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INTEGRATING ARTIFICIAL INTELLIGENCE IN LANGUAGE TEACHING AND NUMERACY EDUCATION: IMPLICATIONS FOR EDUCATIONAL ADMINISTRATION AND INSTRUCTIONAL SUPERVISION IN INDIGENOUS PEOPLES EDUCATION (IPED) SCHOOLS

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Abstract

This study investigates the issues, emerging trends, and opportunities for the integration of Artificial Intelligence (AI) in language teaching and numeracy education in selected Indigenous Peoples Education (IPEd) schools in the Philippines, with focus on educational administration and instructional supervision. Ethnomathematics, culturally responsive pedagogy and Indigenous Peoples Education principles anchor the study. It addresses the gap between the Department of Education's Indigenous Peoples Education Curriculum Framework (DepEd Order No. 32, s. 2015) and classroom realities in teaching language and mathematics to Indigenous learners. The study utilized a qualitative phenomenological approach to collect data thru semi-structured interviews, classroom observations, and document analysis of contextualized learning materials from 18 educators at IPEd implementing schools in Western Mindanao. Thematic analysis revealed four main themes: (1) linguistic and conceptual dissonance in language and numeracy instruction, especially when mathematical concepts are taught in Filipino and English, which do not have direct translations in Indigenous languages; (2) lack of availability of culturally contextualized instructional resources, and the need for teachers to create and adapt materials; (3) socio-cultural, geographical, and technological barriers affecting learning continuity and access to educational resources; and (4) emerging opportunities for AI-facilitated language and numeracy instruction thru culturally responsive digital resources, contextualized learning materials, and individualized educational support. Findings suggest that Indigenous learners' numeracy difficulty is not necessarily a cognitive limitation, but a cultural, linguistic and environmental gap. The study further emphasizes the role of educational administrators and instructional supervisors in setting policies, offering resources, improving teacher competencies, monitoring AI-assisted instruction, and ensuring technology integration is

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culturally responsive and aligned with Indigenous knowledge systems. The paper calls for an inclusive and culturally grounded approach to integrating AI that acknowledges Indigenous languages, counting systems, measurement techniques, and community-based knowledge as viable foundations for learning. Implications for educational administration, instructional supervision, teacher development, curricular contextualization, AI integration and community partnership are highlighted.

Keywords: Artificial Intelligence, language teaching, numeracy education, Indigenous Peoples Education, educational administration, instructional supervision, culturally responsive pedagogy, ethnomathematics

Introduction

The Philippines is home to 110 ethnolinguistic groups and 183 living languages, 175 of which are indigenous. Of the 20.8 million learners in basic education, approximately 1.2 million (5.7%) are Indigenous Peoples (IP) learners, concentrated in geographically isolated and disadvantaged areas. To address historical marginalization, the Department of Education institutionalized the Indigenous Peoples Education (IPEd) Curriculum Framework through DepEd Order No. 32, s. 2015, mandating the contextualization and indigenization of the K to 12 curriculum through the integration of Indigenous Knowledge Systems and Practices (IKSP).

While the framework is progressive, its most critical test lies in numeracy education. National assessments consistently show that IP learners perform lowest in mathematics, a phenomenon often misinterpreted as low aptitude rather than systemic cultural mismatch. Mathematics is frequently taught as a culturally neutral, universal language, ignoring that every culture has its own ways of counting, measuring, estimating, and problem-solving — what D'Ambrosio (1985) termed ethnomathematics.

For example, AI-supported language teaching and numeracy instruction can encourage Indigenous learners by offering interactive, personalized, and culturally relevant learning experiences that make lessons more meaningful and engaging. To improve this motivation, educational administrators and instructional supervisors may provide instructors with suitable AI tools, training, and direction for constructing culturally sensitive instruction (Casimiro, Atrido, & Calahat, 2021). Ramos (2025) further stated that the use of AI in language instruction and numeracy teaching can be a potential measure of both instructional effectiveness of teachers and numeracy achievement of learners thru personalized instruction, timely feedback, engaging learning activities, and culturally responsive resources. Within IPEd schools, educational administration and instructional supervision can also be utilized to strengthen this relationship by providing teachers with the resources, training and guidance to use AI effectively and ethically in ways that respond to the linguistic and cultural contexts of Indigenous learners.

In IPEd schools, numeracy instruction faces unique epistemological tension. Teachers, predominantly non-IP and trained in mainstream teacher education programs, are expected to

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teach abstract mathematical concepts using Filipino and English as media of instruction, while learners conceptualize quantity, space, and time through their mother tongue and lived experiences such as swidden farming, weaving patterns, fishing, and barter trade. This linguistic and conceptual dissonance contributes to high anxiety, low participation, and dropout in mathematics.

Moreover, Salian (2024) explored the idea that information systems approach to evaluating discourse competence can support language teaching and numeracy education by providing systematic, data-driven ways to assess learners' ability to communicate ideas, interpret information, and construct meaningful responses using language and mathematical concepts. Through information systems, teachers and educational administrators can analyze learners' discourse performance to identify learning gaps, improve instructional strategies, and develop responsive interventions that strengthen both language proficiency and numeracy skills.

The use of Artificial Intelligence (AI) in the teaching of language and numeracy education in Indigenous Peoples Education (IPEd) schools is highly associated with teachers' curricular and pedagogical readiness, Pedagogical Content Knowledge (PCK), Human–Computer Interaction (HCI), learning style preferences, and curriculum responsiveness (Casimiro, Ramos, Calahat & Mangila, M. 2024). Teachers' preparation in terms of curriculum and pedagogy is crucial, since the successful integration of AI necessitates teachers' knowledge of curriculum goals and appropriate pedagogical approaches for the use of AI to enhance language development and numeracy learning. Their PCK provides the means to establish how AI-generated explanations, examples, exercises, assessments, and feedback can be customized to include learners' developmental levels and Indigenous cultural and linguistic settings rather than accepting content produced by AI uncritically. Likewise, Human-Computer Interaction (HCI) is vital for the design of AI-supported digital learning environments that are accessible, engaging, age appropriate, and sensitive to learners' requirements, particularly for Indigenous children who may have diverse amounts of digital exposure and access.

Also, teachers could employ different AI-assisted learning experiences based on learning style preferences, such as visual representations, interactive exercises, storytelling, oral language activities, games, and contextualized mathematical tasks, which can promote learners' motivation and engagement (Casimiro, Ramos, Bejerano, Bayos, Salian, 2025). AI-supported instruction should represent Indigenous languages, cultural practices, community experiences, Indigenous Knowledge Systems and Practices (IKSP), and culturally relevant numeracy ideas. Curriculum responsiveness is as vital as AI-supported instruction. In this way, AI should augment teaching resources, not supplant teacher professional judgment or Indigenous knowledge holders. Educational administration and instructional supervision offer the institutional support for this incorporation by setting up the appropriate policies, providing access to digital infrastructure and resources, arranging for professional training, monitoring teaching practices, and supporting teachers' ethical and culturally responsive use

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of AI. All these elements can lead to better teachers, more engaging learning, and better language and numeracy outcomes, while making sure that the integration of AI is in line with the goals and cultural values of IPEd education (Casimiro, 2021) .

This study shifts the discourse from general IPEd access issues to the specific domain of numeracy. It asks: How can numbers become culturally meaningful rather than alienating for IP learners? It is anchored on two theoretical lenses: Ethnomathematics, which posits that mathematical ideas are embedded in cultural practices, and Culturally Responsive Pedagogy (Ladson-Billings, 1995), which argues that academic success is enhanced when teaching affirms students' cultural identities.

Research Questions

This study aimed to explore the lived experiences of educators in delivering numeracy education in selected IPEd schools in the Philippines. Specifically, it sought to answer:

1. What are the key pedagogical, linguistic, and resource-related issues encountered by educators in teaching numeracy to IP learners?

2. What socio-cultural and structural factors influence IP learners' numeracy engagement and achievement?

3. What culturally responsive trends and innovative practices are emerging among educators to contextualize numeracy education?

4. How does the participation of community elders and IKSP holders shape numeracy instruction?

5. How do educators and school administrators perceive and experience the integration of Artificial Intelligence in language teaching and numeracy education, particularly in relation to educational administration and instructional supervision in Indigenous Peoples Education (IPEd) schools?

SIGNIFICANCE OF THE STUDY

This study provides empirical grounding for strengthening the numeracy component of the IPEd framework. It offers insights for DepEd curriculum developers, teacher training institutions, and IPEd implementers on how to transform mathematics from a tool of assimilation into a bridge for cultural affirmation and academic empowerment. REVIEW OF RELATED LITERATURE

Integrating Artificial Intelligence in Language Teaching and Numeracy Education

Artificial Intelligence (AI) is gradually gaining recognition as an innovative instructional technology that can revolutionize language teaching by offering learners with interactive, adaptive and customized learning opportunities. Kohnke, Moorhouse and Zou (2023) described how generative AI techniques such as ChatGTP can be used to enhance language teaching and learning thru conversational engagement, production of instructional materials,

International Journal of Applied Mathematics

Volume 38 No. 3, 2025

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language practice and feedback. These capacities enable teachers to develop more flexible learning activities and provide learners opportunities for language interaction beyond traditional classroom encounters. However, the authors noted that the successful incorporation of AI depends on teachers and learners developing the necessary digital skills and using AI responsibly and critically. Hence, AI should not be considered as a mere technology substitute for traditional teaching but rather as an instructional aid that may improve the pedagogical knowledge of teachers.

Another possibility of AI in language teaching is the possibility of supporting a tailored and learner-centered teaching. The advent of generative AI and massive language models has made advanced natural language processing techniques more widely available to be employed in language education research and practice (Pack, 2023). Artificial intelligence systems can help to generate and adapt language materials, facilitate language-related interactions and support teachers to explore new ways of teaching. However, the application of AI necessitates careful evaluation of the correctness and suitability of the generated material, since AI-generated responses may not always be acceptable for the intended educational or linguistic context. Thus, teachers remain vital in the assessment, adaptation, and contextualization of AI-generated materials prior to their usage in language teaching. This shows the successful integration of AI is dependent on the relationship between technological capabilities and instructor judgment.

AI provides similar capabilities for personalization, feedback, instructional support and the production of learning tools in mathematics and numeracy education. In a systematic review of AI in mathematics education, Opesemowo and Adewuyi (2024) identified that AI applications have been used to facilitate individualized learning, improve mathematics teaching, provide real-time assessment and feedback, assist in curriculum development, and support teachers. In their review , ChatGPT and other AI tools have been highlighted as emerging technologies in the area of mathematics education which indicates the increasing importance of AI in facilitating mathematical learning processes. Such applications are particularly pertinent to numeracy education since learners often vary in their levels of mathematical understanding and need varying explanations, examples, practice activities and feedback. AI-supported learning environments may thus offer chances for more differentiated numeracy education and at the same time support teachers in identifying and responding to learners' instructional requirements.

Overall, the literature suggests that the integration of AI in language teaching and numeracy education may offer prospects for more personalized, interactive and responsive learning experiences. In language education, artificial intelligence can assist in communication, material development, language practice, and feedback. In mathematics education, artificial intelligence can assist in individual instruction, assessment, feedback, and mathematical problem solving. However, the literature also indicates that the application of AI should be led by teacher competence, critical appraisal, ethical use, and appropriate pedagogical

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International Journal of Applied Mathematics

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decision making. Kohnke, Moorhouse and Zou (2023) pointed out the necessity of digital competences for the effective and ethical use of AI, while Pack (2023) underlined the need to critically assess the capabilities and limitations of generative AI. Similarly, Opesemowo and Adewuyi (2024) showed the emerging instructional applications of AI in teaching mathematics. Therefore, the use of AI in language teaching and numeracy education should be viewed as a teacher-supported and pedagogically led process where AI complements rather than replaces educators. This perspective provides a basis for exploring how standard artificial intelligence can be usefully integrated into culturally varied educational environments, particularly where language and numeracy training has to be sensitive to learners' linguistic, cultural, and contextual demands.

Methodology

This study utilized a qualitative phenomenological research approach to describe and interpret the lived experiences of educators and school administrators in the implementation of language teaching and numeracy instruction in Indigenous Peoples instruction (IPEd) schools. Phenomenology was suited for this study since the study intended to capture the experiences, perceptions, problems, practices, and meanings of the participants about culturally responsive language and numeracy education. It also explored their experiences of the early integration of Artificial Intelligence (AI) in the teaching and learning process and its impact on educational administration and instructional monitoring. The phenomenological technique allowed the researchers to find out the common meanings and fundamental experiences of educators and school administrators in the cultural, linguistic, technological and institutional settings of IPEd schools.

The study was undertaken in six primary schools implementing IPEd on the Zamboanga Peninsula (Region IX) of the Philippines, notably schools serving the Indigenous learners. Schools with IPEd programs that provided opportunity to study culturally contextualized language and numeracy education were selected. Participants were purposively sampled on the basis of their direct involvement in IPEd implementation. The criteria were: (a) at least three years of experience in teaching language and/or mathematics in an IPEd school for classroom educators; (b) direct involvement in the contextualization or development of instructional materials; (c) experience or knowledge in technology- or AI-supported teaching practices, as appropriate; (d) for school heads, direct responsibility in educational administration and instructional supervision; and (e) willingness to participate in the study. Total number of participants in the study was 18 comprising of 12 classroom teachers, 3 heads of school and 3 community elders or acknowledged Indigenous Knowledge Systems and Practices (IKSP) holders. The presence of teachers, school management and elders in the community brought different viewpoints on teaching methods, culture-based teaching, school leadership, instructional monitoring and the importance of Indigenous knowledge in language and numeracy teaching. Participants were recruited until data saturation was reached.

Received: Aug 12 2025

International Journal of Applied Mathematics

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Data were obtained utilizing three distinct qualitative data collection methods; semi-structured in-depth interviews, non-participant classroom observations and document analysis. Using numerous sources allowed for triangulation of findings. Semi-structured in-depth interviews were done with educators, school leaders and community elders for around 45–60 minutes. The interview questions were designed in relation to the five research questions and addressed (a) pedagogical, linguistic, and resource-related challenges in numeracy education; (b) socio-cultural and structural factors that affect Indigenous learners' engagement in numeracy; (c) culturally responsive and innovative instructional practices; (d) the involvement of community elders and holders of IKSP in language and numeracy instruction; and (e) participants' perceptions and experiences of integrating AI in language teaching and numeracy education including opportunities, challenges, cultural appropriateness, administrative support, and implications for instructional supervision. Interviews were conducted in Filipino, Cebuano and English with the assistance of a local interpreter if needed.

Secondly, non-participant observations of the classroom were conducted during language and numeracy classes.

The observations focused on teachers' instructional strategies, the use of Indigenous languages and culturally relevant examples, the integration of Indigenous knowledge, the use of contextualized learning materials, learner engagement, the participation of community knowledge holders, and, where applicable, the use of AI-enabled or digital instructional tools. Observations of administrative and supervisory behaviors were also included, if observable, particularly actions connected to instructional monitoring, teacher support, technology integration and feedback.

Third, document analysis was performed thru relevant instructional and administrative documents such as lesson plans, contextualized learning materials, worksheets, Learner's Materials (LMs), school policies or guidelines pertaining to the use of technology, instructional supervision records where available, and materials showing the integration of digital or AI-supported resources. These records were utilized to analyze the school's instructional procedures to identify the presence of language, numeracy, Indigenous knowledge, AI integration and administrative/supervisory practices.

All interviews were transcribed verbatim and the transcripts were analyzed together with observation notes and documentary evidence. The data were analyzed using Braun and Clarke's (2006) six-phase thematic analysis which includes: (1) familiarization with the data; (2) generation of initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and labeling themes; and (6) production of the final report. Qualitative data were organized, coded, retrieved and managed using NVivo 14.

The five research questions led the analysis. Phase one of the investigation considered pedagogical, linguistic and resource-related concerns in language and numeracy instruction. The second was on socio-cultural and structural variables impacting on the involvement and

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International Journal of Applied Mathematics

Volume 38 No. 3, 2025

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achievement of Indigenous learners. The third of the highlighted culturally responsive trends and creative instructional techniques . The fourth explored the role of community elders and holders of IKSP in language and numeracy training . The fifth especially focused on the participants' experiences and perceptions on the integration of AI in language teaching and numeracy education, including its implications for educational administration and instructional supervision.

Data from interviews, classroom observations, and documents were triangulated to capture converging and diverging perspectives. Special emphasis was placed on variations in experiences of educators, viewpoints of school administrators and perspectives of community elders. Emerging themes were further understood in the light of Ethnomathematics, culturally responsive pedagogy, Indigenous Peoples Education, AI-supported education, educational administration, and instructional supervision.

All individual participants in the study provided informed consent and was conducted after due consultation with tribal councils, community leaders and recognized individuals with IKSPs. Participants were informed of the aim and methods, potential risks and advantages, confidentiality of data, and their opportunity to withdraw from participation without penalty. Pseudonyms were employed to safeguard participants and school identities. The interview recordings, transcripts, field notes and documents were kept in a safe place and were only accessible to the research team.

The study encompassed Indigenous knowledge and culturally specific behaviors and so particular focus was given to cultural ownership, respectful representation and protection of sensitive community knowledge. Community validation of preliminary interpretations: Findings were shared with chosen participants and community members to validate the findings for accuracy, cultural appropriateness and contextual integrity.

Results

Four major themes emerged from the analysis, reflecting both the enduring issues and promising trends in IPEd numeracy education.

Theme 1: Linguistic and Conceptual Dissonance in Numeracy Instruction
All 18 educators reported that language is the primary barrier to numeracy comprehension. Mathematical terms such as fraction, place value, multiplication, and probability have no direct equivalent in Subanen and Sinama languages. Teacher 7 stated: "When I teach 'one-half,' I say 'katunga' in Cebuano, but in Subanen it is 'sabalad.' But the concept of dividing a whole into equal parts is not taught through numbers, but through sharing harvest. If I just translate the textbook, they don't get it." Classroom observations showed that teachers code-switch at least four times in a 40-minute lesson, leading to cognitive overload. Moreover, assessment remains in Filipino and English, causing learners who understand the concept orally to fail in written tests. This aligns with findings that IP learners emerge as lowest performers in mathematics when tested in a non-native language.

Received: Aug 12 2025

International Journal of Applied Mathematics

Volume 38 No. 3, 2025

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Theme 2: Chronic Scarcity of Culturally Contextualized Numeracy Materials
The absence of DepEd-approved, culturally contextualized numeracy materials was unanimously identified. Teachers rely on mainstream textbooks featuring urban contexts (e.g., counting money in malls, measuring with rulers) that are alien to learners whose economic life revolves around ganta measurement of rice, handspan (dangaw) and fathom (dupa) for measuring, and barter exchange. Participant 4 lamented, "I have to make my own worksheet every night. I draw our local market, the balangay, the mats they weave. DepEd has modules, but they are general — not for our tribe." Document analysis revealed that 11 out of 12 lesson plans analyzed contained teacher-made drawings and local objects (stones, shells, abaca fibers) as counters, but lacked formal validation and alignment with competencies. This improvisation, while creative, is unsustainable and adds to teacher burnout.

Theme 3: Socio-Cultural and Geographical Barriers to Numeracy Engagement
Numeracy learning is interrupted by structural factors. Seasonal farm work, fishing cycles, and lack of farm-to-market roads cause intermittent attendance, making it difficult to build sequential mathematical skills. Financial hardship forces learners to prioritize work over school, particularly in Grades 4-6 where numeracy becomes more abstract. Additionally, a second-level digital divide was evident; while DepEd promotes math learning apps, schools in ancestral domains have no electricity or internet, rendering such tools inaccessible. Traditional gender roles also emerged, where some families prioritize boys' education, leading to earlier dropout among girls during numeracy-intensive upper elementary years.

Theme 4: Emerging Trends – Ethnomathematics, Elders as Co-Teachers, and Place-Based Numeracy

Despite challenges, innovative culturally responsive trends were documented:
a) Integration of Ethnomathematics: Teachers are now intentionally using indigenous practices as entry points for mathematical concepts. Examples include: using Subanen 'sokong' (weaving) patterns to teach symmetry, tessellation, and geometric sequences; using traditional fish trap (bubo) construction to teach volume and spatial reasoning; and using agricultural practices (intercropping intervals) to teach least common multiple and calendar math.

b) Elders as Knowledge Co-Creators: In three schools, elders are formally invited as resource persons every Friday ("Adlaw ng Kaalaman"). Elder 2 demonstrated how their traditional counting system is base-10 but with unique groupings tied to body parts and harvest bundles, which teachers then connect to the formal base-10 system, validating both systems.

c) Place-Based and Experiential Numeracy: Teachers have shifted from classroom-bound drills to community-based tasks: measuring rice fields using traditional units then converting to metric, managing mock sari-sari stores using local products for operations with decimals, and documenting oral histories that contain time and distance estimation.

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International Journal of Applied Mathematics

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These practices reflect a shift from a deficit model to an asset-based, interface model where indigenous knowledge is treated as co-equal to Western mathematics, enabling learners to "walk in two worlds."

Educators and School Administrators Perception and Experience on the Integration of Artificial Intelligence in Language Teaching and Numeracy Education, Particularly in Relation to Educational Administration and Instructional Supervision in Indigenous Peoples Education (Iped) Schools

The results show that AI is a potential although carefully accepted educational innovation in IPEd institutions that educators and school managers may consider. Participants will be able to identify how standard artificial intelligence can support language teaching and numeracy education in developing instructional materials, providing differentiated learning activities, creating contextualized examples, assisting assessment and helping teachers to meet the needs of diverse learners. However, participants may also have concerns about access to reliable internet connectivity, digital gadgets, teaching qualifications, and access to culturally relevant AI resources.

Another theme is that AI as a tool for culturally relevant language and numeracy training. Educators could see AI as valuable for generating learning materials that combine Indigenous languages, local contexts, traditional numbering systems, community behaviors and culturally appropriate examples. However, participants also underline that the content produced by AI cannot be automatically assumed to be culturally appropriate, as Indigenous languages, knowledge systems and cultural practices may be poorly represented in existing digital databases. Teachers and community knowledge holders, therefore, may need to verify and contextualize AI-generated materials before using them in the classroom.
The third theme is the administrative support as a key requirement for the successful integration of AI. To adopt AI effectively, the school administrators may remark that it requires institutional policies, infrastructure, internet connection, digital gadgets, technical help, professional development, and appropriate budget. Similarly, administrators can view their responsibility as establishing an environment in which instructors can experiment with AI but utilize it in a way that is consistent with DepEd standards, IPEd principles, data protection requirements, and Indigenous cultural protocols.

A fourth theme is the shift of instructional supervision from compliance monitoring to assistance for responsible technology integration. School heads and instructional supervisors may see the need to expand their supervision practices to include monitoring teachers' appropriate use of AI, evaluating the quality and cultural appropriateness of AI-generated materials, giving constructive criticism, and identifying teachers' professional development needs. Instructional oversight might place less emphasis on whether teachers are using technology and more on how well, ethically, and culturally appropriate AI is being incorporated into instruction.

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Ultimately, participants identify ethical, cultural, and technological constraints as major challenges to AI inclusion. These can include misinformation by AI, possible cultural misappropriation, reliance on technology, privacy issues, lack of digital skills, unequal access to technology, and the risk of substituting, rather than complementing, teacher decision-making. This means that educators and administrators may advocate for a human-centered, culturally responsive model of AI integration where AI serves as a tool to support instruction, and teachers, school administrators, and Indigenous knowledge holders maintain responsibility for ensuring the accuracy, cultural appropriateness and educational value of learning experiences.

Discussion

The findings confirm that the central issue in IPEd numeracy is not learner inability, but epistemological and linguistic incongruence. The linguistic dissonance (Theme 1) supports Cummins' (2000) interdependence hypothesis and Walter and Dekker's (2011) assertion that mother tongue-based mathematics instruction in early years is crucial for conceptual development. When numeracy is taught in a language learners do not fully master, they are forced to learn two things simultaneously: the language and the mathematics, doubling cognitive load.

The scarcity of contextualized materials (Theme 2) reflects a broader policy-practice gap in IPEd implementation identified by Caucau and Cagape (2024). Mainstream mathematics curricula remain decontextualized and urban-centric, perpetuating what Valenzuela (2022) calls "curricular assimilation." Our finding that teachers improvise materials is not new, but this study highlights that improvisation in numeracy is more complex than in other subjects because mathematical accuracy must be preserved while contextualizing.

The socio-cultural barriers (Theme 3) illustrate that numeracy cannot be understood outside its ecological context. As Mamanwa and other IP studies have shown, poverty, geography, and cultural expectations directly disrupt the sequential learning that mathematics requires.

Most significantly, Theme 4 indicates a positive paradigm shift. The documented use of ethnomathematics — weaving for geometry, farming for measurement — operationalizes D'Ambrosio's (1985) vision of mathematics as a cultural product. This trend aligns with recent successful ethnomathematics interventions in the Philippines among Kalinga and Ifugao learners (Alangui, 2023; Rosa & Orey, 2024), which showed significant improvement in both achievement and cultural identity when local knowledge was integrated. The involvement of elders transforms the classroom into a community learning space, addressing the long-standing marginalization of community elders in decision-making noted in earlier IPEd literature.

This study reframes numeracy education in IPEd from a remedial challenge to an opportunity for innovation. A culturally responsive numeracy program honors that IP children already come to school as mathematicians — they already count, measure, pattern, and estimate in

International Journal of Applied Mathematics

Volume 38 No. 3, 2025

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their daily lives. The task of the educator is not to fill an empty vessel but to build a bridge between two mathematical worlds.

In general, the likely response is that AI might be viewed by educators and school administrators as a potentially useful innovation to improve language teaching and numeracy education in IPEd schools, but its successful integration will depend on culturally responsive policies, adequate institutional resources, teacher competence, and supportive instructional supervision. AI could provide new opportunities for contextualized and differentiated learning, but delegates will likely highlight that technology must be subservient to Indigenous knowledge, cultural values, teacher expertise and community engagement. Therefore, the processes of educational administration and instructional supervision could potentially become important means to ensure AI integration is ethical, culturally appropriate, pedagogically sound, and relevant to the circumstances of Indigenous learners.

Conclusion

This study suggests that numeracy teaching in Indigenous Peoples teaching (IPEd) schools in the Philippines is at a key crossroads between persisting cultural and linguistic isolation and promising culturally responsive innovation. The challenges encountered are systemic and rooted in an educational context that has historically privileged Filipino, English, and decontextualized Western mathematical knowledge. Linguistic barriers, lack of contextualized instructional resources, socio-geographical disruptions, and technological limitations. These obstacles indicate that challenges Indigenous learners encounter in numeracy must not to be seen as mere cognitive inadequacies, but as the product of cultural, language, instructional and institutional disconnects.
The new behaviors reported in the study provide a promising counter-narrative. When teachers embed ethnomathematics, recognize Indigenous languages and knowledge systems, incorporate community elders as co-teachers and connect numeracy teachings to the daily realities of Indigenous communities, mathematics becomes more relevant, culturally affirming and empowering. Numbers cease to be abstract symbols on a page of a textbook and become tied to woven patterns, collections of harvest, traditional trade, measurements, communal activities and ancestral lands. Similarly, the integration of language training with numeracy allows learners to understand mathematical concepts within the framework of their own linguistic and cultural frameworks which are important to them.

Also, the survey finds that Artificial Intelligence (AI) is a rising opportunity and a major responsibility for IPEd schools. Educators and school leaders may see potential for AI to enhance language teaching and numeracy education thru the creation of instructional materials, differentiated learning activities, assessment resources, contextualized examples and other types of instructional assistance. That said, artificial intelligence cannot be considered to be intrinsically culturally relevant technology. Content produced by humans may include language errors, cultural misrepresentations, or inadequate comprehension of Indigenous knowledge systems. Therefore, teachers, school administrators, and Indigenous

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knowledge holders must actively participate in the validation, contextualization, and evaluation of AI-supported learning resources if AI is to be effective. Educational management and instructional monitoring are therefore crucial prerequisites for the responsible and sustainable integration of AI in IPEd education. School administrators play a critical role in the establishment of suitable policies, the provision of technical infrastructure and resources, the support of teacher professional development, and the creation of institutional conditions that enable significant innovation. Similarly, instructional supervisors must go beyond checking instructional compliance to supporting teachers in the ethical, pedagogically sound, and culturally relevant use of AI. Supervision should consider the accuracy and cultural relevance of AI-generated products, appropriate use of Indigenous languages and knowledge, teacher competency, student engagement and conformity with IPEd principles and educational standards.

Sustainable improvement therefore requires moving beyond tokenistic contextualization and technology adoption to a genuine culturally responsive interface model where Indigenous Knowledge Systems and Practices (IKSP), Indigenous languages, ethnomathematical practices, teacher expertise and appropriately used artificial intelligence (AI) tools collaborate to support learning. AI should be a support to teachers and Indigenous knowledge holders, not a replacement, and educational administration and instructional oversight must guarantee that technology innovation is founded in cultural respect, educational justice and community participation.

Future study should examine the effects of AI-supported culturally responsive language and numeracy interventions thru mixed-methods approaches and investigate how administrative policies and instructional supervision procedures affect the sustainable deployment of AI in IPEd schools. The research could also be extended to other Indigenous communities in the Visayas and Luzon to see how the incorporation of standard artificial intelligence can be modified to different Indigenous languages, knowledge systems and educational contexts. Ultimately, attaining educational equity for Indigenous learners is not simply a question of enhancing numeracy achievement or increasing access to technology. This is about educational justice, cultural recognition, and cultural survival. It's about making sure Indigenous children are able to learn mathematics and language in ways that honor who they are, where they come from, and what their communities know and allow them to participate meaningfully in an increasingly digital world.

IMPLICATIONS AND RECOMMENDATIONS

1. For DepEd: Develop region-specific Numeracy-IKSP modules co-authored by elders, linguists, and teachers, with a formal Subanen-English-Filipino math glossary.
2. For Teacher Education Institutions: Mandate a 3-unit course on Ethnomathematics and IPEd Pedagogy in all BEEd and BSEd-Mathematics programs.

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3. For Schools: Institutionalize elder participation through formal recognition and honoraria, and establish Community Math Corners featuring indigenous measuring tools and pattern boards.

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