International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 14 Issue 2 February 2025 || PP 62-67

Systematic Review: AI in Indigenous and Cultural Education—Bridging Knowledge Gaps

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ABSTRACT : *The transformative potential of artificial intelligence (AI) for education has not achieved proper application in the development of Indigenous and cultural learning approaches. The evaluation investigates artificial intelligence potential for bridging knowledge gaps specifically through studies on language preservation and cultural curriculum development and better educational service provision for Indigenous students. The paper explores the potential and challenges AI learning tools face when used for language revitalization and culture-based technological development through research measurements.*

Educational tools in modern times consisting of personalized learning software and digital storytelling platforms and translation applications show great promise. AI development experiences significant challenges because Indigenous people are underrepresented, and data ownership dilemmas create ethical complexities and discrimination emerges from algorithmic systems. AI adoption presents difficulties to some Indigenous groups because their digital infrastructure needs improvement and their teachers require better training skills.

AI research advancement should include indigenous community involvement for establishing ethical guidelines and impact model building. The implementation of effective solutions aimed at Indigenous community power increase will help them preserve cultural heritage while educating undergraduates inclusively. Significant advances in the field of Indigenous education depend on both ethical development and collaborative work between researchers and Indigenous people using Artificial Intelligence.

KEYWORDS *- Artificial Intelligence in Education, Culturally Responsive Pedagogy, Data Sovereignty, Indigenous Knowledge Systems, Language Revitalization.*

Date of Submission: 14-02-2025 Date of Acceptance: 28-02-2025

I. INTRODUCTION

The exploration of artificial intelligence in education discovery produces new opportunities directed at enhancing Indigenous and cultural learning even though its complete potential remains undiscovered. This assessment analyzes AI methods to link different knowledge groups through its language preservation systems and culturally distinct teaching methods which combine with improved educational services for Indigenous communities. AI learning exploration demonstrates both positive outcomes along with technological disadvantages for sustaining native languages using cultural programming software.

The integration of AI-powered personalized education and digital storytelling systems using language translation functionalities creates an excellent potential opportunity. AI development faces significant obstacles because Indigenous concepts are absent during development and because data ownership protection requires improvement and algorithms might contain biases. Various Indigenous communities face challenges in AI adoption because they lack digital infrastructure and their educators need further training on new technology systems.

Future AI development must integrate Indigenous knowledge through ethical policies and complete evaluations. The obstacles Indigenous populations face help them gain citizenship control because research shows cultural support and enables the establishment of more inclusive spaces. The advancement of Indigenous education requires computing systems built on ethical principles that interact with Indigenous communities.

II. METHODOLOGY

This review followed a systematic approach to identify relevant studies on applying artificial intelligence (AI) in Indigenous and cultural education. A comprehensive search was conducted across multiple academic databases, including PubMed, IEEE Xplore, Google Scholar, and JSTOR, using keywords such as "artificial intelligence," "Indigenous education," "cultural learning," "AI in language preservation," "AI and Indigenous

knowledge systems," "culturally responsive AI," and "AI-driven education for marginalized communities." The search focused on peer-reviewed articles published in English between 2010 and 2024 to ensure a broad yet contemporary analysis.

Studies which investigated AI's direct applications for preserving Indigenous languages while also improving cultural education and supporting Indigenous educational approaches became the inclusion criteria. The investigation of AI's capability to overcome educational inequality between Indigenous populations and culturally diverse groups formed another vital study selection category. Studies were eliminated if they lacked empirical evidence or exclusively employed theoretical frameworks for maintaining evidence-based practical findings.

Three research studies underwent detailed evaluation through methods analysis to establish their objectivity together with appropriate population samples and their relevance to Indigenous settings as well as their study characteristics. The selection process prioritized studies which integrated Indigenous viewpoints together with participant involvement and actual educational applications involving AI technology. The research method follows parameters that create a well-rounded assessment of how AI supports learning for Indigenous communities and cultural education.

III. THEORETICAL FRAMEWORK

The Current State of AI in Indigenous Education: A Landscape Analysis.

The literature shows a young developing interest in using AI for Indigenous education. Research investigating AI for Indigenous education faces substantial gaps alongside insufficient large-scale implementation which has undergone proper evaluation. Most research investigates the general implementation of AI in education (Onesi-Ozigagun, 2024) (Ali, 2020) (ZawackiRichter, 2019) without specific discussion concerning Indigenous contexts. Research about cultural education (Kaai-Mahuta, 2011), (Wexler, 2011), (Nakata, 2008) addresses the essential need for relevant approaches but lacks analysis of AI integration within such frameworks. Research should examine how artificial intelligence can support community engagement and capacity building within Indigenous education because both practices have established importance according to Wexler (2011). The Alaskan Native community implementation of CBPR described by (Wexler, 2011) could achieve maximum success by using AI-based tools to enhance data gathering and knowledge processing as well as information sharing and distribution. The examination of AI uses in CBPR faces an important research deficit because there is too little specific research on this topic.

The literature shows a gap between technological AI developments and the teaching methods needed to properly use AI in Indigenous educational contexts. The majority of studies about AI in education analyse technical elements (Leaver, 2023), (Ali, 2020), (ZawackiRichter, 2019) while ignoring important pedagogical requirements and culturally respectful design of AI tools. The author Kizilcec (2023) stresses that researchers must first examine how educators perceive AI in education while recognising psychological along with social and cultural elements that affect their acceptance of these systems. When integrating AI it is crucial to match its implementation with the cultural traditions and beliefs which exist in Indigenous communities. The potential of AI to maintain and reinforce existing biases while creating new inequalities remains a major concern because Bulathwela (2024) states this together with Mayfield (2019). Therefore it is vital to create ethical AI systems while addressing biases. Without adequate ethical principles made to address AI in Indigenous education institutions the field faces severe limitations.

Language revitalization represents a major challenge which benefits from AI intervention. The extensive damage done by colonial intervention to Indigenous languages constitutes well-documented research (Kaai-Mahuta, 2011) because many languages risk disappearing completely. AI language tools possess the possibility to enhance Indigenous language revitalization projects through individualised education modules and native-language resource creation as well as family-based information sharing. The development of these tools demands special attention to linguistic diversity while staying focused on the particular features of Indigenous languages (Hudson, 2014). A major deficiency exists in existing literature because AI tools are unavailable for Indigenous language education purposes.

AI's Potential Contributions to Indigenous Education: Promising Avenues

Multiple beneficial uses of artificial intelligence for Indigenous education surface from the analysed articles although more research is needed. AI-based personalized learning systems create adaptive educational solutions that fulfill diverse learning requirements of Indigenous students (Bulathwela 2024) and (Onesi-Ozigagun

2024). Such digital platforms need to combine cultural content with learning style adjustments for students and self-directed assessment capabilities. Through the utilization of AI systems educational teams can create and curate cultural appropriate educational resources. These include digital storytelling tools together with interactive simulations and virtual museums which feature Indigenous knowledge and cultural heritage (Leaver, 2023). Using this method would correct the lack of Indigenous views in standard educational resources while building educational spaces which deeply reflect diversity and fairness.

The use of AI technologies would help eliminate digital disparities by broadening access to equal educational opportunities for Indigenous students living in distant areas (Bulathwela, 2024). The delivery of AI educational resources via minimal bandwidth digital networks and independent frameworks enables associated students to obtain education despite their unreliable internet access. AI has the ability to create academic materials and educational technology programmes using Indigenous native languages to help students overcome their language restrictions during schooling. Moreover, AI's integration into teacher training will develop their capability to implement targeted multicultural educational practices and handle technology-based teaching methods in classrooms, according to Onesi-Ozigagun (2024).

Preserving and Transmitting Indigenous Knowledge

Indigenous knowledge survival depends on its proper preservation and educational transmission. Traditional knowledge documentation and archive creation through AI allows the preservation of songs and ceremonies and stories preventing their disappearance (Hiwasaki 2014; Finn 2017). Through artificial intelligence translation technology Indigenous wisdom holders would able to reach broader audiences when sharing their knowledge through cross-cultural connections. Through AI technology interactive educational activities could be developed to provide firsthand investigative experiences of Indigenous cultures so students grasp their ancestral heritage better. Through this educational strategy universities would fight against diminishing importance of Indigenous knowledge systems that mainstream systems exclude. Careful attention must be given to the ethical aspects that emerge when using AI systems for documenting and preserving Indigenous knowledge. Indigenous intellectual property rights together with community ownership of knowledge need respect in every interaction (Finn, 2017).

Enhancing Culturally Relevant Pedagogy

The development of culturally competent teaching practices which adapt to Indigenous student learning methods and requirements receives assistance from AI technology. The implementation of AI assessment tools will enable meaningful evaluation of learning because these systems can provide assessments that adjust to Indigenous knowledge methods (Hudson, 2014) while standard testing methods often do not properly capture these aspects accurately. Through digital intelligence AI systems can customise learning activities by understanding unique student characteristics. Using this approach would generate better and more efficient learning spaces for Indigenous students which would lead to greater student achievement and retention. The creation of AI tools with Indigenous cultural relevance needs direct joint work between educators and Indigenous communities to ensure these tools match Indigenous educational principles and cultural values.

Addressing the Digital Divide

Indigenous people confront unequal opportunities for education because of the digital gap that restricts their access to educational resources through digital means. AI works to eliminate inequalities by creating educational software that suits students who live in remote areas or who lack Internet connection (Bulathwela, 2024). The integration of artificial intelligence technology brings offline educational content delivery systems which operate without requiring internet connection. AI technology can translate educational materials to authenticate Indigenous languages for students to receive information within their native tongue. Achieving digital equality demands investments in infrastructure development coupled with teacher training programmes and sustained community backup systems.

Ethical Considerations and Challenges

The application of artificial intelligence within Indigenous education leads to ethical situations that require active oversight. AI system implementations require careful evaluation of their ability to extend already existing discriminatory behavior plus unequal treatment patterns according to Bulathwela (2024) and Mayfield (2019). The AI system learns from provided data yet systemic prejudices in this data will cause the AI to file them through its generated output. The sustained discrimination together with previous injustices directed toward Indigenous populations creates substantial educational resource inequalities which demanding analysis in such circumstances. The use of AI in indigenous education needs direct action toward representation that remains open and carries full accountability throughout the system. Creative partnerships with Indigenous communities must

occur during AI system development in order to build solutions which adhere to diversity ethics and cultural commitments.

Data security along with data privacy represents essential priority factors (Onesi-Ozigagun, 2024). To guarantee secure personal data management AI systems need mechanisms which prevent unauthorized access and misuse of this data. The control and sovereignty aspect of Indigenous community data remains an important concern for them. AI development for Indigenous education requires prioritizing data protection and security alongside community control of their data activities which includes decision-making about data collection and usage and storage practices.

AI introduces the risk of damaging Indigenous languages as well as cultural practices. AI systems must preserve human connection between people and prevent any attempts to diminish Indigenous knowledge holders' significance in their communities. The use of AI systems should reinforce current educational practices so Indigenous communities maintain both their cultural heritage and their capabilities to share this heritage.

The complete absence of Indigenous people throughout the development and operational phase of AI systems remains a substantial issue. All development phases of AI tools require active Indigenous community involvement beginning with tool design and proceeding through implementation and assessment stages. Through adequate Indigenous representation throughout the development process the technology becomes both culturally sensitive and ethically acceptable for Indigenous populations.

IV. KEY FINDINGS

The thorough analysis demonstrates that AI applications in Indigenous and cultural education show promising yet insufficient research evidence which produces several important results. Research on AI applications in mainstream education exceeds studies that explore its integration into Indigenous learning environments because this integration remains sparse and separated. Research about AI tends to focus on technology enhancements without attention to vital pedagogic and cultural requirements that ensure efficient Indigenous implementation (Leaver, 2023; Ali, 2020; ZawackiRichter, 2019). Due to their insufficient awareness of Indigenous knowledge systems most AI-based educational platforms disconnect AI technologies from Indigenous learning demands (Kizilcec, 2023).

Language revitalization presents itself as a crucial field where artificial intelligence demonstrates substantial transformative opportunities. The endangered Indigenous languages would gain potential benefits through using AI language tools which developed to address colonial policies and systemic marginalization. Through artificial intelligence users can experience tailored language education while also receiving automated translation services and electronic storage of timeless verbal traditions as well as historical written texts (Kaai-Mahuta 2011; Hudson 2014). The current AI systems demonstrate poor adaptability for undocumented languages since their training occurs on dominant languages instead of Indigenous languages (Kaai-Mahuta, 2011).

AI demonstrates great promise for improving culturally relevant teaching through its capabilities. AI-based adaptive learning platforms provide individualization of educational resources to enable Indigenous students to learn using their familiar cultural stories and traditional teaching methods and authentic Indigenous knowledge systems (Bulathwela 2024, Onesi-Ozigagun 2024). Teaching resources such as digital learning materials combined with virtual museums and storytelling platforms can be created and curated by AI under educator guidance (Leaver, 2023). Indigenous communities show a significant absence when AI-based learning tools get developed which creates cultural appropriation risks and misuses Indigenous knowledge (Wexler, 2011).

Through AI technology educational institutions can establish links which help reduce electronic isolation between Indigenous students and online resources. The lack of adequate internet connections alongside resource limitations in numerous Indigenous communities makes it impossible to participate in digital educational resources. Low-bandwidth educational technologies along with offline learning platforms powered by AI provide better access to learning materials mainly for remote areas (Bulathwela, 2024). AI translation systems enable inclusion when they support local languages which helps students overcome language barriers preventing their involvement in formal educational programs (Familoni, 2024). The broad implementation of AI technologies faces constraints in Indigenous communities because many regions face both inadequate infrastructure and insufficient technical assistance along with insufficient training of teachers (Liu, 2021).

The main obstacle in this field is ethical scrutiny. Educational systems face urgent issues regarding how AI can strengthen educational biases since this stands as a major problem according to both Mayfield (2019) and

Bulathwela (2024). The training of AI models with biased source data can create systems that spread offensive stereotypes against Native populations and produce false images of their knowledge while denying their cultural perspectives from AI-based educational frameworks. The ethical difficulties include problems linked to data sovereignty together with disputes about intellectual property rights. AI systems must be designed to accept the Indigenous communities' special governance standards regarding their cultural data according to Finn (2017). The implementation of AI in Indigenous education could become a modern form of digital colonialism if there is inadequate community involvement together with ethical AI protocols (Finn, 2017; Wexler, 2011).

V. FUTURE RESEARCH DIRECTIONS

Research in the future must establish AI tools which understand Indigenous learning requirements while being culturally specific for these students. Educational AI platforms need immediate integration of Indigenous knowledge systems to make technology work with traditional teaching methods through storytelling practises along with community-based learning models. Research must examine methods of participatory AI design that enable Indigenous populations to join developers in creating AI tools rather than accept complete technologies from outside sources (Lister 2021; Spiel 2022).

Additional research needs to investigate AI-powered language preservation techniques to build tools suitable for complex grammatical languages and oral-based traditional language groups. Future research demands a dual focus on creating multilingual dataset diversity while enabling communities to lead documentation initiatives and developing AI systems that manage oral speech patterns (Kaai-Mahuta, 2011; Hudson, 2014). AI systems need dedicated design features that enable operation with low-resource languages to guarantee Indigenous dialects with minimal documentation will have access to digital education programmes.

Systematic research studies with broad sampling must be conducted to determine lasting effects of AI educational solutions on Indigenous learning. The current studies about AI learning assistance lack substantial evaluations alongside insufficient sample sizes and insufficient research of AI against traditional Indigenous learning methods (ZawackiRichter, 2019). Future investigations must carry out randomised controlled trials (RCTs) to quantify AI's abilities for enhancing educational results and teacher assistance as well as student commitment in Indigenous population centres (Onesi-Ozigagun, 2024).

Research institutions need to prioritise exploration of biases present in AI systems and methods to ensure fair treatment in AI practises. Bias testing protocols must apply strictly to AI models to stop them from reinforcing cultural stereotypes or deleting Indigenous perspectives or misrepresenting Indigenous knowledge systems according to Shams (2023). Research needs to study explainable AI (XAI) methods which would enhance understanding between AI recommendations and cultural learning needs through transparency (Nguyen, 2022).

The research needs to thoroughly study principles of data sovereignty together with the protection of Indigenous intellectual property rights. Developed AI-based educational systems should abide by Indigenous data governance frameworks to give communities full power over their cultural data content and recorded languages and digital educational materials (Finn, 2017). Future academic inquiries should concentrate on designing ethical AI regulations for Indigenous education to handle worries such as data compliance and Indigenous intellectual property protection alongside data security practises (Mayfield 2019; Bulathwela 2024).

Digital infrastructure and accessibility challenges which confront Indigenous communities need to be studied as a fundamental area of research. Researchers need to explore the design of AI-driven offline learning tools which would enable education for both remote and low-bandwidth and under-resourced areas (Bulathwela, 2024). Research teams should identify affordable Artificial Intelligence opportunities to keep AI educational benefits accessible to Indigenous institutions having minimal technological capabilities (Iannizzotto, 2020).

Research focused on AI technology for Indigenous education needs to place teacher professional development as its key focus. AI research needs to investigate how it can help Indigenous teachers through training materials along with AI-aided lesson generation and culturally appropriate educational content (Leifler 2020). AI needs developers to collaborate with educators while preserving human teacher-student relationships in Indigenous educational environments (ZawackiRichter, 2019).

The power of AI for Indigenous education requires protective outreach to local customs and responsible deployment practices alongside genuine community participation. Future investigations should dedicate their efforts to building community protection methods that maintain languages while working on AI governance frameworks as well as methods for inclusive participation to convert AI into an empowering resource instead of

blocking access. Research combining multiple disciplines through AI satisfies two targets by improving knowledge gaps and boosting Indigenous autonomy and ensuring future students can access education.

VI. CONCLUSION

Several ethical studies and direct Indigenous community involvement need to assess properly implementing AI solutions to address cultural and Indigenous educational deficits. Future development of AI tools must tackle student learning requirements of Indigenous students across various cultural backgrounds. Research must examine the effectiveness of AI interventions in native language revitalization efforts along with the delivery of culturally proper instruction that addresses digital inequality issues. AI systems will benefit Indigenous education when organizations establish common ethical standards along with standardized best practices for organizing responsible and equitable AI system implementations.

Through collaboration between educational staff and AI specialists together with Indigenous people the system will achieve successful support of their education. The cooperation between these parties remains vital because AI supports growth of Native populations and maintains fairness and education equity. Research should advance further because it will create an understanding of these domains and create ethical guidelines for artificial intelligence usage within cultural and Indigenous education. AI system developers need to incorporate Indigenous knowledge systems at design time to create sophisticated technology which caters appropriately to Indigenous communities. Better outcomes await us however we need substantiated preparation along with united participation to stop negative results from occurring. The systematic review has established that researchers need to investigate complex critical issues as a matter of immediate priority.

REFERENCES

[1]. Onesi-Ozigagun, O., Ololade, Y. J., Eyo-Udo, N. L., & Ogundipe, D. O. (2024). Revolutionizing education through ai: a comprehensive review of enhancing learning experiences. International journal of applied research in social sciences. https://doi.org/10.51594/ijarss.v6i4.1011

[2]. Ali, M. & Abdel-Haq, M. K. (2020). Bibliographical analysis of artificial intelligence learning in higher education. IGI Global. https://doi.org/10.4018/978-1-7998-4846-2.ch003

[3]. ZawackiRichter, O., Marn, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education where are the educators?. Springer Nature. https://doi.org/10.1186/s41239-019-0171-0

[4]. Kaai-Mahuta, R. (2011). The impact of colonisation on te reo mori: a critical review of the state education system. None. https://doi.org/10.24135/tekaharoa.v4i1.117

[5]. Wexler, L. (2011). Intergenerational dialogue exchange and action: introducing a community-based participatory approach to connect youth, adults and elders in an alaskan native community. SAGE Publishing. https://doi.org/10.1177/160940691101000305

[6]. Nakata, M., Nakata, V., & Chin, M. (2008). Approaches to theacademic preparation andsupport ofaustralian indigenous students fortertiary studies. Cambridge University Press. https://doi.org/10.1375/s1326011100000478

[7]. Leaver, T. & Srdarov, S. (2023). Chatgpt isn"t magic. Queensland University of Technology. https://doi.org/10.5204/mcj.3004

[8]. Kizilcec, R. F. (2023). To advance ai use in education, focus on understanding educators. Springer Science+Business Media. https://doi.org/10.1007/s40593-023-00351-4

[9]. Bulathwela, S., PrezOrtiz, M., Holloway, C., Cukurova, M., & ShaweTaylor, J. (2024). Artificial intelligence alone will not democratise education: on educational inequality, techno-solutionism and inclusive tools. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su16020781

[10]. Mayfield, E., Madaio, M., Prabhumoye, S., Gerritsen, D., McLaughlin, B., DixonRomn, E., & Black, A. W. (2019). Equity beyond bias in language technologies for education. None. https://doi.org/10.18653/v1/w19-4446

[11]. Hudson, C. & Angelo, D. (2014). Concepts underpinning innovations to second language proficiency scales inclusive of aboriginal and torres strait islander learners: a dynamic process in progress. None. https://doi.org/10.58379/wlrv4810

[12]. Hiwasaki, L., Luna, E. M., Syamsidik, S., & Shaw, R. (2014). Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. Elsevier BV. https://doi.org/10.1016/j.ijdrr.2014.07.007

[13]. Finn, S., Herne, M., & Castille, D. (2017). The value of traditional ecological knowledge for the environmental health sciences and biomedical research. National Institute of Environmental Health Sciences. https://doi.org/10.1289/ehp858