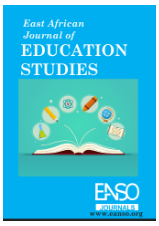

East African Journal of Education Studies
eajes.eanso.org
Volume 8, Issue 2, 2025
Print ISSN: 2707-3939 | Online ISSN: 2707-3947
Title DOI: https://doi.org/10.37284/2707-3947

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness

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Article DOI: https://doi.org/10.37284/eajes.8.2.2872

Date Published:

15 April 2025

Keywords:

Indigenous Materials, ICT Tools, STEM Education, Teacher Readiness, Attitudes, Knowledge, RIIMTI_STEM Model.

ABSTRACT

This article addresses the gap in understanding the integration of Indigenous materials and ICT tools in STEM teaching by secondary school teachers. Conducted within the Rwenzori region, the study assessed teachers' knowledge, experiences, attitudes, and readiness for integration using a mixed-methods approach involving quantitative data from 138 teachers combined with qualitative insights from focus group discussions. The results indicate moderate levels of knowledge (mean=3.2,SD=0.75) and attitudes (mean=3.4,SD=0.85) among teachers, with slightly higher practical experience (mean=3.5,SD=0.80). Knowledge, practical experience, and attitudes significantly correlated with readiness; ($r=0.538, p<0.001$), ($r=0.423, p<0.001$), and ($r=0.385, p<0.001$), respectively. Teachers' knowledge ($\beta=0.419, p<0.001$) and practical experiences ($\beta=0.192, p=0.027$) were found to be significant predictors of readiness, while attitudes were not significant predictors ($\beta=0.128, p=0.136$). This study proposes the RIIMIT-STEM Model (Readiness for Integration of Indigenous Materials and ICT Tools in STEM Instruction), a comprehensive framework designed to assess and strengthen teachers' preparedness for blending culturally relevant resources and digital technologies in STEM education. The model responds to persistent challenges such as limited ICT proficiency, high costs of equipment, and infrastructural limitations while promoting innovative and context-sensitive teaching practices.

APA CITATION

Ndungo, I., Nazziwa, C., Kabiswa, W., Opio, P., Akugizibwe, E. & Mpungu, M. (2025). Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness. *East African Journal of Education Studies, 8*(2), 132-149. https://doi.org/10.37284/eajes.8.2.2872

CHICAGO CITATION

Ndungo, Issa, Cissy Nazziwa, Winston Kabiswa, Phillip Opio, Edwin Akugizibwe and Kassimu Mpungu. 2025. "Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness". *East African Journal of Education Studies* 8 (2), 132-149. https://doi.org/10.37284/eajes.8.2.2872

HARVARD CITATION

Ndungo, I., Nazziwa, C., Kabiswa, W., Opio, P., Akugizibwe, E. & Mpungu, M. (2025) "Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness", *East African Journal of Education Studies*, 8(2), pp. 132-149. doi: 10.37284/eajes.8.2.2872

IEEE CITATION

I. Ndungo, C. Nazziwa, W. Kabiswa, P. Opio, E. Akugizibwe & K. Mpungu "Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness" *EAJES*, vol. 8, no. 2, pp. 132-149, Apr. 2025. doi: 10.37284/eajes.8.2.2872.

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

MLA CITATION

Ndungo, Issa, Cissy Nazziwa, Winston Kabiswa, Phillip Opio, Edwin Akugizibwe & Kassimu Mpungu. "Enhancing STEM Instruction through Indigenous Materials and ICT Integration: A Critical Assessment of Teachers' Knowledge, Experiences, Attitudes, and Readiness". *East African Journal of Education Studies*, Vol. 8, no. 2, Apr. 2025, pp. 132-149, doi:10.37284/eajes.8.2.2872

INTRODUCTION

The prosperity of a country depends on the applications of STEM education, which can be significantly enhanced by combining ICT tools with native content. ICT tools offer dynamic and entertaining content, while indigenous resources provide culturally appropriate context and are also relatable to real-life experiences, thus making teaching and learning easier. This dual approach promotes respect for both local culture and global technical breakthroughs while also assisting with comprehension. The Rwenzori region offers a distinctive backdrop for our study because of its varied natural resources and rich cultural legacy. Indigenous materials are made using locally produced materials and traditional knowledge. They give realistic instances that bring abstract STEM ideas to life. For example, customary farming techniques can serve as examples of biological principles, and regional building techniques can serve as explanations of engineering concepts (Onwu & Mosimege, 2004).

ICT tools, which include software, hardware, and internet resources, improve STEM education by offering multimedia-rich and interactive content. These resources make STEM subjects more approachable and interesting by accommodating different learning styles. Moreover, UNEB has, in several instances, recommended the use of ICT in teaching STEM subjects like mathematics (Ndungo et al., 2024). The integration of indigenous materials and Information Communication Technology (ICT) tools holds significant promise for enhancing STEM education. Leveraging indigenous materials can make learning more relevant and engaging. Studies by Imaduddin et al. (2020) and Sumarni et al. (2022) show how incorporating Indigenous perspectives on plant properties can enrich student understanding of biology, fostering a deeper connection between classroom knowledge and real-world experiences.

In addition to enriching content, indigenous materials play a crucial role in developing critical thinking skills. Research by Eglash et al. (2020) and Moro & Billote (2023) highlights how examining traditional practices like navigation techniques or resource management helps students deconstruct Western-centric paradigms in STEM, enhancing analytical skills and fostering a space for critical analysis. Using local plants, minerals, or artefacts provides a culturally relevant approach to teaching STEM subjects. Familiar materials help contextualize abstract concepts, promote cultural appreciation, and increase student engagement. ICT tools further enhance this by offering innovative ways to deliver content, facilitate interactive learning, and bridge geographical divides through digital resources. Moreover, including Indigenous content preserves cultural heritage (Moro & Billote, 2023; Sumarni et al., 2022). Furthermore, integrating traditional knowledge into educational materials ensures the transmission of cultural heritage across generations. This integration presents challenges, such as the need for teacher training in indigenous knowledge systems and culturally relevant methods (Imaduddin et al., 2020).

Despite initiatives to support these integrations through professional development initiatives and educational policies, there is still a big lack of preparation among instructors to use these tools effectively. This study attempts to close this gap by evaluating teachers' attitudes, expertise, and practical experience with the integration of Indigenous materials and ICT tools in STEM instruction. Additionally, it assesses how prepared they are overall to include these resources and pinpoints the main factors that influence that preparation. Targeted interventions to improve the successful integration of Indigenous materials and ICT technologies in STEM education are informed by this study.

Problem Statement

To improve student engagement, cultural relevance, and learning results, teachers should ideally successfully incorporate indigenous materials and Information Communication Technology (ICT)

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

tools into STEM teaching. Unfortunately, due to infrastructure constraints, as well as gaps in their knowledge, practical experience, and attitudes, many teachers currently struggle with this integration. These obstacles keep the potential advantages of utilizing local resources and ICT tools in STEM education from being fully realized. The goal of the current study is to determine the magnitude of these gaps as well as the critical variables influencing the readiness of instructors to use these resources in their instruction. This knowledge is essential for creating focused interventions that help educators close these gaps and successfully incorporate ICT and indigenous resources.

Research Objectives

- To assess the degree of knowledge, practical experience, and attitudes of teachers on the integration of Indigenous materials and ICT tools in STEM teaching.
- To ascertain the teachers' level of preparedness for successfully incorporating Indigenous resources and ICT tools into STEM instruction.
- To identify the critical factors that influence teachers' preparedness to include Indigenous resources and ICT tools in STEM teaching.

LITERATURE REVIEW

Theoretical Framework

Using the Cultural-Historical Activity Theory (CHAT), this study explores how Indigenous materials and ICT technology might be incorporated into STEM education in the Rwenzori region. CHAT, which emphasizes how cultural and historical contexts affect human behaviour, was extended by Vygotsky and Engeström (Engeström, 2014; Jolm-Steiner et al., 1978). This paradigm gives a thorough way to understand the connections between a variety of educational system elements, such as teachers, students, cultural artefacts, and technology, which makes it particularly well-suited to our research. CHAT emphasizes how crucial mediating artefacts are to the learning process. These mediators in our setting include Indigenous materials and ICT tools, which provide a more contextualized and richer learning experience (Fleer & Veresov, 2018; Miles, 2020).

Our goal in incorporating these technologies is to create a link between conventional wisdom and contemporary scientific ideas, hence increasing students' relevance and interest in STEM education. Furthermore, by emphasizing inconsistencies and expanding learning, CHAT assists us in recognizing and resolving the obstacles teachers have while implementing novel teaching approaches. This method not only improves the attitudes and preparedness of teachers, but it also encourages creative teaching methods that honour and integrate the cultural legacy of the community Through offering empirical information on incorporating Indigenous knowledge systems into contemporary educational practices, our study fills in gaps in CHAT and broadens the theory's applicability to culturally varied settings.

Empirical Review

The literature review section examines how indigenous resources and ICT tools can be integrated into STEM education. It explores existing practices, challenges, teacher needs and support, teacher perspectives, and the impact on students.

Indigenous resources have been acknowledged for their ability to enhance STEM education by offering interesting and culturally appropriate content. The research by Imaduddin et al. (2020) showed that incorporating indigenous knowledge might improve students' comprehension and sense of connection to the subject, especially in biology. Similarly, Sumarni et al. (2022) discovered that the practical applications of plant identification and medicinal uses are provided by the use of ethnobotany in science education. According to Moro & Billote (2023), instructors' inability to successfully incorporate these materials into their classes is hampered by their lack of practical experience. Although these studies highlight the advantages of real-world applications, they don't go into detail on the particular difficulties and issues teachers have when using these resources.

For example, teachers' experiences with indigenous materials vary depending on their cultural competency, community engagement, and chosen

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

pedagogical approach. Successful integration of indigenous materials often hinges on collaboration with external stakeholders (Semali et al., 2015; Shen et al., 2023). Semali and colleagues add that collaborating with Indigenous communities, Elders, and knowledge keepers to co-create learning materials and develop culturally responsive teaching strategies is key in integrating Indigenous materials into STEM teaching (Semali et al., 2015). Similarly, Shen and others emphasize that effective ICT tool integration requires ongoing professional development and collaboration among teachers to share best practices and materials (Shen et al., 2023).

The effective integration of indigenous materials and ICT technologies into STEM education is greatly dependent on the attitudes of educators toward these resources. Positive attitudes are important, however, Semali et al. (2015) discovered that they are frequently constrained by inadequate exposure and training. According to Moro & Billote (2023), it's critical to promote favourable attitudes by highlighting the advantages of including these materials in awareness campaigns. Diverse educational environments are not well covered in these previous studies, especially in remote locations like the Rwenzori region.

Even though there are many pedagogical advantages to using indigenous resources, a lot of teachers are hesitant to include them in their routines. Imaduddin et al. (2020) observed that instructors' lack of readiness was caused by a lack of resources and assistance. According to Sumarni et al. (2022), including indigenous knowledge in teacher education programs may improve students' readiness and self-assurance. These studies, however, don't offer a thorough assessment of teachers' overall readiness. The current study fills this gap by thoroughly assessing the Rwenzori region's teachers' levels of knowledge, practical experience, and attitudes about the integration of indigenous materials and ICT tools in STEM teaching.

A lack of readiness on the part of instructors also impedes the successful use of ICT in education. ICT tools are essential for modern education, yet many teachers lack the necessary training to use them successfully, as noted by Eglash et al. (2016). Infrastructure and training constraints that keep instructors from being completely ready to integrate ICT technologies into their teaching methods are noted by Moro & Billote (2023). This emphasizes how important it is to assess how ready teachers are to use these tools. When it comes to incorporating local resources and ICT technologies, teachers in rural locations confront particular difficulties. Semali et al. (2015) investigated the obstacles the infrastructure poses that prevent instructors from being prepared and proposed focused solutions to these problems. Comprehensive support systems were suggested by Moro and Billote (2023) to improve teachers' preparedness. Notwithstanding these suggestions, actual evidence about the precise impact of these obstacles on educators in rural settings such as the Rwenzori area is lacking.

As already noted, teachers face a myriad of challenges when striving to integrate indigenous materials and ICT tools into STEM instruction. Limited access to culturally appropriate materials and ICT infrastructure in indigenous communities impedes effective implementation. Moreover, navigating the complexities of cultural sensitivity and ethical considerations requires specialized training and ongoing support (Moro & Billote, 2023). Additionally, teachers may lack the digital literacy skills and pedagogical knowledge necessary for effectively integrating ICT tools into their teaching practices, highlighting the need for targeted professional development initiatives (Pelgrum, 2001). Addressing the development needs of teachers is crucial for the successful integration of indigenous materials and ICT tools in STEM education. Professional development programs should provide teachers with opportunities to deepen their understanding of indigenous perspectives, cultures, and knowledge systems (Eglash et al., 2020). This includes training in culturally responsive teaching strategies, such as incorporating indigenous pedagogies like storytelling and land-based learning into STEM instruction (Semali et al., 2015). Furthermore, teachers require training in digital literacy skills, ICT integration strategies, and the selection and utilization of appropriate ICT tools to enhance STEM learning experiences (Spycher & Haynes, 2019).

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

A study conducted by Baker (2024) sought to find out the knowledge and beliefs of educators in bringing Indigenous ways of knowing into their classrooms. Data was obtained from the participants through the survey and online focus groups. Results provided evidence of the awareness of the importance of Indigenous knowledge in classroom practice where 42% of the participants stated that they infused Indigenous teachings regularly, 42% occasionally infused Indigenous teachings, and 16% rarely infused Indigenous teachings. These results provide clear evidence of teachers' indigenous knowledge and their confidence regarding the role of this knowledge in their classroom practice. However, further results reveal that although there is a link between local indigenous knowledge and formal school curriculum concepts, little or no attempts have been made by teachers to use local knowledge to create relevance in the curriculum content they teach to students (Da Silva et al., 2023).

Similarly, Ghavifekr et al. (2014) conducted a study to identify the level of computer skills and knowledge of primary school teachers in the teaching and learning process in Malaysia. Results showed that many teachers more frequently use ICT in the teachers' room for their work rather than using it in their classroom for teaching and learning. While analyzing the statistics for frequencies of ICT Integration in the Teaching and Learning Process, it was found that the majority of the participants were able to use the computer as a tool computer or ICT in the classroom as a tool to help in their teaching and learning process but how to use educational software with their students for learning subject knowledge was a challenge. This lack of awareness about the value of ICT learning is greatly attributed to the discouraging support from school administration and management with little or no financial support from the school to attend workshops or training programs to use ICT integration effectively.

Similarly, Savec (2019) conducted a study that focused on the opportunities and challenges for the use of ICT and innovative teaching methods in STEM education about teachers' Technological Pedagogical Content Knowledge. One important observation made was that teachers often tend to use ICT largely to support, enhance, and complement existing classroom practice rather than re-shaping subject content, goals, and pedagogies. The possible constraints listed by STEM teachers include lack of time to gain confidence and experience with ICT, limited accessibility to reliable resources, lack of time for critical selection of learning resources related to curriculum topics, a STEM curriculum overloaded with content, and the lack of subject-specific guidance for using ICT to support learning.

Teachers' readiness to incorporate indigenous materials and ICT tools is influenced by several crucial elements, including knowledge and training. According to Imaduddin et al. (2020), there is a sizable gap in the knowledge and training of instructors, and to close this gap, specific professional development is required. According to Sumarni et al. (2022), continuous assistance is necessary to guarantee that teachers are adequately equipped. The predictors of instructors' preparedness, however, are not well identified by the research that is currently available. To solve this, the current study identifies major factors and how they affect instructors' readiness to incorporate ICT tools and indigenous resources in the Rwenzori region.

We note a dearth of studies that specifically examine educators' viewpoints and attitudes on the use of ICT and Indigenous resources in STEM education within the framework of Uganda. Furthermore, there is a substantial knowledge gap regarding the awareness and application of Indigenous knowledge by teachers in STEM classrooms because the variables examined to examine teachers' awareness and usage of Indigenous knowledge in teaching and learning do not specifically focus on the STEM domain (Da Silva et al., 2023). Previous studies have emphasized the potential benefits and difficulties of integrating ICT technologies and local resources into STEM education. It is still unclear, though, to what extent instructors are knowledgeable and experienced and how they feel about these tools.

Furthermore, there hasn't been much study done on the critical factors influencing how prepared teachers are to use these tools and resources, particularly in isolated places like the Rwenzori region. By assessing teachers' attitudes, knowledge, and experience as well as their overall level of

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

preparedness and determining the main factors that influence it, the current study aims to close these gaps in knowledge.

METHODOLOGY

This study investigated teachers' preparedness to incorporate Indigenous materials and ICT tools into STEM instruction. It was conducted in two purposely selected districts within the Rwenzori region, one representing a rural setting and the other an urban environment, ensuring diverse perspectives on the use of Indigenous and technological resources in STEM education. A mixed-methods research design was adopted to comprehensively capture both quantitative and qualitative insights into teachers' knowledge, experiences, attitudes, and readiness for integration.

A list of 285 STEM teachers (Physics, Mathematics, Biology, and Chemistry) from the two selected districts was generated from school registries and district education offices. From this population, 140 teachers were randomly selected using a simple random sampling technique to participate in the study, ensuring fair representation across disciplines and school categories. Additionally, 14 heads of science departments were purposively selected to participate in focus group discussions due to their leadership roles and influence in instructional planning and implementation.

To collect data, the study employed both quantitative and qualitative approaches. A standardized questionnaire was designed to assess teachers' knowledge, practical experiences, attitudes, and readiness to integrate Indigenous materials and ICT tools into STEM teaching. The questionnaire included Likert-scale items based on a five-point scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). To ensure content validity, the questionnaire was reviewed and validated by five experts in STEM education, curriculum studies, and educational technology. These experts assessed the instrument for clarity, relevance, and appropriateness in measuring the intended constructs. Their feedback was incorporated to refine the questionnaire before administration. The reliability of the questionnaire was tested using Cronbach’s alpha, yielding a high internal consistency of 0.844, indicating that the instrument was suitable for measuring the intended constructs. Out of the 140 distributed questionnaires, 138 were completed and returned, resulting in a high response rate of 98.6%.

In addition to the questionnaire, focus group discussions were conducted to provide qualitative insights that complemented the quantitative findings. Two focus group discussions were held, each consisting of seven heads of science departments from rural and urban schools. A semi-structured discussion guide was used to ensure consistency across discussions while allowing participants to express their perspectives freely. Discussions were audio-recorded with participant consent, transcribed verbatim, and analyzed to identify emerging themes related to the integration of Indigenous materials and ICT tools in STEM instruction.

The study employed both quantitative and qualitative data analysis techniques. Quantitative data were analyzed using descriptive statistics, including means, standard deviations, and percentages to summarize participants' responses. Independent samples t-tests were conducted to compare teachers' attitudes and preparedness across rural and urban settings. Pearson correlation coefficients were used to explore relationships between teachers' knowledge, attitudes, and readiness to integrate Indigenous and ICT-based instructional strategies. To further examine the predictive power of various factors, such as knowledge, experience, and school setting, hierarchical regression analysis was performed. The significance of each model was tested using ANOVA to ensure robustness in interpreting statistical relationships.

For qualitative data, thematic analysis was applied to the transcripts of focus group discussions. The data were coded inductively, meaning themes emerged organically from participants' responses, allowing for a deeper understanding of their perspectives. Recurring themes and patterns related to teachers' experiences, challenges, and opportunities in integrating Indigenous materials and ICT tools were identified. The qualitative insights were then triangulated with the quantitative findings to validate

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

the results and provide a holistic understanding of teachers' preparedness.

To enhance the credibility and validity of the findings, multiple measures were applied. Triangulation was employed by integrating quantitative and qualitative data, ensuring consistency in the results and strengthening the study's conclusions. The questionnaire underwent expert validation, with five subject matter experts reviewing its content before administration to ensure it effectively measured the intended constructs. A pilot study was conducted before full deployment to identify potential ambiguities and refine the questionnaire. Peer debriefing was carried out, where findings from the thematic analysis were discussed with colleagues in STEM education and research to validate interpretations. Member checking was also employed, where key participants in the focus group discussions were provided with summaries of the analyzed data to confirm that their views were accurately captured.

RESULTS AND DISCUSSION

The analysis of teachers' readiness to integrate Indigenous materials and ICT tools into STEM education reveals insightful findings regarding familiarity, challenges, and practices across diverse school settings as illustrated in the subsequent sections.

Demographic Characteristics

Table 1: Showing Demographic Characteristics of Teachers that Participated in the Study

Category	Sub-Category	Number of Teachers	Percentage (%)
School Location	Rural	81	58.7
	Urban	57	41.3
Gender	Male	95	68.8
	Female	43	31.2
Teaching Subjects	Mathematics	48	34.8
	Biology	27	19.6
	Chemistry	26	18.8
	Physics	37	26.8
Years in Service	Up to 5 years	54	39.1
	6 to 10 years	36	26.1
	11 to 15 years	24	17.4
	16 to 20 years	13	9.4
	21 to 25 years	7	5.1
	Above 25 years	4	2.9
Employment Status	Part-time	28	20.3
	Full-time	110	79.7
Payroll Status	Government	64	46.4
	Private	74	53.6

The study involved 138 secondary school STEM teachers, with 58.7% from rural schools and 41.3% from urban schools. This rural-urban spread allowed for an exploration of context-specific readiness and challenges, particularly in less-resourced rural settings where infrastructural limitations often hinder ICT integration (Jimoyiannis & Komis, 2007). Male teachers constituted 68.8% of the sample, reflecting a gender imbalance commonly observed in STEM education (Blickenstaff, 2005).

Mathematics teachers formed the largest subject group (34.8%), followed by Physics (26.8%), Biology (19.6%), and Chemistry (18.8%). These distributions provided a balanced view across STEM disciplines, each with varying opportunities and constraints for integrating Indigenous materials and ICT tools (Wachira & Keengwe, 2011)

Most teachers (39.1%) had up to 5 years of experience, indicating a predominantly early-career cohort likely open to innovation but requiring support. A fair proportion (43.5%) had between 6 and 15 years of experience, representing a stable and potentially influential group. Teachers with over 15 years of experience were fewer and may face greater challenges in adopting new pedagogies (Mumtaz, 2000).

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Regarding employment, 79.7% of the teachers were full-time, suggesting strong institutional engagement, while 20.3% were part-time, a group often constrained by limited training opportunities. Government-employed teachers made up 46.4% of the sample, compared to 53.6% from private institutions, allowing for cross-comparison of support systems and readiness levels.

Teachers' Knowledge Levels Regarding the Integration of Indigenous Materials and ICT Tools.

Teachers' knowledge levels were measured using a 5-point Likert scale with 1 representing strongly Disagree, 2 representing Disagree, 3 representing Neutral, 4 representing Agree, and 5 representing strongly Agree. The results of the mean and standard deviation (S.D) for each measure of Teachers' knowledge are illustrated in Table 2.

Table 2: Showing Descriptive Statistics of Teachers' Knowledge Levels Regarding the integration of Indigenous materials and ICT tools.

Knowledge Related Statement	Mean	S.D
Knowledge of the use of Indigenous Materials in Practical-based STEM Teaching	3.3	0.95
Knowledge of the Benefits of Incorporating ICT Tools into STEM Lessons	3.6	0.79
Knowledge of Challenges Associated with Using Indigenous Materials and ICT Tools in STEM Education	3.0	0.65
Knowledge of Best Practices for Integrating ICT Tools to Enhance Student Learning in STEM	3.2	0.90
Knowledge of Cultural Significance of Utilizing Indigenous Materials in STEM Education	2.9	1.05
Knowledge of Technical Requirements and Considerations for Using ICT Tools in Practical-based STEM Teaching	2.9	0.79

Teachers exhibited moderate knowledge of using Indigenous materials for STEM instruction (M = 3.3), indicating basic familiarity but a need for improvement through targeted training (Mishra & Koehler, 2006). Their understanding of ICT benefits was relatively strong and consistent (M = 3.6), reflecting positive perceptions of its role in enhancing learning (Hew & Brush, 2007). However, knowledge of integration challenges (M = 3.0) and ICT best practices (M = 3.2) remained limited, suggesting gaps in practical application (Ertmer & Ottenbreit-Leftwich, 2010).

Knowledge of the cultural significance of Indigenous materials (M = 2.9) and technical requirements for ICT use (M = 2.9) was particularly low, pointing to the need for culturally responsive and skills-based training (Barnhardt & Oscar Kawagley, 2005; Pelgrum, 2001).

Focus group data confirmed these findings. Teachers struggled to apply Indigenous materials to abstract STEM topics and lacked skills in creating or sharing digital content, revealing significant practical limitations (Tondeur et al., 2012). These results reinforce the need for ongoing professional development and improved infrastructure to support the effective integration of ICT (Voogt et al., 2013).

Teachers' Attitudes towards Integrating Indigenous Materials and ICT Tools into STEM Teaching.

Teachers' attitudes were measured using a 5-point Likert scale with 1 representing strongly Disagree, 2 representing Disagree, 3 representing Neutral, 4 representing agree and 5 representing strongly Agree. The results of the mean and standard deviation (S.D) for each measure of Teachers' attitudes are illustrated in Table 3.

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Table 3: Showing Descriptive Statistics of Teachers' Attitudes towards Integrating These Resources into STEM Teaching

Attitude Related Statement	Mean	S.D
Perceived Importance of ICT Tools in Promoting Collaborative Learning among Students in STEM	4.1	0.76
Perceived Effectiveness of ICT Tools for Fostering Creativity and Innovation in Practical-based STEM Activities	4.0	0.79
Confidence in the Role of Indigenous Materials and ICT Tools for Enhancing Students' Problem-Solving Skills in STEM	3.6	0.60
Perceived Impact of Integrating Indigenous Materials and ICT Tools on Students' Learning Outcomes in STEM	3.9	0.60
Perceived Long-Term Benefits of Integrating Indigenous Materials and ICT Tools in Shaping Students' Future STEM Careers	4.3	0.76
Perceived Alignment of Indigenous Materials and ICT Tools with Pedagogical Goals of STEM Curriculum	3.9	0.97
Extent of Integration of Indigenous Materials and ICT Tools to Support Development of Critical Thinking Skills among Students	3.4	0.87
Perceived Importance of Combining Indigenous Materials and ICT Tools to Cater to Different Learning Styles and Preferences	4.1	0.72
Frequency of Exposure to Indigenous Materials and ICT Tools in Professional Development Sessions	2.7	0.80

Teachers perceived the importance of ICT tools in promoting collaborative learning among students in STEM highly, with a mean score of 4.1 and a low standard deviation of 0.76, indicating strong agreement and consistency. Similarly, the perceived effectiveness of ICT tools for fostering creativity and innovation in practical-based STEM activities had a mean score of 4.0 and a standard deviation of 0.79, reflecting a positive and consistent attitude. Confidence in the role of Indigenous materials and ICT tools for enhancing students' problem-solving skills in STEM was moderately high, with a mean score of 3.6 and a standard deviation of 0.60, suggesting some variability but generally positive confidence levels. The perceived impact of integrating these resources on students' learning outcomes had a mean score of 3.9 and a standard deviation of 0.60, indicating a positive attitude and low variability among teachers (Law & Plomp, 2008).

Teachers rated the perceived long-term benefits of integrating Indigenous materials and ICT tools in shaping students' future STEM careers very highly, with a mean score of 4.3 and a standard deviation of 0.76, showing strong agreement and consistency. The perceived alignment of these resources with the pedagogical goals of the STEM curriculum had a mean score of 3.9 and a standard deviation of 0.97, indicating a generally positive perception but with more variability. The extent of integration of Indigenous materials and ICT tools to support the development of critical thinking skills among students was rated moderately, with a mean score of 3.4 and a standard deviation of 0.87, suggesting that while there is a positive attitude, there is room for improvement (Schrum et al., 2005). The perceived importance of combining Indigenous materials and ICT tools to cater to different learning styles and preferences was rated highly, with a mean score of 4.1 and a standard deviation of 0.72, indicating strong agreement and consistency. However, the frequency of exposure to indigenous materials and ICT tools in professional development sessions was rated lower, with a mean score of 2.7 and a standard deviation of 0.80, indicating infrequent exposure and more variability among responses (Ertmer & Ottenbreit-Leftwich, 2010).

Teachers' Practical Experiences in Applying Indigenous Materials and ICT Tools in STEM Teaching.

Teachers’ practical experiences were measured using a 5-point Likert scale with 1 representing strongly Disagree, 2 representing Disagree, 3 representing Neutral, 4 representing agree and 5 representing strongly Agree. The results of the mean

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

and standard deviation (S.D) for each measure of Teachers' experience are illustrated in Table 4.

Table 4: Showing Descriptive Statistics of Teachers' Practical Experiences in Applying Indigenous Materials and ICT Tools in STEM Teaching.

Practical Experiences Statement	Mean	S.D
Frequency of Incorporating Indigenous Materials into Practical-based STEM Lessons	3.1	0.78
Time Spent on Preparing and Integrating Indigenous Materials into Curriculum	3.2	1.11
Effectiveness of Indigenous Materials in Enhancing Student Engagement during STEM Activities	3.6	0.81
Perceived Support and Resources for Integrating Indigenous Materials and ICT Tools in Teaching	2.9	1.07
Frequency of Collaboration with Colleagues to Enhance Integration of Indigenous Materials and ICT Tools	3.2	0.90

Teachers reported a moderate frequency of using Indigenous materials in STEM lessons (M = 3.1, SD = 0.78), suggesting occasional but inconsistent integration across classrooms. Preparation time for incorporating these materials was also moderate (M = 3.2), though with wide variability (SD = 1.11), indicating differing levels of effort among teachers (Hew & Brush, 2007)

The perceived effectiveness of Indigenous materials in enhancing student engagement was relatively high and consistent (M = 3.6, SD = 0.81), affirming their educational value. However, support and resources for integrating Indigenous materials and ICT tools were rated lower (M = 2.9, SD = 1.07), reflecting mixed experiences and the need for improved infrastructure and assistance (Pelgrum, 2001)

Focus group data echoed these findings. Teachers noted that Indigenous materials aid in content retention and engagement, while ICT tools support time management and conceptual clarity. One teacher remarked, "ICT tools capture and sustain learners' attention," while another emphasized that Indigenous resources help "promote equity and break boredom" (Law & Plomp, 2008)

Additionally, collaboration among teachers to improve integration was moderate (M = 3.2, SD = 0.90), indicating occasional peer support that could be strengthened to enhance best practice sharing (Kopcha, 2012).

Teachers' Readiness to Integrate Indigenous Materials and ICT Tools into STEM Teaching

Teachers' readiness levels were measured using a 5-point Likert scale with 1 representing strongly Disagree, 2 representing Disagree, 3 representing Neutral, 4 representing agree and 5 representing strongly Agree. The results of the mean and standard deviation (S.D) for each measure of Teachers' readiness are illustrated in Table 5.

Table 5: Showing Descriptive Statistics of Teachers' Readiness to Integrate Indigenous Materials and ICT Tools into STEM Teaching

Readiness Related Statement	Mean	S.D
Preparedness to Integrate Indigenous Materials Effectively into STEM Curriculum	3.4	0.94
Confidence in Identifying Suitable Indigenous Materials for Practical-based STEM Activities	3.4	0.86
Preparedness to Address Potential Challenges Related to Integrating Indigenous Materials and ICT Tools	3.2	0.96
Frequency of Encountering Technical Difficulties when Using ICT Tools in STEM Lessons	3.1	1.00
Perceived Difficulty in Accessing Suitable Indigenous Materials for STEM Activities	2.9	0.90
Perceived Success in Overcoming Challenges Related to ICT Integration in STEM Lessons	3.1	0.97

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

Readiness Related Statement	Mean	S.D
Perceived Adaptability of Indigenous Materials and ICT Tools to Different STEM Topics and Learning Objectives	3.1	0.77
Perceived Value of Additional Training and Support in Improving Proficiency in Using Indigenous Materials for Practical-based STEM Teaching	4.4	0.78

Teachers reported a moderate level of preparedness to integrate Indigenous materials into the STEM curriculum (M = 3.4, SD = 0.94) and a similar level of confidence in identifying suitable materials (M = 3.4, SD = 0.86). While most felt fairly capable, the findings suggest that further support could enhance their readiness (Schrum et al., 2005). Preparedness to address integration challenges was slightly lower (M = 3.2), indicating variability in teachers' ability to manage difficulties with both Indigenous materials and ICT tools.

Technical difficulties during ICT use were a moderate concern (M = 3.1, SD = 1.00), showing that teachers face frequent barriers, including unstable infrastructure (Mumtaz, 2000). Teachers also reported challenges in accessing suitable Indigenous materials (M = 2.9), pointing to the need for improved availability and contextual alignment (Barnhardt & Oscar Kawagley, 2005). Their perceived success in overcoming ICT-related challenges remained moderate (M = 3.1), indicating ongoing limitations despite some adaptive efforts (Pelgrum, 2001).

The adaptability of these resources to different STEM topics was also rated moderately (M = 3.1), while the highest-rated item was the perceived value of additional training and support (M = 4.4), showing widespread agreement on the importance of further professional development (Law & Plomp, 2008).

Focus group discussions supported these results. Teachers described barriers such as poor internet access, high costs of materials, and lack of ICT skills, which constrained integration efforts. One teacher noted, "Some schools lack electricity and internet connectivity, and materials are costly to access." Despite these obstacles, teachers shared innovative practices, such as using local plants for chemistry demonstrations. However, issues like limited lesson time and resource shortages continued to restrict effective use.

These findings are consistent with previous studies highlighting training and infrastructure as critical enablers for ICT integration (Eglash et al., 2020), and they contribute a localized understanding of these challenges within the Rwenzori region.

Categorizing Teachers' Readiness Level

To analyze teachers' readiness for integrating Indigenous materials and ICT tools in STEM education, we combined eight indicators: preparedness to integrate Indigenous materials, confidence in identifying suitable materials, preparedness to address challenges, frequency of technical difficulties, perceived difficulty in accessing materials, success in overcoming ICT challenges, adaptability of materials and tools, and the value of additional training. These indicators were normalized and summed to create a composite readiness score, which was then categorized into four levels- Low, Moderate, High, and Very high- using the 25th, 50th, and 75th percentiles. Table 6 shows the results.

From Table 6, the distribution of teachers' readiness levels for integrating Indigenous materials and ICT tools in STEM teaching indicates that 24.6% fall into the low readiness category, requiring significant support and training. Another 24.6% have moderate readiness and could benefit from additional professional development (Hew & Brush, 2007; Jimoyiannis & Komis, 2007). About 13.0% have high readiness, needing only occasional support and updates, while the largest group, 37.7%, has very high readiness, already effectively integrating these materials and tools into their teaching.

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

Table 6: Frequency Distribution of Readiness Levels

Readiness Level	Frequency	Percent	Valid Percent	Cumulative Percent
Low Readiness	34	24.6%	24.6%	24.6%
Moderate Readiness	34	24.6%	24.6%	49.3%
High Readiness	18	13.0%	13.0%	62.3%
Very High Readiness	52	37.7%	37.7%	100.0%
Total	**138**	**100.0%**	**100.0%**	**100.0%**

Independent Samples t-test Results

The results of the significant differences in readiness among teachers based on their location, gender, payroll status, and employment status are presented in Table 7.

Table 7: Showing Independent Sample t-test Result.

Group Variable	Group 1	Group 2	Mean Group 1	Mean Group 2	t-statistic	p-value
Locations	Rural (1)	Urban (2)	3.28	3.13	2.291	0.028
Gender	Male (1)	Female (2)	3.22	3.22	-0.045	0.964
Payroll status	Govt (1)	Private (2)	3.16	3.27	-1.584	0.166
Employment status	Full-time (1)	Part-time (2)	3.31	3.20	1.298	0.197

The analysis revealed a significant difference in teachers' readiness based on their location, with rural teachers having a higher mean readiness score (3.28) compared to their urban counterparts (3.13). The t-test result (t(136) = 2.291, p = 0.028) indicates that this difference is statistically significant. Possible reasons for this higher readiness among rural teachers could include better adaptation to available resources and closer community ties, which may foster greater support and motivation for teachers in rural areas (Jimoyiannis & Komis, 2007). This contrasts with some previous studies, such as those by Jimoyiannis & Komis (2007), which suggested that urban teachers are generally better prepared due to better access to resources. The higher readiness among rural teachers in this study could be attributed to their closer ties with the community and a greater reliance on available resources, as suggested by the focus group discussions.

The t-test results showed no significant difference in teachers' readiness based on gender, with both male and female teachers having an identical mean readiness score of 3.22 (t(136) = -0.045, p = 0.964). This suggests that both male and female teachers receive similar levels of support and opportunities, leading to comparable levels of readiness (Blickenstaff, 2005). Regarding payroll status, the mean readiness score for government-employed teachers was 3.16, while that for privately employed teachers was 3.27. The t-test result (t(136) = -1.584, p = 0.166) indicated no statistically significant difference in readiness based on payroll status. This similarity in readiness could be attributed to both groups receiving comparable training and professional development. Moreover, differences in payroll might not significantly impact teachers' preparedness and ability to perform their duties (Pelgrum, 2001). The analysis also indicated no significant difference in readiness based on employment status, with full-time teachers having a mean readiness score of 3.31 and part-time teachers having a mean score of 3.20 (t(136) = 1.298, p = 0.197). This finding suggests that both full-time and part-time teachers exhibit similar levels of commitment and engagement in their roles.

Correlation between Teachers' Knowledge, Experiences, Attitudes, and Readiness

Table 8 presents the Pearson correlation coefficients among teachers' knowledge, experiences, attitudes and beliefs, and readiness to integrate indigenous materials and ICT tools in STEM education. The scores for each variable were computed as the average of the corresponding indicators.

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

Table 8: Showing Correlation Coefficients for the Latent Variables.

		Teachers' Knowledge	Teachers' Experiences	Teachers' Attitudes and Beliefs	Teachers' Readiness
Teachers' Knowledge	Pearson Correlation	1	.380**	.356**	.538**
	Sig. (2-tailed)		.000	.000	.000
	N	138	138	138	138
Teachers' Experiences	Pearson Correlation	.380**	1	.560**	.423**
	Sig. (2-tailed)	.000		.000	.000
	N	138	138	138	138
Teachers' Attitudes and Beliefs	Pearson Correlation	.356**	.560**	1	.385**
	Sig. (2-tailed)	.000	.000		.000
	N	138	138	138	138
Teachers' Readiness	Pearson Correlation	.538**	.423**	.385**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	138	138	138	138

**. Correlation is significant at the 0.01 level (2-tailed).

From Table 8, the Pearson correlation coefficient between teachers' knowledge and teachers' experiences is 0.380, which is statistically significant at the 0.01 level ($p < 0.001$). This indicates a moderate positive correlation, suggesting that as teachers' knowledge about Indigenous materials and ICT tools increases, their practical experiences with these resources also tend to improve. The correlation between teachers' knowledge and their attitudes and beliefs is 0.356, also significant at the 0.01 level ($p < 0.001$). This moderate positive correlation implies that higher levels of knowledge are associated with more positive attitudes and beliefs toward integrating Indigenous materials and ICT tools in STEM education (Mishra & Koehler, 2006). Notably, the strongest correlation is between teachers' knowledge and their readiness to integrate these resources, with a coefficient of 0.538 ($p < 0.001$). This strong positive correlation indicates that greater knowledge significantly enhances teachers' readiness to effectively incorporate Indigenous materials and ICT tools into their teaching practices (Ertmer & Ottenbreit-Leftwich, 2010). On the other hand, teachers' experiences are moderately correlated with their attitudes and beliefs, with a Pearson correlation coefficient of 0.560 ($p < 0.001$). This suggests that teachers who have more practical experience with indigenous materials and ICT tools tend to hold more positive attitudes and beliefs about their integration into STEM education. The correlation between teachers' experiences and their readiness is 0.423 ($p < 0.001$), indicating a moderate positive relationship. This means that practical experience contributes to teachers' readiness to integrate these resources, though not as strongly as knowledge does (Tondeur et al., 2012).

Lastly, there is a moderate positive correlation between teachers' attitudes and beliefs and their readiness, with a Pearson correlation coefficient of 0.385 ($p < 0.001$). This indicates that more positive attitudes and beliefs are associated with a higher readiness to integrate Indigenous materials and ICT tools, although this relationship is not as strong as the correlation with knowledge or experiences (Ertmer & Ottenbreit-Leftwich, 2010).

The results revealed that teachers' knowledge is a strong predictor of their readiness to integrate Indigenous materials and ICT tools into STEM education. This aligns with previous research by Imaduddin et al. (2020) and Sumarni & Kadarwati (2020), who emphasized the importance of teachers' understanding of Indigenous knowledge in enriching STEM education. However, this study extends the existing literature by providing a comprehensive evaluation of teachers' knowledge and readiness, specifically in the Rwenzori region. The significant

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correlation between knowledge and readiness underscores the need for targeted professional development programs to enhance teachers' understanding of Indigenous materials and ICT tools, as highlighted by Ertmer & Ottenbreit-Leftwich (2010).

The Predictive Power of Teachers' Knowledge, Experiences, and Attitudes on Their Readiness.

Tables 9 and 10 illustrate the results of the ANOVA and the coefficients, respectively, for the Hierarchical Regression model for teachers' Readiness (as the dependent variable) and teachers' knowledge, experiences, and attitudes (as independent variables).

Table 9: Showing ANOVA for Hierarchical Regression

Model	R Square	Sum of Squares	df	Mean Square	F	Sig.
1	.289	6.181	1	6.181	55.344	.000
2	.332	7.096	2	3.548	33.559	.000
3	.356	7.608	3	2.536	24.694	.000

According to Table 9, the ANOVA results for the hierarchical regression models indicate significant improvements at each step. Model 1 shows that teachers' knowledge significantly predicts readiness, with a sum of squares of 6.181 and an F-value of 55.344 ($p < .001$). Model 2, which adds attitudes and beliefs, further improves the model with a sum of squares of 7.096 and an F-value of 33.559 ($p < .001$). Model 3 includes practical experiences, yielding the best fit with a sum of squares of 7.608 and an F-value of 24.694 ($p < .001$). Each model significantly enhances the explanation of variance in teachers' readiness, highlighting the importance of knowledge, attitudes, and practical experiences in preparing teachers to integrate indigenous materials and ICT tools into STEM teaching (Ertmer & Ottenbreit-Leftwich, 2010).

Table 10: Showing Coefficients for Hierarchical Regression

Model	Variable	B	Std. Error	Beta	t	Sig.
1	(Constant)	1.979	.169		11.680	.000
	Teachers' Knowledge	.397	.053	.538	7.439	.000
2	(Constant)	1.488	.234		6.350	.000
	Teachers' Knowledge	.339	.056	.459	6.096	.000
	Teachers' Attitudes and Beliefs	.170	.058	.222	2.942	.004
3	(Constant)	1.458	.231		6.303	.000
	Teachers' Knowledge	.310	.056	.419	5.495	.000
	Teachers' Attitudes and Beliefs	.098	.065	.128	1.502	.136
	Teachers’ Experiences	.128	.057	.192	2.232	.027

According to Table 10, in Model 1, teachers' knowledge significantly predicted readiness ($B = .397$, $p < .001$), indicating that greater knowledge enhances readiness. Model 2 added attitudes and beliefs, showing further improvement ($B = .339$, $p < .001$ for knowledge; $B = .170$, $p = .004$ for attitudes and beliefs), highlighting the additional positive impact of teachers' perceptions. Model 3 included practical experiences, revealing that while knowledge ($B = .310$, $p < .001$) and practical experiences ($B = .128$, $p = .027$) significantly enhance readiness, the effect of attitudes and beliefs ($B = .098$, $p = .136$) became non-significant. This suggests that practical experiences play a crucial role in readiness, potentially outweighing the impact of attitudes and beliefs. These results accentuate the importance of not only enhancing teachers' knowledge but also providing practical application opportunities to improve their readiness for integrating Indigenous materials and ICT tools into STEM teaching (Ertmer & Ottenbreit-Leftwich, 2010; Pelgrum, 2001).

CONCLUSION

This study revealed that teachers possess moderate knowledge and positive attitudes toward integrating Indigenous materials and ICT tools in STEM

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

education, particularly among rural teachers. However, their practical experience remains limited, indicating a need for more hands-on training. While teachers understand the benefits of ICT, their awareness of the cultural value of Indigenous materials is lower, highlighting a gap in professional development.

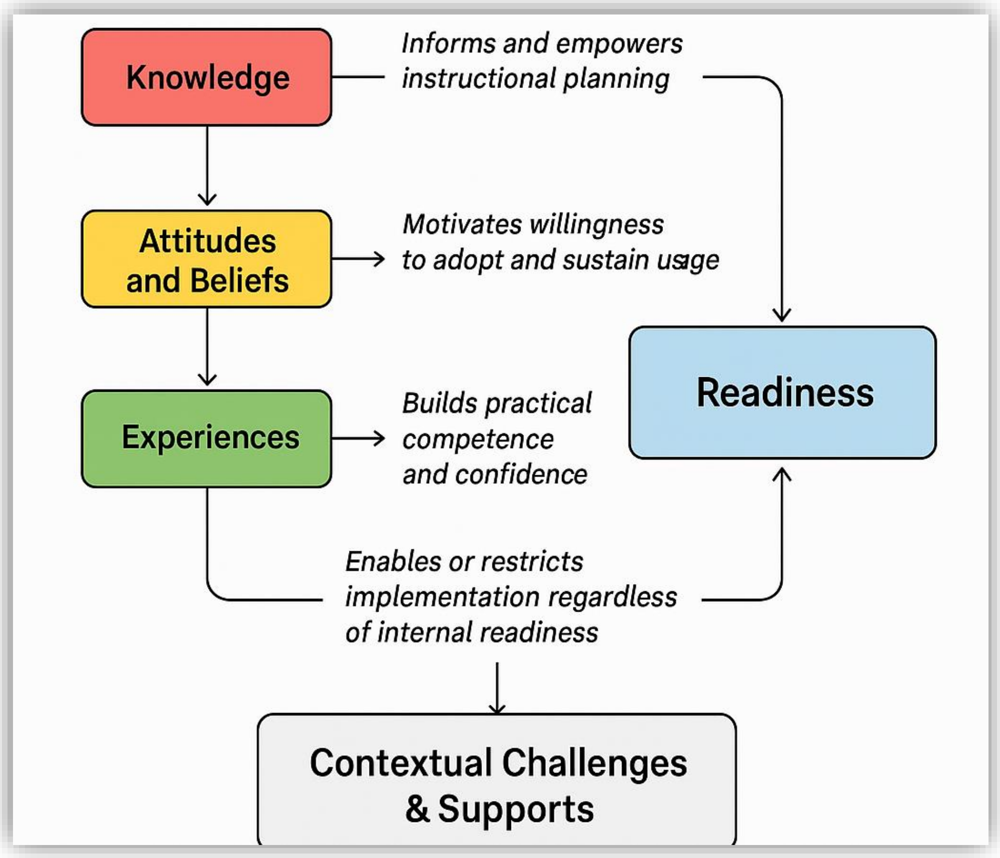
Overall, teacher readiness was found to be moderate, with key challenges including technical barriers and limited access to suitable Indigenous resources. Knowledge emerged as the strongest predictor of readiness, followed by practical experience, while attitudes played a supporting role.

These findings align with the principles of Cultural-Historical Activity Theory (CHAT), emphasizing that learning is shaped by cultural tools and context. The RIIMIT-STEM model developed from this study reinforces the importance of enhancing teachers' knowledge and experience to improve readiness for effective and inclusive STEM instruction.

Proposed Model for Enhancing Teachers' Readiness

The RIIMIT-STEM Model, Readiness for Integration of Indigenous Materials and ICT Tools in STEM Instruction, was developed from the findings of this study to explain how teacher readiness is built and enhanced through the interaction of key factors. The model emerged from both quantitative and qualitative data showing that teacher readiness is shaped by a combination of knowledge, attitudes, and practical experiences, all operating within specific contextual environments as illustrated in Figure 1.

Figure 1: Showing the RIIMIT-STEM Model



In the model as indicated in Figure 1, teacher knowledge serves as the foundation for integration. Teachers with a strong understanding of how to use Indigenous materials and ICT tools in STEM teaching are more likely to feel capable and prepared. Positive attitudes and beliefs, such as confidence in the tools' effectiveness and alignment with curriculum goals, further strengthen their willingness to integrate them.

Article DOI: https://doi.org/10.37284/eajes.8.2.2872

Yet, readiness becomes more solid through practical experience. Teachers who actively apply their knowledge in the classroom gain confidence and refine their integration strategies. Experience reinforces both knowledge and attitudes, creating a continuous cycle of professional growth.

Finally, contextual factors such as infrastructure, school setting, and access to materials influence how well these internal factors can be put into practice. Even well-prepared teachers may face limitations without supportive conditions.

The RIIMIT-STEM Model thus offers a clear, evidence-based framework for improving teacher readiness through professional development, peer collaboration, and targeted support—ultimately promoting inclusive, resource-responsive STEM instruction.

Areas of Further Research

Future research should test and refine the RIIMIT-STEM Model to ensure its effectiveness and applicability in diverse educational settings, explore the long-term impact of Indigenous materials and ICT tools integration on student achievement and cultural preservation efforts, and Pilot some ICT tools such as GeoGebra in teaching specific topics in STEM subjects.

Data Availability

Data is available on Request.

Conflict of Interest

The authors declare no conflict of interest regarding the publication of this study.

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