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INTEGRATING INDIGENOUS KNOWLEDGE SYSTEMS INTO SCIENCE AND TECHNOLOGY TEACHER EDUCATION FOR SUSTAINABLE DEVELOPMENT IN NIGERIA: THE HUMAN TONGUE AS AN INTERDISCIPLINARY CASE STUDY

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Abstract

The integration of Indigenous Knowledge Systems (IKS) into science and technology teacher education has emerged as a compelling strategy for promoting sustainable development, cultural relevance, and contextualized learning outcomes. In Nigeria, teacher preparation programmes have historically privileged Western scientific epistemologies while systematically neglecting the rich body of indigenous knowledge embedded within local communities, thereby limiting both student engagement and the societal applicability of science education. This paper investigates the educational potential of integrating IKS into science and technology teacher education in Nigeria, using the human tongue as a focal interdisciplinary case study [redacted] bridging biological science and indigenous health knowledge systems. A qualitative, documentary research design was adopted, involving systematic review and thematic synthesis of peer-reviewed publications, policy documents, UNESCO and WHO reports, and seminal texts in indigenous science education, teacher preparation, biological

Keywords: Indigenous Knowledge Systems; Science Education; Technology Education; Teacher Education; Sustainable Development; Human Tongue; Tongue Diagnosis; Culturally Responsive Pedagogy; Nigeria; Africa.

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sciences, and sustainable development spanning 2018-2024. Findings reveal that indigenous knowledge pertaining to tongue-based health diagnosis, dietary practices, medicinal plants, and oral health carries significant scientific validity and educational value. Traditional tongue examination practices documented across Nigerian and broader African communities align substantively with contemporary biomedical understandings of tongue morphology as a diagnostic indicator of systemic, nutritional, and oral health conditions. Teacher education programmes, however, provide minimal structured opportunities for such integration. Effective incorporation of IKS into teacher preparation enhances cultural responsiveness, scientific literacy, and sustainable development competencies among future educators. The study concludes with a framework of recommendations for curriculum reform, professional development, institutional partnerships, and research investment to advance culturally responsive science education in Nigeria..

Introduction

Background and Rationale

Science and technology education constitutes a foundational pillar of national development, equipping learners with the knowledge, analytical skills, and practical competencies required for innovation, problem-solving, and sustainable living (Federal Republic of Nigeria, 2023). Within sub-Saharan Africa broadly, and Nigeria specifically, educational policy has increasingly foregrounded the imperative for contextualized, culturally responsive pedagogical approaches capable of addressing localized socioeconomic and environmental challenges (UNESCO, 2023; Mhakure and Mushaikwa, 2023). Nonetheless, the operational landscape of science education in Nigerian schools and teacher training institutions remains predominantly shaped by Western scientific paradigms, frequently to the exclusion of Indigenous Knowledge Systems (IKS) that have informed community life, healthcare, agriculture, and environmental stewardship for generations.

This epistemological asymmetry carries significant consequences. When learners encounter science curricula that bear no relationship to their cultural experiences, motivational engagement diminishes, conceptual transfer to everyday contexts weakens, and the transformative potential of science education for local development remains unrealised (Aikenhead and Michell, 2022; Yore and Treagust, 2023). Teacher education programmes, as the primary vehicle through which pedagogical norms are established and perpetuated, bear particular responsibility for addressing this structural gap.

The Human Tongue as an Interdisciplinary Bridge

The human tongue offers a uniquely instructive example for demonstrating the epistemological complementarity of indigenous and scientific knowledge systems. Across numerous Nigerian ethnic and cultural traditions, tongue examination has long constituted an integral component of traditional health diagnosis. Healers and community health practitioners observe variations in tongue colour, surface texture, coating density, moisture levels, and anatomical markings to identify disease states, nutritional deficiencies, and systemic disorders (Greenberg, Glick, and Ship, 2024; Villa, Woo, and Neville, 2024).

Contemporary biomedical science corroborates the diagnostic significance of such observations. Changes in tongue appearance are now well documented as clinical indicators of conditions including iron-deficiency anaemia, vitamin B12 and folate deficiency, dehydration, diabetes mellitus, oral candidiasis, and gastrointestinal disorders (Berman and Jones, 2023; Villa *et al.,* 2024). The convergence of traditional and scientific observations around the tongue as a health indicator provides a compelling, accessible, and culturally grounded entry point for science instruction across secondary and tertiary educational contexts.

Aims and Objectives

This paper pursues the following objectives:

1. To examine the nature and educational relevance of Indigenous Knowledge Systems within Nigerian and broader African contexts.
2. To analyse the human tongue as a case study through which indigenous health knowledge and scientific biological understanding can be integrated in science and technology teacher education.
3. To evaluate existing teacher education frameworks in Nigeria for their capacity to accommodate IKS integration.
4. To propose evidence-based recommendations for curriculum reform, teacher professional development, and research in culturally responsive science education.

Significance of the Study

This study contributes to growing international scholarship on decolonising science education and aligns with UNESCO's Education for Sustainable Development (ESD) framework, which explicitly recognises indigenous knowledge as a resource for achieving the Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education), SDG 3 (Good Health and Well-Being), and SDG 11 (Sustainable Communities) (UNESCO, 2023; WHO, 2024).

Defining Indigenous Knowledge Systems

Indigenous Knowledge Systems (IKS) are defined as cumulative, dynamic bodies of knowledge, practices, innovations, and beliefs developed by local and indigenous communities through sustained interaction with their natural and social environments over extended historical periods (UNESCO, 2023). These systems are characterised by: (a) community ownership and collective custodianship; (b) practical orientation toward problem-solving within specific ecological and social contexts; (c) commitment to environmental sustainability and resource conservation; (d) transmission through oral traditions, apprenticeship, and embodied practice; and (e) deep cultural embeddedness and contextual specificity (Aikenhead and Michell, 2022).

In the Nigerian context, IKS encompasses a vast repertoire of knowledge spanning traditional medicine and phytotherapy, indigenous agricultural and agroforestry practices, ecological and weather forecasting systems, food preservation and processing technologies, and community-based health diagnostic methods including tongue examination. These knowledge systems, while diverse across Nigeria's numerous ethnic communities, share the epistemological quality of being derived from empirical observation, practical experimentation, and accumulated communal experience (Ogunniyi and Hewson, 2022).

Education for Sustainable Development

The concept of sustainable development, foundationally articulated in the Brundtland Commission's report Our Common Future (World Commission on Environment and Development, 1987), encompasses development that satisfies present needs without compromising the capacity of future generations to meet their own needs. Education for Sustainable Development (ESD), as elaborated in UNESCO's current frameworks (UNESCO, 2023), promotes: environmental sustainability and ecological literacy; social equity and inclusive participation; economic development grounded in local resources; and cultural preservation and intergenerational knowledge transfer. IKS integration into science education directly advances these ESD dimensions by grounding scientific learning in culturally meaningful, locally applicable, and environmentally sustainable knowledge frameworks.

Constructivist Learning Theory (Piaget, 1972)

Constructivism posits that learners actively construct new knowledge by assimilating it into existing cognitive schemas derived from prior experience (Piaget, 1972). Indigenous knowledge provides culturally familiar experiential contexts that enable learners to construct scientific understanding through meaningful cognitive scaffolding. When students who are familiar with traditional tongue health assessments encounter formal

biological explanations of lingual anatomy and physiology, prior cultural knowledge serves as productive prior knowledge upon which formal scientific understanding can be built.

Sociocultural Theory (Vygotsky, 1978)

Vygotsky's sociocultural theory emphasises that learning is fundamentally mediated by social interaction and cultural context (Vygotsky, 1978). The Zone of Proximal Development (ZPD) concept implies that instruction is most effective when it begins within learners' existing cultural and experiential frameworks and extends toward new scientific understandings through guided interaction. Indigenous practices surrounding tongue diagnosis and oral health provide authentic cultural contexts that situate science learning within learners' lived realities.

Culturally Responsive Pedagogy (Gay, 2018)

Gay's (2018) framework of Culturally Responsive Teaching advocates for the deliberate and systematic integration of learners' cultural backgrounds, experiences, and knowledge into instructional practice. The framework argues that cultural responsiveness is not merely additive but constitutive of quality teaching, particularly in diverse, postcolonial educational contexts. Integrating indigenous tongue-related health knowledge into biology and health education exemplifies culturally responsive science pedagogy by validating students' cultural inheritance while extending their scientific understanding.

Indigenous Knowledge and Science Education: Global and African Perspectives

A substantial and growing body of international research documents the pedagogical benefits of integrating IKS into science education. Aikenhead and Michell (2022) demonstrate that cross-cultural science education - which bridges indigenous and Western scientific epistemologies - enhances student motivation, conceptual understanding, and the perceived relevance of formal science instruction. Their work illustrates that learners who encounter scientific concepts through culturally familiar knowledge frameworks achieve deeper and more durable understanding than those exposed to purely decontextualized, universalized content.

Within the African context, Mhakure and Mushaikwa (2023) document emerging trends in IKS integration across sub-Saharan science education systems, noting that culturally contextualised instruction consistently improves learning outcomes while simultaneously promoting environmental stewardship. Similarly, Yore and Treagust (2023) argue that science literacy in the twenty-first century demands engagement with multiple

knowledge systems, including indigenous frameworks, as a prerequisite for equipping learners to address complex, context-specific sustainability challenges.

Teacher Education and Indigenous Knowledge in Africa

Despite the accumulating evidence for the educational value of IKS integration, teacher preparation institutions across Africa have been slow to incorporate indigenous science content into their curricula. Ogunniyi and Hewson (2022) conducted a cross-national analysis of African teacher education programmes and identified a pervasive inadequacy in preparing teachers to navigate the epistemological tensions between indigenous and Western scientific knowledge systems. Their findings indicate that many teacher educators themselves lack the training and conceptual frameworks needed to facilitate IKS integration confidently and rigorously.

Effective teacher education for IKS integration should incorporate: structured engagement with indigenous science content across disciplinary areas; community-based learning experiences with indigenous knowledge holders; training in ethno science methodologies and participatory research approaches; and development of skills for local knowledge documentation, validation, and curriculum contextualization (Ogunniyi and Hewson, 2022; Mhakure and Mushaikwa, 2023).

Traditional and Indigenous Perspectives

Tongue examination as a diagnostic modality has a documented history across multiple indigenous and traditional medical systems, including Traditional Chinese Medicine, Ayurvedic medicine, and various African traditional healing systems (Greenberg *et al.,* 2024). Within Nigerian traditional medical contexts, tongue observation is employed by traditional healers across diverse ethnic communities to assess general health status, detect disease conditions, and evaluate nutritional status. Observations typically encompass tongue colour, surface texture and papillary characteristics, coating colour and thickness, moisture levels, and the presence of fissures, ulcerations, or unusual markings.

These diagnostic practices are grounded in empirically accumulated community observations linking specific tongue presentations to recognisable health states. While the theoretical explanatory frameworks differ from those of biomedicine, the observational data upon which traditional tongue diagnosis is based reflect genuine empirical knowledge developed through sustained, systematic community experience (Villa *et al.,* 2024).

Biomedical Perspectives on Tongue Morphology and Health

Contemporary biomedical science has extensively documented the clinical significance of tongue appearance as an indicator of systemic and local health conditions. Villa, Woo, and

Neville (2024) provide a comprehensive review of tongue manifestations of systemic diseases, documenting associations between specific tongue presentations and a wide range of clinical conditions. A pale tongue may indicate iron-deficiency anaemia; a bright red tongue may indicate vitamin B12 or niacin deficiency; a white-coated tongue may reflect candidal infection or dehydration; a purple or dark tongue may suggest cardiovascular compromise; and geographic tongue patterns may be associated with allergic or autoimmune conditions.

Greenberg, Glick, and Ship (2024) further detail the role of oral examination, including tongue assessment, in the identification of systemic diseases during routine consultations. The clinical literature supports the position that tongue examination provides a readily accessible, non-invasive window into a patient's general health status - a conclusion that traditional health practitioners arrived at through empirical observation centuries before formal biomedical documentation.

Convergent Educational Implications

The substantive overlap between traditional tongue diagnosis practices and contemporary biomedical understanding creates an exceptional pedagogical opportunity. Science teachers who can facilitate structured comparison of indigenous and biomedical tongue knowledge enable learners to: (a) engage with authentic cultural and scientific knowledge simultaneously; (b) develop critical thinking skills for evaluating the epistemic status of different knowledge claims; (c) appreciate the empirical foundations of indigenous knowledge; and (d) connect biological science content to health-relevant real-world applications (Berman and Jones, 2023; Yore and Treagust, 2023).

Technology Integration and Documentation of Indigenous Knowledge

Digital technologies present transformative opportunities for the documentation, preservation, validation, and pedagogical application of indigenous knowledge. Mobile health applications, digital microscopy platforms, virtual laboratories, multimedia repositories, and geographic information systems have all been identified as promising tools for making indigenous knowledge accessible and educationally deployable (UNESCO, 2023). In the specific context of tongue-based health knowledge, digital imaging technologies enable direct visual comparison between traditional observational data and microscopic analysis of lingual epithelial cells, papillary structures, and surface microbiology, allowing students to move fluidly between the macroscopic observational scale of indigenous practice and the microscopic analytical scale of modern biological science (Yore and Treagust, 2023).

Indigenous Knowledge, Sustainability, and Health Education

Indigenous health knowledge systems are inherently oriented toward prevention, holistic wellbeing, and sustainable utilisation of available resources - characteristics that align closely with the principles of the World Health Organization's Traditional Medicine Strategy 2025-2034 (WHO, 2024). The WHO explicitly advocates for greater integration of traditional and complementary medicine into national health systems and health education frameworks, providing important policy legitimacy for IKS integration in Nigerian science education. Integrating such knowledge into science and health education curricula can contribute to improved public health literacy, stronger preventive health behaviours, and more sustainable patterns of healthcare-seeking, while simultaneously preserving culturally significant knowledge heritage.

Research Design

This study employs a qualitative documentary research design, engaging in systematic review and thematic synthesis of existing scholarly literature, policy documents, and institutional reports. Documentary research is appropriate for investigations aimed at synthesising knowledge from diverse disciplinary sources to construct conceptual frameworks and policy-relevant recommendations (Mhakure and Mushaikwa, 2023). Given the interdisciplinary nature of the research questions - spanning indigenous science education, teacher preparation, biological sciences, and sustainable development - a literature-based approach affords access to the breadth of relevant scholarship necessary for comprehensive analysis.

Data Sources

Data were drawn from the following categories of sources:

- Peer-reviewed journal articles published between 2018 and 2024 in indexed journals covering science education, teacher education, indigenous knowledge, oral biology, and sustainable development
- Seminal theoretical and methodological texts in constructivist learning theory, sociocultural theory, and culturally responsive pedagogy
- Policy documents including the Nigerian National Policy on Education (Federal Republic of Nigeria, 2023)
- International institutional reports from UNESCO (2023) and the World Health Organization (2024)
- Biomedical reference texts in oral medicine and clinical oral biology

Analytical Approach

Thematic content analysis was employed to identify, organise, and interpret recurring themes across the reviewed literature. Analysis proceeded through the following phases:

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(1) systematic identification and retrieval of relevant literature; (2) critical reading and abstraction of key findings; (3) inductive coding of salient themes; (4) thematic synthesis across source categories; and (5) interpretive framework construction linking identified themes to the study's objectives. Rigour was maintained through triangulation across multiple source types and reflexive engagement with the epistemological tensions inherent in cross-cultural knowledge comparison.

Educational Opportunities at the Indigenous-Scientific Interface

The literature review reveals substantial and underexploited opportunities for integrating indigenous knowledge into science and technology teacher education. The human tongue exemplifies, in microcosm, the broader epistemological relationship between traditional observational knowledge and modern biological science: both are grounded in empirical engagement with natural phenomena; both generate valid and practically useful knowledge; and both are enriched by dialogue with the other.

Traditional tongue-based health assessments represent genuine empirical science - systematic, communally validated observation of natural phenomena for practical health-related purposes - conducted without the formal theoretical apparatus of modern biomedicine. When science teachers contextualise the teaching of lingual anatomy (papillae types, epithelial histology, taste receptor physiology, blood supply), digestive system function, nutritional biochemistry, and clinical health assessment within the framework of indigenous tongue health knowledge familiar to their students, they create pedagogical conditions characterised by cognitive engagement, cultural affirmation, and genuine scientific inquiry (Aikenhead and Michell, 2022; Gay, 2018).

The Tongue as a Teaching Resource across Biological Topics

The human tongue serves as a versatile pedagogical resource across multiple biological science topics. In the teaching of human anatomy, the tongue's complex musculature, its dual embryological origin, its rich vascularisation and innervation, and the structural diversity of its papillae (fungiform, filiform, foliate, and circumvallate) offer abundant content for detailed anatomical study. Indigenous knowledge regarding tongue appearance and surface morphology provides an authentic observational scaffold from which microscopic and histological inquiry can proceed naturally (Greenberg *et al.*, 2024). In the teaching of sensory biology, tongue physiology - encompassing the molecular mechanisms of taste transduction, the distribution of taste receptors across the lingual surface, and the neurological processing of gustatory signals - can be introduced through culturally familiar contexts of food preference, dietary assessment, and flavour recognition in indigenous culinary traditions. In health education, the documented correlations between tongue presentation and systemic disease conditions (Villa *et al.*,

2024) provide compelling, evidence-based illustrations of the body's systemic interconnections and the diagnostic significance of careful clinical observation.

Technology Education and Digital Enhancement of Indigenous Knowledge

Technology education can make a critical contribution to IKS integration through the development of digital tools for indigenous knowledge documentation, validation, and pedagogical deployment. Digital microscopy platforms that enable students to examine lingual epithelial cells and papillary architecture alongside traditional observational categories constitute a powerful pedagogical bridge between indigenous and scientific knowledge scales. Mobile health applications that incorporate indigenous tongue diagnosis categories alongside biomedical correlates could serve both educational and community health purposes, providing an authentic technology education design challenge (UNESCO, 2023).

Furthermore, the systematic digital documentation of traditional tongue diagnosis practices across Nigeria's diverse ethnic communities would constitute a valuable research and educational resource, preserving culturally significant knowledge while enabling its systematic scientific evaluation. Such documentation projects, undertaken collaboratively between teacher education institutions and indigenous knowledge holders, would exemplify the community-based learning partnerships that researchers consistently identify as essential to effective IKS integration (Ogunniyi and Hewson, 2022; Mhakure and Mushaikwa, 2023).

Implications for Teacher Education

Teacher education programmes that systematically expose future science educators to indigenous health knowledge - including tongue-based diagnostic traditions - are more likely to produce educators equipped to facilitate culturally responsive science instruction. However, the literature consistently indicates that such preparation currently occurs minimally, if at all, in Nigerian teacher training institutions (Ogunniyi and Hewson, 2022). Rectifying this deficit requires not merely the addition of IKS content to existing curricula, but a more fundamental re-examination of the epistemological assumptions underpinning how scientific knowledge is framed, valued, and taught in teacher preparation contexts.

This re-examination must be accompanied by professional development support enabling practising teachers to develop the knowledge, skills, and dispositions required for IKS-integrated science instruction: familiarity with local indigenous knowledge traditions; understanding of ethnoscience methodologies; ability to facilitate critical, respectful comparison of indigenous and scientific knowledge claims; and confidence in navigating

the epistemological complexities that arise when multiple knowledge systems are engaged simultaneously (Gay, 2018; Yore and Treagust, 2023).

Alignment with Sustainable Development Goals

The integration of IKS into science and technology teacher education aligns directly with multiple Sustainable Development Goals. SDG 4 (Quality Education) is advanced through more culturally inclusive, engaging, and effective science instruction. SDG 3 (Good Health and Well-Being) is supported through the incorporation of indigenous health knowledge that promotes preventive healthcare literacy and validates community health practices. SDG 11 (Sustainable Cities and Communities) and SDG 15 (Life on Land) benefit from the environmental stewardship and biodiversity knowledge embedded in many indigenous knowledge systems. SDG 17 (Partnerships for the Goals) is operationalised through the community-institutional partnerships required for authentic IKS integration (UNESCO, 2023; WHO, 2024).

Key Findings

The thematic synthesis of reviewed literature yields the following principal findings:

i. Indigenous Knowledge Systems possess substantive scientific validity, empirical foundations, and significant educational relevance for science and technology teacher education in Nigeria.
ii. The human tongue serves as an exceptionally productive interdisciplinary example through which indigenous health knowledge and biological science can be integrated, offering pedagogical access to anatomy, physiology, nutrition, health assessment, sensory biology, and clinical medicine.
iii. Traditional tongue-based health assessment practices documented across Nigerian and broader African communities share substantive observational and diagnostic correspondences with contemporary biomedical understanding of lingual manifestations of systemic disease.
iv. Science and technology teacher education programmes in Nigeria currently provide minimal structured opportunities for indigenous knowledge integration, reflecting a broader epistemological gap between formal education and indigenous community knowledge systems.
v. Digital technologies offer promising tools for the documentation, validation, comparative analysis, and pedagogical deployment of indigenous knowledge, including tongue-based health diagnostic traditions.
vi. IKS integration into science education demonstrably enhances cultural relevance, learner engagement, scientific literacy, and sustainability awareness among students in African educational contexts.

vii. The achievement of Sustainable Development Goals - particularly SDG 3, SDG 4, SDG 11, and SDG 17 - can be meaningfully advanced through culturally responsive science education grounded in validated indigenous knowledge.

Conclusion

The integration of Indigenous Knowledge Systems into science and technology teacher education represents a strategically important and educationally productive pathway toward culturally responsive, locally relevant, and globally sustainable science education in Nigeria. The human tongue - as a site of convergence between traditional health observation and modern biological science - exemplifies the broader epistemological complementarity of indigenous and scientific knowledge systems and demonstrates how culturally grounded biological content can simultaneously deepen scientific understanding and affirm cultural heritage.

This study has argued that the persistent marginalisation of IKS in Nigerian science education reflects historical epistemological asymmetries that teacher education institutions are uniquely positioned to address. By preparing future science educators to engage respectfully, critically, and rigorously with indigenous knowledge traditions - and by equipping them with the pedagogical strategies necessary to facilitate productive dialogue between indigenous and scientific epistemologies - teacher training programmes can play a transformative role in creating science education that is simultaneously scientifically rigorous, culturally responsive, and oriented toward sustainable development.

The successful realisation of this vision requires sustained commitment at multiple systemic levels: curriculum reform within teacher education institutions; professional development investment for practising teachers; institutional partnerships with indigenous knowledge holders and communities; supportive government policy frameworks; and continued empirical research on the effectiveness and implementation of IKS-integrated science instruction. The evidence reviewed in this study provides a compelling basis for this commitment and an actionable framework for its pursuit.

Curriculum and Institutional Reform

i. Science and technology teacher education curricula should be systematically revised to incorporate IKS content across relevant disciplinary courses, with the human tongue and other locally significant biological phenomena serving as anchor case studies for interdisciplinary indigenous-scientific knowledge integration.
ii. Teacher education institutions should establish formal academic partnerships with indigenous knowledge holders, traditional health practitioners, and community

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organisations to facilitate community-based learning experiences and collaborative curriculum development.

iii. Ethnoscience methodologies should be incorporated as a required component of science teacher preparation, equipping future educators to document, evaluate, and pedagogically deploy indigenous knowledge ethically and rigorously.

Professional Development

i. Continuing professional development programmes for practising science and technology teachers should address IKS integration explicitly, providing content knowledge, pedagogical strategies, and epistemological frameworks for culturally responsive science instruction.
ii. Regional and national science teacher networks should establish platforms for sharing IKS integration practices, resources, and research findings across Nigerian educational contexts.

Research

i. Indigenous health practices related to tongue diagnosis should be systematically investigated and documented through collaborative research between educational institutions, biomedical researchers, and indigenous knowledge custodians.
ii. Empirical studies examining the learning outcomes, engagement effects, and long-term impacts of IKS-integrated science instruction in Nigerian schools and teacher education programmes should be prioritised in national research agendas.

Policy

i. The Federal Ministry of Education and relevant state-level agencies should formulate explicit policies supporting IKS integration in science and technology education, providing regulatory frameworks, resource allocations, and institutional incentives for implementation.
ii. Nigeria's National Policy on Education should be strengthened to align with UNESCO's ESD framework and WHO's Traditional Medicine Strategy in explicitly mandating culturally responsive approaches to science and health education across all levels.

Contribution to Knowledge

This study makes the following contributions to the academic literature:

i. It provides an original interdisciplinary analysis of the human tongue as a pedagogical bridge between indigenous health knowledge systems and formal biological science education, establishing a replicable case study model for IKS integration.

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ii. It advances scholarship on culturally responsive science and technology teacher education in Nigeria, contributing empirically grounded arguments for systemic curriculum reform.
iii. It offers a synthesised conceptual framework - drawing on constructivist, sociocultural, and culturally responsive pedagogical theories - for understanding and facilitating IKS integration in science teacher preparation.
iv. It documents and analyses the substantive scientific correspondences between traditional Nigerian tongue diagnosis practices and contemporary biomedical clinical knowledge, providing a foundation for further empirical investigation.
v. It contributes to the emerging pan-African scholarship on decolonising science education and advancing indigenous knowledge-based approaches to sustainable development.

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