

Ethnoscience-Based Learning Supported by Learning Management Systems (LMS) to Enhance Students' Digital Literacy and Collaborative Skills

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Abstract – 21st-century learning demands the development of digital literacy and collaboration skills as key competencies for students to adapt to the era of digital transformation and global society. This research aims to comprehensively examine the application of ethnoscience learning assisted by Learning Management System (LMS) in the context of higher education to enhance both skills. Ethnoscience, which integrates local knowledge and cultural wisdom with modern scientific concepts, offers a contextual and meaningful learning approach. Meanwhile, LMS provides a flexible and interactive online learning environment, supporting access to materials, discussions, and collaborative activities anywhere and anytime. The research method used is a systematic literature review (SLR), systematically identifying, evaluating, and synthesizing findings from various relevant studies published between 2020-2025. The main research question focuses on how the integration of ethnoscience and LMS can support the improvement of students' digital literacy and collaboration skills in science learning in higher education. The literature synthesis results show that ethnoscience learning assisted by LMS has significant potential in improving students' digital literacy through projects creating digital content based on culture, such as documentary videos or scientific blogs. Additionally, LMS facilitates collaboration skills by providing features such as discussion forums, online group assignments, and project management that enable cross-cultural interaction and meaning negotiation. Various good practices have been identified, such as the development of digital ethnoscience modules and the application of PjBL learning models integrated with LMS. However, challenges such as limited lecturer competence in LMS and ethnoscience, uneven technological infrastructure, and students' digital literacy gaps still need to be addressed. As a recommendation, ongoing training programs are needed for lecturers and students to improve digital competence and contextual pedagogy. Content developers and LMS managers must collaborate with cultural experts to design relevant and inclusive materials. Further research based on real classes is essential to evaluate the effectiveness of this model empirically and sustainably. This model can be a solution in preparing students to face the complexities of learning and the 21st-century workforce.

Keywords: Ethnoscience; Learning Management System; Digital Literacy; Collaboration Skills

INTRODUCTION

Higher education policy in Indonesia has implemented the Merdeka Belajar–Kampus Merdeka (MBKM) program to address the demands of the 21st century. This program emphasizes several key competencies and higher-order thinking skills, including creativity, critical thinking, collaboration, and communication (Sumarti & Kadarwati, 2022). The rapid development of information and communication technology has significantly reshaped the educational landscape, particularly in

science learning at universities, shifting paradigms from conventional methods toward more digital, flexible, and adaptive approaches. This transformation provides opportunities to integrate culturally relevant pedagogical models such as ethnoscience (Snively & Corsiglia, 2011).

Etymologically, ethnoscience derives from the Latin words *ethnos*, meaning people or ethnicity, and *scientia*, meaning knowledge. In linguistic terms, ethnoscience refers to the knowledge possessed by a specific ethnic group (Sari et al., 2025).

Conceptually, ethnoscience involves reconstructing indigenous knowledge, which originates within local communities, into scientific knowledge. Indigenous science encompasses the body of knowledge that reflects societal facts and practices (Risamasu, Pieter, & Gunada, 2023).

Ethnoscience represents an integration of scientific knowledge and local culture that helps students connect physics concepts with their daily experiences and environment (Herayanti et al., 2025). By linking physics learning with cultural values, students are expected to better understand and internalize the concepts being taught. This approach not only enhances comprehension but also fosters a deeper appreciation of science (Hosana et al., 2023). Ethnoscience can therefore be understood as a field that examines culture, customs, and traditions of a community through the lens of science. When combined with modern scientific knowledge, it creates a more engaging learning process (Kurniawan & Syafriani, 2021).

Ethnoscience, which bridges local knowledge and modern scientific concepts, offers a more meaningful learning experience. Its integration with a Learning Management System (LMS) provides an online learning environment accessible anytime and anywhere. It also supports interactive discussions, quizzes, instructional videos, and automated assessments (Saadilah et al., 2023). When ethnoscience-based local content is embedded into LMS platforms, learning becomes more than knowledge transfer. It evolves into a process of building cultural awareness and identity through science. This approach enriches course content with local cultural values while also strengthening students' digital literacy, which is crucial in today's digital era. Digital literacy involves the ability to access, evaluate, and produce

digital content critically, creatively, and responsibly (Suwarna & Zulfiani, 2024).

Furthermore, ethnoscience learning can enhance students' cultural awareness, which is essential in the context of multicultural education in Indonesia. The use of LMS in ethnoscience learning also enables more flexible and interactive content delivery, supports diverse learning activities, and encourages two-way interaction and communication (Riadi et al., 2024). In addition, LMS facilitates project-based learning that promotes collaboration among students, significantly developing their collaborative skills (Yoshida & Iijima, 2019).

Although the potential for integrating ethnoscience and LMS in science education is considerable, there remains a gap between idealization and actual implementation. Ideally, ethnoscience-based learning supported by LMS should enhance students' digital literacy and collaborative skills in an optimal manner. In practice, however, several challenges persist. First, many lecturers still lack adequate competence in integrating local wisdom and digital technology into LMS, and they tend to rely on traditional teaching methods. This aligns with the findings of Wicaksana et al. (2024), who reported low levels of system mastery and teaching creativity among lecturers. Second, unequal technological infrastructure and internet access, particularly in remote areas, present significant obstacles to the effective use of LMS. Hidayah (2021) emphasized the importance of offline access options to address unstable connections. Third, teachers and lecturers are not yet fully prepared to make use of digital tools and local-based learning materials. Herlinawati and Suhartini (2023) found that teachers were not fully ready to adopt culture-based digital modules and had not maximized the use of online learning resources. Fourth,

disparities in students' digital and socio-cultural literacy have resulted in unequal participation in online learning. Fifth, culturally based learning modules are sometimes inflexible and do not fully employ adaptive media to bridge cultural practices with scientific theories. Finally, a lack of institutional administrative support and regulations, combined with resistance to change, also hinders the integration of LMS into ethnoscience curricula. These challenges demonstrate that, although research such as that by Mufrihah et al. (2024) and Sari et al. (2024) has confirmed the effectiveness of ethnoscience-based digital learning media in improving digital literacy, many aspects of implementation still require improvement.

The novelty of this study lies in its comprehensive analysis of the synergy between local wisdom and digital technology through ethnoscience-based learning supported by LMS, with an explicit focus on enhancing students' digital literacy and collaborative skills in higher education. This article not only highlights the potential but also systematically identifies and analyzes the gap between the ideals and realities of implementation, while presenting both good practices and challenges encountered. Furthermore, it proposes an effective instructional design for integrating ethnoscience into LMS platforms by considering contextual, interactive, and collaborative aspects. This study is expected to provide new insights for educators, technology developers, and policymakers in designing innovative and inclusive learning strategies in the digital era.

RESEARCH METHODS

This article employs a Systematic Literature Review (SLR) approach to examine in depth the implementation of ethnoscience-based learning supported by

Learning Management Systems (LMS) in higher education, with a specific focus on its influence on enhancing students' digital literacy and collaborative skills. The SLR method was chosen for its ability to identify, evaluate, and synthesize findings from prior studies in a systematic and structured manner.

The review process followed several stages:

1. Formulation of Research Questions

The first stage involved formulating the main research question and its sub-questions. The central research question guiding this review was: *"How can the integration of ethnoscience and LMS support the enhancement of students' digital literacy and collaborative skills in science learning at the university level?"* The sub-questions addressed the role of local values in ethnoscience for digital literacy, the ways in which LMS facilitates culturally based collaborative activities, examples of good practices in integrating ethnoscience and LMS, the challenges faced, and effective instructional designs for embedding ethnoscience into LMS.

2. Literature Search Strategy

Literature was systematically collected from reputable electronic databases, including Scopus, Web of Science, ERIC, Google Scholar, and DOAJ. The search process used combinations of keywords and Boolean operators such as *"ethnoscience" OR "local knowledge" OR "indigenous knowledge" AND "learning management system" OR "LMS" AND "digital literacy" AND "collaborative skills" AND "higher education."* A snowballing technique was also applied by reviewing the reference lists of key articles to identify additional relevant sources.

3. Inclusion and Exclusion Criteria

To ensure quality and relevance, strict inclusion criteria were applied. Eligible articles included empirical studies

(quantitative, qualitative, or mixed-methods) that addressed ethnoscience, LMS, digital literacy, or collaborative skills. Conceptual or systematic reviews closely related to the topic were also included. Only articles published in reputable peer-reviewed journals or indexed conference proceedings between 2020 and 2025, in either Indonesian or English, were considered. Articles that were irrelevant, not peer-reviewed, or outside the higher education context were excluded. Selection was conducted in two stages: initial screening based on titles and abstracts, followed by full-text review.

4. Data Extraction

From the selected studies, the following information was extracted: research focus/topic, methodology and design, participant characteristics, platforms or types of LMS used, forms of collaborative or digital literacy activities implemented, outcomes and impacts on digital literacy and collaborative skills, reported barriers and challenges, and recommendations for future instructional design. Data extraction was organized using a structured matrix format.

5. Data Synthesis and Analysis

The reviewed literature was synthesized through a thematic narrative approach. Articles were categorized according to their content focus, such as the role of ethnoscience in learning, the effectiveness of LMS, the development of digital literacy, the strengthening of collaboration, and implementation challenges. Critical analysis was applied to identify patterns, gaps, and contributions, as well as points of convergence and divergence across the studies.

6. Interpretation and Conclusion

Final interpretation was carried out based on the synthesis to answer the main research question and sub-questions. The conclusions highlight the potential synergy between local

wisdom and digital technology in 21st-century learning, along with both theoretical and practical implications for higher education. Suggestions for future research and the development of effective learning models are also presented.

RESULTS AND DISCUSSION

Results

This section presents the key findings identified from the systematically reviewed literature. These findings provide insights into the role of local values in ethnoscience-based learning for enhancing students' digital literacy, the ways in which LMS facilitates culturally grounded collaborative activities, and examples of good practices in integrating ethnoscience with LMS.

1. The Role of Local Values in Ethnoscience-Based Learning for Students' Digital Literacy

The cultural context in ethnoscience learning fosters digital relevance by encouraging students to create digital artifacts such as videos, infographics, and multimedia presentations that highlight regional cultural practices. These activities meaningfully develop students' digital content production skills, transforming local cultural materials into digitally packaged resources that serve as a bridge between culture and technology.

The implementation of ethnoscience-based Project/Problem-Based Learning (PjBL/PBL) provides students with hands-on experiences in using technology to complete academic tasks. Students are required to design digital media, prepare collaborative reports on online platforms, and present their results using digital communication tools. The development of ethnoscience-based digital pocketbooks also equips students with the ability to integrate cultural content with technology, including

skills in digital layout design, the use of LMS platforms, and the application of digital illustrations.

In the context of chemistry learning, ethnoscience has been shown to enhance students' ability to access, analyze, and visualize digital data derived from local cultural phenomena, such as the use of natural materials in buffer solutions. This contextual approach improves science literacy with a digital dimension, fostering the ability to search, evaluate, and communicate evidence-based information. Furthermore, a meta-analysis by Zahrotin et al. (2025) revealed that ethnoscience-based learning significantly strengthens students' critical thinking skills, which serve as the foundation for digital literacy in evaluating and selecting digital information effectively. Psychological factors, such as exploratory interest and self-determination, also play a role in enhancing digital literacy when ethnoscience is integrated with technology. Kristian (2024) found that students were able to utilize social media platforms such as Instagram to digitally present cultural information, thereby strengthening their digital communication skills through visual communication and digital storytelling.

2. LMS in Facilitating Collaborative Activities in Culturally Based Learning

LMS functions as a connecting platform across cultural backgrounds, enabling students from diverse communities to interact within the same learning space. Through features such as forums, group assignments, and project-based collaboration, students can share their local cultural perspectives in an open and structured manner, creating a reflective space for mutual understanding of cultural values.

Cultural-based online collaboration is supported by flexible LMS features such as

discussion forums, group document storage, and video conferencing integration. These features facilitate cross-regional collaboration in exploring diverse cultural practices, for instance by uploading documentation of traditions, responding to peer perspectives, and building collaborative digital products. Culturally oriented learning also requires negotiation of meaning within LMS, allowing students to clarify cultural concepts through in-depth online discussions, thereby strengthening collaboration in a multicultural environment.

LMS supports team structures in cultural projects through features that allow role distribution, scheduling, and collaborative document revision. These tools help manage group tasks such as designing cultural presentations, documenting local traditions, or compiling interviews with community leaders in an organized way. Progress reporting and feedback features within LMS foster ongoing collaboration and accountability among students in completing their tasks.

Cross-cultural exploration through joint projects facilitated by LMS encourages the development of a collective identity that reflects diversity, such as regional cultural videos or interactive maps of local traditions. Integrated peer assessment within LMS further strengthens intercultural collaboration by promoting active participation and awareness of different cultural contributions and working styles. Potential cultural barriers can be minimized through lecturer moderation and guidance in LMS, ensuring inclusivity and sustainability of collaboration.

3. Good Practices in Integrating Ethnoscience and LMS in Higher Education

Several good practices of ethnoscience–LMS integration have been identified:

- Development of ethnoscience-based digital modules in LMS: Irfandi et al. (2021) designed an LMS integrating physics content with Malay culture (pandan weaving). The module was developed using an R&D model and demonstrated improved student learning outcomes from cycle I (gain = 0.58) to cycle III (gain = 0.73), while meeting high validity and practicality criteria.
- Validation of the LOK R model in Moodle: Purwati et al. (2022) and Simanullang & Rajagukguk (2020) tested Moodle within the LOK R model (Literacy–Orientation–Collaboration–Reflection) incorporating ethnoscience content. The results showed that features such as videos, forums, and quizzes effectively enhanced literacy and problem-solving skills among adult learners, while strengthening critical thinking skills.
- Digital ethnoscience materials improving digital literacy: Mufrihah et al. (2024) developed digital ethnoscience teaching materials and found a significant increase in students' digital literacy, with an N-gain score of 0.70 in the experimental class.
- Implementation of interactive ethnoscience modules for educators: Widayanti (2020) designed an interactive ethnoscience e-module on non-renewable resources. The module successfully bridged local wisdom and digital pedagogy through LMS and OER platforms.
- Hybrid PjBL–Etno-STEM model in higher education LMS: Reffiane et al. (2023) developed a hybrid etno-STEM model using LMS to support students at PGRI Semarang. The system readiness level reached 86%, and offline learning motivation exceeded 80%.
- Integration of ethnoscience-based PjBL with virtual assistant technology: Wahyudi et al. (2025) implemented ethnoscience-based PjBL supported by virtual assistant technologies (such as simulations) within LMS, which was proven to improve the critical thinking skills of preservice science teachers.
- Development of ethnoscience-based web and mobile learning media: Suryani et al. (2023) developed ethnoscience-based web and mobile learning media on conductivity using the ADDIE model. The media achieved a validity score of $\geq 89\%$, and student responses were highly positive (88%).
- Application of TPACK and ethnoscience in e-learning: Widyasari (2021) employed a TPACK approach to incorporate cultural values into e-learning. Although designed as a popular resource, this study represents good practice by balancing pedagogy, content, and technology in the context of the pandemic.
- Use of traditional games in LMS: Aisyah & Khotimah (2023) demonstrated that incorporating traditional games as LMS content increased student motivation and interaction in ethnoscience learning.
- Development of ethnoscience-based project worksheets (LKPD) in LMS: Hanum et al. (2020) created ethnoscience-based project worksheets within a PjBL framework in LMS. The approach effectively improved students' critical thinking and problem-solving skills.

Table 1. Summary of good practices

Good Practices	Description	Effectivity
Digital Module of ethnoscience (weaving pandan)	Pre-design and validated in LMS, R-D	N-Gain 0.58 → 0.73 (Irfandi et al. 2021)
LOK-R model in Moodle	Literacy→Orientation→Collaboration →Reflection	Improve literacy and critical thinking skills (Purwati et al., 2022)
Digital Teaching Material	ADDIE → N-gain 0.70	Enhance digital literacy (Mufrihah et al., 2024)
Interactive E-module	Unsustainable resources	Cultural bridge and digital pedagogy (Widayanti, 2020)
Hybrid Etno-STEM	Online-offline PjBL	System readiness 86 %, interest 80 % (Reffiane et al., 2023)
Virtual Assistant & PjBL	Simulation for science teacher	Improvement in critical thinking (Wahyudi et al., 2025)
Mobile web learning	ADDIE for junior high school students	Media validity 89 %, response 88 % (Suryani et al., 2023)
TPACK + E-learning	The LMS integrates cultural values	Good practice during pandemic. (Widyasari, 2021)
Traditional Games	To enhance motivation and interaction	Content-based engagement (Aisyah & Khotimah, 2023)
PjBL Student Worksheet in LMS	Ethnoscience Student' Project Worksheet	Problem-solving skill improves (Hanum et al., 2020)

4. Challenges in Implementing Ethnoscience-Based Learning Supported by LMS

Although LMS functions as a connecting platform in ethnoscience learning systems, its implementation faces several challenges:

- **Limited Lecturer Competence in LMS and Ethnoscience:** Many lecturers continue to rely on traditional methods and struggle to integrate local wisdom with digital technology through LMS. This is consistent with the findings of Wicaksana et al. (2024), which highlighted low system mastery and limited teaching creativity. Addressing this challenge requires regular training and mentoring to improve lecturers' competence.
- **Unequal Technological Infrastructure and Internet Access:** Limited internet connectivity, especially in remote areas, poses a major barrier to LMS utilization.

Related studies emphasize the need for offline access options so that materials remain available despite unstable connections (Hidayah, 2021).

- **Insufficient Teacher Preparedness in Using Digital Tools and Local Materials:** Studies on e-module implementation revealed that teachers are not yet fully ready to use culturally based digital modules and have not optimized the use of online resources such as videos and the internet (Herlinawati & Suhartini, 2023; Madrasah Ibtidaiyah Lombok Timur, 2022).
- **Digital and Socio-Cultural Literacy Gaps Among Students:** Not all students possess equal access to devices or digital literacy skills, resulting in disparities in online learning participation (Panicker, 2020; Digital Divide Study, 2021).

- **Inflexible Design of Culturally Based Modules:** In some institutions, ethnoscience learning models do not yet employ adaptive media such as videos, local environments, or internet-based resources to effectively link cultural practices with scientific theory (Madrasah Ibtidaiyah Lombok Timur, 2022).
- **Cultural Barriers and Interpretation of Local Values:** Integrating local values requires cultural sensitivity, as symbols and practices may carry different meanings across regions. Without appropriate contextualization, miscommunication or misinterpretation may occur within LMS platforms.
- **Lack of Institutional Administrative and Regulatory Support:** In the absence of policies that encourage LMS use for ethnoscience, lecturers and students find it difficult to integrate LMS as a formal part of the curriculum (E-learning Challenges in Indonesia Study, 2025).
- **High Cost of Developing Ethnoscience-Based LMS Modules:** Creating digital content rooted in local wisdom requires funding for software, LMS hosting, and training, which becomes a constraint for institutions with limited budgets.
- **Digital Culture Gaps Between Lecturers and Students:** Differences in digital skills between lecturers and students lead to communication gaps and suboptimal use of LMS (Wicaksana et al., 2024).
- **Resistance to Change and Digital Cultural Reluctance:** Some stakeholders still believe ethnoscience is best taught directly in the field rather than through LMS, leading to resistance against adopting digital approaches (Panicker, 2020).

5. Effective Instructional Design for Integrating Ethnoscience into LMS

An effective instructional design for integrating ethnoscience into LMS includes the following components:

- **Adopting Contextual and Locally Based Design Models:** Instructional design for ethnoscience integration in LMS should be grounded in local contexts relevant to students' lives. Contextual Teaching and Learning (CTL) is particularly appropriate, as it places culture as the foundation of meaningful learning. Astuti et al. (2023) demonstrated that CTL implemented in culture-based LMS environments enhanced students' engagement and absorption of scientific concepts framed with local values.
- **Applying Project-Based Learning (PjBL) with Ethnoscience:** Project-based approaches that use local culture as the context for learning activities can be implemented in LMS to foster collaboration, exploration, and innovation. Wulandari et al. (2022) found that applying PjBL integrated with local wisdom through LMS contributed to improvements in students' critical thinking skills and cultural literacy.
- **Integrating Interactive Multimedia with Local Cultural Content:** Instructional design should include videos, infographics, and animations that present local cultural practices within scientific contexts. Nugroho and Purwaningsih (2021) reported that incorporating culture-based multimedia into LMS not only improved conceptual understanding but also significantly increased students' learning motivation.
- **Developing Ethnoscience Modules in SCORM or HTML5 Formats:** To ensure compatibility with LMS platforms such as Moodle or Canvas, ethnoscience

modules should be created in SCORM or HTML5 formats. These formats enable interactivity, activity tracking, and interoperability. Prasetyo and Hartati (2021) emphasized the importance of using standardized digital formats to ensure optimal functionality across different LMS platforms.

- **Designing Collaborative Learning Through Thematic Cultural Discussion Forums:** LMS discussion forums can serve as spaces for exploring cultural values. Instructional designs that pose open-ended questions about local cultural phenomena can stimulate ethnosience-based scientific discussions. Putri and Dewi (2022) highlighted that LMS forums structured around cultural topics foster contextual scientific awareness.
- **Utilizing LMS Analytics for Personalized Interventions:** Modern LMS platforms provide learning analytics that can be used to identify patterns of student interaction and deliver contextualized feedback. Rahmawati and Yuliana (2023) noted that applying LMS analytics enhances the effectiveness of ethnosience-based learning by enabling need-based interventions tailored to individual learners.
- **Implementing Authentic and Culturally Based Project Assessments:** Evaluation in ethnosience learning should go beyond objective testing. It should include project-based assessments, self-assessments, and cultural reflection. Setiawan et al. (2020) showed that authentic, contextual assessment approaches more accurately reflect mastery of content and engagement with cultural values.
- **Adopting Universal Design for Learning (UDL) Principles:** To reach all

students, including those with diverse cultural, economic, or ability backgrounds, LMS-based ethnosience learning should adopt UDL principles. Arifin and Marlina (2021) recommended using multimodal and flexible formats in presenting ethnosience materials to ensure inclusivity and accessibility for a broad range of learners.

Discussion

The findings consistently indicate that integrating ethnosience with LMS holds significant potential for enhancing students' digital literacy and collaborative skills. The role of local values in ethnosience-based learning is crucial in fostering digital literacy, not merely as a tool for gathering information but as a foundation for producing meaningful digital content. This extends beyond basic digital literacy into advanced literacy that emphasizes creativity and contextual application. These findings align with social constructivist theory, which posits that learning becomes more effective when individuals construct knowledge through interactions with their social and cultural environment, facilitated in this case by the production of digital ethnosience artifacts. The use of active learning models such as PjBL/PBL, which inherently require technology to complete tasks and present outcomes, further strengthens students' functional and critical digital literacy. Evidence from Zahrotin et al.'s (2025) meta-analysis, which demonstrated improvements in critical thinking through ethnosience, reinforces the view that a strong cognitive foundation is a prerequisite for effective digital literacy, enabling students to evaluate information accurately. Moreover, the ability to utilize social media for learning purposes (Kristian, 2024) illustrates students' adaptability to dynamic digital

environments and their skills in digital storytelling.

As a digital infrastructure, LMS has proven effective in facilitating collaboration, particularly in culturally based learning. Its role as a cross-cultural connector is a notable advantage, enabling interactions and exchanges of perspectives that might otherwise be difficult in traditional classroom settings. Features such as discussion forums and video conferencing directly support cultural meaning negotiation (Henderson et al., 2021) and collaborative project management (Yusri et al., 2023), both of which are essential for teamwork in cultural projects. The ability of LMS to track progress and provide feedback (Ramadani & Hartanto, 2022) underscores the role of technology in building collective accountability. In addition, peer assessment (Hasanah & Munir, 2023) and lecturer moderation (Putra & Wulandari, 2024) address potential challenges in cross-cultural collaboration, ensuring inclusive learning environments and fostering awareness of diverse contributions and cultural work styles. These concepts are consistent with collaborative learning theory, which emphasizes positive interdependence, promotive interaction, and individual accountability as core elements in achieving shared goals.

Nevertheless, the discussion highlights that these potentials cannot be realized without addressing a range of significant challenges. Inadequate lecturer competence in integrating ethnoscience and LMS remains a major obstacle, underscoring the need for continuous and structured professional development. This challenge is not only technical but also pedagogical, requiring a deeper understanding of how local wisdom can be adapted into digital formats, as indicated by Wicaksana et al. (2024). Unequal technological infrastructure

and internet access, particularly in Indonesia, pose external challenges that call for broader policy interventions. Hidayah (2021) highlighted how digital inequality affects online learning in the Indonesian context. Moreover, disparities in digital literacy among students necessitate differentiated approaches to learning, given that not all students begin with the same level of digital competence. Issues related to inflexible module design and cultural barriers in interpreting local values emphasize the importance of careful content curation and cultural sensitivity in material development. Resistance to change further illustrates that the adoption of technology requires not only technical capacity but also a shift in mindset and trust in the effectiveness of new methods, as noted by Panicker (2020).

Despite these challenges, effective instructional design can serve as a solution. The adoption of contextually grounded models such as CTL (Astuti et al., 2023) and PjBL (Wulandari et al., 2022) with ethnoscience is essential to ensure relevance and student engagement, consistent with meaningful learning theory. The integration of interactive multimedia (Nugroho & Purwaningsih, 2021) and the use of standardized formats such as SCORM or HTML5 (Prasetyo & Hartati, 2021) enhance the quality and interoperability of learning materials. Leveraging LMS features such as thematic cultural discussion forums (Putri & Dewi, 2022) and learning analytics (Rahmawati & Yuliana, 2023) can substantially improve interaction and personalization of learning experiences. Finally, implementing authentic and culturally based project assessments (Setiawan et al., 2020) along with Universal Design for Learning (UDL) principles (Arifin & Marlina, 2021) ensures that ethnoscience-based learning supported by

LMS is inclusive and relevant for all students, reflecting a holistic and contextualized understanding. Thus, while challenges remain, proven instructional design solutions can bridge the gap between idealism and actualization in the implementation of ethnoscience-based learning with LMS.

CONCLUSION

Ethnoscience-based learning supported by Learning Management Systems (LMS) in higher education demonstrates significant potential to enhance students' digital literacy and collaborative skills. The integration of local cultural values into science content, when supported by structured and interactive digital technologies, fosters learning experiences that are more contextual, reflective, and aligned with the competencies required in the 21st century. LMS facilitates collaborative activities through features such as discussions, resource sharing, and online group work, while good practices such as project-based modules, authentic assessment, and the integration of local content have been shown to enrich the learning process.

Nevertheless, this implementation faces several challenges, including limitations in digital infrastructure, human resource readiness, and the need for scientifically valid cultural content curation. To maximize the potential of ethnoscience-based learning in LMS and to address issues related to lecturer competence and human resource readiness, higher education institutions should design continuous training programs for both lecturers and students to strengthen digital competence and contextual pedagogy. To address the challenges of content curation, content developers and LMS managers are advised to collaborate with cultural experts and local

educators to design materials that are relevant, inclusive, and rooted in local wisdom. Regarding infrastructure and access gaps, government and stakeholders are also expected to provide policy and infrastructure support so that digital inequality does not hinder implementation. Furthermore, future classroom-based research is essential to empirically and sustainably evaluate the effectiveness of ethnoscience integration in LMS across diverse higher education contexts in Indonesia.

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