvananda et al., 2024](#)). Second, studies of project-based and ethno-project-based learning have primarily emphasized student learning, cultural awareness, engagement, or empowerment, without specifically integrating the technical workflow of manuscript digitization and preservation ([Boakye-Yiadom et al., 2025](#); [Purbosari et al., 2025](#); [Widyaswari et al., 2026](#)). Third, limited empirical research has examined a pedagogical model in which university–community partnership functions as the central mechanism connecting student learning with the actual preservation needs of community-owned Lontar collections. Thus, what remains insufficiently understood is not simply whether Lontar can be digitized or whether project-based learning can improve student competencies, but how these two domains can be systematically integrated through an authentic university–community partnership within a higher-education learning model. This study addresses this gap by proposing and examining a Community-Based Project-Based Lontar Digitization Learning Model in higher education. The model positions university students as active learners and community members or manuscript owners as knowledge holders and partners

in the preservation process. Students first acquire theoretical and procedural knowledge concerning Lontar preservation and digitization and subsequently engage in field-based projects involving manuscript identification, conservation preparation, digital capture, metadata development, documentation, and presentation of the resulting digital archive. Through this structure, the community is not treated merely as the source of research data or the recipient of university activities; rather, community participation is embedded as an essential component of the learning process.

The novelty of the proposed model lies in the integration of three dimensions within a single instructional framework: project-based student learning, authentic Lontar digitization, and university–community partnership. Unlike conventional project-based learning, in which projects are primarily designed as classroom learning tasks, the proposed model uses an actual community preservation need as the basis of the student project. Unlike technology-oriented Lontar digitization initiatives, the model places digitization within a structured pedagogical process that develops students' digital, cultural, collaborative, and community-engagement competencies. Unlike community-based cultural programs that focus primarily on preservation outcomes, the model explicitly connects community preservation activities with measurable educational experiences and student competency development.

Accordingly, this study aims to analyze how the Community-Based Project-Based Lontar Digitization Learning Model is implemented in higher education and to examine its contribution to (1) students' digital, cultural, collaborative, and community-engagement competencies and (2) the preservation and digital documentation of community-owned Balinese Lontar manuscripts. The study therefore seeks to answer the following questions: (1) How is the Community-Based Project-Based Lontar Digitization Learning Model implemented through university–community collaboration? (2) What educational outcomes emerge from students' participation in authentic Lontar digitization projects? and (3) What community-development and preservation outcomes are generated through the partnership?

Research Procedure

The instructional intervention consisted of the following six stages:

1. Orientation and Conceptual Understanding

Students studied the concepts of traditional knowledge, Balinese Lontar manuscripts, manuscript conservation, digital preservation, and digital heritage. This stage provided the theoretical foundation for subsequent field activities.

2. Project Planning

Students were organized into collaborative groups to design project plans, identify manuscript locations, determine digitization strategies, and prepare field documentation instruments.

3. Community-Based Field Investigation

Each group visited villages, temples, traditional households, or private collectors to identify Lontar manuscripts, establish communication with manuscript owners, document manuscript conditions, and obtain informed consent for digitization activities.

4. Lontar Digitization and Metadata Development

Students digitized manuscripts using high-resolution digital photography, organized digital image files, and developed standardized metadata, including manuscript title, ownership, physical characteristics, script type, language, estimated age, and thematic classification.

5. Digital Archiving and Knowledge Interpretation

The digitized collections were systematically archived and accompanied by preliminary descriptions and interpretations of manuscript contents to improve educational utilization and long-term preservation.

6. Reflection, Presentation, and Evaluation

Student groups presented their project outcomes, reflected on their learning experiences, discussed challenges encountered during community engagement, and received feedback from lecturers and peers regarding both the digitization process and learning achievements.

Data Collection

Data were collected using multiple qualitative techniques to ensure methodological triangulation, including classroom observations of students' participation and collaborative learning, field observations during community-based Lontar digitization activities, assessment of students' project outputs using a performance rubric, students' reflective journals, semi-structured interviews with selected students and Lontar manuscript owners, and documentation of digitized Lontar manuscripts and project portfolios.

Data Analysis

The qualitative data were analyzed using thematic analysis following the framework proposed by [Braun and Clarke \(2006\)](#). First, all observation notes, interview transcripts, reflective journals, and project documentation were organized and repeatedly reviewed to achieve data familiarization. Second, open coding was conducted to identify meaningful segments related to students' learning experiences, community engagement, manuscript preservation practices,

and competency development. Third, similar codes were grouped into broader categories representing recurring patterns across different data sources. These categories were subsequently synthesized into overarching themes describing the implementation of the Project-Based Lontar Digitization Learning Model and its contribution to traditional knowledge preservation. Finally, the themes were interpreted by comparing findings across observations, interviews, project documentation, and students' performance assessments to generate comprehensive conclusions. Students' project performance was descriptively evaluated using predetermined assessment indicators, including project planning, documentation quality, metadata completeness, collaboration, digital archiving, and contributions to traditional knowledge preservation. The performance assessment served as supporting evidence for the qualitative interpretation rather than as a statistical measure of learning effectiveness. The trustworthiness of the findings was enhanced through methodological triangulation of observations, project documentation, performance assessments, and field reports. Member checking with selected participants was conducted to verify the accuracy of the findings, while peer debriefing among the researchers supported the consistency of data interpretation. An audit trail documenting coding decisions and theme development was maintained to enhance the dependability and confirmability of the analysis. Institutional permission to conduct the study was obtained from the Undergraduate Program of Balinese Language Education, STKIP Agama Hindu Amlapura. All participants voluntarily provided informed consent prior to data collection, and permission for manuscript documentation and digitization was obtained from the manuscript owners before field activities commenced. Throughout the research process, the researchers respected community ownership rights, local cultural values, and ethical principles governing the handling, documentation, and preservation of Balinese Lontar manuscripts.

Result and Discussion

Implementation of the Project-Based Lontar Digitization Learning Model

The Project-Based Lontar Digitization Learning Model was implemented through a combination of classroom-based learning and authentic community-based field activities. The learning process involved eight undergraduate students from the Bali Language Education Study Program, who were divided into two collaborative project groups. Each group was assigned to conduct Lontar digitization activities using community-owned manuscript collections. Within this instructional model, students actively participated in all stages of the preservation process, allowing qualitative data to be generated through classroom observations, field observations, project documentation, reflective journals, interviews, and

performance assessments. The implementation process consisted of several interconnected stages, including classroom discussions, identification of potential Lontar collectors, field observation, obtaining permission from manuscript owners, physical conservation, manuscript digitization, metadata identification, report preparation, and presentation of project outcomes. The field activities were conducted at the Lontar collection owned by Jro Mangku Karya in Banjar Bukit Badabudu, Tenganan Village. Through direct interaction with manuscript owners, students experienced authentic learning situations that enabled them to understand not only technical aspects of manuscript preservation but also the social, cultural, and historical values associated with Balinese Lontar traditions. During the digitization process, students were required to produce high-resolution digital images while simultaneously conducting systematic metadata identification. The metadata included manuscript ownership, collection location, manuscript title, physical dimensions, number of palm-leaf sheets, writing medium, script, language, literary form, physical condition, cultural function, and a brief description of the manuscript contents. The metadata identification process ensured that each digitized manuscript was accompanied by structured descriptive information to facilitate documentation, accessibility, and educational utilization. The project produced digital documentation of two Balinese Lontar manuscripts, namely Kakawin Arjuna Wiwaha and Kakawin Partha Karma. Both manuscripts belong to the kakawin literary tradition written in Balinese script using the Old Javanese (Kawi) language. Students successfully identified not only the physical characteristics of the manuscripts but also their linguistic, literary, and cultural attributes. The identified metadata components are presented in Table 1.

Table 1 Metadata Identification Components of Digitized Lontar Manuscripts

Metadata Component	Identification Description
Manuscript Owner	Community-owned Lontar collection (Jro Mangku Karya)
Collection Location	Banjar Bukit Badabudu, Tenganan Village
Title of Manuscript	Kakawin Arjuna Wiwaha and Kakawin Partha Karma
Physical Dimension	Identified based on the measurement of each Lontar manuscript
Number of Pages	Identified based on the total number of palm-leaf sheets
Writing Medium	Palm leaf manuscript (daun Lontar)
Script	Balinese Script (Aksara Bali)
Language	Old Javanese (Kawi)
Literary Form	Kakawin (Sekar Agung)
Physical Condition	Examined based on completeness, readability, and preservation condition
Function	Cultural heritage document, classical literary learning resource, and medium used in Mabebasan (Pasantian) tradition
Manuscript Description	Description of the content, literary characteristics, and cultural significance of the manuscript

Source: Student Activity Report, 2026

The qualitative findings were complemented by a performance assessment conducted throughout the project. Students were assessed using seven indicators: participation, collaboration, critical discussion, field investigation, documentation quality, metadata completeness, and digital archiving. Each indicator was assessed using a four-level performance scale, and the scores were converted into percentages to provide descriptive evidence of students' project performance. These numerical results were used as supporting evidence for the qualitative findings rather than as inferential statistical evidence.

$$\text{Percentage Score} = (\text{Obtained Score} / \text{Maximum Possible Score}) \times 100 \quad (1)$$

The percentage scores were subsequently averaged across all project groups to provide descriptive evidence of students' learning performance during the implementation of the instructional model.

Table 2 Students' Project Performance During the Implementation of the Project-Based Lontar Digitization Learning Model

Assessment Indicator	Mean (%)	Category
Participation	90	Excellent
Collaboration	93	Excellent
Critical Discussion	85	Very Good
Field Investigation	100	Excellent
Documentation Quality	89	Very Good
Metadata Completeness	88	Very Good
Digital Archiving	89	Very Good
Overall Project Achievement	90.57	Very Good

Source: Student Activity Report, 2026

As presented in Table 2, students demonstrated consistently high performance across all assessment indicators. The highest score was achieved in field investigation (100%), indicating that all project groups successfully completed community-based manuscript identification and documentation activities. Collaboration (93%) and participation (90%) also reached the excellent category, indicating that students demonstrated active participation and teamwork during the Lontar digitization project. In addition, documentation quality (89%), metadata completeness (88%), and digital archiving (89%) were all rated very good, demonstrating that students were able to produce well-organized digital records and apply appropriate archival practices during the digitization process. Overall, the project achievement reached a mean score of 90.57%, which falls within the excellent category. This result indicates that students successfully accomplished all stages of the project in accordance with the established assessment criteria. These quantitative findings provide descriptive support for the qualitative evidence obtained from classroom observations, semi-structured interviews, reflective

journals, and project documentation. Taken together, the findings indicate that students were able to participate in the project, collaborate with peers, conduct community-based manuscript documentation, and develop practical competencies related to Lontar digitization. The findings indicate that the Project-Based Lontar Digitization Learning Model provided students with opportunities to develop systematic competencies in manuscript preservation. Rather than merely performing technical digitization tasks, students demonstrated the ability to analyse manuscript characteristics, organize metadata, classify traditional knowledge, and interpret the cultural significance of Balinese Lontar manuscripts. This learning process was also reflected in the students' own accounts. As one student explained:

Through the digitization of Lontar manuscripts, we learned not only about documentation techniques but also about manuscript characteristics, Balinese script, the Kawi language, and the literary, cultural, and religious values contained in the manuscripts. This activity enabled us to connect the theories learned in our courses with real-world practice while also developing an awareness of the importance of preserving Balinese cultural heritage (Anggi Putri, interview, 2026). The student's account illustrates that the field-based activity involved learning about the manuscripts and their cultural context, rather than focusing solely on technical digitization procedures. It also demonstrates that the project facilitated the integration of theoretical knowledge with practical experience while fostering students' awareness of cultural heritage preservation. The classification of the digitized manuscripts referred to the WAWIBT classification system introduced by Nyoman Kadjeng at the Gedong Kirtya Library, Singaraja, in 1928. According to this classification, Balinese manuscripts are grouped into six major categories: Weda, Agama, Wariga, Itihasa, Babad, and Tantri. Based on this framework, both Kakawin Arjuna Wiwaha and Kakawin Partha Karma were classified within the Itihasa category, specifically the kakawin literary tradition. This finding demonstrates that students were able to integrate practical digitization activities with theoretical knowledge acquired during classroom instruction, thereby connecting academic learning with authentic cultural preservation practices. The metadata identification activity became an important component of the learning process because digital preservation does not only involve converting physical manuscripts into digital files but also requires the creation of structured information that explains the identity and significance of the preserved objects. Therefore, students developed an understanding that manuscript digitization consists of interconnected activities involving documentation, description, interpretation, and cultural preservation. Throughout the implementation process, students documented their project progress through the class WhatsApp Group (WAG). Progress reports included activity descriptions, photographic documentation, and reflective notes from each stage of the project. This mechanism facilitated continuous supervision by the lecturer, promoted collaborative

problem-solving among student groups, and encouraged reflective learning during community engagement.

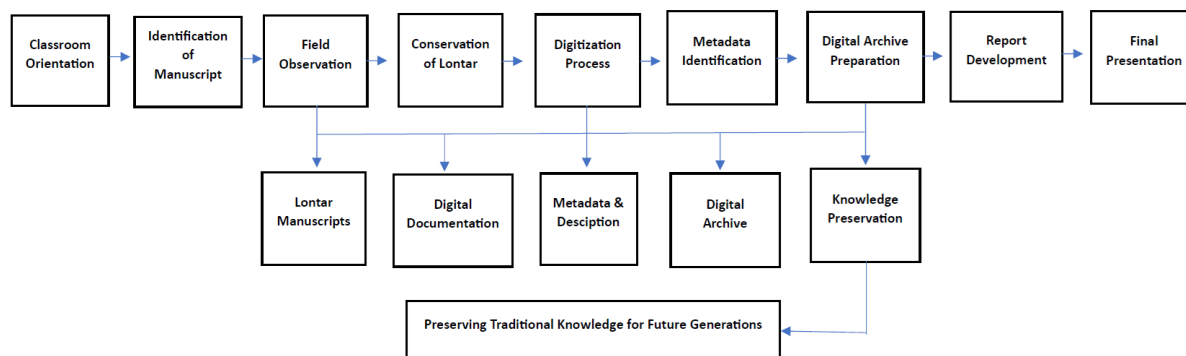


Figure 1 Implementation Flow of the Project-Based Lontar Digitization Learning Model

The present findings support the constructivist perspective underpinning Project-Based Learning, which emphasizes that meaningful learning occurs when students actively construct knowledge through authentic real-world experiences. By engaging directly in community-based manuscript preservation, students integrated theoretical understanding with practical experience, enabling them to develop digital literacy, cultural awareness, and collaborative competencies within a culturally relevant context. This finding is consistent with (Boakye-Yiadom et al., 2025), who reported that project-based learning incorporating indigenous knowledge enhanced students' engagement and appreciation of local cultural values. Similarly, (Widyaswari et al., 2026) demonstrated that community-based ethnoproject learning strengthened students' cultural understanding through authentic learning experiences. In the context of digital heritage preservation, the present findings also complement (Sarasvananda et al., 2024), who emphasized the importance of digital technologies in improving the preservation and accessibility of Balinese Lontar manuscripts. Unlike previous studies that primarily focused either on technological development or educational outcomes, this study integrates project-based learning, community participation, and digital preservation within a single instructional model. From a theoretical perspective, these findings extend the application of Project-Based Learning by demonstrating its potential as a pedagogical framework for integrating indigenous knowledge preservation with digital heritage education. The study also contributes to culturally responsive education by illustrating how authentic community engagement can strengthen students' understanding of local cultural heritage. Practically, the Project-Based Lontar Digitization Learning Model offers an alternative instructional approach for higher education institutions seeking to integrate cultural heritage preservation into university curricula. Furthermore, the collaboration established between universities and local communities provides a sustainable strategy for documenting vulnerable Lontar manuscripts while supporting the preservation of Balinese traditional knowledge for future generations.

Students Engagement in Community-Based Digitization Activities

Student engagement was observed throughout classroom learning and community-based field implementation to examine four complementary dimensions of engagement during the implementation of the Project-Based Lontar Digitization Learning Model, namely behavioral engagement, collaborative engagement, community engagement, and cultural engagement. These dimensions represent students' active participation in learning activities, teamwork during project implementation, interaction with manuscript owners and local communities, and respect for local cultural traditions throughout the digitization process. Observation data indicated consistently high levels of engagement across all dimensions, with students participating in both learning activities and community-based cultural heritage preservation activities. The results are presented in Table 3.

Table 3 Students' Engagement in Community-Based Lontar Digitization Activities

Engagement Dimension	Indicator	Mean (%)	Category
Behavioral Engagement	Active Participation	90	Excellent
Collaborative Engagement	Team Collaboration	93	Excellent
Community Engagement	Interaction with Manuscript Owners	96	Excellent
Cultural Engagement	Respect for Local Traditions	100	Excellent

Source: Student Activity Report, 2026

As presented in Table 3, students demonstrated consistently high levels of engagement across all four dimensions of community-based learning. Among these dimensions, cultural engagement recorded the highest score (100%), indicating that all students consistently respected local traditions and ethical procedures throughout the digitization project. Before commencing field activities, students participated in traditional prayers together with manuscript owners and community members, followed local cultural protocols, and handled the manuscripts with appropriate respect. These observations indicate that cultural values were incorporated into the learning activities through students' direct participation in locally established practices. Community engagement also achieved an excellent level (96%). Students established meaningful interactions with manuscript owners and local community members during manuscript identification, conservation, digitization, and documentation activities. Through these interactions, students gained first-hand knowledge regarding the historical background, cultural significance, and traditional preservation practices associated with the manuscripts. More importantly, the field activities revealed a reciprocal exchange of knowledge between the university and the community. Students contributed knowledge

related to digital photography, metadata documentation, file organization, and digital archiving, while manuscript owners contributed culturally situated knowledge concerning manuscript history, cultural meaning, traditional maintenance, and appropriate cultural practices. Thus, community members were not merely recipients or facilitators of the digitization activity; they also functioned as knowledge holders who shaped students' understanding of the manuscripts and their cultural context. The collaborative engagement dimension obtained a score of 93%, reflecting effective teamwork throughout the project. Students successfully coordinated responsibilities within their respective groups, including preparing digitization equipment, conducting conservation procedures, photographing manuscripts, compiling metadata, and preparing project reports. These activities required students to distribute tasks, communicate with peers, and address project-related problems collectively. Meanwhile, behavioral engagement reached 90%, indicating that students actively participated throughout both classroom instruction and field implementation. Although classroom observations identified two students who were initially less active during discussions, these students became considerably more engaged during community-based activities by documenting manuscripts, communicating with community members, and completing assigned project tasks. This observation suggests that the field-based setting provided additional opportunities for participation that were less evident during initial classroom discussions. The findings demonstrate that student engagement extended beyond classroom participation to encompass collaboration, community partnership, and cultural responsibility within authentic learning contexts. These results are consistent with previous studies reporting that Project-Based Learning promotes active participation, collaborative learning, and authentic problem-solving ([Blumenfeld et al., 1991](#); [Bell., 2010](#); [Almulla., 2020](#)). Likewise, community-based learning strengthens civic responsibility and collaborative competence through meaningful interaction with community partners ([Celio et al., 2011](#)). The present study extends this discussion by showing how these engagement dimensions can operate simultaneously within a community-based Lontar digitization activity. In this setting, students were not only completing project tasks but also interacting with manuscript owners, learning culturally situated knowledge, and applying digital documentation practices. The contribution therefore lies in connecting project-based learning with reciprocal university–community knowledge exchange in the context of Lontar preservation, rather than in demonstrating the effectiveness of Project-Based Learning itself.



Figure 2 Students' Activities During Community-Based Lontar Digitization

Figure 2 illustrates the interaction between students, manuscript owners, and community members during the community-based digitization process. The interaction is significant because it shows that manuscript preservation was conducted through complementary contributions from academic and community actors. Manuscript owners provided contextual and culturally situated knowledge, while students contributed digital documentation and archiving practices. The activity therefore functioned not only as a field-based learning experience but also as a space for reciprocal knowledge exchange. The integration of Balinese cultural and spiritual values constituted a distinctive characteristic of the learning process. Prior to digitization, all participants jointly performed traditional prayers to seek blessings for the preservation activities. The practice observed during the field activity indicated that the manuscripts were treated by participants as cultural materials requiring respectful handling, rather than merely as documentary objects. Collectively, Figure 2 complements the quantitative findings presented in Table 3 by illustrating how behavioral, collaborative, community, and cultural engagement were manifested during the field activities. The figure particularly highlights the interaction between students and community knowledge holders, showing that digitization involved both the application of digital preservation practices and the exchange of culturally situated knowledge. This interaction represents an important feature of the learning model: students learned through direct engagement with community knowledge holders while contributing digital documentation practices to the preservation activity.

Digital Preservation Outputs and Metadata Quality

The Project-Based Lontar Digitization Learning Model produced tangible outputs in the form of digital manuscript archives and structured metadata that facilitate the documentation, organization, and accessibility of Balinese Lontar manuscripts. Unlike the previous section, which described the implementation process of the learning model, this section focuses on the quality and characteristics of the preservation products generated by students throughout the project. The preservation outputs consisted of two categories. First, during classroom-based

learning, students documented six Lontar manuscripts as part of practical training in conservation, digital photography, metadata preparation, and archive organization. Second, the community-based project produced complete digital documentation of two culturally significant manuscripts, namely Kakawin Arjuna Wiwaha and Kakawin Partha Karma. These manuscripts were compiled into digital archives in Portable Document Format (PDF), providing an organized digital format for educational and research use. The quality of the preservation outputs was evaluated based on four aspects, namely the completeness of manuscript documentation, image clarity, metadata completeness, and systematic digital archive organization. Overall, the students successfully produced digital archives with clear manuscript images accompanied by comprehensive metadata describing manuscript ownership, location, title, physical characteristics, script, language, literary classification, cultural function, and descriptive information. These metadata provide contextual information that supports the identification, organization, and interpretation of the digitized manuscripts.

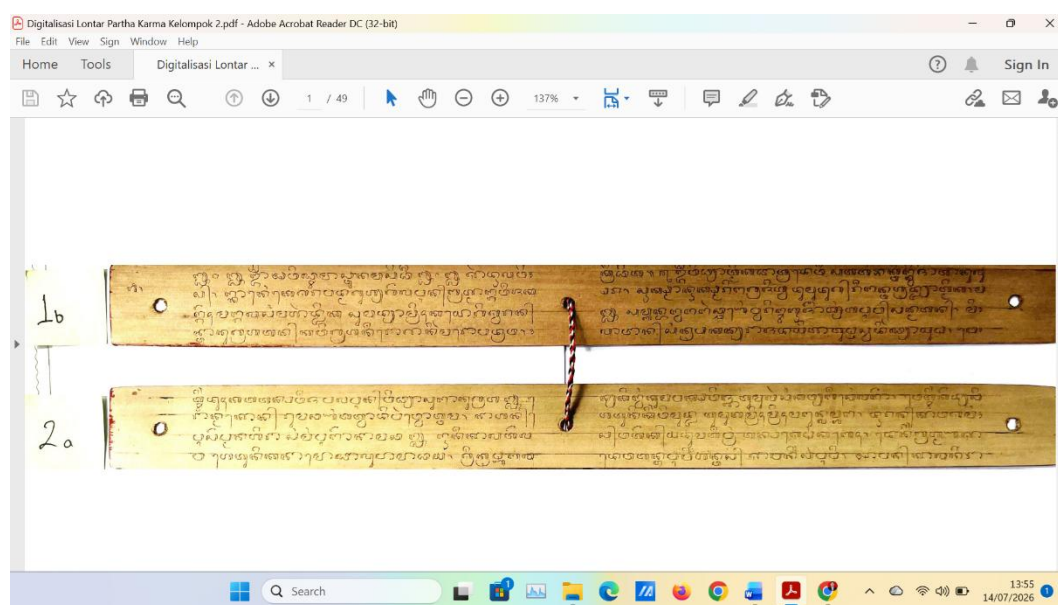


Figure 3 Digital Preservation Outputs of Lontar Manuscripts

Figure 3 presents an example of the digital preservation output produced by students during the project. The original Lontar manuscripts were converted into digital PDF documents to facilitate digital documentation and accessibility for educational and research purposes. Each PDF page displays two photographed manuscript surfaces, following the traditional arrangement of Balinese Lontar manuscripts. Each manuscript surface is identified using a coding system consisting of a leaf number and page position, such as 1b and 2a. The code 1b refers to the lower side (b) of the first Lontar leaf, whereas 2a indicates the upper side (a) of the second leaf. In traditional Balinese manuscript writing, textual reading generally begins from page 1b and continues sequentially through the following leaves. Furthermore, page

numbering is conventionally written only once on the lower side (b) of each leaf, representing an important codicological characteristic that was preserved in the digital archive. Maintaining this original pagination system allows the digital version to retain the physical sequence and organization of the manuscript while facilitating future scholarly reference.

The production of standardized PDF archives represents an important output of the learning model because it organizes digital images of the manuscripts while retaining their original physical sequence and page structure. The resulting digital archives therefore preserve documentary information such as manuscript sequence, writing conventions, and textual organization in a structured digital format. The findings indicate that the digitization outputs extended beyond individual manuscript images to include organized files and descriptive metadata. These outputs provide digital materials that can be used in educational activities and serve as documented resources for further scholarly examination. The significance of the outputs thus lies in the integration of image documentation, metadata, and archive organization within the students' project work.

Students' Digital, Cultural, and Collaborative Competencies in the Digitization Project

Students' digital, cultural, and collaborative competencies were examined through a performance-based assessment conducted during the Lontar digitization project. Students were assessed through a performance-based task requiring each group to digitize one selected Lontar manuscript according to predetermined technical guidelines. The assessment emphasized several competencies, including manuscript selection, report organization, technical writing ability, quality of digital documentation, and digital editing skills. The assessment results are presented in Table 4.

Table 4 Assessment Results of Students' Lontar Digitization Performance

Assessment Criteria	Maximum Score	Average Score
Selection of Interesting/Important Lontar Manuscript	10	8
Report Writing Systematics	5	5
Writing Technique (spelling, citation, reference, numbering, etc.)	10	8
Quality of Lontar Digital Images	15	14
Digital Editing and Presentation Quality	5	4
Total Score	45	39
Final Achievement Score		86.66

The overall achievement score of 86.66 indicates that students demonstrated a relatively high level of performance in the assessed aspects of the Lontar digitization project. The highest achievement was found in digital image quality (14 out of 15 points), indicating that students were able to apply the technical procedures required for manuscript image documentation. Meanwhile, the lower scores in manuscript selection (8 out of 10) and writing technique (8 out of 10) indicate areas in which students required further guidance, particularly in evaluating manuscript significance and preparing academic reports. The assessment also shows that students were able to operate digital documentation equipment, edit manuscript images, convert files, merge digital documents, and identify technical errors in digital archives. These results provide descriptive evidence of the competencies demonstrated by students during the project. In addition to digital competence, students demonstrated cultural competence through direct interaction with traditional manuscript owners. Students followed ethical procedures when handling culturally significant manuscripts, including showing respect, maintaining appropriate conduct, and observing local cultural practices during field activities. Students also demonstrated collaborative competence through group-based project implementation. They divided responsibilities, communicated with team members, coordinated with manuscript owners, and completed project outputs collectively. These observations indicate that the digitization project required students to apply digital, cultural, and collaborative competencies simultaneously within an authentic community-based setting. Through involvement in actual cultural preservation projects, students applied competencies that extended beyond conventional classroom tasks, particularly in digital documentation, cultural interaction, collaboration, and project reporting.

Community Perspectives on Lontar Preservation

The involvement of local communities constituted an essential component of the Project-Based Lontar Digitization Learning Model. Community perspectives were identified through field observations, informal interviews, and direct interactions between students and manuscript owners during the implementation of the digitization project. Overall, the findings revealed that community members demonstrated positive attitudes, strong enthusiasm, and active participation throughout the preservation activities. The positive response from the community was influenced by several factors. First, the owners recognized that palm-leaf manuscripts are increasingly vulnerable to physical deterioration caused by aging, humidity, insects, dust, and improper storage conditions. Although the manuscripts had traditionally been preserved within families, they had never been systematically digitized, creating concerns regarding the potential loss of valuable cultural knowledge if physical damage occurred. Second, community members expressed the need for digital archives that could preserve the contents of the manuscripts while reducing the frequency of handling the original

Lontar. Consequently, the digitization project was perceived as an important effort to complement traditional preservation practices rather than replace them.

This perspective was also expressed by Jero Mangku Karya, the owner of the Lontar manuscripts, who highlighted the new knowledge gained through the students' conservation activities. He stated:

“The arrival of the student conservation team provided new insights into Lontar digitization. This is considered important because it can help preserve the Lontar in digital form. The condition of the Lontar is still relatively good; however, conservation efforts are still necessary to prevent the manuscripts from deteriorating quickly” (Jero Mangku Karya, interview, 2026).

The statement indicates that the community recognized digitization as a complementary preservation practice while also acknowledging the importance of continuing physical conservation. The owner's perspective also shows that the value of the activity was not limited to receiving technical assistance; the interaction provided new knowledge about digital preservation that complemented the community's existing practices of maintaining the physical manuscripts. The project also facilitated reciprocal knowledge transfer between the university and the local community. Students introduced practical knowledge regarding basic conservation techniques, appropriate handling procedures, metadata documentation, digital photography, and digital archiving. At the same time, manuscript owners shared culturally situated knowledge concerning the historical background of the manuscripts, traditional maintenance practices, cultural values, and the social functions of Lontar within Balinese society. This exchange was not unidirectional. Rather, technical and digital knowledge contributed by the students intersected with culturally situated knowledge contributed by manuscript owners, creating a shared learning process in which both groups contributed to and gained knowledge relevant to Lontar preservation.



Figure 4 Community Engagement in Lontar Preservation Activities

Figure 4 illustrates the interaction between students, manuscript owners, and local community members during the digitization activities. The interaction is analytically important because it shows that community involvement extended beyond providing access to manuscript collections. Manuscript owners contributed contextual knowledge about the manuscripts, including their historical background, cultural significance, and appropriate handling practices, while students contributed digital documentation and archiving practices. The figure therefore illustrates a reciprocal learning relationship in which academic and community knowledge were brought together during the preservation process.

The active participation shown in Figure 4 also reflects the emergence of a collaborative partnership between the university and the community. Rather than functioning solely as research participants, community members became partners in preserving traditional knowledge. This partnership was characterized by mutual trust, facilitated the exchange of academic and indigenous knowledge, and promoted shared responsibility for protecting endangered manuscript collections. Furthermore, the digital copies provided the community with an additional documented resource that could be consulted alongside the original manuscripts. These findings are consistent with previous studies emphasizing the importance of community participation in cultural heritage preservation, particularly because local communities hold and maintain knowledge associated with cultural heritage ([UNESCO, 2003](#); [Wijesuriya et al., 2013](#)). Research on participatory heritage management has likewise highlighted the importance of involving local communities in documentation and heritage

management processes ([Poulios., 2014](#)). The present study extends this perspective by demonstrating a reciprocal form of university–community engagement within a Project-Based Lontar Digitization Learning Model. Rather than positioning manuscript owners solely as sources of information, the project involved them as knowledge holders who contributed contextual, historical, and culturally situated knowledge about the manuscripts. In parallel, university students contributed knowledge and practical skills related to conservation procedures, digital photography, metadata documentation, and digital archiving. This reciprocal interaction indicates that community participation in the present study operated through knowledge exchange rather than one-way assistance. The students learned about the cultural context and traditional practices associated with Lontar, while manuscript owners gained new insights into digital documentation and preservation practices. Thus, the community-based activity functioned simultaneously as a learning environment for students and a collaborative space for exchanging technical and culturally situated knowledge. This finding adds to previous Project-Based Learning and digital preservation studies by showing how manuscript digitization can connect academic learning with community-held cultural knowledge within an actual preservation context.

Contribution of the Learning Model to Traditional Knowledge Preservation

The Project-Based Lontar Digitization Learning Model contributed to traditional knowledge preservation through interconnected dimensions involving manuscript documentation, knowledge documentation, educational contribution, community contribution, and scientific contribution. These dimensions represent the observable outputs and learning processes identified during the implementation of the model. The contribution framework is presented in Figure 5.

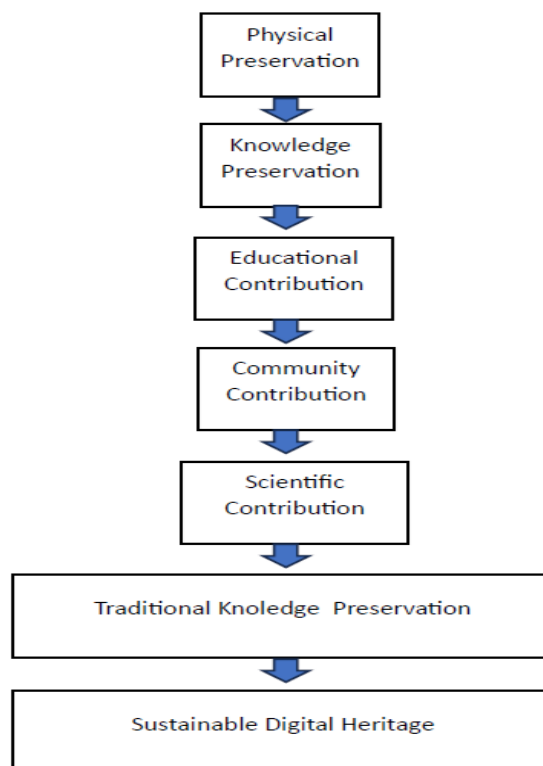


Figure 5 Contribution Framework of Project-Based Lontar Digitization Learning Model for Traditional Knowledge Preservation

The first contribution dimension is physical preservation. Through digitization activities, vulnerable palm-leaf manuscripts were documented into digital formats. The resulting digital files provide additional documentation of the physical manuscripts and reduce the need to rely exclusively on direct handling of the original materials during educational and research activities. The second dimension is knowledge preservation. Through metadata identification and manuscript description, students documented information related to manuscript identity, classification, language, script, literary form, and cultural functions. Students also developed experience in reading Balinese script, interpreting classical texts, and describing traditional knowledge contained within Lontar manuscripts. These activities show that digitization involved not only the production of digital images but also the documentation of contextual information associated with the manuscripts. The third dimension is educational contribution. The model provided students with opportunities to move beyond classroom-based learning through direct engagement with manuscripts and manuscript owners. Students demonstrated ethical behavior, responsibility, communication, and collaborative skills when interacting with communities during the field activities. Furthermore, students applied digital skills through manuscript image processing, file management, metadata preparation, and digital archive organization. These activities indicate that students exercised digital, cultural, and collaborative competencies within an authentic community-based learning context. The fourth dimension is community contribution. Communities participated

in the preservation activities by providing access to their Lontar collections, sharing information about manuscript history and cultural context, and interacting directly with students during the documentation process. Communities also received digital documentation of selected Lontar manuscripts as an output of the project. More importantly, the community contribution was characterized by reciprocal knowledge exchange. Manuscript owners contributed culturally situated knowledge concerning manuscript history, traditional maintenance practices, cultural values, and social functions, while students contributed knowledge and practical skills related to conservation, digital photography, metadata documentation, and digital archiving. Thus, community members functioned not only as sources of manuscript information but also as knowledge holders who contributed to the students' understanding of the cultural context of the manuscripts. The fifth dimension concerns the scientific contribution and novelty of the proposed learning model. Unlike previous studies that primarily focused on technological aspects of manuscript digitization ([Sarasvananda et al., 2024](#)) or community-based project learning ([Widyaswari et al., 2026](#)), the Project-Based Lontar Digitization Learning Model connects digital manuscript documentation, project-based learning, and reciprocal university–community knowledge exchange within a single instructional framework. The contribution of the model therefore lies not simply in combining digitization and project-based learning, but in positioning community-held cultural knowledge as an integral component of the learning process. The novelty of this model lies in integrating student learning, community knowledge, and digital preservation activities within an authentic cultural heritage context. Students are positioned not merely as learners who acquire digital skills, but as participants who apply those skills in documenting cultural heritage while learning from community knowledge holders. At the same time, manuscript owners participate in the learning process by providing contextual and culturally situated knowledge about the manuscripts. The relationship between students and communities is therefore characterized by complementary contributions rather than one-way knowledge transfer. The conceptual framework explaining how the proposed learning model contributes to traditional knowledge preservation is presented in Figure 6.

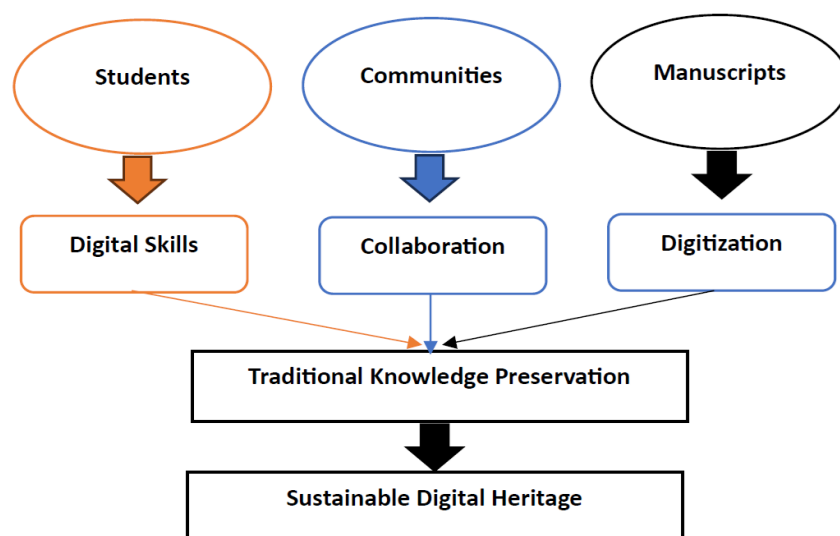


Figure 6 Conceptual Framework Illustrating the Contribution of the Project-Based Lontar Digitization Learning Model to Traditional Knowledge Preservation

The conceptual framework presented in Figure 6 illustrates that the Project-Based Lontar Digitization Learning Model operates through the interaction of three primary components, namely students, communities, and Lontar manuscripts. Each component performs a complementary role within the learning process. Students function as active learners who develop digital competencies through authentic preservation activities. Communities act as knowledge holders and preservation partners by providing access to manuscript collections, sharing culturally situated knowledge, and participating in documentation activities. Meanwhile, Lontar manuscripts serve as the primary source of traditional knowledge that becomes the object of documentation, interpretation, and digitization. The interaction among these three components generates three immediate outcomes. Students develop digital skills related to documentation, image processing, metadata preparation, and digital archiving. Collaboration between students and communities facilitates communication, coordination, and reciprocal knowledge exchange. Simultaneously, the manuscripts undergo systematic digitization, resulting in organized digital documentation accompanied by descriptive metadata. These outcomes contribute to the documentation of traditional knowledge associated with the manuscripts. In this process, preservation extends beyond the production of digital images to include documentation of cultural values, literary traditions, historical information, and culturally situated knowledge embedded within the Lontar texts. Consequently, preservation is understood as both a technological and cultural process.

The framework therefore demonstrates that the integration of student learning, community participation, and digital preservation creates a learning process in which technical knowledge and community-held cultural knowledge intersect. Rather than treating the community solely as a source of information or the students solely as recipients of knowledge, the model

facilitates complementary roles in which students contribute digital documentation practices while manuscript owners contribute contextual and culturally situated knowledge. This reciprocal relationship represents a central contribution of the proposed learning model and distinguishes it from approaches that treat manuscript digitization primarily as a technical documentation activity.

Conclusions

This study investigated the implementation of the Project-Based Lontar Digitization Learning Model as an instructional framework integrating project-based learning, community engagement, and digital preservation in the context of Balinese manuscript heritage. The empirical findings indicate that the model provided students with opportunities to develop digital, cultural, and collaborative competencies through authentic manuscript preservation activities. Students demonstrated project performance with an overall achievement score of 90.57% across participation, collaboration, critical discussion, field investigation, documentation quality, metadata completeness, and digital archiving. The competency assessment also recorded an overall achievement of 86.66%, with the highest performance observed in the quality of digital manuscript images. In addition, the community engagement findings showed active interaction between students and manuscript owners, particularly in manuscript documentation, conservation, and knowledge exchange. Importantly, the findings indicate that the relationship between the university and the community was reciprocal: students contributed knowledge and practical skills related to conservation and digital documentation, while manuscript owners contributed culturally situated knowledge concerning manuscript history, traditional maintenance practices, cultural values, and the social functions of Lontar. The resulting digital archives and metadata therefore constituted documented preservation outputs, while the learning process connected technical digital practices with community-held cultural knowledge. The study has several limitations. First, the implementation involved a relatively limited number of students and selected Lontar manuscripts within a specific Balinese cultural context; therefore, the findings should not be generalized to other educational or cultural heritage settings without further investigation. Second, the study primarily examined the learning process, student performance, community interaction, and digital preservation outputs during the project implementation. It did not measure long-term changes in community awareness, sustained preservation practices, or the long-term use and maintenance of the resulting digital archives. Third, the performance assessment provides descriptive evidence of student achievement but does not establish causal effectiveness of the learning model in comparison with other instructional approaches. The findings have several implications for education and cultural heritage practice. For higher education, the model provides a framework for integrating project-based learning with

authentic cultural heritage activities and community-held knowledge. For manuscript preservation activities, the findings indicate the value of combining technical digital documentation with contextual information provided by manuscript owners. The reciprocal knowledge exchange identified in this study also suggests that communities should be positioned not merely as recipients of university-based preservation activities but as knowledge holders and active participants in the learning process. Future research should examine the implementation of the model with larger and more diverse groups of students, different types of manuscripts, and other cultural heritage contexts. Longitudinal studies are also needed to examine the continued use, maintenance, and educational utilization of digital archives, as well as changes in community participation and preservation practices over time. Comparative or mixed-methods research could further investigate how the proposed model performs in relation to other project-based or digital preservation learning approaches.

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