TEACHERS' PERCEPTIONS, PRACTICES AND CHALLENGES OF INTEGRATING TECHNOLOGY AND INDIGENOUS KNOWLEDGE SYSTEMS IN SCIENCE PEDAGOGY IN NIGERIAN SECONDARY SCHOOLS

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Abstract

This study examined science teachers' perceptions, instructional practices, and challenges in integrating technology and Indigenous Knowledge Systems (IKS) in science pedagogy within Nigerian secondary schools. A mixed-method research design was adopted and a stratified sampling technique was used to select participants from riverine, rural upland and city centre schools in Rivers State. Two research instruments were employed: the Technology and Indigenous Knowledge Integration in Science Pedagogy Questionnaire (TIKISPQ), which yielded a reliability coefficient of 0.81 using Cronbach's alpha and Technology and Indigenous Knowledge Integration in Science Pedagogy Interview Template. Both instruments were validated by experts in science education and educational technology. Data were analyzed using frequency counts, mean, and standard deviation to answer the research questions, while Analysis of Variance (ANOVA) and Scheffй post hoc tests were used to test the null hypotheses. Findings revealed that science teachers held positive perceptions of integrating technology and IKS (M = 3.33, SD = 0.91), though their instructional practices were generally low (M = 2.18, SD = 0.92). Teachers also reported facing several challenges in implementation (M = 3.26, SD = 0.92). ANOVA results indicated no significant differences in perceptions [F(2,118) = 1.87, p = .158] or challenges [F(2,118) = 1.32, p = .271], but a significant difference in instructional practices across school locations [F(2,118) = 5.72, p = .004]. It was recommended that government and educational authorities provide adequate ICT facilities and that teacher training institutions offer continuous professional development to enhance teachers' capacity for effective technology and IKS integration in science pedagogy.

Keywords: Technology Integration, Indigenous Knowledge Systems, Science Pedagogy, Teachers' Perceptions, Nigerian Secondary Schools

Introduction

Technology integration in education refers to the deliberate and systematic application of digital tools and resources to enhance the process of teaching and learning across various educational settings. This approach includes the embedding of digital technologies, both hardware and software such as computers, tablets, Learning Management Systems, Educational Apps, digital laboratories, interactive whiteboards, simulations and multimedia presentations into instructional practices to enhance content delivery, learner engagement and knowledge construction (Hennessy et al., 2022). For technology integration to be effective, it must go beyond the simple use of digital devices. It also requires the alignment of technological tools with pedagogical goals and curriculum objectives to facilitate active, inquiry-based and collaborative learning experiences. Utilizing digital simulations and virtual experiments allows students to visualize complex scientific phenomena, while multimedia content addresses various learning styles and encourages deeper understanding. As a result, the integration of technology transforms classrooms into dynamic and student-centered environments where teachers take on the role of facilitators, guiding students in their exploration and application of knowledge through digital resources (UNESCO, 2023).

Amidst the ongoing digital transformation, the integration of Indigenous Knowledge Systems (IKS) into science teaching and learning has garnered increasing global recognition as a fundamental aspect of inclusive and culturally relevant pedagogy. Indigenous Knowledge Systems are bodies of knowledge that are locally grounded and community based, developed over generations through interactions with the natural environment (Aderonmu & Adolphus, 2021). They are inherently experiential, relying on observation, practice and oral transmission to interpret and manage natural phenomena such as weather patterns, agriculture, health, among others. This knowledge has been vital for traditional societies, guiding their survival strategies, resource management, and environmental stewardship, all of which are deeply rooted in cultural values and lived experiences (Ngubane & Mkhize, 2021). Indigenous knowledge provides deep, contextual understandings of natural phenomena based on centuries of lived experiences and interactions with the environment. When coupled with digital technologies, IKS can be preserved, recorded and shared more efficiently, creating opportunities for learners to relate scientific theories to local contexts (Aderonmu & Adolphus, 2021). This intersection affirms indigenous ways of knowing and promotes a comprehensive science pedagogy that connects contemporary scientific exploration with ancestral knowledge, harmonizing innovation with cultural preservation. In recent years, Indigenous Knowledge Systems (IKS) have garnered more recognition as important and culturally significant resources for contextualizing science teaching, especially in African educational contexts. IKS includes the shared knowledge, values and practices that indigenous groups have cultivated over time to understand and engage with their natural surroundings (Ngubane & Mkhize, 2021).

Technology and Indigenous Knowledge Systems (IKS) can complement one another to foster significant and culturally pertinent science teaching by

combining contemporary scientific tools with traditional methods of understanding the environment. Digital technologies like multimedia applications, simulations and virtual reality can serve to preserve, showcase and convey indigenous practices and environmental knowledge, rendering them accessible to learners in captivating and interactive formats. This integration enhances profound conceptual comprehension, affirms learners' cultural identities, and promotes valuing diverse ways of understanding. Thus, integrating technology with IKS enhances scientific teaching and promotes decolonized, inclusive and contextually relevant education that aligns with students' real-life experiences.

Integrating technology and indigenous knowledge into science teaching and learning activities aligns well with Nigeria's ongoing educational reforms, the National ICT-in-Education Policy, and the International Sustainable Development Goal 4 (SDG 4) concerning Quality Education. Nigeria's educational policy framework highlights leveraging ICT to enhance teaching quality, widen access and encourage innovative teaching methods that consider learners' cultural and social backgrounds (FME, 2021). Integrating technology with Indigenous Knowledge Systems (IKS) in science teaching offers numerous advantages as highlighted by (Eze & Mphahlele, 2023; UNESCO, 2023)

(i) *enhance cultural significance and inclusiveness*: Integrating technology with IKS guarantees that science pedagogy reflect learners' cultural histories and personal experiences, enhancing the meaning and inclusivity of the learning process.

(ii) *promotes better grasp of scientific ideas*: Applying digital resources to demonstrate indigenous methods like farming, medicine or ecological management enables students to link theoretical science with real world applications.

(iii) *preserves and revitalizes indigenous knowledge:* Technology facilitates capturing, storing, and sharing IKS via digital archives, videos and online platforms, preserving cultural heritage for future generations.

(iv) *promotes inquiry-driven and participatory learning*: The integration of IKS and digital tools fosters experiential, hands-on learning, allowing students to explore local phenomena through a combination of traditional knowledge and contemporary technology.

(v) *fosters critical thinking and innovation abilities*: The integration of traditional knowledge and digital inquiry cultivates creativity, problem-solving and innovative skills vital for tackling scientific challenges both locally and globally.

Science teachers serve as crucial players in integrating technology and Indigenous Knowledge Systems (IKS) in classroom practice. Their capacity to merge these domains relies on their perceptions, teaching skills, cultural understanding and technological expertise, which together affect how well they contextualize science learning (Aikenhead & Ogawa, 2021). Teachers not only design and implement lessons that incorporate digital tools such as multimedia presentations, simulations and online resources but also draw connections to indigenous practices and locally relevant examples that resonate with students' experiences. Investigating teachers' practices, perceptions and challenges is crucial for enhancing

culturally responsive science pedagogy in Nigeria since teachers act as the main facilitators of curriculum implementation. Examining their classroom practices and perceived obstacles offers understanding into the contextual factors that influence teaching and learning processes, encompassing infrastructural, pedagogical and cultural limitations.

Statement of Problem

Despite the increasing advocacy and support for merging technology with Indigenous Knowledge Systems (IKS) in science pedagogy, there is still a lack of empirical evidence regarding how teachers actually apply this dual approach in classroom environments, especially in developing regions such as Nigeria. Most existing studies in science pedagogy have examined either Information and Communication Technology (ICT) integration or Indigenous Knowledge Systems (IKS) in isolation, rather than exploring their intersection as complementary pedagogical frameworks. Research on ICT integration has largely emphasized digital literacy, infrastructure, and teacher competency, while studies on IKS have focused on cultural preservation, contextual learning and decolonizing the curriculum. This separation overlooks the potential synergy between technology and indigenous knowledge in creating more inclusive, culturally responsive and inquiry-based science teaching. Consequently, there is a growing need for empirical studies that investigate how teachers can harmonize technological tools with indigenous epistemologies to enrich science learning experiences, particularly within African educational contexts. It is on this premise that this study was carried out to investigate science teachers' perception, practices and challenges towards the integrating technology and indigenous knowledge systems in science pedagogy in Nigerian secondary schools.

Aim and objectives of the study

The aim of this study is to examine teachers' perceptions, practices and challenges of integrating technology and indigenous knowledge systems in science pedagogy. Specifically, the objectives of the study are to;

(i) investigate teachers' perceptions toward the integration of technology and Indigenous Knowledge Systems in science pedagogy.

(ii) **examine the instructional practices** of science teachers in integrating technology and Indigenous Knowledge Systems (IKS) within secondary school science classrooms in Nigeria.

(iii) **identify the major challenges** faced by science teachers in implementing the integration of technology and Indigenous Knowledge Systems in Nigerian secondary schools.

Research Questions

The following research questions were raised to guide the study.

1. What are the perceptions of science teachers toward the integration of technology and Indigenous Knowledge Systems in science pedagogy?
2. What instructional practices do science teachers employ in integrating technology and Indigenous Knowledge Systems (IKS) in science teaching and learning in Nigerian secondary schools?
3. What challenges do science teachers face in implementing the integration of technology and Indigenous Knowledge Systems in Nigerian secondary schools?

Hypotheses

The following hypotheses were tested at 0.005 level of significance.

Ho_1: There is no significant difference in the perceptions of science teachers toward the integration of technology and Indigenous Knowledge Systems (IKS) in science pedagogy across riverine areas, rural upland and city centres.

Ho_2: There is no significant difference in the instructional practices of science teachers in integrating technology and Indigenous Knowledge Systems (IKS) across riverine areas, rural upland and city centres.

Ho_3: There is no significant difference in the challenges faced by science teachers in implementing the integration of technology and Indigenous Knowledge Systems (IKS) across riverine areas, rural upland and city centres.

Methodology

This study adopted a mixed-method research design, which combines both quantitative and qualitative approaches to provide a comprehensive understanding of science teachers' practices, perceptions, and challenges in integrating technology and Indigenous Knowledge Systems (IKS) in science pedagogy. The quantitative aspect involved the use of a structured questionnaire to collect numerical data on teachers' practices perceptions, practices and challenges, while the qualitative component used semi-structured interviews to obtain in-depth insights into teachers' experiences and contextual realities. The mixed-method approach was chosen to enhance the validity of findings through triangulation and to provide a richer interpretation of the data collected from diverse educational settings.

The population of this study comprised all science teachers in public secondary schools located across riverine, rural upland, and city centre areas of Rivers State, Nigeria. People in riverine, rural upland, and city centers are classified by their unique geographic settings, which influence population density, building patterns and economic activities. Riverine communities are located along rivers with characteristics such as potential flooding and reliance on the water for transport, while rural upland settlements feature dispersed, low-density populations and significant agricultural activity. City centers are characterized by high population density, numerous amenities and dense infrastructure, distinguishing them from other settlement types. These regions were selected to reflect the geographical and infrastructural diversity of the state, which may influence teachers' access to technology and their use of Indigenous Knowledge Systems in science instruction.

A sample size of 121 Science teachers was selected for the study obtained by the stratified sampling technique from the three geographical strata; riverine (21), rural upland (43) and city centre (57). Two researchers' self-designed instruments were employed for data collection. A structured questionnaire titled "Technology and Indigenous Knowledge Integration in Science Pedagogy Questionnaire" (TIKISPQ) was developed by the researchers. The instrument consisted of 30 item statements distributed across the three research questions, 10 item statements each addressing teachers' perceptions, practices and challenges. The items were structured on a four-point Likert scale with a reliability coefficient index of 0.81 using Cronbach's Alpha.

The second instrument was titled, Technology and Indigenous Knowledge Integration in Science Pedagogy Interview Template (TIKISPIT) which

consist of a semi-structured interview guide was developed to complement the quantitative data. The interview focused on eliciting teachers' detailed views on how they integrate technology and IKS in their teaching, as well as the contextual challenges they face in their respective environments. The instrument was validated by two experts in Educational Research to ensure clarity, relevance, and alignment with the study objectives. Data analysis was conducted using mean and standard deviations to answer the research questions while Analysis of Variance (ANOVA) to test the hypotheses and a Post Hoc analysis using Scheffй test to identify the specific groups contributing to the difference.

Results

Research Question 1: What are the perceptions of science teachers toward the integration of technology and Indigenous Knowledge Systems in science pedagogy?

Table 2

Mean and Standard Deviation of Science Teachers' Perceptions toward the Integration of Technology and Indigenous Knowledge Systems in Science Pedagogy.

S/N	Item Statements	Mean	SD
1	Integrating technology with Indigenous Knowledge Systems enhances students' understanding of science concepts.	3.45	0.91
2	The use of Indigenous Knowledge makes science lessons more relatable and culturally meaningful to students.	3.38	0.87
3	I believe technology can help preserve and promote local Indigenous scientific practices.	3.42	0.94
4	Incorporating Indigenous Knowledge into science lessons improves students' critical and reflective thinking.	3.51	0.95
5	Combining technology and Indigenous Knowledge encourages student participation and engagement in science learning.	3.33	0.89
6	I perceive the integration of technology and Indigenous Knowledge as essential for achieving culturally responsive science education.	3.47	0.96
7	Digital tools such as videos and simulations can effectively present Indigenous scientific practices in the classroom.	3.29	0.82
8	Integrating Indigenous Knowledge and modern technology supports the goals of Nigeria's science education curriculum.	3.40	0.92
9	I believe students gain deeper appreciation of science when lessons include both technological and traditional knowledge perspectives.	3.36	0.97
10	I feel confident that integrating technology and Indigenous Knowledge can help bridge the gap	2.68	0.84

S/N	Item Statements	Mean	SD
	between modern science and local realities.		
	Aggregate Mean Value	3.33	0.91

Source: Researchers' field work, 2025.

As presented in Table 2, the aggregate mean score of 3.33 indicates that science teachers generally agreed with the item statements on the integration of technology and Indigenous Knowledge Systems in science pedagogy. This finding implies that teachers hold positive perceptions, acknowledging that such integration enhances students' understanding, engagement and appreciation of culturally relevant science learning.

Research Question 2: What instructional practices do science teachers employ in integrating technology and Indigenous Knowledge Systems (IKS) in science teaching and learning in Nigerian secondary schools?

Table 3

Mean and Standard Deviation of Science Teachers' Instructional Practices in Integrating Technology and Indigenous Knowledge Systems (IKS) in Science Teaching and Learning.

S/N	Item Statements	Mean	SD
1	I use multimedia tools (videos, animations, and slides) to demonstrate Indigenous scientific practices during science lessons.	2.52	0.94
2	I encourage students to share Indigenous explanations of natural phenomena before introducing scientific concepts.	2.47	0.92
3	I design science lessons that combine local examples with digital simulations for better conceptual understanding.	2.41	0.90
4	I use digital platforms (e.g., YouTube, educational apps) to showcase Indigenous innovations relevant to science topics.	2.38	0.95
5	I integrate community-based Indigenous practices (e.g., fishing, farming, or herbal medicine) when teaching related science topics.	2.33	0.97
6	I employ digital assessment tools (e.g., Google Forms, quizzes) to evaluate students' understanding of Indigenous and modern scientific ideas.	2.28	0.91
7	I collaborate with local artisans or elders to demonstrate traditional scientific methods using technological support (e.g., video documentation).	2.10	0.93
8	I use locally produced videos and photographs to connect Indigenous practices with modern science principles.	2.05	0.96

S/N	Item Statements	Mean	SD
9	I engage students in group projects where they investigate Indigenous technologies using digital research tools.	1.84	0.89
10	I adapt ICT tools to create culturally relevant instructional materials that integrate Indigenous and modern science knowledge.	1.38	0.78
	Aggregate Mean Value	**2.18**	**0.92**

Source: Researchers' field work, 2025.

As presented in Table 3, the aggregate mean score of 2.18 indicates that science teachers' instructional practices in integrating technology and Indigenous Knowledge Systems (IKS) are generally low on the four-point Likert scale. This suggests that while teachers acknowledge the value of integrating technology with Indigenous knowledge, their actual classroom implementation remains limited.

Research Question 3: What challenges do science teachers face in implementing the integration of technology and Indigenous Knowledge Systems in Nigerian secondary schools?

Table 4

Mean and Standard Deviation of Science Teachers' Perceived Challenges in Implementing the Integration of Technology and Indigenous Knowledge Systems (IKS) in Nigerian Secondary Schools.

S/N	Item Statements	Mean	SD
1	Inadequate access to ICT facilities makes it difficult to integrate technology and Indigenous Knowledge in science teaching.	3.81	0.91
2	Lack of proper training limits my ability to use digital tools to teach Indigenous Knowledge-based science concepts.	3.67	0.93
3	The school curriculum does not adequately support the inclusion of Indigenous Knowledge in science lessons.	3.59	0.87
4	Limited internet connectivity hinders the effective use of online platforms for integrating Indigenous Knowledge in science education.	3.46	0.95
5	There is insufficient time within the school timetable to include both technological and Indigenous-based science instruction.	3.33	0.99
6	Lack of institutional support discourages teachers from integrating technology with Indigenous Knowledge practices.	3.25	0.88
7	Some Indigenous Knowledge practices are difficult to align with modern scientific concepts using technology.	3.12	0.84
8	Students show low interest when Indigenous Knowledge is	2.97	0.80

S/N	Item Statements	Mean	SD
	taught using technology-based methods.		
9	I experience technical difficulties when using ICT tools to demonstrate Indigenous science-related activities.	2.84	0.92
10	There is a lack of collaboration between teachers and Indigenous community members in developing culturally relevant digital resources.	2.53	0.89
		3.26	**0.90**

Aggregate Mean Value

Source: Researchers' field work, 2025.

As presented in Table 4, the aggregate mean score of 3.26 (SD = 0.90) indicates that science teachers generally agree that they encounter various challenges in implementing the integration of technology and Indigenous Knowledge Systems in science pedagogy.

Ho$_1$: There is no significant difference in the perceptions of science teachers toward the integration of technology and Indigenous Knowledge Systems (IKS) in science pedagogy across riverine areas, rural upland and city centres.

Hypotheses

Table 5

One-Way ANOVA Summary of Science Teachers' Perceptions toward Integration of Technology and Indigenous Knowledge Systems across School Locations.

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F	p-value
Between Groups	1.842	2	0.921	1.87	0.158
Within Groups	58.241	118	0.494		
Total	60.083	120			

Source: Researchers' field work, 2025.

As shown in Table 5 one-way analysis of variance (ANOVA) was conducted to determine whether there were significant differences in science teachers' perceptions of integrating technology and Indigenous Knowledge Systems across school locations. The result revealed no statistically significant difference among the three groups, F(2, 118) = 1.87, p = .158. This implies that teachers across riverine, rural upland, and city centre schools hold similar positive perceptions toward integrating technology and Indigenous Knowledge Systems in science pedagogy.

Ho$_2$: There is no significant difference in the instructional practices of science teachers in integrating technology and Indigenous Knowledge Systems (IKS) across riverine areas, rural upland and city centres.

Table 6

One-Way ANOVA Summary of Science Teachers' Instructional Practices in Integrating Technology and Indigenous Knowledge Systems across School Locations.

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F	p-value
Between Groups	6.482	2	3.241	5.72	0.004*
Within Groups	66.859	118	0.567		
Total	73.341	120			

Source: Researchers' field work, 2025.

A one-way analysis of variance (ANOVA) as shown in Table 6 was conducted to examine whether science teachers' instructional practices in integrating technology and Indigenous Knowledge Systems differ across school locations. The result showed a statistically significant difference among the three groups, $F(2, 118) = 5.72$, $p = .004$. Therefore, the null hypothesis (Ho_2) is rejected, indicating that there is a significant difference in the instructional practices of science teachers in integrating technology and Indigenous Knowledge Systems (IKS) across riverine areas, rural upland, and city centres. Since the hypothesis revealed a statistically significant difference among the three groups a post hoc test was further employed to revealed that margin of significant differences

Table 7

Scheffй Post Hoc Test of Differences in Science Teachers' Instructional Practices Across School Locations

Groups Compared	Mean Difference (I–J)	Std. Error	p-value	Decision
Riverine Area – Rural Upland	−0.42	0.18	0.042*	Significant
Riverine Area – City Centre	−0.63	0.20	0.006*	Significant
Rural Upland – City Centre	−0.21	0.17	0.218	Not Significant

Source: Researchers' field work, 2025.

The Scheffй post hoc analysis in Table 7 revealed that significant differences exist between Riverine Area and Rural Upland teachers ($p = .042$) and between Riverine Area and City Centre teachers ($p = .006$), while the difference between Rural Upland and City Centre teachers was not statistically significant ($p = .218$). The Scheffй post hoc test indicated that teachers in city centre schools reported significantly higher levels of instructional practices integrating technology and Indigenous Knowledge Systems compared to those in riverine schools. Similarly, rural upland teachers demonstrated moderately higher integration practices than their riverine counterparts. This pattern suggests that geographical and infrastructural factors may influence the extent of technology and IKS integration, with urban teachers having greater access to digital tools and pedagogical support for innovative instructional practices.

Ho_3: There is no significant difference in the challenges faced by science teachers in implementing the integration of technology and Indigenous Knowledge Systems

(IKS) across riverine areas, rural upland and city centres.

Table 8

One-Way ANOVA Summary of Science Teachers' Challenges in Implementing the Integration of Technology and Indigenous Knowledge Systems Across School Locations.

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F	p-value
Between Groups	1.926	2	0.963	1.32	0.271
Within Groups	86.187	118	0.730		
Total	88.113	120			

Source: Researchers' field work, 2025.

A one-way analysis of variance (ANOVA) was conducted to determine whether there were significant differences in the challenges faced by science teachers when integrating technology and Indigenous Knowledge Systems across different school locations. The results showed no statistically significant difference among the three groups, $F(2, 118) = 1.32$, $p = .271$. This finding implies that teachers across riverine, rural upland, and city centre schools experience similar levels of challenges.

Discussion of Findings

The findings of this study revealed that science teachers possess positive perceptions toward the integration of technology and Indigenous Knowledge Systems (IKS) in science pedagogy, as shown by the aggregate mean score of 3.33. The result implies that most teachers agree that technology and IKS integration makes science concepts more relatable, enhances cultural relevance, and promotes deeper understanding among students. This finding aligns with the assertion of Ogunlade and Fatoba (2022) that integrating culturally grounded knowledge with modern technologies can enhance students' conceptual comprehension and engagement in science classrooms. Experts from the interviewed participants revealed the following;

"In my view, technology plays an important role in preserving and promoting Indigenous scientific practices for future generations. So I feel that integrating technology with Indigenous Knowledge in science lessons increases students' engagement and participation." (C_6)

"I believe that combining Indigenous Knowledge with technology makes science learning more meaningful and culturally relevant to students." (C_{17})

Teachers' positive perception underscores their awareness of the pedagogical value of cultural inclusivity in teaching science. By combining Indigenous knowledge with technology, teachers believe they can bridge the gap between abstract scientific ideas and students' lived experiences. This supports the argument of Aikenhead and Ogawa (2021) that contextualizing science within students' cultural environments promotes meaningful learning and critical thinking. Despite the overall positive perception, the moderate standard deviation (SD = 0.91) indicates slight variations in teachers' views, possibly due to differences in school environments, access to resources, or professional

development opportunities. Teachers in urban areas may have more exposure to digital tools, while those in rural and riverine schools might rely more heavily on community based Indigenous knowledge due to infrastructural limitations. This variability supports Oluwaseun and Adeoye's (2023) observation that contextual factors such as location and access to ICT facilities significantly influence teachers' readiness and ability to integrate technology into science teaching.s

The findings of this study also revealed that science teachers' instructional practices in integrating technology and Indigenous Knowledge Systems (IKS) are generally low, as reflected by the aggregate mean score of 2.18. The limited use of ICT tools, digital simulations, and Indigenous examples in science teaching may be attributed to inadequate access to technological resources, insufficient training and lack of institutional encouragement. This finding aligns with Adebayo and Yusuf (2021), who observed that most Nigerian teachers still rely on conventional, teacher-centered methods due to infrastructural and skill-based constraints.

Experts from participants indicated that;

"Although I understand the importance of integrating Indigenous examples, I often rely on conventional teaching methods due to lack of digital resources."(C_{14})

"I find it difficult to combine local Indigenous practices with modern technology in my lessons because I have not received enough training on how to do so." (C_{11})

Similarly, Oluwaseun and Adeoye (2023) reported that even when teachers express positive attitudes toward ICT integration, their classroom practices often remain minimal because of limited digital literacy and contextual barriers. Excerpts from some participants noted that;

"I would like to design culturally relevant materials using ICT, but the absence of technical support and appropriate content limits my efforts."(C_9)

"I sometimes use local illustrations in my science lessons, but without technological support, it is hard to make the lessons engaging."(C_{21})

The low level of instructional practices highlights a disconnect between teachers' perceptions and classroom implementation, suggesting that awareness of innovation does not automatically translate into pedagogical transformation.

"Collaborating with community members to integrate Indigenous practices through technology is difficult because there is no formal structure for such partnerships." (C_3)

This supports the position of Ezeudu and Sampson (2022) that effective integration requires continuous teacher mentoring, context-sensitive training, and supportive school environments. Therefore, while teachers may conceptually value the integration of technology and IKS, systemic challenges such as poor infrastructure, insufficient pedagogical support and inadequate exposure to blended teaching models limit their ability to implement these practices effectively.

The findings of this study revealed that science teachers generally experience numerous challenges in integrating technology and Indigenous Knowledge Systems (IKS) into science teaching, as indicated by the aggregate mean value of 3.26. This suggests that despite teachers' positive perceptions about the relevance of technology and IKS integration, several contextual and systemic barriers hinder their effective classroom implementation. Excerpts

from some interviewed participants stated that;

"We have very few functioning computers and no reliable internet access, which makes it almost impossible to integrate technology with Indigenous Knowledge in our science lessons."(C_{18})

"Most of us were not trained to use ICT tools for teaching, especially in connecting them with Indigenous practices, so we often feel unprepared." (C_{25})

"We receive little or no support from school administrators to develop projects that merge technology with local Indigenous content."(C_1)

These findings are consistent with those of Ogunlade and Fatoba (2022) and Ezeudu and Sampson (2022), who reported that infrastructural deficits, low digital competence, and minimal administrative encouragement significantly constrain teachers' use of innovative pedagogies in Nigerian secondary schools.

"The school curriculum focuses mainly on Western science and leaves little room for including Indigenous Knowledge or technology-based innovations."(C_{24})

"Sometimes, Indigenous Knowledge cannot be easily linked to scientific explanations using technology, and that discourages teachers from trying."(C_{18})

Moreover, the lack of collaboration between teachers and Indigenous community experts further limits the development of culturally relevant digital materials as highlighted by Aderonmu and Adolphus (2021). Excerpts noted from a participant revealed that;

"There is no formal collaboration between teachers and Indigenous community members to create culturally relevant digital learning materials."(C_{10})

While teachers acknowledge the value of integrating technology and IKS in science pedagogy, addressing these persistent challenges through improved policy implementation, continuous professional development, and community partnerships is crucial for sustainable educational reform.

Conclusion

The study concludes that science teachers in public secondary schools generally hold positive perceptions toward the integration of technology and Indigenous Knowledge Systems (IKS) in science pedagogy. They acknowledge that such integration can enhance students' understanding, engagement and appreciation of culturally relevant science learning. However, despite these favorable perceptions, teachers' actual instructional practices in implementing this integration remain significantly low, as reflected in the aggregate mean value. This discrepancy highlights a gap between teachers' beliefs and classroom realities, suggesting that the potential of technology and IKS integration is yet to be fully harnessed within the Nigerian science instructional context.

Furthermore, the study established that numerous contextual and institutional challenges continue to hinder science teachers from effectively implementing this pedagogical approach. Key constraints include inadequate access to ICT resources, poor internet connectivity, limited training opportunities and insufficient institutional support. These challenges are particularly pronounced in rural and riverine schools compared to their urban counterparts, reflecting disparities in educational infrastructure and support systems. Therefore, the study concludes that achieving meaningful integration of technology and Indigenous Knowledge in science pedagogy requires a multifaceted approach involving policy reform, sustained teacher capacity development, curriculum review and collaborative partnerships with

Indigenous communities to promote culturally inclusive and technologically enriched science learning experiences.

Recommendations

The following recommendations were stated for the study.

1. Government and educational authorities should provide adequate ICT infrastructure and reliable internet connectivity across all school locations to support the effective integration of technology and Indigenous Knowledge Systems in science pedagogy.
2. Teacher training institutions and Ministries of Education should organize continuous professional development programs to enhance teachers' digital competence and pedagogical skills for blending Indigenous Knowledge with modern scientific concepts.
3. Curriculum developers and policymakers should incorporate Indigenous Knowledge components into science curricula and promote collaboration between schools and local communities to ensure culturally relevant and context-based science instruction.

References

Adebayo, R. O., & Yusuf, M. O. (2021). Teachers' classroom utilization of ICT resources for effective science teaching in Nigerian secondary schools. *Journal of Educational Media and Technology*, 25(2), 44–58.

Aderonmu, T. S. B. & Adolphus, T. (2021). Thinking through ethnoscientific scenarios for Physics teaching: Implication for curriculum implementation. *International Journal of Trend in Scientific Research and Development*, 5(2), 114-122.

Aikenhead, G. S., & Ogawa, M. (2021). Indigenous knowledge and science education: Reconsidering integration through digital mediation. *Science Education Review*, 20(2), 45–58.

Eze, C. J., & Mphahlele, M. L. (2023). Integrating indigenous knowledge systems into science education for contextualized learning in Africa. *African Journal of Science, Technology, Innovation and Development*, 15(3), 211–222.

Ezeudu, F. O., & Sampson, M. (2022). Enhancing culturally responsive science teaching through digital integration: Challenges and opportunities. *African Journal of Science and Mathematics Education,* 10(1), 63–75.

Federal Ministry of Education. (2021). *National policy on information and communication technology (ICT) in education.* Abuja: FME Publications.

Hennessy, S., Harrison, D., & Wamakote, L. (2022). Teacher perspectives on effective technology integration in African classrooms. *Computers & Education,* 190, 104598.

Ngubane, N., & Mkhize, N. (2021). The relevance of indigenous knowledge in science classrooms: A South African perspective. *Journal of Education and Learning*, 10(4), 45–56.

Ogunlade, O. O., & Fatoba, J. O. (2022). Integrating Indigenous knowledge and ICT tools for effective science teaching in Nigerian secondary schools. *International Journal of Education and Development Using ICT*, 18(3), 101–115.

Oluwaseun, A. T., & Adeoye, A. O. (2023). Contextual challenges in teachers' use of ICT for science instruction in Nigeria. *Journal of*

Educational Technology and Society, 26(1), 77–88.

UNESCO. (2023). *Technology and indigenous knowledge for sustainable education transformation.* Paris: UNESCO Publishing.