



Biology Teachers' Perceptions toward Integrating Indigenous Knowledge in the Teaching of Ecology in Secondary Schools in Dodoma, Tanzania

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Abstract: Despite increasing recognition of Indigenous Knowledge (IK) as a resource for culturally relevant and context-based science education, less is known about how Biology teachers in Tanzanian secondary schools perceive its integration into ecology teaching. This study explored Biology teachers' perceptions toward integrating Indigenous Knowledge in the teaching of ecology in selected secondary schools in Dodoma, Tanzania. Culturally Relevant Pedagogy guided the interpretation by emphasizing the importance of connecting formal learning with learners' cultural backgrounds and community knowledge. This paper reports the teacher-focused component of a qualitative case study involving four Biology teachers from four secondary schools. Data were collected primarily through semi-structured interviews, with classroom observations and documentary review used to contextualise the teachers' accounts, and were analysed through reflexive thematic analysis. The findings revealed that teachers generally perceived Indigenous Knowledge positively because they believed it could clarify ecological concepts through familiar examples, make lessons relevant and interesting, and promote appreciation of cultural and environmental knowledge. At the same time, teachers described practical barriers that limit consistent implementation, including inadequate teaching materials and curriculum guidance, limited professional preparation, and pressure to complete the Biology syllabus. The findings therefore reveal a clear gap between teachers' positive beliefs about IK and the institutional conditions available for its classroom use. The study concludes that the participating teachers were willing to integrate Indigenous Knowledge into ecology teaching, but effective implementation requires systematic curriculum support, culturally relevant instructional resources, and sustained professional development.

Keywords: Indigenous Knowledge, teachers' perceptions, ecology education, culturally relevant pedagogy, science education, secondary schools, Tanzania

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1. Introduction

The integration of Indigenous Knowledge (IK) into formal science education has gained attention because it can make learning more meaningful, culturally responsive, and connected to learners' environments. IK includes knowledge, skills, values, practices, and interpretations developed through long-term community interaction with natural and social environments (Berkes, 2018; Thompson et al., 2020). In ecology, it can provide local examples related to farming, weather observation,

conservation, pest management, and natural-resource use (Oando, 2024; Sospeter et al., 2026). Its educational value is therefore best understood as complementing formal science by providing familiar contexts for interpreting ecological ideas (Aikenhead & Ogawa, 2007; Greenall & Bailey, 2022).

Teachers are central to this process because curriculum intentions reach the classroom through their knowledge, beliefs, confidence, and pedagogical choices. African studies describe perceived educational benefits of IK alongside difficulties in integrating it consistently

(Jumba & Mwiti, 2022; Mkhwebane, 2024). Yet positive attitudes do not automatically produce systematic integration. Teachers may still face limited preparation, inadequate resources, rigid curriculum demands, and uncertainty about how Indigenous and scientific knowledge should be related (Mlotshwa & Tsakeni, 2024; Ramnarain & Hlatwayo, 2018). Their perceptions therefore influence whether IK becomes a meaningful instructional resource or remains an occasional illustration.

In Tanzania, this issue is important because communities possess extensive environmental knowledge while research on the wider education system identifies a gap between curriculum intentions and implementation (Komba & Shukia, 2023). Work on managing IK also highlights difficulties in connecting community knowledge with other knowledge systems (Lwoga et al., 2011). Dodoma is especially relevant because farming, rainfall variability, conservation, and natural-resource management are familiar community experiences that can support ecology learning. However, the broader dissertation found that IK integration remains largely informal and dependent on individual teacher initiative rather than clearly institutionalised classroom practice.

Although IK has been studied in science education, limited evidence explains how Biology teachers in Dodoma specifically understand its value and the conditions shaping its classroom use. Research has identified teacher preparation, curriculum support, and institutional recognition as important influences, but much of the evidence comes from other contexts or from science education generally (Jumba & Mwiti, 2022; Mkhwebane, 2024; Mlotshwa & Tsakeni, 2024). This paper therefore addresses the second specific objective of the broader study: assessing teachers' perceptions toward integrating Indigenous Knowledge in the ecology topic of the Biology subject in selected secondary schools in Dodoma, Tanzania.

1.1 Statement of the Problem

The integration of Indigenous Knowledge (IK) into formal science education has gained attention because it can make learning more meaningful, culturally responsive, and connected to learners' everyday environments. Indigenous Knowledge encompasses knowledge, skills, values, practices, and interpretations developed through communities' long-term interactions with their natural and social environments (Berkes, 2018; Thompson et al., 2020). In Biology, particularly ecology, IK can provide familiar examples related to farming, weather observation, conservation, pest management, and natural-resource use (Aikenhead & Ogawa, 2007; Greenall & Bailey, 2022; Oando, 2024). However, the potential of IK is not automatically realized in classroom practice. Teachers play a central role in determining whether local knowledge is meaningfully connected to scientific concepts, yet studies report challenges including inadequate teacher preparation, limited

resources, curriculum and assessment pressures, and uncertainty about how Indigenous and scientific knowledge should be related (Jumba & Mwiti, 2022; Mkhwebane, 2024; Mlotshwa & Tsakeni, 2024). Thus, teachers may recognize the value of IK while still using it only occasionally or informally.

In Tanzania, this issue is particularly important because communities possess extensive environmental knowledge that could support the teaching of ecology, while evidence indicates gaps between intended curriculum provisions and their implementation in schools (Komba & Shukia, 2023). In Dodoma, learners' experiences of farming, rainfall variability, conservation, and natural-resource management provide potentially valuable contexts for understanding ecological concepts. Nevertheless, the integration of IK appears to remain largely dependent on individual teacher initiative rather than being consistently institutionalized in Biology teaching. Although previous studies have examined IK and science education, limited evidence specifically explains how secondary school Biology teachers in Dodoma perceive its educational value, relevance to ecology, and the conditions that facilitate or constrain its classroom integration. This study therefore addresses this gap by examining teachers' perceptions toward integrating Indigenous Knowledge into the teaching of ecology in selected secondary schools in Dodoma, Tanzania.

2. Literature Review

2.1 Empirical Literature

Indigenous Knowledge is increasingly recognized as a complement to formal science because it reflects environmental understanding developed through observation, practice, and intergenerational experience (Berkes, 2018; Thompson et al., 2020). In ecology education, it can connect scientific concepts with familiar practices such as farming, conservation, seasonal observation, and natural-resource use (Greenall & Bailey, 2022; Oando, 2024). This contextualization can reduce the distance between textbook science and everyday environmental realities while broadening recognition of the knowledge systems through which communities understand ecological relationships (Aikenhead & Ogawa, 2007; García Franco et al., 2022).

Teacher perceptions matter because teachers determine when local knowledge is introduced and how clearly it is related to scientific content. Jumba and Mwiti (2022), studying Kenyan primary schools, identified limited teacher awareness of IK alongside resource shortages and unclear guidelines for its integration into the curriculum. Mkhwebane (2024) reported inadequate training, limited support, and negative attitudes among some South African Life Sciences teachers, despite a curriculum mandate to integrate IK. These studies show that perceptions differ and that formal curriculum

recognition alone does not ensure confident classroom integration.

Teachers' perceptions are also shaped by curriculum and institutional conditions. Mlotshwa and Tsakeni (2024) identified inadequate resources, limited IK understanding, assessment pressure, and weak curriculum-policy alignment as major barriers, while Ramnarain and Hlatswayo (2018), in a study of inquiry-based science teaching, examined how teacher beliefs and school conditions influenced implementation. Komba and Shukia (2023) identified a broader gap between intended and enacted curricula in Tanzania, while Mkhwebane (2024) documented practical difficulties in IK integration. These findings suggest that the conditions surrounding teachers' work need attention alongside curriculum intentions. Teacher perception is therefore formed within an educational environment that can either legitimize or marginalize Indigenous Knowledge.

The literature also emphasizes the cultural significance of IK integration. Culturally relevant teaching validates learners' backgrounds while supporting academic learning and critical engagement (Ladson-Billings, 2021; García Franco et al., 2022). Mutekwe (2015) argues that recognizing Indigenous Knowledge can challenge Western-centred curriculum assumptions, while Shabalala (2025) links its inclusion with decolonizing environmental education. At the same time, integration must explain relationships between knowledge systems rather than simply placing them side by side (Aikenhead & Ogawa, 2007; De Beer & Van Wyk, 2021). Thus, culturally grounded teaching requires both respect for local knowledge and careful scientific mediation.

In Tanzania, Komba and Shukia (2023) identified a gap between intended and enacted curricula in relation to 21st-century skills. Although their study did not examine IK in ecology, it provides context for considering the resources and professional support needed to implement curriculum intentions. Professional development is also important because teachers need pedagogical strategies for connecting local environmental practices with formal ecology (Komba & Mwakabenga, 2019; Mafugu et al., 2024). Across the reviewed literature, a consistent pattern emerges: teachers often appreciate IK, but its classroom use depends on preparation, curriculum flexibility, instructional materials, and institutional recognition. The present study examines how Biology teachers in Dodoma describe these opportunities and constraints.

2.2 Theoretical Framework

This paper is guided primarily by Culturally Relevant Pedagogy (CRP), which argues that effective teaching should support academic learning while recognising learners' cultural identities and encouraging critical engagement with the realities shaping their lives (Ladson-Billings, 2021; García Franco et al., 2022). CRP is appropriate for examining teachers' perceptions of IK

because it focuses on whether community experience and cultural knowledge are treated as legitimate classroom resources. In ecology teaching, it supports the use of local farming, conservation, weather, and resource-management practices as meaningful contexts for discussing scientific concepts rather than as peripheral anecdotes.

CRP also helps explain the gap between teachers' positive perceptions and the conditions surrounding their practice. Teachers may value IK because it makes ecology understandable and culturally meaningful yet still be constrained by curriculum demands, limited materials, and insufficient preparation. Culturally responsive teaching therefore requires both teacher willingness and institutional support (Ladson-Billings, 2021; Mutekwe, 2015). The framework is complemented by the broader study's constructivist emphasis that learners understand new concepts more effectively when formal knowledge is connected with prior environmental experience (García Franco et al., 2022; Latip et al., 2024).

3. Methodology

3.1 Research Design

The broader study used a qualitative approach within an interpretive orientation to explore Indigenous Knowledge in ecology teaching in selected secondary schools in Dodoma. This approach was appropriate because the study sought detailed accounts of teachers' experiences and interpretations rather than statistical measurement. A case-study design involving four schools allowed the phenomenon to be examined within bounded educational settings and emphasised contextual explanation rather than statistical generalisation (Yin, 2018).

3.2 Sample and Sampling

This paper reports the teacher-focused component of the broader study. Four Biology teachers, one from each participating school, formed the primary participant group. They were purposively selected because they taught Biology, were involved in the ecology topic, and had relevant awareness or experience concerning IK. Purposive sampling was appropriate because the intention was to obtain information-rich accounts from participants directly involved in the phenomenon (Palinkas et al., 2015). Although the broader study included 36 participants, this article centres on the four teachers' perceptions.

3.3 Data Collection Tools

Semi-structured interviews were the principal source of evidence. The interview questions explored the forms of IK teachers recognized, the value they attached to integration, student responses, teaching strategies, practical challenges, and the support they considered necessary. Classroom observations and documentary

review provided supplementary context. The documents reviewed included the Biology syllabus and lesson plans.

3.4 Data Collection Procedures

Interviews were conducted in person and allowed participants to elaborate beyond the prepared questions. Most responses were provided in Swahili and translated into English during transcription. The translations were reviewed, and some were cross-checked by a bilingual colleague. Classroom observations and documentary review formed part of the broader study. In this article, these sources contextualize the teacher accounts rather than generate separate observation-based themes.

3.5 Data Analysis and Trustworthiness

Interview transcripts were analyzed through reflexive thematic analysis, informed by the guidance of Kiger and Varpio (2020). The researcher repeatedly read the transcripts, generated initial codes, grouped related codes into candidate themes, and refined the themes in relation to the study objective. Trustworthiness was supported through triangulation across the broader data sources, clear documentation of the analysis, and direct quotations. The interpretation focused on teachers' accounts of IK integration; it did not directly measure changes in students' understanding, engagement, or cultural appreciation.

3.6 Ethical Considerations

Before consent was obtained, participants received information about the study, voluntary participation, confidentiality, and their right to withdraw. Teachers and schools are identified by codes in the reported quotations.

4. Results and Discussion

This section presents and discusses the themes generated from Biology teachers' interviews concerning the integration of Indigenous Knowledge in ecology teaching. The teachers' accounts provide the primary evidence, while the broader study's classroom and documentary evidence helps situate their perceptions within the realities of formal teaching. Overall, teachers expressed strong support for IK as a pedagogical resource, but their positive beliefs were consistently accompanied by concerns about the curriculum, teaching materials, professional preparation, and time. The discussion therefore considers both the educational value teachers attributed to IK and the conditions that influenced its classroom use.

4.1 Teachers' Perceptions toward Integrating Indigenous Knowledge

Across the four teacher interviews, Indigenous Knowledge was generally described as useful for making ecology understandable, relevant, and connected to learners' cultural and environmental experiences. Teachers repeatedly referred to familiar community

practices as examples that could help learners interpret ecological relationships and environmental processes. At the same time, their accounts showed that IK integration was not viewed as a simple addition to existing lessons. Teachers emphasised that meaningful use requires guidance, appropriate resources, and sufficient time to relate local practices clearly to formal scientific concepts. This combination of positive belief and practical constraint is central to understanding teachers' perceptions in the present study.

4.1.1 Teachers' Beliefs that Indigenous Knowledge Enhances Students' Understanding

One of the strongest perceptions expressed by teachers was that Indigenous Knowledge improves students' understanding of ecological concepts by connecting formal scientific explanations with situations learners already know. Teachers described ecology as particularly suitable for this form of contextualisation because the subject addresses relationships between organisms and their environments, resource use, conservation, adaptation, and other processes that can be observed in community life. Their accounts indicate that familiar environmental practices can provide concrete starting points for discussing concepts that might otherwise remain abstract when presented only through textbooks.

For instance, one teacher explained:

"When we explain ecology using examples from indigenous practices such as farming or conservation, students quickly understand them because they have seen these practices in their communities." (Interview, Biology Teacher 1, School A, February 2026).

This response illustrates the teachers' belief that familiarity supports comprehension. The teacher was not suggesting that community practice replaces scientific explanation; rather, the local example provides an entry point from which scientific relationships can be made visible. This interpretation is consistent with Latip et al. (2024), who argue that local and Indigenous knowledge can strengthen science learning by situating new content within familiar contexts. García Franco et al. (2022) similarly emphasise that culturally relevant science education supports deeper interpretation when learners can relate abstract ideas to observable environmental phenomena. In the present study, the teacher's use of farming and conservation examples therefore reflects a pedagogical strategy that links new ecological knowledge to learners' prior experiences.

A second teacher made the connection between community practice and ecological relationships more explicit:

"Ecology is about the relationships between organisms and their environment. Many of these relationships can be seen in traditional farming practices and environmental

management in our communities.” (Interview, Biology Teacher 3, School D, February 2026).

This account shows that teachers perceive Indigenous Knowledge as relevant to the conceptual substance of ecology rather than merely to student motivation. Traditional farming, environmental management, and conservation can illustrate interactions among organisms, human activity, resources, and environmental conditions. Berkes (2018) and Thompson et al. (2020) similarly describe Indigenous ecological knowledge as knowledge built through sustained observation and practice, while Oando (2024) notes its usefulness for contextualizing environmental processes in science education. The teachers’ perceptions are therefore grounded in the idea that local ecological practices can make scientific relationships more observable and interpretable for learners.

Jumba and Mwiti (2022) provide a relevant comparison from Kenyan primary schools, where limited awareness and implementation barriers constrained IK integration. Their study did not directly establish gains in students’ ecological understanding. Mkhwebane (2024) also documented difficulties in meaningful IK integration, including inadequate training and negative attitudes among some teachers. The comparison shows that positive perceptions are not uniform across settings and that the benefits described by the Dodoma teachers need to be interpreted alongside the support required for classroom implementation.

Teachers’ belief in contextual learning also raises the question of how local knowledge relates to formal science. De Beer and Van Wyk (2021) caution that Indigenous and Western scientific knowledge may differ in validation and epistemological foundations, while Aikenhead and Ogawa (2007) emphasize careful movement between knowledge traditions. The present findings suggest that teachers attempt this mediation by using Indigenous examples to complement scientific explanations. Their positive perception is strongest where IK serves as a bridge to scientific understanding rather than as an isolated cultural reference.

From a Culturally Relevant Pedagogy perspective, this perception is important because it recognizes learners’ environments and cultural experiences as legitimate resources for academic learning (Ladson-Billings, 2021). When teachers draw on familiar ecological practices, learners are positioned not simply as recipients of textbook knowledge but as students whose prior experiences can contribute to meaning-making. The teachers’ accounts therefore suggest perceived opportunities for conceptual understanding and classroom participation when local examples are explicitly linked to scientific concepts. These accounts do not establish measured improvements in student learning.

4.1.2 Teachers’ Perception that Indigenous Knowledge Makes Ecology Lessons More Relevant and Interesting

Teachers also perceived Indigenous Knowledge as a way of making ecology lessons more relevant and interesting. They explained that learners respond more actively when classroom discussion includes environmental practices they recognize from their homes or communities. In this sense, relevance was not treated as a superficial attempt to entertain students; it was linked to the ability of learners to recognize the practical significance of ecological content and to contribute their own experiences during lessons.

One teacher stated:

“When we use examples from the community, students become more interested in the lesson because they recognize the situations being discussed. It makes ecology more meaningful for them.” (Interview, Biology Teacher 3, School A, February 2026).

The teacher’s account suggests that recognition increases attention because students can locate scientific ideas within situations that are already meaningful to them. In their guide for undergraduate Biology teaching, Greenall and Bailey (2022) argue that the inclusion of Traditional Ecological Knowledge can strengthen engagement and a sense of belonging when science teaching acknowledges learners’ cultural and environmental contexts. Latip et al. (2024) also associate local and Indigenous knowledge with stronger engagement because students can interpret science content through familiar examples. Although that guide concerns a different educational level, it offers a useful pedagogical comparison. The present teachers likewise associated familiar examples with learners’ willingness to participate when those examples were tied to the scientific content being taught.

Another teacher described students’ response in more concrete terms:

“Students feel excited when we discuss practices that happen in their villages, such as traditional farming methods or protecting water sources. They realize that ecology is connected to their daily lives.” (Interview, Biology Teacher 2, School A, February 2026).

This statement links interest with practical recognition. Farming methods and the protection of water sources are not simply cultural illustrations; they represent environmental actions through which students can recognize ecological ideas related to resource management, sustainability, and human-environment relationships. Oando (2024) emphasizes that Traditional Ecological Knowledge can strengthen the practical relevance of science education, while Berkes (2018) demonstrates that community-based ecological knowledge is grounded in long-term interaction with local environments. Teachers in the present study therefore viewed IK as a means of showing learners that

ecology is not confined to the classroom but is reflected in environmental decisions and practices around them.

The finding is also consistent with Culturally Relevant Pedagogy. Ladson-Billings (2021) argues that teaching becomes more inclusive when learners' cultural backgrounds are treated as resources rather than obstacles to academic learning. García Franco et al. (2022) further show that culturally relevant science education can promote critical engagement when students examine scientific issues through contexts that matter to their communities. The teachers' perceptions in this study point in the same direction: local examples appeared to create opportunities for students to ask questions, share experiences, and participate as contributors to classroom knowledge.

Relevance alone, however, is not sufficient. Ramnarain and Hlatwayo (2018) examined inquiry-based science teaching rather than IK integration, but their findings provide a broader comparison of how school conditions can limit the implementation of favourable teacher beliefs. Teachers in this study valued IK because it encouraged interest and participation, but its benefit depends on how examples are used. Brief mentions may add familiarity without deeper analysis, whereas comparison, explanation, discussion, and inquiry can support the learner-centred teaching teachers associated with effective ecology learning.

4.1.3 Teachers' Perception that Indigenous Knowledge Promotes Appreciation of Cultural and Environmental Knowledge

A third important perception was that integrating Indigenous Knowledge can strengthen students' appreciation of cultural heritage and community-based environmental knowledge. Teachers described local practices as knowledge developed over long periods of interaction with the environment and believed that their inclusion in Biology lessons helps learners recognize that useful ecological understanding exists within their own communities. This perception extends the value of IK beyond immediate comprehension or classroom interest by connecting science learning with questions of cultural identity, environmental responsibility, and whose knowledge is recognized within formal education.

One teacher explained:

"Many environmental practices used by our communities have been developed over a long time. When students learn about them in class, they begin to appreciate the knowledge that exists in their culture." (Interview, Biology Teacher 2, School C, February 2026).

This account reflects the idea that formal recognition can influence how learners value community knowledge. Mutekwe (2015) argues that incorporating Indigenous Knowledge into education can support cultural consciousness and challenge the assumption that meaningful knowledge is produced only through

Western-centred systems. Shabalala (2025) similarly links the inclusion of African knowledge systems in environmental education with decolonizing the curriculum. The present teacher's perception fits this broader argument because classroom inclusion is seen as a way of helping students view local environmental knowledge as relevant to contemporary learning rather than as an outdated tradition.

Another teacher focused specifically on conservation practices:

"When students understand that some conservation practices have existed in our communities for many years, they begin to see the value of those traditions." (Interview, Biology Teacher 4, School D, February 2026).

The quotation shows that cultural appreciation and environmental learning are intertwined. Indigenous conservation practices can communicate both ecological principles and social values about the use and protection of natural resources. Sospeter et al. (2026) emphasize the continuing contribution of Indigenous Knowledge to climate adaptation and resource management in Tanzanian communities, while Oando (2024) argues that Traditional Ecological Knowledge can help learners understand the relationship between cultural practice and environmental sustainability. In the present study, teachers therefore perceived cultural recognition as educationally relevant because it can strengthen learners' awareness of the historical and practical foundations of environmental stewardship.

This finding fits Culturally Relevant Pedagogy, which emphasises recognition of learners' cultural identities within academic learning (Ladson-Billings, 2021). Classroom inclusion can make the curriculum more representative of students' lived realities, but recognition should also encourage critical engagement (García Franco et al., 2022). Teachers therefore need not treat every traditional practice as scientifically equivalent or beyond question; they can examine its ecological meaning, evidence, strengths, and limitations while maintaining respect for the knowledge system from which it emerges.

Teachers' positive perceptions must also be understood against the marginal position of Indigenous Knowledge in formal education. Kaya and Seleti (2013) note that African Indigenous Knowledge Systems have often been undervalued within Western-oriented educational structures, while Lwoga et al. (2011) identify challenges in documenting and managing IK systematically. Teachers in the present study appeared to counter this marginalization by drawing attention to environmental knowledge embedded in community practices. Their accounts suggest that IK can enrich scientific understanding while strengthening respect for cultural knowledge and environmental responsibility.

4.1.4 Teachers' Perception of the Practical Challenges of Integrating Indigenous Knowledge in Ecology Teaching

Despite their generally positive perceptions, teachers consistently described practical conditions that limited their ability to integrate Indigenous Knowledge systematically. These concerns are important because they reveal a distinction between valuing IK and having the institutional capacity to use it. The teachers' accounts identified three closely related constraints: limited curriculum guidance and instructional materials, insufficient professional preparation for integrating IK with scientific content, and time pressure associated with syllabus coverage. Their perceptions therefore combine willingness with uncertainty about how integration can be sustained within the existing structure of Biology teaching.

The first concern involved the absence of clear curriculum guidance and teaching materials. One teacher explained:

"The biology syllabus focuses mainly on scientific explanations. Sometimes we want to include examples from Indigenous knowledge, but there are no teaching materials that guide us on how to do that effectively." (Interview, Biology Teacher 3, School D, February 2026).

This statement demonstrates that teachers do not necessarily reject IK; rather, they experience difficulty translating positive attitudes into structured classroom practice when the curriculum provides little explicit direction. Mlotshwa and Tsakeni (2024) similarly found that teachers' efforts to integrate Indigenous Knowledge were constrained by weak curriculum support and limited instructional resources. Mkhwebane (2024) also reported that the absence of clear pedagogical guidance contributed to fragmented and inconsistent integration in Life Sciences classrooms. In the present study, the lack of structured materials appears to push teachers toward occasional references based on personal experience rather than planned integration across learning objectives and activities.

The broader dissertation's documentary review supports this interpretation by showing limited explicit direction for systematic IK integration within the reviewed Biology syllabus and lesson plans. This context helps explain why teachers described themselves as interested in using Indigenous examples but dependent on their own knowledge and initiative. Komba and Shukia (2023) similarly identified weaknesses affecting curriculum implementation in Tanzania, although their focus was 21st-century skills rather than explicit IK provision in Biology. Where curriculum guidance remains general, contextualized teaching may depend heavily on individual teacher confidence, resulting in unequal opportunities for learners across schools and lessons.

Professional preparation was a second major concern. One teacher stated:

"During our training as teachers, we were mostly taught how to teach scientific concepts. We were not really trained on how to integrate indigenous knowledge into science lessons." (Interview, Biology Teacher 1, School B, February 2026).

This response indicates that teachers perceived a specific pedagogical gap in their professional preparation. Integrating IK requires more than knowing local examples; teachers must decide which examples are relevant, how they relate to ecological principles, how to discuss similarities and differences between knowledge systems, and how to avoid superficial or inaccurate representation. Komba and Mwakabenga (2019) emphasise the importance of teacher professional development for expanding instructional capacity in Tanzania, while Mafugu et al. (2024) argue that Indigenous Knowledge integration requires sustained professional support. The present finding therefore suggests that teacher education and in-service development should provide practical strategies for conceptual bridging rather than simply encouraging teachers to include local examples.

The issue of preparation also has an epistemological dimension. Aikenhead and Ogawa (2007) argue that science classrooms often require careful movement between different knowledge traditions, and De Beer and Van Wyk (2021) caution that validation and knowledge claims may be understood differently across Indigenous and Western scientific systems. Without professional preparation, teachers may avoid IK because they are uncertain about how to present it responsibly, or they may include examples without explaining their scientific relevance. The teachers' concerns therefore point to the need for pedagogical confidence as well as institutional permission.

Time pressure associated with the Biology syllabus was the third major constraint. One teacher explained:

"The syllabus is already very wide, and we have limited time to cover all the topics. Sometimes it becomes difficult to include extra discussions about indigenous practices." (Interview, Biology Teacher 2, School C, February 2026).

The wording 'extra discussions' is revealing because it shows how curriculum pressure can position Indigenous Knowledge as additional material rather than as a way of teaching required ecological content. When teachers are evaluated through syllabus completion and examination preparation, they may prioritize textbook coverage even if they believe contextual examples improve understanding. Ndjangala et al. (2021) identified resource shortages, overcrowding, and other challenges in upper-primary natural science teaching in Namibia. Ramnarain and Hlatswayo (2018) examined constraints on inquiry-based science teaching in South Africa. These

studies provide broader comparisons of classroom constraints; they do not directly establish the syllabus-related barriers to IK integration reported by the Dodoma teachers. The present teachers' perceptions therefore suggest that meaningful integration will remain difficult unless IK is connected explicitly to existing learning outcomes rather than treated as content to be added after the formal syllabus has been covered.

Taken together, these constraints reveal a gap between positive perception and classroom feasibility. Teachers believed that IK can improve understanding, interest, cultural appreciation, and real-life relevance, yet they did not feel fully supported to use it consistently. This pattern can be compared with the implementation challenges discussed by Jumba and Mwiti (2022), Mlotshwa and Tsakeni (2024), and Mkhwebane (2024), while recognizing that teacher attitudes and curriculum contexts differ across those studies. Effective integration therefore depends on aligning teacher beliefs with curriculum guidance, instructional resources, professional development, and realistic classroom time.

From a Culturally Relevant Pedagogy perspective, culturally responsive practice cannot depend solely on individual teachers' personal commitment. If education systems expect teachers to connect science with learners' cultural and environmental contexts, they must also provide the curricular legitimacy and pedagogical support needed for that work (Ladson-Billings, 2021; García Franco et al., 2022). The teachers' accounts therefore shift the discussion from whether IK has value to how curriculum and school structures can enable its systematic and responsible use.

At the same time, the findings demonstrate that positive perception and consistent implementation are not equivalent. Teachers can value IK and still be unable to integrate it systematically when curriculum guidance, instructional materials, professional preparation, and classroom time are limited. Komba and Shukia (2023) identified systemic barriers to curriculum implementation in Tanzania, while Mlotshwa and Tsakeni (2024) examined challenges specific to IK integration. Ramnarain and Hlatswayo (2018) provide a broader comparison concerning inquiry-based science teaching. Together, these sources help situate the reported constraints without implying that they examined identical practices or settings. The implication from the present study is therefore that teacher willingness should be treated as an important enabling condition, but not as a substitute for institutional support. For IK to move from occasional teacher-selected examples to a more coherent component of ecology teaching, teachers need clear curricular space, relevant materials, and professional learning that helps them relate Indigenous and scientific knowledge critically and respectfully (Aikenhead & Ogawa, 2007; García Franco et al., 2022).

5. Conclusion and Recommendations

5.1 Conclusion

This study examined Biology teachers' perceptions of integrating Indigenous Knowledge in ecology teaching in four secondary schools in Dodoma, Tanzania. The participating teachers generally viewed IK as valuable for connecting ecological concepts with familiar farming, conservation, and resource-management practices. Their accounts identified three related educational benefits: clearer understanding of ecological concepts, greater perceived relevance and interest, and appreciation of cultural and environmental knowledge. They understood community experience as a resource that could complement scientific explanation when the relationship between local practices and ecological concepts was made explicit.

Teachers also described limits to consistent implementation. Inadequate curriculum guidance and instructional materials, insufficient professional preparation, and pressure to complete the Biology syllabus restricted their ability to use IK systematically. Positive perceptions therefore coexisted with practical constraints. The central conclusion is that teacher willingness provides a foundation for culturally relevant ecology teaching, but sustained integration requires institutional support for planning, resources, and professional learning. Culturally Relevant Pedagogy helps explain why recognizing learners' community knowledge must be accompanied by conditions that enable teachers to use it critically and responsibly.

These conclusions concern the perceptions of four purposively selected teachers in the participating schools. The accounts provide contextual insight rather than a basis for statistical generalization, and they do not demonstrate causal improvements in student achievement or engagement. The recommendations therefore address the implementation needs described by the teachers.

5.2 Recommendations

The recommendations below respond to the perceived benefits and implementation barriers identified in the teacher interviews.

1. Curriculum developers and education authorities should provide explicit guidance linking relevant Indigenous ecological practices to existing Biology learning outcomes, lesson activities, and assessment tasks. Embedding these examples within the required ecology content would address teachers' concern that IK discussions compete with syllabus coverage.
2. Teacher education institutions and professional development providers should offer practical preparation in selecting local ecological examples, explaining their relationship to scientific concepts, and facilitating respectful

critical comparison between knowledge systems. Lesson planning and opportunities to share classroom experiences should help teachers apply this preparation to the challenges they reported.

3. Schools and education authorities should support the development and sharing of culturally relevant teaching materials covering farming, conservation, weather observation, and resource management. Materials developed with Biology teachers and knowledgeable community members should connect local examples explicitly to the syllabus and provide clear explanations that teachers can adapt to their lessons.
4. Biology teachers should use learner-centred activities that invite students to describe environmental experiences, compare explanations, and discuss the evidence behind local practices and scientific ideas. These activities should be incorporated into planned ecology lessons. Teachers should review students' explanations and participation to assess whether the examples support the intended learning objectives.

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