Ethnodigital-AI Learning Model Based on Local Wisdom: Systematic Literature Review

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ABSTRACT

Purpose: This research aims to develop an Ethnodigital-AI learning model based on local wisdom through a systematic synthesis of research on the integration of artificial intelligence, digital technology, learning, and cultural knowledge. This study focuses on identifying research patterns, conceptual gaps, and the key components needed to build an AI-based learning model that is responsive to local cultural contexts.

Design/Methodology/Approach: The study employed the Systematic Literature Review method with the PRISMA protocol. A literature search was conducted through the Scopus database with the help of Publish or Perish for publications from 2016 to 2026, using keywords related to ethnodigital learning, artificial intelligence, and local wisdom. The initial search yielded 284 articles. A duplication check excluded four articles, resulting in a final 280 articles entering the screening stage. The inclusion and exclusion process yielded 17 articles meeting the criteria, while 263 articles were excluded. The 17 articles were then synthesized using thematic analysis to identify patterns, AI functions, research gaps, and elements of the Ethnodigital-AI model.

Findings: The synthesis results show that AI is being used for personalized learning, content production, cultural knowledge preservation, learner interaction, assessment, and multimodal learning. Local wisdom is most powerful when used as a source of knowledge and the basis for learning design, not simply as a context for the material.

Research Implications: The research produced a conceptual model that integrates local wisdom, digital cultural content, AI personalization, AI content generation, teacher mediation, cultural validation, learner interaction, learning outcomes, and feedback mechanisms.

Practical Implications: The model can serve as a reference for educators and educational institutions in designing AI-assisted learning that is adaptive, contextual, and maintains the relevance of local cultural identity.

Originality/Value: The novelty of this research lies in the placement of local wisdom as the epistemic foundation of AI-based learning and the integration of technological, cultural, pedagogical, and evaluation dimensions in one Ethnodigital-AI model.

Keywords: Ethnodigital-AI; Local Wisdom; Artificial Intelligence in Education; Culturally Responsive Learning; Systematic Literature Review

1. INTRODUCTION

Digital technology is drastically changing the landscape of modern education. Educators are using computing tools to design interactive materials. Students are accessing scientific information without the constraints of time and space (Cao, 2024). This transformation has given rise to a new learning paradigm based on data velocity. Educational institutions are adopting intelligent systems to improve the quality of academic outcomes.

Local wisdom-based education effectively maintains students' cultural identity. This ethnopragmatic approach is deeply rooted in the community's traditional values. Teachers integrate local wisdom into the formal school curriculum. Students understand their ancestral heritage through contextual learning experiences. The nation's noble values remain relevant, countering the tide of global cultural homogenization (Wei, 2022).

The ethnodigital concept bridges cutting-edge technology with the preservation of traditional culture. Curriculum developers design interactive applications based on folklore or local games. Digital media visualizes cultural elements into precise learning objects (Sun, 2024). Students interact with cultural artifacts through virtual modules. This approach makes cultural preservation efforts more innovative.

Artificial intelligence uniquely personalizes each student's learning experience. Algorithms analyze individual learning styles and comprehension speeds in real time. Intelligent systems recommend specific materials tailored to students' cognitive needs. Educators leverage data analytics to evaluate academic progress. AI technology efficiently accelerates the achievement of curriculum targets (Llerena-Izquierdo, 2024).

Various academic literature empirically demonstrates the effectiveness of these three elements. Researchers have found a positive impact of AI on students' cognitive learning outcomes. Other studies confirm the improvement of moral character through local culture-based education. Academics have also validated the feasibility of ethnodigital media in the classroom. The academic world recognizes the immense potential of integrating technology and tradition.

Researchers currently have not comprehensively mapped ethnodigital-AI learning models. Most studies examine artificial intelligence or local wisdom separately. The academic world lacks a comprehensive framework that synergizes these three elements. Scientific publications rarely address the specific interactions between intelligent algorithms and local cultural values. This knowledge gap obscures the potential for real collaboration between technology and tradition.

The application of artificial intelligence algorithms to local cultural contexts remains very superficial. Educational technology developers often ignore the specific cultural nuances of a region. The majority of existing AI systems utilize cultural databases from developed countries. Educators struggle to find AI platforms that recognize the context of local wisdom in the Indonesian archipelago. This lack of databases hinders the development of accurate ethnodigital learning models (Chao, 2026).

Previous literature reviews have missed a systematic evaluation of the ethnodigital-AI model specifically. Academics have not synthesized research trends on this topic over the past decade. Research roadmaps on the integration of AI and local culture are scattered and lack a clear direction. Education practitioners lack scientifically validated instructional design references. This lack of literature synthesis complicates the adoption of this learning model in schools (Furey, 2022).

The effectiveness of the ethnodigital-AI model in improving student skills has not been empirically measured. Researchers have not compared the success rate of this hybrid model with conventional approaches. The inhibiting and supporting factors for implementing ethnodigital-AI in the operational field remain a mystery. Policymakers need strong scientific evidence before modifying national curriculum standards. Fundamental questions about the long-term impact of this model demand urgent clarification (Zourmpakis, 2023).

The education sector needs a new conceptual framework to balance AI advancements and cultural preservation. Younger generations face the risk of losing their local identities due to massive exposure to global algorithms. The ethnodigital-AI model offers a strategic solution for maintaining cultural relevance through cutting-edge technology. Academics must formulate a strong theoretical foundation

to guide this innovation. This effort will direct AI technology to function as a catalyst for preserving civilization.

Researchers applied the Systematic Literature Review method to extract data from various previous studies. This systematic approach objectively identifies patterns, trends, and research gaps (Beatrice, 2024). Researchers selected highly reputable scientific articles published in the past five years. This literature analysis yielded an empirical mapping of ethnodigital practices and AI in education. This structured method ensures the validity and reliability of the final findings (Hu, 2024).

This research aims to construct a conceptual model of ethnodigital-AI learning based on local wisdom. This study formulates a comprehensive literature synthesis to guide educators in designing innovative learning. Policymakers can use these findings as a basis for formulating future education standards. The research hypothesis projects that a structured integration of ethnodigital and AI can create a superior learning ecosystem. This innovation will strengthen students' cultural identity while maximizing their computational intelligence potential.

2. LITERATURE REVIEW / THEORETICAL FRAMEWORK

Local Wisdom-Based Learning

Local wisdom-based education instills noble cultural values in students. The integration of local wisdom significantly strengthens students' national identity. Educators use this method to maintain the existence of local traditions. Students grasp academic material more quickly through the context of their surroundings. This ethnopragmatic approach has been empirically proven to improve students' cognitive understanding (Mülbe, 2024).

Ethnodigital Technology in Education

The ethnodigital concept digitizes cultural artifacts into interactive learning media. Technology developers design folklore-based applications for classrooms. Virtual modules facilitate the preservation of traditions in a modern way. Cultural visualization through devices attracts the learning interest of the younger generation. This digital ecosystem ensures the preservation of historical values without dimensional limitations (Rizakhojayeva, 2026).

Artificial Intelligence in Personalized Learning

Artificial intelligence personalizes educational materials according to each individual's cognitive profile. Computational algorithms analyze students' learning patterns in a timely manner. This intelligent system recommends specific learning materials to maximize academic outcomes. Teachers rely on the system's analytical data to monitor class progress. Smart machine learning interventions efficiently accelerate the process of knowledge acquisition (Le, 2025).

Synergy of Ethnodigital-AI Model

The collaboration between ethnodigital and artificial intelligence creates a new, holistic instructional model. This synergy bridges cutting-edge technological advancements with the cultural roots of the Indonesian archipelago. An intelligent system sorts local tradition content based on students' understanding. Educators gain precise tools to disseminate local wisdom. This integration creates a highly relevant, character-based learning ecosystem.

3. RESEARCH METHOD

The researchers adopted a Systematic Literature Review design to comprehensively summarize empirical findings. This approach evaluated academic literature related to ethnodigital learning models and artificial intelligence. This research design used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. The PRISMA protocol ensures transparency and replicability of the literature search process. The researchers objectively identified trends, patterns, and research gaps (Muth, 2024).

The subjects of this research include primary scientific articles indexed by Scopus. The publication period of the target articles is from 2016 to 2026. Researchers are targeting reputable international journals that discuss educational technology and the preservation of traditions. Target articles must

present empirical data related to the implementation of local wisdom in a digital environment. The selection of the Scopus database ensures the methodological quality of the analyzed literature.

The research procedure adheres to the four main stages of the PRISMA workflow. The first stage involves identifying initial articles through electronic databases. The second stage involves systematic screening to remove duplicate documents and articles outside the timeframe. The third stage requires researchers to assess the eligibility of manuscripts based on reading the abstracts. The fourth stage selects final articles for the full data extraction process.

The Publish or Perish software served as the primary data collection tool. The researchers entered three specific English-language keywords in a single search. These keywords specified the terms "ethnodigital learning," "artificial intelligence," and "local wisdom." The researchers restricted the search parameters specifically to the Scopus database. This extraction technique stored all article metadata in a reference database format (Ferriz-Valero, 2025).

The data analysis technique applied thematic analysis methods to extract relevant information from the final articles. Researchers grouped findings based on smart technology, digital artifacts, and local wisdom. This synthesis process identified empirical interactions between computational instruction and traditional values. Researchers constructed a literature matrix to compare the results of various studies. The results of this analysis formulated a solid conceptual framework for the ethnodigital-AI learning model.(Guo, 2025).

4. RESULTS

The principal findings should be presented objectively and systematically in accordance with the research objectives or questions. Tables and figures may be used when they improve clarity and should be referred to explicitly in the manuscript.

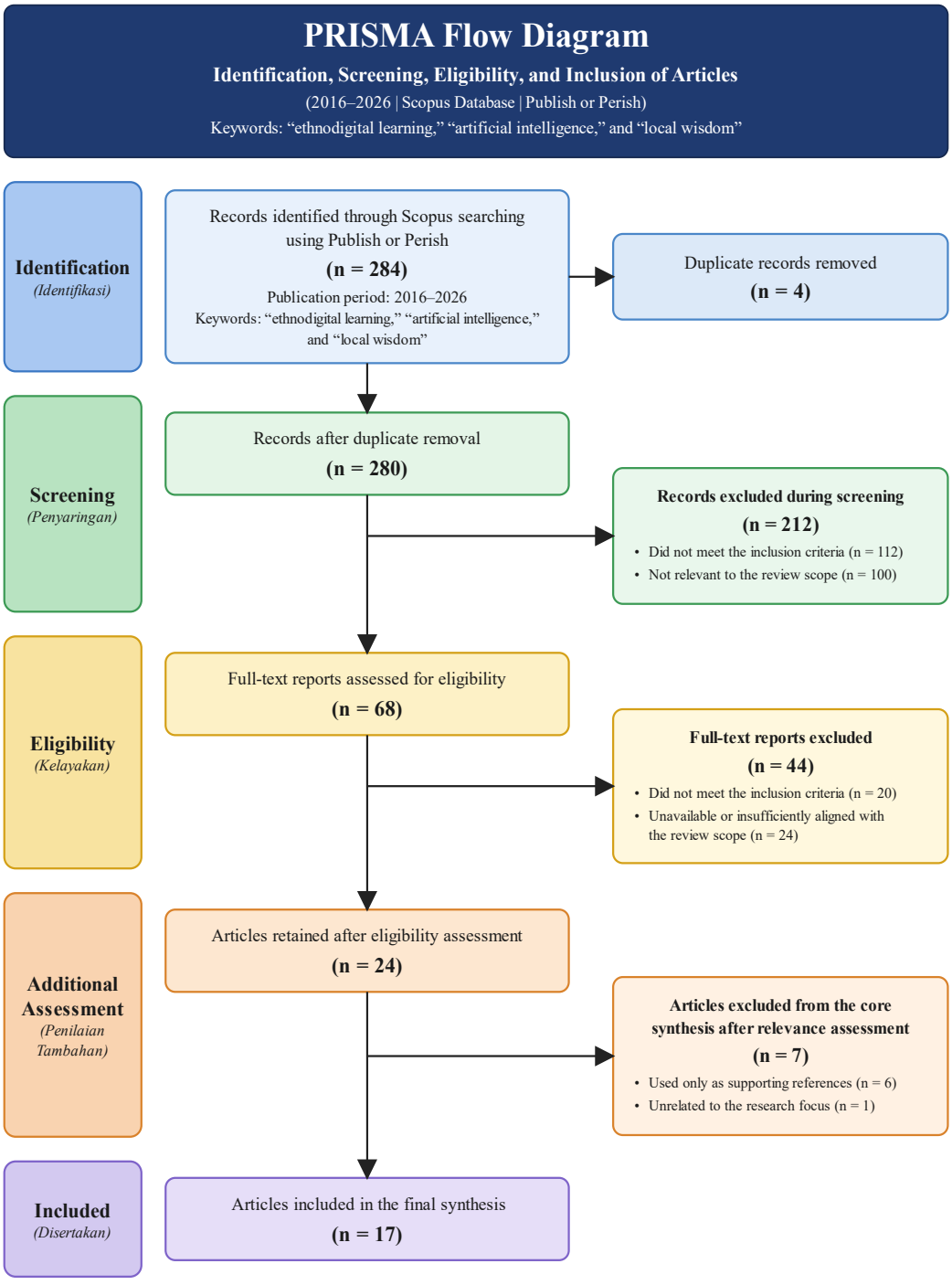


Figure 1. PRISMA Flow Diagram

The literature search was conducted in the Scopus database using Publish or Perish for the 2016–2026 period, with the keywords "ethnodigital learning," "artificial intelligence," and "local wisdom," which yielded 284 records. After removing 4 duplicates, 280 records were screened, and 212 were excluded because they did not meet the inclusion criteria (n = 112) or were not relevant to the review scope (n = 100). The remaining 68 full-text reports were assessed for eligibility, and 44 were excluded due to unmet inclusion criteria (n = 20) or limited availability and alignment with the review scope (n = 24). Of the 24 articles retained, 7 were excluded from the core synthesis after a relevance assessment, since

6 served only as supporting references and 1 was unrelated to the research focus. As a result, 17 articles were included in the final synthesis.

Table 1. Demographic and Methodological Characteristics of the Studies Included in the Synthesis

No.	Author(s) and Year	Country/Research Context	Research Design	Participants/Sources of Data	Main Research Focus
1	DaCosta (2025)	Cultural heritage and historical learning	AI-based character development and evaluation	AI-generated historical characters; participant details are not specified in the retrieved abstract	Development of AI-generated historical characters to facilitate interactive engagement with cultural heritage and learning.
2	Canh (2026)	Vietnam, particularly Khmer ethnic communities	Pedagogical experiment with pre-intervention and post-intervention assessment	262 Grade 11 students, including 144 Khmer ethnic minority students	Application of AI to improve multimodal information processing, reading comprehension, and culturally contextualized literature learning.
3	Anohah and Suhonen (2016)	African cultural heritage and computing education	Systematic literature review using a constructivist perspective	Published literature on indigenous knowledge and computing education; the number of publications is not specified in the retrieved abstract	Integration of Indigenous knowledge and cultural heritage into computing education through constructivist learning principles.
4	Jufrida et al. (2025)	Jambi, Indonesia; Malay cultural knowledge	Mixed-methods approach combining qualitative analysis and educational data mining	Malay ethnoscience practices and student performance and engagement data; sample size is not specified in the retrieved source	Integration of Malay cultural knowledge, ethnoscience, data-driven recommendations, and AI-supported physics learning.
5	Age and Machaba (2026)	African mathematics education	Conceptual narrative review and framework development	Existing literature on ethnomathematics, Indigenous knowledge, decolonial education, and AI	Use of AI to document Indigenous mathematical knowledge and develop culturally responsive mathematics curricula.
6	Toktarova and Zolotova (2026)	Republic of Mari El, Russia	Intelligent learning environment development and methodological analysis	Russian folklore materials, supported by automated processing and expert verification	Development of AI-supported learning environments for folklore pedagogy and intangible cultural heritage.
7	Ndeot et al. (2026)	East Nusa Tenggara, Indonesia	Design-based research and quasi-	112 preschool children aged 4–6 years: 57 in the experimental group	Digital ethnomathematics through traditional

No.	Author(s) and Year	Country/Research Context	Research Design	Participants/Sources of Data	Main Research Focus
			experimental evaluation	and 55 in the control group	patterns, batik, beads, and folklore-inspired activities to improve mathematical problem-solving and cultural identity.
8	Meesakul (2026)	Thailand and non-Western musical traditions	Systematic literature review following PRISMA 2020	Published studies on AI in non-Western music education; the final number of studies is not specified in the retrieved abstract	Integration of AI with traditional music education to support musical learning and preserve cultural identity.
9	Lachney et al. (2025)	Midwestern United States	Qualitative multiple-case study	Four Black ninth-grade students participating in a five-week virtual after-school program	Exploration of relationships between culture, computational technology, and student identity through ethnocomputing research.
10	Festiyed et al. (2026)	Indonesia and Indigenous ethnoscience	Development of a conversational AI framework; evaluation details require full-text confirmation	Indigenous ethnoscience knowledge and the proposed Etnovan framework; participant and sample details are not established in the retrieved record	Development of conversational AI to document, preserve, and advance Indigenous ethnoscience knowledge.
11	Nyaaba et al. (2024)	Ghana, United States, and China	Conceptual framework development and pilot comparison of AI-generated assessment items	Generated science assessment items based on cultural contexts in three countries; no human sample was reported for the pilot comparison	Development of a generative AI framework for culturally responsive science assessment incorporating Indigenous knowledge, language, ethnicity, and religion.
12	Tsai et al. (2022)	Taiwan; Han Chinese and Indigenous student groups	AI-assisted programming intervention and comparative analysis	96 university students: 62 Han Chinese students and 34 Indigenous students	Examination of cultural background, learning expectations, motivation, and learning effectiveness in AI-assisted programming education.
13	Godwin-Jones (2025)	Indigenous and less commonly taught language contexts	Conceptual and critical analysis of language pedagogy and	Literature and pedagogical issues concerning AI, minority languages,	Examination of AI-supported language learning, Indigenous language

No.	Author(s) and Year	Country/Research Context	Research Design	Participants/Sources of Data	Main Research Focus
			educational technology	and translanguaging; no participant sample reported	representation, and pedagogical translanguaging.
14	Sutrisno et al. (2025)	Indonesia; four universities	Quantitative survey research	285 undergraduate students from four Indonesian universities	Assessment of students' readiness for AI-based project learning that incorporates local wisdom.
15	Turner-Jones et al. (2024)	Laura, Australia; Indigenous cultural heritage	Applied technology development and educational citizen-science evaluation	Indigenous youth and rock art materials associated with Laura State School; the total participant count is not specified in the retrieved source	Application of machine learning to classify rock art motifs and support Indigenous cultural heritage education and conservation.
16	Wandera (2024)	Kenyan, Indonesian, and Taiwanese cultural perspectives	Qualitative, culturally informed textual analysis	One AI-generated children's storybook, Alice and Sparkle, examined through three participants' cultural and linguistic perspectives	Critical examination of cultural representation, linguistic bias, and inclusiveness in AI-generated learning materials.
17	Mahmoudi-Dehaki and Nasr-Esfahani (2025)	Iran, Iraq, Kuwait, and Egypt	Qualitative study with a semester-long intervention	57 EFL teachers and 5,637 learners exposed to AI-generated learning materials; data included online focus-group interviews	Use of generative AI to develop culturally responsive English language curricula and improve language learning, cultural awareness, and engagement.

The 17 studies included in the preliminary synthesis were published between 2016 and 2026 and covered diverse educational and cultural contexts, including Indonesia, Vietnam, Taiwan, Australia, Russia, African communities, and other international settings. The studies employed different methodological approaches, including quantitative surveys, qualitative case studies, mixed-methods research, experimental interventions, systematic literature reviews, and conceptual framework development. Research participants ranged from preschool children and secondary school students to university students and teachers, while several studies relied on scholarly literature, cultural artefacts, folklore, or AI-generated materials. The main research themes included culturally responsive AI, Indigenous knowledge integration, digital ethnomathematics, AI-assisted language learning, cultural heritage preservation, and the development of learning frameworks grounded in local cultural contexts. Collectively, these studies provide complementary evidence for developing an Ethnodigital-AI learning model that connects digital innovation, artificial intelligence, pedagogical design, and local wisdom.

Table 2. Publication Trends of the Included Studies, 2016–2026

Year	Number of Articles	Proportion (%)	Total Citations
2016	1	5.88	5
2017	0	0.00	0
2018	0	0.00	0
2019	0	0.00	0
2020	0	0.00	0

Year	Number of Articles	Proportion (%)	Total Citations
2021	0	0.00	0
2022	1	5.88	16
2023	0	0.00	0
2024	3	17.65	46
2025	6	35.29	52
2026	6	35.29	1
Total	17	100.00	120

The publication trends indicate increasing scholarly attention to the integration of artificial intelligence, digital technology, and local wisdom in education. Of the 17 selected studies, six were published in 2025 and another six in 2026, representing 70.58% of the included literature when calculated before rounding. The three publications from 2024 account for an additional 17.65%. Earlier publications provide foundational perspectives on Indigenous knowledge and culturally informed computing education. The concentration of recent studies suggests that the integration of AI and local wisdom has become an emerging area of research, although further empirical validation is needed to establish the effectiveness and sustainability of Ethnodigital-AI learning models.

Table 3. Comparison of AI Functions in Local Wisdom-Based Learning

AI Functions	Forms of Integration	Findings from the Literature	Remaining Challenges	Development Needs
Personalized learning	Adapting learning materials, activities, recommendations, and feedback to students' needs and cultural backgrounds	AI-supported learning can connect educational content with students' characteristics and cultural contexts.	Personalization may prioritize individual performance without adequately considering cultural values and local knowledge.	Incorporate cultural background, local knowledge, and learner characteristics into adaptive learning mechanisms.
Content generation	Generating culturally relevant stories, teaching materials, learning activities, and assessments	Generative AI creates opportunities to develop contextualized educational content.	Generated content may contain cultural inaccuracies, stereotypes, or oversimplified representations.	Establish cultural review procedures involving teachers, subject experts, and local communities.
Cultural knowledge preservation	Digitizing folklore, historical narratives, Indigenous knowledge, language, and cultural artefacts	AI and digital technologies can facilitate the documentation and educational use of cultural knowledge.	Digital documentation does not automatically ensure cultural authenticity or meaningful learning.	Transform verified cultural knowledge into structured learning resources and activities.
Interaction and dialogue	Conversational AI, virtual historical characters, chatbots, and interactive cultural applications	Interactive technologies can support student engagement with cultural knowledge and educational materials.	AI-generated responses may lack contextual accuracy and cultural sensitivity.	Implement human oversight and source verification in AI-mediated cultural interactions.
Teacher support	Assisting teachers with instructional planning, material development, assessment, and feedback	Teachers remain central to interpreting AI outputs and aligning learning activities with	Excessive reliance on AI may weaken pedagogical judgment and contextual adaptation.	Position teachers as pedagogical facilitators, cultural mediators, and validators of AI-generated content.

AI Functions	Forms of Integration	Findings from the Literature	Remaining Challenges	Development Needs
		educational objectives.		
Learning and skills development	Supporting literacy, problem-solving, information processing, language learning, and STEM education	Selected studies examine learning processes and outcomes in culturally situated educational environments.	Research findings remain heterogeneous, and long-term effects are not consistently established.	Assess cognitive, digital, cultural, linguistic, and affective outcomes using appropriate longitudinal and comparative designs.

The functional mapping reveals that artificial intelligence serves multiple purposes in local wisdom-based learning, extending beyond the conventional delivery of instructional content. AI supports personalized learning, content generation, cultural knowledge preservation, interactive communication, teacher assistance, and learning development. These functions demonstrate the potential of technology to connect educational objectives with culturally situated knowledge and learner experiences. However, the presence of multiple AI functions does not automatically establish an integrated pedagogical system. The central challenge lies in coordinating these functions to produce coherent, culturally meaningful, and educationally effective learning experiences.

A critical examination of the selected literature highlights the tension between technological capabilities and cultural accountability. AI can generate materials and facilitate interactions, yet its outputs may simplify cultural meanings, misrepresent local traditions, or overlook community-specific knowledge. Teachers and local knowledge holders therefore remain essential in validating content, guiding interpretation, and maintaining pedagogical relevance. The development of an effective Ethnodigital-AI model requires cultural validation to operate throughout the learning process rather than as a final inspection. This approach positions AI as a supporting mechanism within a human-guided educational system that prioritizes cultural authenticity and measurable learning outcomes.

Table 4. Research Gaps Identified in the Selected Literature

Gap Dimension	Evidence from Selected Studies	Unresolved Issues	Proposed Development Direction
Conceptual integration	Anohah and Suhonen (2016), Jufrida et al. (2025), Age and Machaba (2026), and Festiyed et al. (2026) address different aspects of technology, culture, and learning.	Technological, cultural, and pedagogical components are not consistently integrated into a single learning model.	Develop an integrated Ethnodigital-AI framework connecting local wisdom, digital resources, AI functions, pedagogy, and learning outcomes.
Cultural depth	Canh et al. (2026), Ndeot et al. (2026), and Mahmoudi-Dehaki and Nasr-Esfahani (2025) address culturally situated learning.	Culture may be treated as contextual material rather than a source of knowledge that shapes learning design.	Position local wisdom as an epistemic foundation for content, learning activities, and assessment.
Integration of AI functions	DaCosta (2025), Jufrida et al. (2025), and Festiyed et al. (2026) illustrate different applications of AI.	AI-supported personalization, content generation, cultural preservation, and interaction are often examined separately.	Connect AI functions within a coherent learning cycle.
Cultural validation	Nyaaba et al. (2024), Wandera (2024), and DaCosta (2025) highlight	Inaccurate cultural representations and algorithmic bias may	Establish systematic validation involving teachers,

Gap Dimension	Evidence from Selected Studies	Unresolved Issues	Proposed Development Direction
	cultural representation and the use of AI-generated content.	undermine the quality of learning materials.	subject experts, and local communities.
Teacher competence	Godwin-Jones (2025), Jufrida et al. (2025), and Mahmoudi-Dehaki and Nasr-Esfahani (2025) address AI-supported teaching and learning.	Teacher roles in evaluating cultural accuracy and guiding AI-mediated learning require further development.	Strengthen teachers' pedagogical, digital, and cultural competencies.
Local languages and cultural representation	Canh et al. (2026), Godwin-Jones (2025), and Festiyed et al. (2026) address ethnic or Indigenous knowledge and language-related contexts.	Local languages and culturally specific knowledge may receive insufficient representation in AI systems.	Develop multilingual and culturally grounded AI resources supported by local knowledge.
Learning outcome evaluation	Canh et al. (2026), Ndeot et al. (2026), Tsai et al. (2022), and Sutrisno et al. (2025) examine different learning-related outcomes.	Assessment approaches vary across contexts and do not consistently capture cognitive, cultural, and digital outcomes together.	Develop multidimensional evaluation frameworks covering achievement, engagement, digital literacy, and cultural understanding.
Transfer and sustainability	The selected studies cover different age groups, disciplines, and cultural environments.	Evidence regarding long-term effectiveness and transferability across educational settings remains limited.	Conduct longitudinal studies and comparative testing across cultural, disciplinary, and educational contexts.
Indonesian context	Jufrida et al. (2025), Sutrisno et al. (2025), Festiyed et al. (2026), and Ndeot et al. (2026) address Indonesian educational or cultural settings.	Existing evidence covers distinct contexts and does not yet establish a comprehensive model for Indonesia's cultural diversity.	Develop and empirically test adaptable Ethnodigital-AI designs for different forms of Indonesian local wisdom.

The research gap analysis identifies conceptual fragmentation as a central limitation in the development of Ethnodigital-AI learning. Existing studies examine artificial intelligence, Indigenous knowledge, ethnoscience, language learning, cultural heritage, and educational assessment through different disciplinary perspectives. These contributions provide valuable insights, but their separate orientations limit the development of a comprehensive instructional framework. Culture frequently appears as learning content or contextual background rather than as a foundation that shapes instructional objectives, knowledge construction, and assessment. An integrated model must therefore connect technological functions, cultural epistemology, pedagogical processes, and learning outcomes within a coherent structure.

Beyond conceptual fragmentation, the literature reveals unresolved challenges involving cultural validation, teacher competence, local language representation, evaluation, and implementation sustainability. These challenges indicate that technological sophistication alone cannot guarantee culturally appropriate or educationally meaningful learning. Limited evidence across diverse educational settings also restricts conclusions about the transferability of existing approaches. Future research should develop explicit validation procedures, strengthen teacher involvement, and measure cognitive, digital, cultural, and affective outcomes. Empirical testing across different cultural communities and educational levels is necessary to determine whether the proposed model works beyond the specific contexts in which its individual components were developed.

Table 5. Comparison of Evidence Types and Methodological Limitations

Study Group	Representative Studies	Strength of Evidence	Methodological Limitations	Implications for the SLR
Intervention and learning-outcome studies	Canh et al. (2026); Ndeot et al. (2026); Jufrida et al. (2025); Mahmoudi-Dehaki and Nasr-Esfahani (2025)	Provide evidence related to the implementation of educational approaches, student engagement, or learning outcomes.	Findings may depend on intervention duration, population characteristics, subject matter, and cultural context.	Identify promising instructional mechanisms and assess whether findings are transferable to other contexts.
Quantitative and comparative studies	Tsai et al. (2022); Sutrisno et al. (2025)	Support the analysis of learner characteristics, readiness, motivation, and differences between groups.	Associations and group differences do not necessarily establish long-term causal effects.	Distinguish learner readiness and perceptions from evidence of learning effectiveness.
Qualitative and contextual studies	Lachney et al. (2025); Wandera (2024)	Provide detailed insights into cultural interpretation, student experiences, and representation in digital or AI-generated materials.	Context-specific findings may not be generalizable to other groups or educational environments.	Use contextual evidence to explain cultural mechanisms and risks that quantitative measures may overlook.
Conceptual and framework studies	Anohah and Suhonen (2016); Age and Machaba (2026); Nyaaba et al. (2024); Godwin-Jones (2025)	Establish conceptual principles for connecting Indigenous knowledge, AI, language, and culturally responsive pedagogy.	Some proposed frameworks require further empirical implementation and validation.	Use established concepts to inform model development while identifying components that require testing.
Systematic literature review	Meesakul (2026)	Provides a synthesis of research patterns concerning AI and non-Western music education.	Conclusions depend on the search scope, inclusion criteria, and quality of the underlying studies.	Compare existing synthesis findings with evidence from other cultural and educational domains.
AI system and cultural-artefact studies	DaCosta (2025); Toktarova et al. (2026); Festiyed et al. (2026); Turner-Jones et al. (2024)	Demonstrate technical and conceptual possibilities for using AI to represent, analyze, or preserve cultural materials.	Technical feasibility does not automatically establish educational effectiveness or cultural authenticity.	Separate technological performance from pedagogical value and require validation of cultural content.

The methodological comparison demonstrates that the selected studies contribute different forms of evidence to the development of an Ethnodigital-AI learning model. Intervention studies can examine changes in learning outcomes, quantitative investigations can identify learner readiness and response patterns, and qualitative studies can explain how cultural context shapes learning experiences. Conceptual studies contribute design principles, while research on AI systems and cultural artefacts demonstrates technological possibilities. These approaches address complementary research questions rather than providing interchangeable forms of evidence. Their integration allows the review to connect practical implementation, contextual interpretation, theoretical development, and technological feasibility.

Methodological diversity also creates an important limitation because the strength of the conclusions depends on the type and quality of available evidence. Conceptual frameworks may propose promising mechanisms without demonstrating their effectiveness in real classrooms, while short-term interventions may not establish sustained learning or cultural understanding. Technical demonstrations likewise cannot independently confirm pedagogical value or cultural authenticity. The synthesis must therefore distinguish demonstrated outcomes from theoretical propositions and anticipated benefits. Stronger evidence will require transparent research designs, validated outcome measures, appropriate comparison groups where relevant, and longer-term evaluation across cultural contexts. Such evidence can clarify which components of the Ethnodigital-AI model are effective, under what conditions, and for which learners.

Table 6. Literature Synthesis and the Proposed Ethnodigital-AI Learning Model

Model Component	Basis in the Selected Literature	Function in the Ethnodigital-AI Model	Contribution to the Research Gap
Local wisdom	Ethnoscience, ethnomathematics, Indigenous knowledge, and local languages, as discussed by Anohah and Suhonen (2016), Jufrida et al. (2025), and Age and Machaba (2026).	Serves as a source of knowledge, learning contexts, cultural values, and locally meaningful educational problems.	Positions culture as an epistemic foundation rather than merely a contextual feature.
Digital cultural content	Cultural heritage, folklore, historical characters, and digital ethnomathematics, as represented by DaCosta (2025), Ndeot et al. (2026), and Turner-Jones et al. (2024).	Converts verified local knowledge into digital learning materials, activities, and interactive resources.	Connects cultural preservation with structured learning experiences.
AI personalization	AI-supported and context-sensitive learning, including Jufrida et al. (2025) and Canh et al. (2026).	Adapts learning materials, activities, recommendations, and feedback to learner characteristics and learning progress.	Connects adaptive learning with cultural background and learner needs.
AI content generation	Generative AI for culturally responsive teaching and assessment, as discussed by Nyaaba et al. (2024) and Mahmoudi-Dehaki and Nasr-Esfahani (2025).	Generates contextualized stories, instructional materials, assessment items, and learning activities.	Integrates generative AI with culturally grounded instructional design.
Teachers as cultural-pedagogical mediators	Research on culturally responsive assessment, AI-assisted teaching, and multilingual pedagogy, including Nyaaba et al. (2024) and Godwin-Jones (2025).	Guides AI use, evaluates educational appropriateness, and aligns AI-generated resources with learning objectives.	Strengthens human judgment in technology-supported learning.
Student interaction	Conversational AI, cultural computing, digital activities, and contextual learning, as examined by DaCosta (2025), Lachney et al. (2025), and Canh et al. (2026).	Enables students to explore, interpret, discuss, and apply cultural knowledge through digital environments.	Promotes active engagement with cultural knowledge rather than passive content consumption.
Cultural validation	Research on AI-generated historical and educational content, including DaCosta	Checks cultural accuracy, authenticity, representation, and	Reduces risks of cultural misrepresentation, bias,

Model Component	Basis in the Selected Literature	Function in the Ethnodigital-AI Model	Contribution to the Research Gap
	(2025), Nyaaba et al. (2024), and Wandera (2024).	sensitivity before and during implementation.	and fabricated knowledge.
Learning outcomes	Research addressing learning performance, problem-solving, readiness, motivation, and engagement, including Tsai et al. (2022), Sutrisno et al. (2025), and Ndeot et al. (2026).	Measures cognitive, digital, cultural, linguistic, and affective learning outcomes.	Expands assessment beyond academic achievement alone.
Reflection and feedback loop	Evidence from adaptive learning, educational assessment, and teacher-guided AI use, including Jufrida et al. (2025) and Canh et al. (2026).	Uses assessment results and stakeholder feedback to improve subsequent learning materials and activities.	Creates a continuous improvement process for culturally grounded learning.
Scalability and contextual adaptation	Research conducted across different cultural, linguistic, disciplinary, and educational settings.	Provides adaptable principles for implementing the model in different local contexts while preserving cultural specificity.	Addresses the limited transferability of models developed for individual contexts.

The integrated synthesis positions local wisdom as the epistemic foundation of the proposed Ethnodigital-AI learning model. Digital cultural content translates community knowledge into educational resources, while AI supports personalization, material generation, and interaction. Teachers mediate the relationship between technological processes, cultural interpretation, and instructional objectives. Cultural validation and multidimensional assessment provide mechanisms for monitoring the accuracy of learning content and the quality of student outcomes. The model therefore moves beyond the simple combination of AI tools and cultural materials by establishing relationships among knowledge sources, instructional processes, human oversight, and educational evaluation.

The model's principal contribution lies in treating cultural knowledge as an active component of instructional design rather than as supplementary content. Its implementation nevertheless requires systematic validation because the proposed integration remains a conceptual contribution until it is tested empirically. Future studies should examine whether culturally grounded AI activities improve learning achievement, engagement, digital literacy, and cultural understanding across different learner groups. Researchers should also assess the feasibility of teacher oversight, community participation, and adaptation to different local knowledge systems. Evidence from such evaluations will determine whether the model can provide a transferable framework while preserving the cultural specificity of each educational setting.

5. DISCUSSION

Literature developments indicate that ethnodigital-AI research has increased in intensity, particularly in the 2024-2026 period. A synthesis of the analyzed articles shows that the integration of AI with culture-based learning is no longer limited to the use of technology as a learning aid. AI is beginning to be used for personalization, content production, interaction, documentation of cultural knowledge, and the development of more contextual learning experiences. This pattern yields the key finding that local wisdom-based learning becomes more potent when digital technology not only presents culture as material but also utilizes it as a source of knowledge in the learning process. This finding aligns with Jufrida, (2025) who developed a machine learning-based ethnoscience learning framework by placing local wisdom as a predictive variable in contextual learning recommendations.

The structure of the results also indicates a shift from a conceptual approach to a more concrete implementation of learning. Ndeot, (2026) shows that ethnomathematics artifacts can be incorporated into game-based digital applications to develop problem solving while strengthening students'

engagement and cultural identity. Canh, (2026) demonstrates a similar direction through the use of AI in multimodal learning that links material to Khmer culture and local life. Both studies reinforce the synthesis's finding that cultural relevance can be embedded directly in the design of learning activities, materials, and interactions, not just in the introductory part of the lesson.

The overall literature overview reveals a more important pattern: technological development is outpacing the development of conceptual models that integrate all its components. Research has addressed AI, ethnoscience, ethnomathematics, heritage, language, assessment, and culture through different channels. Models that simultaneously connect local wisdom, digital content, AI personalization, teacher roles, cultural validation, student interaction, and evaluation of learning outcomes are still relatively limited. This position strengthens the contribution of systematic literature reviews because the results not only map the use of AI but also compile the elements needed to build a more integrated Ethnodigital-AI model.

Comparison with DaCosta, (2025) demonstrate similarities in the use of AI to enhance learners' interactions with cultural heritage. DaCosta developed a large language model-based historical character through retrieval-augmented generation and demonstrated that AI is capable of producing coherent and interactive historical representations. These results reinforce the study's findings that AI can transform cultural knowledge into more interactive digital learning experiences. The difference lies in the scope of integration, as DaCosta's approach centers on the representation of historical figures, while the Ethnodigital-AI model synthesized in this study encompasses a broader process, from sourcing local knowledge to evaluating learning.

Perspective Jufrida, (2025) provides empirical support for this position. Their research integrates machine learning, project-based learning, and Malay ethnoscience in Jambi, using student performance and engagement data to generate contextual learning recommendations. A 25% increase in engagement and a 15-20% increase in understanding of physics concepts demonstrate that integrating local wisdom with technology can yield measurable pedagogical benefits. The results of this systematic review expand on this position by demonstrating that AI-based personalization needs to be placed within an ecosystem that also considers cultural authenticity, the role of teachers, and validation mechanisms.

Findings Age, (2026) demonstrates a more critical development through a decolonial perspective. AI is positioned not merely as a learning tool, but as a technology for documenting local mathematical knowledge, building connections between local knowledge systems and formal mathematics, and producing culturally responsive learning. The similarity with the results of this study lies in the need to position local communities as the owners of knowledge authority. The difference lies in the scope because Age and Machaba focused on ethnomathematics in an African context, while this research synthesis seeks to produce a model that can be adapted across disciplines and cultural contexts.

The consistency of findings from various studies indicates that culture is shifting from being a decorative element in learning to an epistemic component in instructional design. Local wisdom is no longer simply used to introduce students' life contexts, but can also become a source of concepts, data, activities, problems, language, and artifacts processed through digital technology. Widodo, (2025) shows that local wisdom can even be incorporated as a predictive variable in personalized learning systems. This direction suggests that future learning models can be designed based on the relationship between learner identity and their local knowledge structures.

The presence of AI in literature also signals a shift in the boundaries between technology and pedagogy. AI has moved from automation to interpretation, recommendation, content production, and interaction Nyaaba, (2024) demonstrates that generative AI can be used to generate scientific assessments that take into account indigenous languages, local knowledge, identity, religion, family, and community. This position demonstrates that cultural sensitivity can be designed into the parameters of AI use, but its quality depends on how humans define the context and direct the system.

The changing role of teachers is the third important sign Chen, (2026) discovered the emergence of the concept of AI-pedagogical knowledge, namely the ability of teachers to translate learning objectives and pedagogical considerations into AI-processable instructions. These findings demonstrate that AI

does not eliminate the role of teachers, but rather changes the form of their professional competence. Teachers must be able to assess AI output, adapt materials to students' needs, and maintain the human interaction that is a vital part of the learning process. This condition strengthens the position of the Ethnodigital-AI model, which positions teachers as pedagogical mediators and cultural validators.

The theoretical implications of this research lie in the need to broaden our understanding of technology-based learning. A perspective that views AI solely as an instrument for increasing efficiency is insufficient to explain learning in environments with high cultural diversity. The Ethnodigital-AI model demonstrates that technology, culture, pedagogy, and learner identity need to be understood as interconnected components Mahmoudi-Dehaki, (2025) support these needs by placing indigenous knowledge as part of the basis of curriculum design, not as an add-on after the curriculum structure has been formed.

Practical implications are evident in the design of teaching materials and learning activities. Learning developers can use cultural artifacts, stories, local languages, traditional practices, geometric patterns, and community knowledge as raw materials for AI processing Ndeot, (2026) demonstrates that cultural artifacts can be translated into digital activities that support problem-solving and engagement. This pattern provides the basis for the digitalization of culture to have educational value when accompanied by clear instructional design, measurable learning objectives, and activities appropriate to the developmental stage of the learners.

Institutional implications relate to the governance of AI use in culture-based learning. Educational institutions need to provide validation mechanisms for the accuracy, authenticity, representation, and cultural sensitivity of AI-generated content DaCosta, (2025) demonstrates that using AI to represent cultural heritage requires source analysis, careful prompt design, a refinement process, collaboration, and ethical oversight and transparency. These principles are relevant to the Ethnodigital-AI model because cultural misrepresentation can produce materials that appear technically convincing but are inconsistent with community knowledge.

The dominance of integrative approaches in the literature can be explained by the increasing capabilities of AI in processing various types of educational and cultural data. AI systems can process text, images, patterns, language, and learning metadata more flexibly than conventional digital media. Meesakul, (2026) demonstrated that machine learning can analyze student performance and engagement to generate learning recommendations that take cultural familiarity into account. This capacity opens up the opportunity for AI to more systematically connect students' social identities to instructional decisions.

The gap between technological potential and model consolidation can arise because research evolves across different disciplines. Studies of educational AI often emphasize personalization and performance, while cultural studies emphasize preservation, identity, and indigenous knowledge. Assessment studies focus on contextual relevance, while teacher studies emphasize professional judgment Nyaaba, (2024) While generative AI can integrate several cultural dimensions into assessment, these studies focus on the assessment function, not the entire learning cycle. This explains why the literature yields many important components but does not always yield a single integrative model.

Human involvement remains a critical factor because AI does not have the social experience and contextual knowledge of a teacher or local community. Chen, (2026) shows that the effectiveness of teacher-AI collaboration depends on the teacher's ability to translate pedagogical goals, critique AI output, and make contextual adaptations Li, (2025) also positions AI as a pedagogical support for Khmer learners' learning, not as a substitute for teacher-managed learning processes. This pattern explains why the Ethnodigital-AI model requires a human-in-the-loop structure as a pedagogical and cultural quality control mechanism.

The next research direction needs to move from concept development to empirical model testing. The Ethnodigital-AI model can be tested through experimental, quasi-experimental, or mixed methods designs by comparing AI-based learning with traditional learning. Outcome variables should not be

limited to academic achievement. Problem-solving, digital literacy, engagement, cultural identity, critical thinking skills, and knowledge retention can serve as indicators to more comprehensively test the model's effectiveness.Meesakul, (2026) provides the basis that combining cognitive indicators, engagement, and cultural responses can produce a more complete evaluation.

Model development also requires strengthening cultural validation mechanisms at each learning stage. Knowledge sources need to be verified by teachers, subject matter experts, and local knowledge stakeholders before being used as the basis for prompts or AI materials. This principle is consistent with Wandera, (2024) which emphasizes source analysis, refinement, collaboration, and ethical oversight in the development of AI-based historical characters. The Ethnodigital-AI model can be developed through the stages of identifying local wisdom, digitizing knowledge, developing AI content, cultural validation, pedagogical implementation, evaluating learning outcomes, and feedback-based improvement.

A medium-term agenda needs to test the model's sustainability and scalability across diverse cultures and educational levels. The Malay context in Jambi, Khmer in Vietnam, African ethnomathematics, and East Nusa Tenggara demonstrate that the relationship between AI and culture is highly contextual Tsai, (2022) explicitly recommends cross-context testing and the development of interactive digital resources, whereas Sutrisno, (2025) emphasizing the importance of community authority, data sovereignty, and preventing new epistemological domination. The next Ethnodigital-AI model needs to be built as a framework that is technologically flexible, yet remains rigorous in its cultural validation and pedagogical objectives.

6. CONCLUSION

This study found that the Ethnodigital-AI learning model based on local wisdom develops through the integration of four main elements, namely cultural knowledge as an epistemic source, digital technology as a representation medium, artificial intelligence as an instrument of personalization and content generation, and teachers as pedagogical mediators and cultural validators; these findings indicate that AI integration is not solely directed at learning efficiency, but needs to be built through an authentic cultural context, learner interaction, cultural validation, and evaluation of learning outcomes that include cognitive, digital, cultural, and affective aspects. The main contribution of the study lies in the development of an Ethnodigital-AI conceptual model that combines components of technology, local wisdom, pedagogy, teacher roles, cultural validation, and feedback mechanisms in a single learning framework that can be adapted to various local contexts; this conceptual value expands the study of AI in education from a technological orientation to an approach that places culture as a source of knowledge and the basis of instructional design. Limitations of the study relate to the reliance on literature available in databases and the imbalance of empirical, conceptual, and contextual evidence between articles, so that the effectiveness of the model cannot be ascertained for various levels, regions, and learner characteristics. Further research needs to test the model through experiments, mixed methods, and longitudinal studies, involving teachers and local knowledge-holding communities in the validation process, developing multidimensional learning outcome indicators, and testing the model's scalability across various forms of local wisdom in Indonesia and other cultural contexts.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

REFERENCES

Age, T. J. (2026). Decolonizing mathematical futures: The role of artificial intelligence in reviving and repositioning ethnomathematics in curriculum design in Africa. Frontiers in Computer Science, 8. https://doi.org/10.3389/fcomp.2026.1855557

Beatrice, P. (2024). Adding immersive virtual reality laboratory simulations to traditional teaching methods enhances biotechnology learning outcomes. Frontiers in Education, 9. https://doi.org/10.3389/feduc.2024.1354526

Canh, TV (2026). Applying Artificial Intelligence to Train Multimodal Information Processing Skills for Ethnic Minority Students in Particularly Disadvantaged Areas: The Case of Khmer Ethnic Minority Students at Khanh Hoa Secondary and High School, Can Tho City, Vietnam. International Journal of Special Education, 41(6), 175–188.

Cao, L. (2024). A study of project-based learning to intermediate EFL learners in reading classes: Enhancing self-regulated learning of post-secondary students in Macao. Asian Pacific Journal of Second and Foreign Language Education, 9(1). https://doi.org/10.1186/s40862-024-00298-6

Chao, P. C. (2026). Access Profiles and Motivational Predictors of Online Reading Performance: A Study of Digital Equity in Taiwan. Sage Open, 16(1). https://doi.org/10.1177/21582440251391242

Chen, Q. (2026). Teacherness in the age of GenAI: An ethnographic exploration of pedagogical decision-making and AI integration in English language teaching. System, 136. https://doi.org/10.1016/j.system.2025.103877

DaCosta, B. (2025). Speaking with the Past: Constructing AI-Generated Historical Characters for Cultural Heritage and Learning. Heritage, 8(9). https://doi.org/10.3390/heritage8090387

Ferriz-Valero, A. (2025). Autolycus' Game: Game-Based Learning in Natural Environments for Meaningful Physical Education. Education Sciences, 15(12). https://doi.org/10.3390/educsci15121642

Furey, J. (2022). Actively Involving Students With Learning Disabilities in Progress Monitoring Practices. Intervention in Schools and Clinics, 57(5), 329–337. https://doi.org/10.1177/10534512211032618

Guo, F. (2025). Autonomy and familiarity in AI-mediated collaboration: A self-determination theory perspective on motivational interdependence in EFL learners. Learning and Motivation, 92. https://doi.org/10.1016/j.lmot.2025.102219

Hu, J. (2024). An Informational Model of Mathematics Teaching and Research Activities Based on the ARCS Model. Applied Mathematics and Nonlinear Sciences, 9(1). https://doi.org/10.2478/amns-2024-0764

Jufrida, J. (2025). AI-DRIVEN ETHNOSCIENCE LEARNING: ENHANCING PHYSICS EDUCATION THROUGH MALAY CULTURAL INSIGHTS. Journal of Information Technology Education: Innovations in Practice, 24. https://doi.org/10.28945/5520

Le, H. V. (2025). Assessing student satisfaction with MOOCs: A comprehensive analysis of Coursera's instructional design and learner experience. International Journal of Information and Learning Technology, 42(2), 207–223. https://doi.org/10.1108/IJILT-07-2024-0159

Li, W. (2025). Application of artificial intelligence in medical education: A meta-ethnographic synthesis. Medical Teacher, 47(7), 1168–1181. https://doi.org/10.1080/0142159X.2024.2418936

Llerena-Izquierdo, J. (2024). Academic Tracking Strategy and Motivation in a Virtual Learning Environment Using a Visual Representation of Learning Outcomes. Lecture Notes in Networks and Systems, 797, 42–53. https://doi.org/10.1007/978-3-031-70981-4_4

Mahmoudi-Dehaki, M. (2025). Utilizing GenAI to create a culturally responsive EFL curriculum for pre-teen learners in the MENA region. Education 3-13, 53(7), 1175–1189. https://doi.org/10.1080/03004279.2025.2502016

Meesakul, P. (2026). The Fusion of Musical Traditions and Technology: A Systematic Literature Review of Artificial Intelligence in Music Education within Non-Western Contexts and Its Implications for Thai Music. Rangsit Music Journal, 21(2). https://doi.org/10.59796/rmj.V21N2.2026.R0307

Mulbe, S. von der. (2024). Applying a three-component approach to motivational regulation: Relations of frequency, situation-specific fit and application quality of motivational regulation strategies with students' well-being. Learning and Individual Differences, 116. https://doi.org/10.1016/j.lindif.2024.102561

Muth, J. (2024). Associations between Autonomy-Supportive Teaching, the Use of Non-Academic ICTs, and Student Motivation in English Language Learning. Sustainability Switzerland, 16(3). https://doi.org/10.3390/su16031337

Ndeot, F. (2026). Apps Meet Ancestry: A Digital Ethnomathematics Play Framework for Preschool Problem-Solving. International Journal of Special Education, 41(8), 369–382.

Nyaaba, M. (2024). Generative AI for Culturally Responsive Science Assessment: A Conceptual Framework. Education Sciences, 14(12). https://doi.org/10.3390/educsci14121325

Rizakhojayeva, G. (2026). Art & Game-Based Approaches in Language Teaching: From Creativity to Communication. Journal of Curriculum Studies Research, 8(1), 345–363. https://doi.org/10.46303/jcsr.2026.18

Sun, D. (2024). A systematic review of technology-supported scaffoldings in empirical studies from 2017–2022: Trends, scaffolding design features and learning outcomes. Educational Technology and Society, 27(3), 185–203. https://doi.org/10.30191/ETS.202407_27(3).RP11

Sutrisno, S. (2025). Assessing students' readiness for artificial intelligence-based project learning to strengthen local wisdom values in Indonesia. Cogent Education, 12(1). https://doi.org/10.1080/2331186X.2025.2582948

Tsai, C.W. (2022). Integrating Multiculturalism Into Artificial Intelligence-Assisted Programming Lessons: Examining Inter-Ethnicity Differences in Learning Expectancy, Motivation, and Effectiveness. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.868698

Wandera, D. B. (2024). Skewed Artificial Intelligence: Flagging Embedded Cultural Practices in Children's Stories Featuring “Alice and Sparkle.” Reading Research Quarterly, 59(4), 651–664. https://doi.org/10.1002/rrq.572

Wei, D. (2022). A Systematic Review of Mobile Learning and Student's Self-Regulated Learning. Eurasian Journal of Educational Research, 2022(102), 233–252. https://doi.org/10.14689/ejer.2022.102.013

Widodo, H. (2025). An AI-Gamification-Religiosity Learning Model to Enhance Critical Literacy in Private Islamic Universities. Islamic Quarterly, 69(1), 75–120.

Zourmpakis, A.I. (2023). Adaptive Gamification in Science Education: An Analysis of the Impact of implementation and Adapted game Elements on Students' Motivation. Computers, 12(7). https://doi.org/10.3390/computers12070143