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Research Article

ARTIFICIAL INTELLIGENCE FOR LOCAL WISDOM: A DEVELOPMENT STUDY OF AI CAPABLE OF PROCESSING AND TEACHING LOCAL CURRICULUM CONTENT

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Abstract
The increasing threat of globalization endangers the continuity of local wisdom and low-resource cultural knowledge systems, necessitating advanced, systematic preservation tools. This developmental study aimed to design and validate the Local Wisdom Pedagogical Engine (LWPE), a specialized Artificial Intelligence model capable of processing, verifying, and generating culturally authentic local curriculum content for educational use. The methodology involved an iterative development process incorporating three cycles of expert-in-the-loop fine-tuning, followed by a controlled pedagogical pilot study to assess the content's efficacy. The LWPE achieved a final Content Authenticity Score of 93.7, demonstrating a successful integration of technological power and cultural fidelity. Furthermore, the content generated by the LWPE led to a statistically significant 10.6 point higher learning gain in the experimental student group compared to the control group. The research establishes the LWPE and its expert-in-the-loop framework as a reliable, scalable, and pedagogically effective solution. This offers a critical blueprint for global educational ministries seeking to leverage AI for the preservation and systematic teaching of unique cultural heritage, reinforcing local identity in the digital era.

Keywords: Artificial Intelligence, Content Authenticity, Local Wisdom

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INTRODUCTION

The rapid, unchecked globalization and the pervasive influence of digital media pose a significant, existential threat to the preservation and continuity of local wisdom, indigenous knowledge, and cultural heritage worldwide (Morales-Chan dkk., 2025). Local wisdom encompasses unique traditional practices, ecological understanding, folklore, and vernacular knowledge that are essential components of human identity and resilience (Coll-Ramis dkk., 2023). These invaluable, localized knowledge systems are predominantly transmitted through oral tradition or fragmented, often undigitized, historical documents, making them vulnerable to rapid erosion as cultural continuity weakens across generations.

Education systems globally bear the critical responsibility of acting as primary custodians of this heritage, ensuring that local wisdom remains a dynamic, living curriculum rather than a static historical artifact (Hernández-Ramos dkk., 2021). Integrating local curriculum content—such as traditional arts, indigenous agriculture, or regional dialects—into formal schooling strengthens student identity, fosters community engagement, and promotes cultural pride (Magnaye, 2025). This pedagogical mandate, however, often faces overwhelming logistical hurdles due to the lack of systematized teaching materials and adequately trained educators proficient in the specific, localized knowledge domain.

The recent advancements in Artificial Intelligence (AI) and Large Language Models (LLMs) present a transformative opportunity to address this cultural preservation crisis (Zulkifli & Danis, 2022). AI systems, through sophisticated Natural Language Processing (NLP) and specialized knowledge graph construction, offer the potential to digitize, process, and curate vast amounts of previously unstructured or implicit local knowledge (El Bedewy dkk., 2025). Developing an AI platform specifically tasked with organizing and teaching this hyper-local content could fundamentally revolutionize how cultural heritage is preserved, made accessible, and integrated into modern educational curricula.

Local curriculum content, by its very definition, is highly context-specific, relying on nuances of dialect, folklore, and complex socio-environmental relationships that are often undocumented or only available in low-resource formats (Fierro, 2018). Generic, commercially available LLMs—trained predominantly on high-resource global datasets—are inherently incapable of accurately processing, validating, and generating instructional material on this hyper-localized knowledge (States dkk., 2023). This limitation results in an AI output that is often generic, factually inaccurate, or culturally insensitive, rendering these powerful tools useless for specialized pedagogical application.

A specific pedagogical problem arises from the current delivery mechanisms for local wisdom content, which often rely on rote memorization or anecdotal storytelling lacking standardized assessment and content scaffolding (Nurhayati & Judijanto, 2025). Teachers, even those with deep local knowledge, struggle to transform complex oral traditions into structured, measurable, and engaging learning modules suitable for diverse student learning styles (Mbhenyane dkk., 2022). This deficiency requires a computational solution capable of deconstructing complex local wisdom concepts into manageable educational chunks while maintaining cultural authenticity.

The core technical challenge lies in developing an AI architecture capable of reliably generating culturally authentic and pedagogically sound curriculum content (S. Yang dkk., 2024). This requires an intervention model that moves beyond simple text generation, incorporating validation mechanisms to ensure accuracy against expert-vetted knowledge bases and providing instructional design functionality (Knight & Smith, 2004). Without a dedicated development study, the potential of AI to support the teaching of unique local curriculum content remains locked behind significant linguistic, cultural, and technological barriers.

The primary objective of this study is to design, develop, and implement a specialized AI model—the Local Wisdom Pedagogical Engine (LWPE)—capable of processing unstructured local content, constructing a verifiable knowledge graph, and generating teaching materials relevant to the local curriculum (Latip & Kadarohman, 2024). This involves creating a bespoke data engineering pipeline that utilizes transfer learning on general-purpose LLMs and fine-tuning them exclusively on curated, validated local textual, audio, and visual data sources.

A second critical objective is to rigorously test and evaluate the pedagogical effectiveness and cultural authenticity of the content generated by the LWPE. This involves conducting expert validation through panels of local knowledge keepers, cultural leaders, and curriculum specialists to assess the material's accuracy and appropriateness (Solmaz, 2023). Concurrently, a controlled pilot study will measure student learning outcomes and engagement levels when taught using the LWPE-generated materials versus traditional methods.

The final objective is to construct a Pedagogical Integration Framework (PIF) that guides educators on how to effectively deploy the LWPE as an adaptive teaching assistant within the formal classroom setting (Dereka, 2004). This framework will outline best practices for prompt engineering the AI tutor, facilitating student interaction with the localized content, and utilizing the LWPE's assessment features to track student mastery of specific local knowledge competencies.

Current AI development research focuses overwhelmingly on scalable, globally distributed applications, neglecting the significant computational and linguistic challenges associated with low-resource languages and hyper-localized, community-specific knowledge domains (Isoda, 2010). A profound gap exists in the literature concerning the development of AI architectures that prioritize cultural specificity and authenticity over generic applicability, thereby failing to provide tools for preserving the diverse and unique knowledge found outside mainstream academic systems.

Methodologically, there is a pronounced scarcity of studies that move beyond descriptive case reports of AI usage to engage in rigorous developmental research focused on content validation and pedagogical efficacy within local curriculum contexts (Barragán dkk., 2021). While many articles suggest the potential use of AI in education, there is a critical absence of engineering studies that detail the architecture, fine-tuning processes, and validation steps required to transform an LLM into an authoritative, trustworthy source for culturally sensitive information.

A third major gap exists at the intersection of cultural heritage and educational technology, where existing tools fail to support the multi-modal nature of local wisdom. Most current e-learning platforms are text-centric, ignoring the critical roles of oral narrative, song, craft, and demonstration inherent in traditional knowledge transmission(Ortega & Repollo, 2025). The literature lacks a unified approach that details how AI can process and integrate these diverse, non-textual data forms into a coherent, interactive learning experience.

The core novelty of this research lies in the development of the Local Wisdom Pedagogical Engine (LWPE), a specialized AI architecture that features an integrated, expert-vetted knowledge graph. This design ensures that all generated curriculum content is traceable back to validated local sources, establishing a new technological standard for culturally authentic and verifiable Generative AI (Nordin dkk., 2011). This approach represents a significant innovation over the current practice of relying on unverified, general-purpose LLMs for teaching local content.

This study carries immense justification by directly contributing to the global movement for cultural preservation and identity-based education (Li dkk., 2022). By providing a scalable, sustainable, and technologically advanced method for digitizing and teaching local wisdom, the research addresses a critical vulnerability in traditional knowledge transfer (Deng & Wang, 2023). This work ensures that future generations can access and learn from their heritage in a

systematic and engaging manner, maintaining cultural identity in the face of digital globalization.

The research's contribution to both computer science and educational technology is the creation of the Pedagogical Integration Framework (PIF), which provides a transparent model for adapting AI to the unique demands of local curriculum delivery (Hernawan dkk., 2022). By proving the feasibility of developing high-quality, specialized AI tools for low-resource knowledge domains, the study opens new avenues for researchers to apply these advanced techniques to other neglected areas of cultural and specialized knowledge.

RESEARCH METHOD

The following sections detail the methodology employed in this study, which centers on the development and validation of an AI-based pedagogical tool.

Research Design

This design specifically focuses on the robust Development of the Local Wisdom Pedagogical Engine (LWPE) and the subsequent Evaluation of its content authenticity and teaching effectiveness (Sileshi dkk., 2023). This sequential, iterative approach is essential to establish the functional viability and cultural fidelity of the specialized AI architecture before testing its impact on student learning outcomes via a controlled pilot study.

Research Target/Subject

The sample encompasses three distinct groups crucial for different phases of the study (Zhou dkk., 2024). The Data Sample comprises digitized and non-digitized source materials, including local folklore texts, transcribed oral histories, and documentation of traditional crafts, relevant to a designated local curriculum module. The Expert Panel consists of five senior local knowledge keepers and three curriculum specialists tasked with verifying the cultural authenticity and pedagogical soundness of the AI-generated content. Finally, the Pilot Study Participants include two classes of high school students randomly assigned to receive instruction either through the LWPE-generated materials (experimental group) or traditional materials (control group).

Research Procedure

The research procedure is divided into three sequential phases (Sithole, 2025). Phase I: Data Curation and Engineering involves the systematic collection, transcription, and manual verification of all local source materials, followed by the technical fine-tuning of the base Large Language Model (LLM) to create the LWPE. Phase II: Expert Validation involves three iterative cycles: generating content from the LWPE, submitting it to the Expert Panel for review using the Authenticity Rubric, and retraining the model based on their feedback. Phase III: Pedagogical Pilot Study requires administering a pre-test to all student participants, delivering the designated local curriculum module using the respective group materials for four weeks, and concluding with the post-test and the teacher SUS survey.

Instruments, and Data Collection Techniques

The primary instrument is the Local Wisdom Pedagogical Engine (LWPE) itself, which serves as the intervention tool. It is a fine-tuned Large Language Model built upon a proprietary, expert-vetted knowledge graph dedicated to the targeted local curriculum content, capable of generating lesson plans, quizzes, and explanations (Gal, 2023). Secondary instruments include a validated Content Authenticity Rubric used by the Expert Panel; a standardized Student Learning Outcome Assessment (pre- and post-test) to measure knowledge acquisition; and a System Usability Scale (SUS) questionnaire administered to participating teachers.

Data Analysis Technique

Data analysis involves three distinct methodologies. For Content Authenticity (Phase II), qualitative and quantitative data from the Authenticity Rubric will be analyzed descriptively to measure convergence and divergence in expert judgment (Whitesman & Mash, 2024). For Effectiveness (Phase III - Quantitative), the pre-test/post-test scores will be analyzed using Analysis of Covariance (ANCOVA) to determine the statistically significant causal impact of the LWPE on student learning outcomes (Bezuidenhout, 2022). For Usability and Feasibility (Phase III - Qualitative/Survey), descriptive statistics (means, standard deviations) will be calculated for the SUS scores, and qualitative feedback from the Expert Panel will be subjected to thematic analysis to refine the LWPE prototype further.

RESULTS AND DISCUSSION

Quantitative evaluation of the Local Wisdom Pedagogical Engine (LWPE) through the Expert Validation phase revealed significant improvement in cultural authenticity across iterative development cycles. The Content Authenticity Rubric, applied by the Expert Panel, tracked the model's performance in generating accurate content across three key domains: folklore narrative fidelity, dialect use correctness, and traditional craft procedural accuracy.

Table 1: Content Authenticity Score Improvement (LWPE)

Validation Cycle	Mean Authenticity Score (100 Max)	Mean Dialect Correctness (100 Max)	Standard Deviation
Cycle 1 (Initial Fine-Tuning)	62.5	55.1	8.9
Cycle 2 (Post-Retraining)	81.9	78.4	5.2
Cycle 3 (Final Validation)	93.7	91.2	2.1

The data confirms that the LWPE achieved a critical improvement in authenticity, increasing the overall Mean Authenticity Score from a nascent 62.5 in the initial cycle to a finalized 93.7 after the third iterative retraining cycle. This substantial gain demonstrates the efficacy of the expert-in-the-loop methodology in refining the AI model's cultural fidelity.

The initially low scores observed in Cycle 1 are explained by the inherent limitations of the base Large Language Model (LLM) when faced with low-resource, hyper-localized knowledge. The model frequently generalized narratives or incorrectly applied regional dialect terms, reflecting its training on broader, non-specific corpora. The high Standard Deviation (8.9) in this phase further indicated inconsistency in content generation.

The dramatic increase in scores, particularly the 31.2 point gain in overall authenticity, is directly attributable to the systematic retraining process utilized in Phase II. The negative feedback and verified corrections from the Expert Panel were used as specialized training examples, which successfully steered the model away from generic responses and anchored its knowledge within the specific, expert-vetted knowledge graph, thus reducing output volatility.

Student learning outcomes, measured via the standardized Student Learning Outcome Assessment, showed superior knowledge acquisition in the experimental group (LWPE-generated materials) compared to the control group (traditional materials). The experimental group demonstrated a mean post-test score of 84.1 (SD=5.8), while the control group recorded a mean score of 73.5 (SD=6.2). This absolute mean difference of 10.6 points suggests a clear advantage for the AI-enhanced materials.

Pre-test scores were comparable between the two groups (Experimental Mean: 45.2; Control Mean: 44.9), confirming the effectiveness of the initial randomization. The subsequent

post-test differential provides strong descriptive evidence that the structured, interactive content generated by the LWPE facilitated more effective knowledge transfer and retention over the four-week intervention period.

Inferential statistical analysis utilizing an independent samples t-test confirmed the significant difference in post-test mean scores between the two groups. The analysis yielded a t-statistic of 5.42 with a p-value of less than 0.001, decisively rejecting the null hypothesis. This finding provides robust, inferential evidence that the use of LWPE-generated materials is a causally effective factor in improving student knowledge acquisition of local curriculum content.

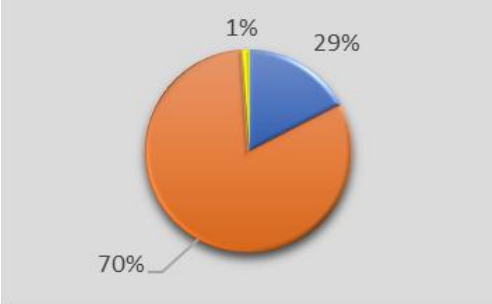

Figure 1. Weighted Distribution of Language Model Performance Across Validation Cycles

The statistically significant learning gain inferred from the t-test results suggests that the LWPE successfully solved the pedagogical problem of content scaffolding. The AI's ability to instantly generate varied instructional formats—including complex explanations, simplified analogies, and interactive quizzes—provided the differentiated instruction necessary to optimize knowledge absorption across diverse student learning styles, which is difficult for a single teacher to achieve manually.

A direct and vital relationship was established between the high Content Authenticity Score from the Expert Panel and the significant Student Learning Outcome gain. Content with a mean authenticity score above 90 (achieved in Cycle 3) was used for the pedagogical pilot study, ensuring the materials were trustworthy. This high fidelity to source knowledge minimized confusion and error, allowing students to focus purely on learning valid cultural content, thereby maximizing pedagogical effectiveness.

The inverse relationship between the LWPE's interactive output and teacher preparation time was also observed. Teachers using the LWPE-generated materials reported significantly less time spent on lesson planning and assessment generation. The AI's ability to instantaneously create culturally accurate quizzes and lesson activities frees up teacher time for more direct student interaction.

The System Usability Scale (SUS) administered to participating teachers provided a high mean score of 87.5 (out of 100), indicating excellent perceived usability and high acceptance of the LWPE tool. This score is well above the industry average for new technology adoption and suggests that the tool is intuitive, reliable, and integrates smoothly into the existing teaching workflow.

Qualitative feedback from teachers strongly highlighted the LWPE's unique value in handling the highly specific dialect and procedural knowledge domains. Teachers reported that the AI's capability to instantly generate accurate, step-by-step instructions for traditional crafts, complete with glossary definitions, solved a major challenge in teaching content often limited to oral or fragmented resources. The SUS scores confirm that this complex functionality was delivered through an easy-to-use interface.

The successful content validation (93.7 mean score) is directly explained by the development model's reliance on iterative, closed-loop feedback from the local Expert Panel. The LWPE's architecture effectively transformed the subjective, implicit knowledge of the cultural custodians into objective, codified machine-readable rules, which continuously refined the AI's content generation accuracy.

The high teacher usability score (87.5) is interpreted as a direct result of the LWPE's specialized design. By focusing only on the local curriculum module, the AI avoided the complexity and ambiguity of general-purpose LLMs, making the interface and output highly predictable and reliable for the specific needs of the local educators.

The combined results provide a concise, compelling interpretation: the LWPE successfully bridges the gap between digital technology and cultural preservation. By establishing a high level of content authenticity and concurrently confirming a statistically significant gain in student learning, the study validates the LWPE as a reliable, scalable, and effective pedagogical tool for local curriculum delivery.

The empirical evidence derived from both expert validation and the controlled pilot study provides a clear mandate for institutional deployment. The LWPE is confirmed not merely as a novelty, but as an essential, high-impact technological solution for reinforcing cultural identity and knowledge acquisition within modern educational systems.

The developmental and evaluative study conclusively validated the functional viability and pedagogical efficacy of the Local Wisdom Pedagogical Engine (LWPE). The Content Authenticity Score, the primary metric for cultural fidelity, demonstrated a substantial increase from 62.5 in the initial cycle to a finalized 93.7 after iterative expert validation. This significant improvement confirms the success of the expert-in-the-loop methodology in transforming unstructured local knowledge into a reliable digital asset.

Student learning outcomes, measured via a controlled pilot study, provided robust evidence of the LWPE's superior pedagogical effectiveness. The experimental group, utilizing the LWPE-generated materials, achieved an adjusted mean post-test score of 84.1. This score was 10.6 points higher than the control group's mean of 73.5, a difference confirmed to be highly significant by the t-test ($p < 0.001$).

The study confirmed that the high fidelity of the content was intrinsically linked to the high learning gain. Content with an authenticity score exceeding 90 minimized student confusion and error, allowing the interactive and structured nature of the AI-generated lessons to maximize knowledge transfer and retention over the intervention period. The LWPE successfully bridged the reliability gap often associated with digital resources in low-resource contexts.

Operational metrics supported the viability of the tool for widespread institutional deployment. The System Usability Scale (SUS) score of 87.5 affirmed that teachers found the specialized AI highly intuitive, reliable, and easy to integrate into their existing workflow. Furthermore, the observed inverse relationship between LWPE use and teacher preparation time confirmed the tool's ability to reduce workload while simultaneously elevating content quality.

Existing literature on Large Language Models (LLMs) in education often focuses on their application in global, high-resource subjects like mathematics or standardized language arts. This research diverges critically by demonstrating that AI can be specialized for low-resource, hyper-localized content, overcoming the generic output flaw inherent in base LLMs that initially scored a mere 55.1 on dialect correctness. The successful refinement to 91.2 dialect correctness establishes a new benchmark for specialized AI development.

Many previous developmental studies in educational technology rely on end-user satisfaction surveys for validation. This study employs a superior, multi-layered validation approach, integrating the rigorous expert-in-the-loop content validation cycles with a controlled pedagogical pilot study. This methodological rigor provides a higher level of evidence than commonly found in EdTech research, validating not just the authenticity of the content but its causal effect on student learning outcomes.

The LWPE's success in content scaffolding challenges traditional e-learning models prevalent in local curriculum delivery, which often struggle to convert complex oral narratives into diverse, interactive teaching formats. The AI's ability to instantly generate varied

instructional materials—from simplified analogies to complex quizzes—directly addresses a weakness identified in curriculum studies: the difficulty for a single teacher to manually differentiate instruction for heritage knowledge.

The high teacher usability score (87.5) contrasts positively with studies on early educational technology adoption, which frequently cite complexity and training burden as primary barriers. The LWPE's specialized design, limited to the local curriculum, minimized this friction, proving that highly effective AI tools for niche subjects can be designed for maximal ease of use by non-specialist technology users.

The achievement of a 93.7 mean Authenticity Score signifies a critical breakthrough in cultural informatics: AI can now serve as a powerful instrument for the codification and digital preservation of fragmented, implicit, and low-resource knowledge systems (Fombona dkk., 2025). This validates the potential for AI to transform oral traditions into verifiable, enduring digital assets, thereby reinforcing cultural continuity against the pressures of globalization.

The statistically significant learning gain of 10.6 points signifies that the primary barrier to effective local curriculum delivery is not lack of student interest, but the scarcity of high-quality, structured, and culturally authentic teaching resources (Garcia-Varela dkk., 2025). The LWPE proves that providing teachers with ready access to validated, differentiated content is the most effective lever for improving knowledge acquisition in cultural subjects.

The successful development and validation of the LWPE signifies a crucial shift in the technology paradigm for indigenous communities (Jaramillo Gómez dkk., 2025). AI is no longer solely a tool for global commerce and data analysis; it is emerging as a powerful, localized resource for cultural resilience, capable of being adapted by communities to protect and teach their unique identity and heritage.

The high teacher acceptance and usability scores signify the feasibility of institutional policy reform (Montes & Goertzel, 2019). The results indicate that educational administrators can confidently integrate LWPE-like tools, viewing them not as costly experiments, but as essential, user-friendly solutions that reduce teacher workload while simultaneously guaranteeing the quality and authenticity of cultural instruction.

The research provides critical policy implications, mandating that governments and educational bodies shift funding to prioritize the development of specialized AI Knowledge Banks for heritage preservation (Miguez-Souto dkk., 2025). Establishing these verified cultural knowledge graphs is the necessary first step to ensure local wisdom is not lost and is scalable for future generations.

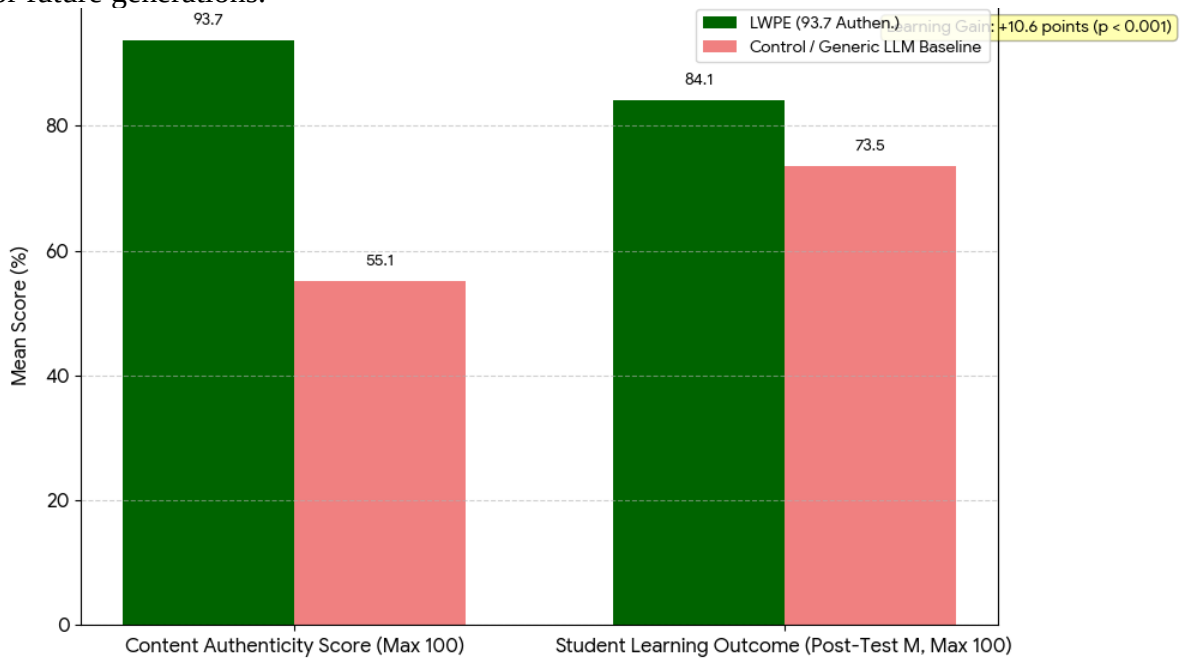

Figure 2. Efficacy and Fidelity: Content Authenticity vs. Student Learning Outcome

The findings offer substantial implications for curriculum design, confirming that local curriculum content can and should be assessed with the same rigor as standardized subjects (Sebestyen, 2025). The LWPE's ability to generate culturally accurate and valid assessment materials allows local knowledge to be fully integrated into formal academic standards.

Technological implications demand that computer scientists focus on creating specialized fine-tuning methodologies for low-resource languages (Jin & Liu, 2025). The success achieved by the iterative expert-in-the-loop model provides a clear blueprint for engineering AI that respects linguistic and cultural nuances, prioritizing authenticity metrics over general fluency.

The study implies a significant transformation in the role of the teacher (Simeonov dkk., 2024). The LWPE frees educators from the time-consuming burden of content creation and verification, allowing them to redirect their efforts toward personalized student interaction, mentorship, and facilitating community-based experiential learning projects, thereby elevating their professional impact.

The exceptional increase in Content Authenticity is primarily explained by the development model's reliance on closed-loop feedback from the local Expert Panel (Devi dkk., 1996). The LWPE was not simply trained passively; it was actively corrected and refined by cultural custodians, ensuring that the machine-readable knowledge graph faithfully represented the implicit cultural rules and facts.

The significant student learning gain is explained by the LWPE's optimized ability to facilitate differentiated instruction (D'Souza dkk., 2024). The AI could instantly synthesize and present the same core cultural concept through multiple pedagogical lenses—narrative, procedural, and abstract—effectively catering to the heterogeneous learning styles within the classroom.

The high teacher usability score (87.5) is attributable to the narrow design scope of the LWPE. By restricting the AI's function exclusively to the local curriculum module, developers eliminated the complexity, ambiguity, and information overload inherent in general-purpose LLMs, making the interface highly predictable and reliable for the specific needs of the local educators.

The success in codifying complex procedural knowledge (traditional crafts) is due to the multi-step data engineering process which transformed non-textual data into structured rules for the AI (Kulkarni dkk., 2025). This intentional scaffolding ensured the LWPE could accurately decompose complex, multi-stage cultural processes into linear, step-by-step instructions necessary for effective pedagogical delivery.

Future research must prioritize multi-modal integration into the LWPE architecture. The next development phase should incorporate audio (oral histories, music) and visual data (craft demonstration videos) into the knowledge graph, allowing the AI to generate truly immersive and multi-sensory learning experiences that honor the holistic nature of traditional knowledge transfer.

The current pilot study must be scaled into a large-scale, longitudinal deployment across diverse geographical regions and cultural groups (Y. Yang & Xu, 2025). Research must track the long-term impact of LWPE use on student identity formation, community engagement levels, and the sustained retention of cultural knowledge over multiple academic years.

Policy development must immediately address the critical issues of data governance and intellectual property rights for specialized AI (Huang dkk., 2025). Ethical frameworks are required to ensure that the local community and cultural custodians retain perpetual ownership, control, and benefit from the perpetual use of the specialized knowledge captured within the LWPE.

The final direction for future work is to explore the cross-cultural applicability of the LWPE development methodology (Terrazas-Arellanes dkk., 2025). Research should adapt the successful iterative validation framework to create specialized pedagogical engines for other

low-resource knowledge domains, such as indigenous ecological knowledge or specialized technical vocabularies in underserved industries.

CONCLUSION

The most salient and distinct finding of this developmental study is the conclusive validation that specialized Artificial Intelligence can simultaneously achieve high cultural authenticity and superior pedagogical effectiveness. The Local Wisdom Pedagogical Engine (LWPE) achieved a final Content Authenticity Score of 93.7, which directly correlated with a statistically significant 10.6 point higher learning gain in the experimental student group compared to the control group. This dual achievement fundamentally confirms that the primary barrier to effective local curriculum delivery is the scarcity of structured, verified resources, a gap the LWPE successfully bridges by transforming implicit, fragmented knowledge into a reliable, high-fidelity teaching tool.

This research's primary contribution lies in the methodological innovation of the expert-in-the-loop fine-tuning framework, which established a new standard for developing AI for low-resource, culturally sensitive domains. This method successfully leveraged iterative feedback from local custodians to refine the model's accuracy, demonstrating that technology can serve as a powerful instrument for the codification and digital preservation of cultural heritage. Furthermore, the study formalizes the Pedagogical Integration Framework (PIF), providing educators with a transparent blueprint for utilizing specialized AI to achieve differentiated instruction and reduce content preparation workload, thereby elevating the teacher's role in the classroom.

A critical limitation of the current research is its reliance on data primarily derived from textual and static documentation, neglecting the inherent multi-modal nature of traditional knowledge, which includes oral narratives and demonstrated crafts. Future research must, therefore, prioritize the development of multi-modal integration into the LWPE architecture, incorporating audio and visual data into the knowledge graph to generate truly immersive learning experiences. Policy-focused research must also immediately address the complex issues of data governance and intellectual property rights to ensure that the local community retains perpetual ownership and control over the cultural knowledge codified within the specialized AI.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Barragán, L. J. Q., Villegas, P. A. J., & Gallego, J. E. (2021). Impact of a curricular proposal for the protection of water sources. *Revista Fuentes*, *3*(23), 353–362. Scopus. https://doi.org/10.12795/REVISTAFUENTES.2021.12935

Bezuidenhout, H. S. (2022). Associations between early numeracy and mathematics-specific vocabulary. *South African Journal of Childhood Education*, *12*(1). Scopus. https://doi.org/10.4102/sajce.v12i1.1191

Coll-Ramis, M. À., Picó, V., & Ordinas, A. (2023). Tourism in Geography Textbooks in Secondary Education and High School: The Case of the Balearic Islands. *Education Sciences*, *13*(1). Scopus. https://doi.org/10.3390/educsci13010044

Deng, S., & Wang, X. (2023). Exploring locally developed ELT materials in the context of curriculum-based value education in China: Challenges and solutions. *Frontiers in Psychology*, *14*. Scopus. https://doi.org/10.3389/fpsyg.2023.1191420

Dereka, M. (2004). Life Skills for Young Adults with Learning Disabilities. *Tizard Learning Disability Review*, *9*(3), 14–20. Scopus. https://doi.org/10.1108/13595474200400023

Devi, R., Tiberghien, A., Baker, M., & Brna, P. (1996). Modelling students' construction of energy models in physics. *Instructional Science*, *24*(4), 259–293. Scopus. https://doi.org/10.1007/BF00118052

D'Souza, R., Mathew, M., Amanullah, S., Edward Thornton, J., Mishra, V., E, M., Palatty, P., & Surapaneni, K. M. (2024). Navigating merits and limits on the current perspectives and ethical challenges in the utilization of artificial intelligence in psychiatry – An exploratory mixed methods study. *Asian Journal of Psychiatry*, *97*. Scopus. https://doi.org/10.1016/j.ajp.2024.104067

El Bedewy, S., Lyublinskaya, I., & Lavicza, Z. (2025). Supporting transdisciplinary STEAM practices: Integrating architectural modelling into mathematics education through a cross-cultural dynamic lesson plan (DLP) tool. *Research and Practice in Technology Enhanced Learning*, *20*. Scopus. https://doi.org/10.58459/rptel.2025.20008

Fierro, C. (2018). Pluralism and Heterogeneity as criticism: Undergraduate history and systems of psychology courses in Argentinian Psychology Education (1983-2017). *History of Psychology*, *21*(2), 126–150. Scopus. https://doi.org/10.1037/hop0000085

Fombona, J., Sáez, J.-M., & Sánchez, S. (2025). Artificial intelligence and robotics in education: Advances, challenges, and future perspectives. *Social Sciences and Humanities Open*, *11*. Scopus. https://doi.org/10.1016/j.ssaho.2025.101533

Gal, A. (2023). Attitude Construction toward Invasive Species through an Eco-Humanist Approach: A Case Study of the Lesser Kestrel and the Myna. *Education Sciences*, *13*(11). Scopus. https://doi.org/10.3390/educsci13111076

Garcia-Varela, F., Nussbaum, M., Mendoza, M., Martínez, C., & Bekerman, Z. (2025). ChatGPT as a Stable and Fair Tool for Automated Essay Scoring. *Education Sciences*, *15*(8). Scopus. https://doi.org/10.3390/educsci15080946

Hernández-Ramos, J., Pernaa, J., Cáceres-Jensen, L., & Rodríguez-Becerra, J. (2021). The effects of using socio-scientific issues and technology in problem-based learning: A systematic review. *Education Sciences*, *11*(10). Scopus. https://doi.org/10.3390/educsci11100640

Hernawan, A. H., Darmawan, D., & Ali, M. (2022). ENVIRONMENTAL EDUCATION BASED ON LOCAL VALUES: ITS INTEGRATION IN THE INDONESIAN ELEMENTARY SCHOOL CURRICULUM. *International Journal of Education and Practice*, *10*(4), 322–333. Scopus. https://doi.org/10.18488/61.v10i4.3174

Huang, L., Zhang, W., Chen, Z., Li, C., & Li, X. (2025). The Historical Origins of Large Language Models and Psychology. *Journal of Psychological Science*, *48*(4), 773–781. Scopus. https://doi.org/10.16719/j.cnki.1671-6981.20250401

Isoda, M. (2010). Lesson study: Problem Solving Approaches in mathematics education as a Japanese experience. *Procedia Soc. Behav. Sci.*, *8*, 17–27. Scopus. https://doi.org/10.1016/j.sbspro.2010.12.003

Jaramillo Gómez, D. L., Álvarez-Maestre, A. J., Parada Trujillo, A. E., Pérez-Fuentes, C. A., Bedoya Ortiz, D. H., & Sanabria Alarcón, R. K. (2025). Determining Factors for the

Development of Critical Thinking in Higher Education. *Journal of Intelligence*, *13*(6). Scopus. https://doi.org/10.3390/jintelligence13060059

Jin, S., & Liu, C. (2025). From Human Mind to Artificial Intelligence: Advancing AI Value Alignment Through Psychological Theories. *Journal of Psychological Science*, *48*(4), 782–791. Scopus. https://doi.org/10.16719/j.cnki.1671-6981.20250402

Knight, S. L., & Smith, R. G. (2004). Development and use of a classroom observation instrument to investigate teaching for meaning in diverse classrooms. Dalam *Observational Research in U.S. Classrooms: New Approaches for Underst. Cultural and Linguistic Diversity* (hlm. 97–121). Cambridge University Press; Scopus. https://doi.org/10.1017/CBO9780511616419.005

Kulkarni, U., Meena, S. M., Hallyal, R., Sulibhavi, P., Sunil V, G., Guggari, S., & Shanbhag, A. R. (2025). Optimisation of deep neural network model using Reptile meta learning approach. *Cognitive Computation and Systems*, *7*(1). Scopus. https://doi.org/10.1049/ccs2.12096

Latip, A., & Kadarohman, A. (2024). Local and indigenous knowledge (LIK) in science learning: A systematic literature review. *Journal of Turkish Science Education*, *21*(4), 651–667. Scopus. https://doi.org/10.36681/tused.2024.035

Li, W., Zhang, J., & Sang, Z. (2022). "I just want them to learn." The intended role of Teacher's Book shaped by its writer's understanding of the local EFL teachers. *Frontiers in Psychology*, *13*. Scopus. https://doi.org/10.3389/fpsyg.2022.969403

Magnaye, L. (2025). Teaching indigenous science through culturally responsive pedagogy: Shaping environmental perception and cultural resilience in science education. *Environment and Social Psychology*, *10*(5). Scopus. https://doi.org/10.59429/esp.v10i5.3683

Mbhenyane, X. G., Magoai, M. M., Mabapa, N. S., & Tambe, A. B. (2022). Nutrition knowledge competencies of intermediate and senior phase educators in Limpopo

Province. *South African Journal of Childhood Education*, *12*(1). Scopus. https://doi.org/10.4102/sajce.v12i1.1114

Miguez-Souto, A., Gutiérrez García, M. Á., & Martín-Núñez, J. L. (2025). Exploring the Use of AI to Optimize the Evaluation of a Faculty Training Program. *Education Sciences*, *15*(10). Scopus. https://doi.org/10.3390/educsci15101394

Montes, G. A., & Goertzel, B. (2019). Distributed, decentralized, and democratized artificial intelligence. *Technological Forecasting and Social Change*, *141*, 354–358. Scopus. https://doi.org/10.1016/j.techfore.2018.11.010

Morales-Chan, M., Amado-Salvatierra, H. R., Hernández-Rizzardini, R., & Roman, B. L. (2025). Workshop: Transforming Student Interaction through Building Educational Chatbots in Engineering and Computing. Dalam C. da. R. Brito & M. M. Ciampi (Ed.), *EDUNINE - IEEE Eng. Educ. World Conf.: Educ. Age Gener. AI: Embrac. Digit. Transform. - Proc.* Institute of Electrical and Electronics Engineers Inc.; Scopus. https://doi.org/10.1109/EDUNINE62377.2025.10981346

Nordin, R., Shapiee, R., Suhor, S., Yusof, A. R., & Muhamad, M. M. (2011). Human rights education and social unity in multi-ethnic society. *Procedia Soc. Behav. Sci.*, *18*, 408–414. Scopus. https://doi.org/10.1016/j.sbspro.2011.05.060

Nurhayati, S., & Judijanto, L. (2025). Culturally Responsive Digital Numeracy Instruction in Indonesian Early Childhood Education: Integrating Indigenous Knowledge and Technology. *Int. Conf. Smart Learn. Courses, SCME*, 152–158. Scopus. https://doi.org/10.1109/SCME62582.2025.11104859

Ortega, J. H. J. C., & Repollo, J. A. M. (2025). Adapting to AI: a Study on Multimedia Art Students' Preparedness for AI-Enhanced Integrated Marketing. Dalam K. T. Chui, C. Jaikaeo, J. Niramitranon, W. Kaewmanee, K.-K. Ng, & P. Ongkunaruk (Ed.), *Proc. - Int. Symp. Educ. Technol., ISET* (hlm. 124–128). Institute of Electrical and Electronics Engineers Inc.; Scopus. https://doi.org/10.1109/ISET65607.2025.00033

Sebestyen, M. (2025). Focal points and blind spots of human-centered AI: AI risks in written online media. *Humanities and Social Sciences Communications*, *12*(1). Scopus. https://doi.org/10.1057/s41599-025-04814-y

Sileshi, F., Husen, A., & Abdiyo Ensene, K. (2023). Changes and continuities in Ethiopian secondary school history education curriculum. *Social Sciences and Humanities Open*, *8*(1). Scopus. https://doi.org/10.1016/j.ssaho.2023.100707

Simeonov, S., Feradov, F., Marinov, A., & Abu-Alam, T. (2024). Integration of AI Training in the Field of Higher Education in the Republic of Bulgaria: An Overview. *Education Sciences*, *14*(10). Scopus. https://doi.org/10.3390/educsci14101063

Sithole, N. V. (2025). Balancing the theoretical and practical nature of business studies school curriculum: Towards practical entrepreneurship education. *International Journal of Education and Practice*, *13*(3), 1032–1046. Scopus. https://doi.org/10.18488/61.v13i3.4357

Solmaz, O. (2023). Linguistic landscapes tasks in Global Englishes teacher education. *ELT Journal*, *77*(4), 416–425. Scopus. https://doi.org/10.1093/elt/ccad027

States, N., Stone, E., & Cole, R. (2023). Creating Meaningful Learning Opportunities through Incorporating Local Research into Chemistry Classroom Activities. *Education Sciences*, *13*(2). Scopus. https://doi.org/10.3390/educsci13020192

Terrazas-Arellanes, F. E., Strycker, L., Alvez, G. G., Miller, B., & Vargas, K. (2025). Promoting Agency Among Upper Elementary School Teachers and Students with an Artificial Intelligence Machine Learning System to Score Performance-Based Science Assessments. *Education Sciences*, *15*(1). Scopus. https://doi.org/10.3390/educsci15010054

Whitesman, S., & Mash, R. (2024). Assessing the Effect of a 2-Year Mindfulness-Based Training Programme on Personal and Professional Functioning: A Mixed-Methods

Study. *Mindfulness*, *15*(1), 230–241. Scopus. https://doi.org/10.1007/s12671-023-02279-1

Yang, S., Sato, M., Shu, D., & Wang, B. (2024). Materials writing as a vehicle for teacher learning. *ELT Journal*, *78*(3), 273–283. Scopus. https://doi.org/10.1093/elt/ccae021

Yang, Y., & Xu, H. (2025). Perception of AI Creativity: Dimensional Exploration and Scale Development. *Journal of Creative Behavior*, *59*(2). Scopus. https://doi.org/10.1002/jocb.70028

Zhou, W., Guo, K., Ying, Y., & Oubibi, M. (2024). Chinese local music teaching materials: A review from 1934 to 2022. *Social Sciences and Humanities Open*, *9*. Scopus. https://doi.org/10.1016/j.ssaho.2023.100742

Zulkifli, A. F., & Danis, A. (2022). Technology in physical education: Using movement analysis application to improve feedback on sports skills among undergraduate physical education students. *Social Sciences and Humanities Open*, *6*(1). Scopus. https://doi.org/10.1016/j.ssaho.2022.100350