Linguistically responsive pedagogies in undergraduate biology education: A systematic review and implications for English-medium instruction in Zambian universities

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ABSTRACT

This systematic review synthesises global evidence on linguistically responsive pedagogies (LRP) in undergraduate biology education and examines their relevance for English-medium universities in Zambia. English is the sole language of instruction in most Zambian higher education institutions, despite students' multilingual backgrounds, which can limit comprehension, participation, and learning outcomes in disciplines such as biology, where abstract concepts and specialised terminology are central. The study was anchored on Vygotsky's sociocultural theory of learning as well as Ladson-Billings (1995)'s culturally responsive pedagogy theoretical framework. A comprehensive literature search was conducted across Scopus, Web of Science, ERIC, and Google Scholar, including studies published between 2018 and 2025. From 1,042 records, 57 studies were selected, involving 6,832 students and 412 instructors across multilingual contexts, including the United States, South Africa, the Philippines, China, and Europe. Findings suggest that strategies such as translanguaging, bilingual instruction, culturally responsive teaching, scaffolded support, narrative pedagogy, and technology-enhanced learning boost student engagement, conceptual understanding, academic performance, and identity affirmation. Main barriers include teachers' reliance on authoritative discourse, limited professional training, and institutional policies requiring English-only instruction. Conversely, enablers feature structured pedagogical tools, professional development, and the integration of students' prior knowledge and cultural backgrounds into the curriculum. Applying LRP to the Zambian context suggests it can improve epistemic access and encourage inclusive participation in biology classes. Using translanguaging, culturally relevant examples, and scaffolded explanations helps connect students' prior knowledge with disciplinary content. Aligning teaching methods with assessment practices is essential to maximise the effectiveness of these strategies. This review confirms that linguistically responsive pedagogies offer a viable, evidence-based pathway for improving biology education in Zambia's English-medium universities. By adapting strategies such as translanguaging, culturally relevant examples, and scaffolded instruction, institutions can bridge the gap between students' multilingual realities and the demands of disciplinary learning. However, success depends on addressing key barriers: providing targeted professional development for lecturers, revising English-only policies to allow strategic use of local languages, and ensuring assessment methods align with inclusive teaching practices. Implementing these changes can enhance epistemic access, engagement, and academic outcomes for Zambian biology students.

Keywords: Linguistically Responsive Pedagogy, Multilingual Higher Education, Student Engagement, Translanguaging, Undergraduate Biology, Zambia

I. INTRODUCTION

Higher education worldwide is increasingly characterised by linguistic and cultural diversity, as students bring multiple languages and varied cultural backgrounds into the classroom. Addressing this diversity is essential for promoting equitable participation and improving learning outcomes. In Zambia, English remains the sole medium of instruction in most universities, despite students' multilingual realities. This monolingual approach can restrict epistemic access, limit understanding, and hinder full participation in academic discourse (Wildsmith-Cromarty et al., 2022; Mavutha & Biyase, 2025). Scholars have criticised English-only instruction as a form of symbolic multilingualism, where linguistic diversity is acknowledged in principle but rarely incorporated into teaching practice, thereby reinforcing inequalities in learning opportunities (Rantanen, 2024).

Zambia is a highly multilingual nation, with over 70 indigenous languages spoken across its ten provinces. The most widely spoken local languages include Bemba, Nyanja, Tonga, Lozi, and Luvale, each serving as a regional lingua franca in different parts of the country (Ministry of Education, Science, Vocational Training and Early Education [MESVTEE], 2013). Despite this rich linguistic diversity, English has remained the sole official language of instruction from Grade 5 onwards, a policy inherited from the colonial era and reinforced in post-independence educational frameworks. The Zambia Education Curriculum Framework explicitly states that "English shall be the official language

of instruction from Grade 5 upwards" (MESVTEE, 2013, p. 39). This policy positions English as a unifying national language and as a pathway to global engagement, academic mobility, and socioeconomic progress. However, the policy also creates a significant linguistic discontinuity for the majority of Zambian students, who are taught in local languages during their early primary years before abruptly transitioning to English-medium instruction.

Research evidence from diverse global contexts indicates that linguistically responsive pedagogies (LRP), which purposefully incorporate students' linguistic repertoires, can enhance learning outcomes, engagement, and identity affirmation. These pedagogies include translanguaging, culturally responsive teaching, differentiated instruction, scaffolded support, and narrative-based teaching (Chapman et al., 2022; Nakhooda & Paxton, 2021; Barron et al., 2021). By recognising students' multilingual abilities, LRP fosters a learning environment that affirms diverse linguistic identities and aids the comprehension of complex academic content. Evidence from South African universities shows that brief professional development programmes in multilingual pedagogies positively affect lecturer attitudes and classroom practices, promoting inclusivity and equity even within predominantly English-medium institutions (Reyneke & Kaiser, 2025; Wildsmith-Cromarty et al., 2022).

The relevance of LRP to science education, particularly biology, cannot be overstated. Biology as a discipline is characterised by abstract concepts, specialised terminology, dense academic texts, symbolic representations, and culturally sensitive content, including genetics, evolution, reproduction, and human variation. When instruction occurs solely in a language that students have not fully mastered for academic purposes, learning often becomes procedural and rote rather than conceptual and generative (Brownel et al., 2014; Wright & Domke, 2019). For many Zambian students, whose prior scientific understanding is shaped by indigenous languages and community-based knowledge systems, English-only instruction can create a disconnect between lived experience and formal academic knowledge. Translanguaging enables students to use their dominant language alongside English to negotiate meaning, enhancing academic literacy and conceptual understanding (Nakhooda & Paxton, 2021). Narrative-based instruction supports knowledge transfer, particularly for students with limited prior knowledge of biology, while culturally responsive teaching promotes equitable participation by linking content to students' lived experiences (Tobler, Sinha, Köhler, & Kapur, 2025; Barron et al., 2021). Additionally, intentionally framing genetics topics to include gender, race, and disability can reduce stereotype threat and foster inclusivity (Hales, 2020; Guevara et al., 2023).

In undergraduate biology education, LRP is especially vital because of the cumulative nature of biological knowledge. Students who fail to grasp foundational concepts due to language barriers may struggle throughout their degree programmes, leading to high dropout rates, low academic achievement, and underrepresentation of certain linguistic groups in science careers. The conceptual density of biology courses, combined with the technical vocabulary that often has no direct equivalent in local languages, creates challenges for multilingual learners. For example, terms such as "photosynthesis," "mitosis," "homeostasis," and "allele" are rarely encountered outside formal education contexts, and students may need repeated exposure and multiple forms of explanation to internalise these concepts. LRP strategies, such as bilingual glossaries, peer discussions in home languages, and culturally relevant analogies, can bridge this gap by connecting unfamiliar scientific terms to familiar cognitive frameworks.

Despite this evidence, the adoption of LRP in biology education remains inconsistent. Many instructors still rely on authoritative, teacher-centred discourse even when employing active learning strategies, thereby limiting dialogic engagement and perpetuating misconceptions such as anthropocentric reasoning (Kranzfelder et al., 2020; Betz et al., 2019; Nielson et al., 2025). Debate continues over the practicality of implementing LRP in English-medium contexts, particularly in resource-limited universities. Critics claim that multilingual scaffolding could slow curriculum delivery or complicate the standardisation of assessments, while supporters highlight its potential to improve understanding and promote equity (Gallagher & Haan, 2018; Liu, Çolak, & Ağirdağ, 2021). In the Zambian context, specifically, concerns have been raised about the availability of instructional materials in local languages, the lack of a standardised orthography for scientific terminology, and potential resistance from lecturers who view English-only instruction as a marker of academic professionalism. Against this backdrop, this systematic review synthesises evidence on LRP in undergraduate biology education and critically interprets its relevance for English-medium instruction in Zambian universities. Specifically, it aims to identify effective pedagogical practices, evaluate their impact on student engagement, learning outcomes, and identity affirmation, and examine barriers and enablers to implementation.

1.1 Research Questions

i. I. What linguistically responsive pedagogical practices are documented in undergraduate biology education?
ii. What evidence is available on the impact of these practices on student engagement, learning outcomes, and identity affirmation?
iii. What are the main barriers and enablers for implementing LRP in undergraduate biology courses taught in English?
iv. What lessons can be learned to guide pedagogical strategies in Zambian universities?

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Vygotsky's Sociocultural Theory of Learning

This review is grounded in Vygotsky's (1978) Sociocultural Theory of learning, which posits that cognitive development occurs through social interaction and cultural mediation. According to Vygotsky, learning is fundamentally a social process in which learners acquire knowledge and skills through interaction with more knowledgeable others, including teachers and peers, within culturally structured environments. Two key concepts from this theory are particularly relevant to linguistically responsive pedagogy: the Zone of Proximal Development (ZPD) and scaffolding. The ZPD refers to the distance between what a learner can accomplish independently and what they can achieve with guidance and support from a more knowledgeable other (Vygotsky, 1978). In the context of undergraduate biology education, students' ZPD includes concepts they cannot yet grasp in English alone but can understand when supported by their home languages, peer collaboration, and scaffolded instruction. Translanguaging and peer discussion in familiar languages can therefore function as powerful tools for moving students through their ZPD.

Scaffolding, a concept derived from Vygotsky's work (Woo et al., 1976), refers to the temporary support provided to learners to help them accomplish tasks beyond their independent capability. In linguistically responsive biology classrooms, scaffolding can take the form of bilingual glossaries, peer tutoring in home languages, visual aids, and structured dialogue that connects everyday language with scientific discourse. As students develop proficiency, these supports can be gradually removed. Sociocultural theory also emphasises the role of cultural tools in mediating learning. Language is the primary cultural tool through which knowledge is constructed and communicated. When instruction is delivered exclusively in English to students who are more proficient in other languages, the cultural tool becomes a barrier rather than a bridge. LRP addresses this by recognising students' full linguistic repertoires as legitimate cognitive resources (García & Wei, 2014). This theoretical framework underpins the review's focus on how social interaction, cultural relevance, and linguistic scaffolding can enhance learning in biology in multilingual university settings.

2.1.2 Culturally Responsive Pedagogy

Ladson-Billings (1995) developed Culturally Relevant Pedagogy (CRP), which argues that effective teaching for culturally diverse students must simultaneously support academic achievement, cultural competence, and sociopolitical awareness. In the biology classroom, CRP involves connecting scientific concepts to students' lived experiences, cultural practices, and community knowledge. For example, lessons on ecology can draw on students' knowledge of local farming practices, while discussions of genetics can incorporate students' understanding of hereditary conditions within their families and communities. More recently, scholars have extended CRP to specifically address linguistic diversity. Paris and Alim (2017) proposed Culturally Sustaining Pedagogy, which goes beyond mere relevance to actively sustain and promote cultural and linguistic pluralism. In multilingual contexts, this means not merely tolerating students' home languages but explicitly valuing and incorporating them as assets for learning. This perspective is particularly relevant to Zambian universities, where students speak more than 70 indigenous languages yet are expected to learn exclusively in English.

2.2 Empirical Review

2.2.1 Pedagogical Practices in LRP

A consistent finding across the literature is that translanguaging and bilingual pedagogies improve student outcomes in undergraduate biology. Chapman et al. (2022) compared bilingual (Spanish-English) biology sections with English-only sections taught by the same instructors. Students in bilingual sections achieved 18% higher exam scores and demonstrated significantly better conceptual understanding of biological processes. The authors concluded that language flexibility enhances conceptual understanding rather than diluting disciplinary rigour. Similarly, Nakhooda and Paxton (2021) demonstrated that translanguaging pedagogies support academic literacy and deeper engagement with biotechnology concepts by enabling students to utilise their full linguistic repertoires when deciphering complex scientific content.

Barron, Brown, and Cotner (2021) examined the culturally responsive science teaching practices of 12 undergraduate biology teaching assistants across 124 students. The study found that teaching assistants who intentionally incorporated students' prior knowledge, used differentiated instruction, and scaffolded learning tasks encouraged more equitable participation and reduced classroom anxiety by approximately 25%. Students reported feeling more confident contributing to discussions and asking questions when instructors made explicit connections to their cultural backgrounds. Hales (2020) demonstrated that deliberately framing genetics topics to acknowledge gender identity, disability, and race reduced stereotype threat and created more inclusive learning environments. The study

provided practical strategies, including separating the sperm/egg binary from gendered terms in coverage of inheritance patterns and including transgender people in pedigree charts.

Tobler, Sinha, Köhler, and Kapur (2025) examined the impact of narrative-based instruction in undergraduate biology courses with 200 students. The study found that narrative pedagogies were particularly beneficial for students with lower prior knowledge of biology, improving knowledge transfer and engagement in over 70% of classroom interactions. Narratives, including case studies and storytelling, presented complex scientific concepts in relatable, sequential, and meaningful ways, supporting comprehension and retention. Ussenova, Zhailybayeva, Toktamys, and Amanbay (2025) investigated the impact of Content and Language Integrated Learning (CLIL) technologies on 132 college students in Kazakhstan. The study found that CLIL technology significantly increased student engagement, motivation, satisfaction, and perceived learning, while also supporting English language development and understanding of biological concepts. Digital platforms enabled multimodal explanations, interactive learning tasks, and translanguaging opportunities, making complex content more accessible in large, linguistically diverse classes.

2.2.2 Impact on Student Outcomes

Connell et al., (2016) demonstrated that the consistent use of student-centred pedagogies in undergraduate biology (n = 98 students, 4 instructors) resulted in post-assessment scores 15-20% higher than those in moderate teacher-centred classes. Students in student-centred sections also developed more expert-like epistemological views of biology. Chapman et al. (2022) similarly reported that bilingual instruction produced significantly higher learning outcomes than English-only sections. David and Venuste (2021) examined pedagogical language strategies in Tanzanian secondary science classrooms (n = 120 students, 6 teachers). The study found that the strategic use of students' home languages increased interaction rates by approximately 30%, accompanied by higher levels of collaborative problem-solving and active inquiry. Barron et al. (2021) reported that culturally responsive practices reduced classroom anxiety by 25% and increased equitable participation among historically marginalised students.

Nakhooda and Paxton (2021) found that translanguaging pedagogies validated students' home languages and identities, increasing self-reported sense of belonging by approximately 35% in a linguistically diverse university context. Tobler et al. (2025) showed that narrative-based instruction improved knowledge transfer and engagement, particularly for students with limited prior biology knowledge, indicating that pedagogies attentive to the emotional aspects of learning can reduce alienation and encourage persistence in science disciplines. Guevara et al. (2023) demonstrated that explicitly teaching updated scientific views on human genetic variation decreased students' endorsement of racial essentialism and challenged scientifically incorrect beliefs. Nielson et al. (2025) found that anthropocentric language use was associated with greater endorsement of biological misconceptions, emphasising the need for careful language choices in teaching.

2.2.3 Barriers and Enablers

Kranzfelder et al. (2020) found that even when instructors employed active learning strategies, classroom discourse remained predominantly teacher-centred and authoritative, limiting opportunities for dialogic interaction and student meaning-making. Betz et al. (2019) found that anthropocentric and construal-consistent language was prevalent among 10 instructors and 248 students, thereby reinforcing misconceptions. Barron et al. (2021) noted that many instructors and teaching assistants begin undergraduate biology courses with strong subject knowledge but little formal instruction in inclusive or multilingual teaching strategies. Nakhooda and Paxton (2021) highlighted that dominant monolingual ideologies in higher education often regard English as the only legitimate academic language, deterring instructors from including students' home languages.

Meaders et al. (2025) demonstrated that structured 10-hour pedagogy courses for 60 undergraduate biology instructional apprentices improved participants' understanding of inclusive teaching, classroom community building, and effective learning strategies. Ussenova et al. (2025) showed that CLIL-based technologies enhanced student engagement, satisfaction, and perceived learning. Koukoulidis et al. (2025) developed the CLIMB observation protocol, which provides a systematic framework for identifying and strengthening culturally and linguistically responsive teaching practices. Barron et al. (2021) emphasised how culturally responsive curricular choices, including differentiated instruction and intentional scaffolding, allowed students from diverse linguistic backgrounds to engage more meaningfully with biological concepts.

2.2.4 Implications for the Zambian Context

Zambia's national language-in-education policy explicitly endorses English as the main language of schooling beyond the early grades. However, empirical research conducted at Zambian universities consistently shows a mismatch between this policy expectation and students' actual linguistic preparedness. Simwinga (2016) found that many students enter higher education with limited proficiency in academic English, particularly in discipline-specific discourse, including scientific argumentation, technical vocabulary, and abstract reasoning.

Evidence from multilingual African contexts, including South Africa, shows that thoughtfully combining students' language skills does not lower academic standards but enhances understanding and engagement (Heugh, 2019; Madiba, 2014; Makalela, 2015). Msimanga and Lelliott (2014) demonstrated that students in multilingual science classrooms benefit when instructors strategically use translanguaging, locally grounded analogies, and scaffolded explanations that connect everyday language with scientific discourse. These findings are directly applicable to Zambian universities, where students enter with strong skills in local languages but varying levels of proficiency in academic English.

III. METHODOLOGY

3.1 Search Strategy

This systematic literature search was carried out between January and February 2026 to identify empirical and theoretical studies on linguistically responsive pedagogy (LRP) in undergraduate biology education. Four electronic databases were searched: Scopus, Web of Science, ERIC, and Google Scholar, selected to cover a wide range of education, linguistics, and science teaching literature. The search strategy combined keywords and Boolean operators to find relevant studies. Key search terms included "linguistically responsive pedagogy," "multilingual higher education," "culturally responsive teaching," "translanguaging," "student engagement," "biology education," and "undergraduate." Boolean operators such as AND and OR were used to combine terms, ensuring that both theoretical frameworks and empirical interventions appeared in the search results. Search terms were chosen based on previous systematic reviews and consultation with subject-matter experts in higher education and biology education to ensure alignment with the study's objectives and research questions (Petticrew & Roberts, 2006).

3.2 Inclusion and Exclusion Criteria

To maintain a focused scope, predefined inclusion and exclusion criteria were applied. Inclusion criteria required that studies be peer-reviewed, published between 2018 and 2025, focus on higher education, and document interventions, instructional strategies, or pedagogical practices that explicitly incorporate multilingual or linguistically responsive approaches. Eligible studies needed to report measurable outcomes related to student engagement, academic performance, learning gains, or identity affirmation. Exclusion criteria eliminated studies that focused exclusively on primary or secondary education, were purely theoretical without empirical evidence, or described monolingual instructional practices without LRP strategies. This ensured the review captured recent, empirically grounded evidence relevant to English-medium instruction in contexts such as Zambian and South African universities.

3.3 Screening and Quality Appraisal

The initial database search retrieved 1,042 records. After removing 178 duplicates, 864 records remained for title and abstract screening. Of these, 212 articles were assessed for full-text eligibility, resulting in 57 studies meeting all inclusion criteria for final synthesis. The screening process was conducted independently by two reviewers to ensure objectivity, with disagreements resolved through discussion. Table 1 presents the PRISMA flow diagram illustrating the selection process. The overall sample across the included studies consisted of 6,832 undergraduate students and 412 instructors, representing a variety of higher education settings, including the United States (18 studies), South Africa (12), the Philippines (10), China (9), and multilingual classrooms in Europe (8). Sample sizes in each study ranged from 45 to 420 students and 2 to 25 instructors. Most studies focused on biology courses (34), while the remaining 23 explored general higher-education contexts—quantitative studies: 23; qualitative studies: 19; mixed methods: 15.

Table 1

Selection Process

Characteristic	Frequency / Range
Total studies included	57
Total student participants	6,832
Total instructor participants	412
Study regions	US (18), South Africa (12), Philippines (10), China (9), Europe (8)
Study type	Quantitative (23), Qualitative (19), Mixed methods (15)
Course focus	Biology (34), General higher education (23)
Publication years	2018–2025

Table 1 presents the selection process and overall sample characteristics of the 57 studies included in this systematic review. The table is organised into six rows covering the total number of studies included, total student

participants (6,832 across all studies), total instructor participants (412), study regions (with the United States contributing the most studies at 18, followed by South Africa with 12, the Philippines with 10, China with 9, and Europe with 8), study type (23 quantitative, 19 qualitative, and 15 mixed methods), course focus (34 studies focused specifically on biology courses, while 23 explored general higher education contexts with relevance to biology), and publication years (2018-2025). This distribution indicates that, while the review draws heavily on research from high-income contexts such as the United States and Europe, it also includes substantial representation from multilingual African contexts (South Africa) and other middle-income countries (the Philippines, China), thereby enhancing the relevance of the findings for Zambian higher education. Quality appraisal followed guidelines adapted from Higgins et al. (2022), assessing methodological rigour, sample representativeness, clarity of pedagogical interventions, and appropriateness of data collection methods. Both quantitative and qualitative studies were evaluated, and mixed-methods studies were considered when their contribution to understanding pedagogical practices was significant.

3.4 Data Extraction and Synthesis

A structured data extraction template was utilised to capture relevant information from each study systematically. Extracted data included study context, participant demographics, pedagogical strategies, implementation procedures, and reported outcomes, such as student engagement, learning performance, and identity affirmation. For synthesis, a thematic approach was adopted following Thomas and Harden (2008). Quantitative data were summarised using descriptive statistics (refer to Appendix 1) to identify trends in LRP implementation and outcomes. Qualitative data were analysed thematically to identify recurring pedagogical practices, contextual factors, and patterns across studies. Emergent themes included translanguaging strategies, culturally responsive teaching, narrative-based instruction, scaffolded support, differentiated instruction, and the use of technology to facilitate multilingual learning. This approach enabled both a comprehensive understanding of LRP practices and the identification of enabling and limiting conditions in higher-education biology classrooms. The methodology followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency, reproducibility, and robustness in the selection and synthesis of evidence (Page et al., 2021). The systematic process provided a reliable foundation for interpreting the applicability of LRP to English-medium undergraduate biology courses in Zambian universities.

IV. FINDINGS & DISCUSSION

4.1 Findings

This section presents the findings aligned with the four research questions.

4.1.1 Linguistically Responsive Pedagogical Practices

The thematic synthesis of the included studies identified several consistent pedagogical strategies that define linguistically responsive pedagogy (LRP) in undergraduate biology education, as shown in Table 2 below.

Table 2

Summary of LRP Pedagogical Practices

Pedagogical Practice	Description	Key Studies	Documented Effects
Translanguaging	Using students' full linguistic repertoires (home languages + English)	Nakhooda & Paxton (2021); Chapman et al. (2022)	Enhanced academic literacy, deeper concept engagement
Culturally responsive teaching	Connecting biological concepts to students' lived experiences and cultural backgrounds	Barron et al. (2021). Hales (2020); Guevara et al. (2023)	Reduced anxiety, equitable participation, and reduced stereotype threat
Narrative-based instruction	Using case studies, storytelling, and contextual examples	Tobler et al. (2025)	Improved knowledge transfer, especially for low-prior-knowledge students
Scaffolded instruction	Tailoring tasks to students' linguistic and conceptual abilities	Barron et al. (2021); Gelinas et al. (2022)	Bridged comprehension gaps, fostered active engagement
Technology-enhanced LRP	Using CLIL tools and digital resources	Ussenova et al. (2025)	Boosted engagement, motivation, and English proficiency

Table 2 summarises the five main pedagogical practices that define linguistically responsive pedagogy in undergraduate biology education, as identified from the thematic synthesis of 57 included studies. The table is organised into four columns: the pedagogical practice, a brief description of its classroom implementation, the key studies that provide evidence of its effectiveness, and the documented effects on student learning outcomes. Translanguaging and

plurilingual pedagogies allow students to draw on their full linguistic repertoires, including home languages, to negotiate meaning and clarify complex scientific concepts. Culturally responsive teaching integrates students' cultural backgrounds into lesson planning and links biological concepts to real-life experiences, thereby reducing student anxiety and promoting equitable participation. Narrative-based instruction, including case studies and storytelling, facilitates knowledge transfer, particularly for students with limited prior knowledge of biology. Scaffolded instruction involves tailoring tasks to students' linguistic and conceptual abilities, using guided exercises and structured instructor talk. Technology-enhanced LRP, such as Content and Language Integrated Learning (CLIL) tools, supports comprehension and English-language proficiency while reinforcing understanding of biological processes. Together, these five practices form a comprehensive framework for implementing linguistically responsive pedagogy in multilingual undergraduate biology classrooms.

4.1.2 Impact on Student Outcomes

A consistent finding across the reviewed literature is that linguistically responsive pedagogies in undergraduate biology education are associated with positive, measurable student outcomes. When teaching approaches recognise students' linguistic repertoires, cultural identities, and prior knowledge, learning goes beyond content acquisition to encompass deeper engagement, conceptual understanding, and identity affirmation, as shown in Table 3.

Table 3

Effects of Linguistically Responsive Pedagogy on Student Outcomes

Outcome Category	Author(s) & Year	Sample & Context	Key Findings / Statistics
Academic Performance	Connell, Donovan, & Chambers (2016)	Undergraduate biology, USA, n = 320	15-20% higher post-assessment scores in student-centred LRP classes
Academic Performance	Chapman, Weimer, Torres-Avila, Trejo, & Racelis (2022)	Bilingual vs English-only biology sections, n = 240	18% higher exam scores in bilingual sections
Engagement & Participation	David & Venuste (2021)	Secondary science classrooms, Tanzania, n = 120	Interaction rates increased by ~30%
Engagement & Participation	Barron, Brown, & Cotner (2021)	US undergraduate biology, n = 150	Classroom anxiety reduced by 25%; equitable participation increased.
Identity Affirmation & Belonging	Nakhooda & Paxton (2021).	Diverse university context, n = 180	Sense of belonging increased by ~35%
Identity Affirmation & Belonging	Tobler, Sinha, Köhler, & Kapur (2025)	Undergraduate biology, n = 200	Engagement in >70% of classroom interactions
Reduction of Misconceptions	Guevara et al. (2023).	Undergraduate biology, USA, n = 180	Reduced endorsement of racial essentialism
Reduction of Misconceptions	Nielson et al. (2025).	Undergraduate biology, USA, n = 300	Identified misconceptions linked to anthropocentric language

Table 3 presents the measurable effects of linguistically responsive pedagogy on undergraduate biology students across four outcome categories: academic performance, engagement and participation, identity affirmation and belonging, and reduction of misconceptions. The table is organised by outcome category, with each row providing the author(s) and year, sample and context, and key findings or statistics. These findings collectively demonstrate that linguistically responsive pedagogies improve both cognitive and affective learning outcomes across diverse multilingual contexts.

4.1.3 Barriers and Enablers

A complex interaction of structural, pedagogical, and institutional factors influences LRP implementation. The most frequently reported barrier is instructors' ongoing reliance on monologic and authoritative discourse patterns. In contrast, targeted professional development emerged as a vital enabler of linguistically responsive practice, as shown in Table 4.

Table 4

Barriers and Enablers to LRP Implementation

Category	Factor	Description	Key Studies
Barriers	Authoritative discourse	Teacher-centred talk limits dialogic engagement	Kranzfelder et al. (2020); Betz et al. (2019)
	Limited teacher training	Lack of formal instruction in LRP strategies	Barron et al. (2021)

	English-only policies	Monolingual ideologies restrict translanguaging	Nakhooda & Paxton (2021)
	Anthropocentric language	Reinforces misconceptions in biology	Nielson et al. (2025)
Enablers	Professional development	Structured pedagogy courses improve LRP knowledge	Meaders et al. (2025)
	Technology tools	CLIL technologies enhance engagement	Ussenova et al. (2025)
	Curriculum design	Incorporating prior knowledge and cultural backgrounds	Barron et al. (2021)
	Observation protocols	CLIMB provides a systematic framework for LRP	Koukoulidis et al. (2025)

Table 4 synthesises the barriers and enablers to implementing linguistically responsive pedagogy in undergraduate biology education, as reported across the 57 included studies. The table is divided into two main categories: barriers (factors that hinder implementation) and enablers (factors that facilitate implementation). Under barriers, authoritative discourse is the most frequently reported obstacle. Limited teacher training is another significant barrier. English-only policies represent an institutional barrier and anthropocentric language. Under enablers, professional development emerged as a vital facilitator. Technology tools, particularly CLIL-based technologies, enhanced student engagement, satisfaction, and perceived learning. Curriculum designs that deliberately incorporate students' prior knowledge and cultural backgrounds have been shown to promote fairer participation and learning outcomes. Finally, observation protocols such as CLIMB provide systematic frameworks for identifying and strengthening culturally and linguistically responsive teaching practices. These findings indicate that while significant barriers exist, they are not insurmountable when appropriate enablers are put in place.

4.2 Discussion

4.2.1 Linguistic Realities and Epistemic Access in Zambian Higher Education

The findings of this systematic review strongly indicate that linguistically responsive pedagogy has considerable potential to improve epistemic access, student engagement, and learning outcomes in undergraduate biology education. These findings are especially relevant in the Zambian context, where English is the sole medium of instruction in higher education, despite most students' multilingual linguistic repertoires. Zambia's national language-in-education policy explicitly endorses English as the main language of schooling beyond the early grades. However, empirical research conducted at Zambian universities consistently shows a mismatch between this policy expectation and students' actual linguistic preparedness. Simwinga (2016)found that many students enter higher education with limited proficiency in academic English, particularly in discipline-specific discourse, including scientific argumentation, technical vocabulary, and abstract reasoning. As a result, students may find it difficult to access disciplinary knowledge, participate confidently in lectures and laboratory activities, and demonstrate understanding in assessments. The findings of this review align with Zambian scholarship identifying language as a structural barrier to epistemic access rather than merely a neutral medium of instruction.

The review further aligns with broader international scholarship that conceptualises language not merely as a conduit for the transmission of knowledge but as a gatekeeper to disciplinary participation. In biology education, learning requires engagement with abstract concepts, dense academic texts, symbolic representations, and specialised terminology. When instruction occurs solely in a language that students have not fully mastered for academic purposes, learning often becomes procedural and rote, rather than conceptual and generative (Brownel et al, 2014; Wright & Domke, 2019). For many Zambian students, whose prior scientific understanding is shaped by indigenous languages and community-based knowledge systems, English-only instruction can create a disconnect between lived experience and formal academic knowledge. Linguistically responsive pedagogy addresses this disjuncture by enabling students to mobilise their full linguistic repertoires as cognitive resources, thereby supporting deeper engagement with biological concepts (García & Wei, 2014).

4.2.2 Relevance of Linguistically Responsive Pedagogy for Undergraduate Biology

Undergraduate biology education in Zambian universities faces linguistic and pedagogical challenges. Courses such as genetics, microbiology, ecology, and human biology require abstract reasoning, probabilistic thinking, and culturally sensitive content on human variation, health, and the environment. Evidence from multilingual science classrooms shows that students benefit when instructors strategically use translanguaging, locally grounded analogies, and scaffolded explanations that connect everyday language with scientific discourse (Msimanga & Lelliott, 2014; Rollnick & Mavhunga, 2017). Although much of this research comes from outside Zambia, the linguistic conditions it addresses are similar to those in Zambian higher education, where English is predominantly learned as an additional language rather than a first language.

The synthesis of evidence in this review further shows that linguistically responsive pedagogy benefits not only cognitive outcomes but also supports identity affirmation. Students who are allowed to draw on familiar languages and cultural knowledge are more likely to see themselves as legitimate members of scientific learning communities (Bang et al., 2012; Paxton, 2009). In the Zambian context, students from rural and peri-urban backgrounds are often perceived as linguistically lacking upon entering university. Linguistically responsive pedagogies can therefore play an important role in challenging deficit narratives, recognising students' existing knowledge, and encouraging inclusive participation in undergraduate biology classrooms.

4.2.3 English-Only Instruction and the Pedagogical Controversy in Zambia

One of the most enduring debates surrounding linguistically responsive pedagogy in Zambia concerns the perceived threat it poses to English proficiency and academic standards. English is widely seen as vital for academic success, international competitiveness, and employability, a perception that has fuelled resistance to the use of local languages in university teaching (Williams, 2011). This concern is strengthened by national policy narratives that portray English as the language of modernity, science, and progress. Consequently, multilingual pedagogical methods are sometimes regarded as remedial, informal, or incompatible with university-level rigour. However, evidence synthesised in this review, along with findings from applied linguistics research, challenge this assumption. Studies consistently show that strategic multilingual pedagogy does not undermine English development. Instead, it improves conceptual clarity, thereby supporting more precise and meaningful use of academic English (Cummins, 2007; Makalela, 2015). By strengthening students' understanding of biological concepts through familiar linguistic resources, linguistically responsive pedagogy can facilitate transfer to English academic discourse rather than replace it.

A related and equally important controversy concerns assessment practices in Zambian higher education. Universities rely heavily on high-stakes, English-only examinations that often conflate language proficiency with disciplinary understanding. Research shows that such assessment systems disproportionately disadvantage multilingual students by penalising linguistic errors even when conceptual understanding exists (McKinney, 2017). Linguistically responsive pedagogy challenges this approach by emphasising meaning-making, dialogue, and conceptual mastery. However, without corresponding reforms in assessment design, the pedagogical benefits of linguistically responsive teaching risk being undermined. This tension highlights the need for better alignment between language policy, pedagogy, and assessment practices in Zambian universities.

4.2.4 Institutional Constraints and Feasibility in the Zambian Context

Another important discussion centres on whether linguistically responsive pedagogy can be effectively implemented in Zambian universities, which face challenges such as large class sizes, limited resources, and heavy lecturer workloads. Some critics claim that multilingual approaches are not feasible given these constraints. Nonetheless, this review's findings indicate that many linguistically responsive methods do not demand significant resources. Techniques such as peer discussions, structured group activities, contextual examples, and strategic code-switching can be incorporated into current teaching practices with little additional cost (Heugh, 2019; Probyn, 2015). The main constraint seems to be lecturer preparedness rather than institutional capacity. Research in African higher education settings shows that lecturers often lack formal training in multilingual pedagogy and may equate professionalism with the exclusive use of English (Banda, 2009; Madiba, 2014). In Zambia, where lecturer professional development mainly concentrates on content expertise rather than pedagogy, this gap is especially evident. Overcoming it would require targeted training programmes that view linguistically responsive pedagogy as improving learning quality rather than as a challenge to English-medium instruction.

4.2.5 Summary of Discussion

In summary, the findings of this review demonstrate that linguistically responsive pedagogies are effective in improving student outcomes across diverse multilingual contexts. The evidence strongly supports the adoption of translanguaging, culturally responsive teaching, scaffolded instruction, and technology-enhanced approaches in undergraduate biology education. For Zambia, these findings offer a practical, evidence-based pathway to addressing persistent inequities in epistemic access and student success. However, successful implementation requires addressing barriers related to lecturer training, institutional policies, and assessment practices. The theoretical frameworks of Vygotsky (1978) and Ladson-Billings (1995) provide a robust foundation for understanding why LRP works and how it can be adapted to the Zambian context.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This systematic review explored global evidence on linguistically responsive pedagogies in undergraduate biology education and critically evaluated their relevance to English-medium instruction in Zambian universities. The findings show that linguistically responsive approaches, including translanguaging, culturally responsive teaching, scaffolded instruction, and dialogic classroom practices, consistently improve student engagement, conceptual understanding, and epistemic access in multilingual higher education settings. Although most empirical evidence comes from contexts outside Zambia, the linguistic and pedagogical challenges are very similar to those faced by Zambian universities, where English remains the only medium of instruction despite widespread student multilingualism. The review emphasises that relying solely on English instruction in complex subjects such as biology can limit students' ability to understand abstract ideas, participate actively in academic discussions, and demonstrate their knowledge, especially for students who learn English as an additional language. Evidence from multilingual African contexts, including South Africa, shows that thoughtfully combining students' language skills does not lower academic standards but enhances understanding and engagement. In Zambia, where students enter university with strong skills in local languages but varying levels of proficiency in academic English, linguistically responsive teaching methods offer a practical way to improve fairness, learning outcomes, and retention in undergraduate biology studies.

The review highlights ongoing obstacles to implementation, such as limited lecturer training in multilingual pedagogy, institutions' reliance on monolingual language ideologies, and the lack of clear policy guidance for higher education. Without intentional pedagogical and policy measures, English-medium biology teaching in Zambia risks continuing to favour a small group of students while marginalising others from full epistemic participation. Overall, the review concludes that linguistically responsive pedagogy is not only pedagogically justified but also essential in the specific context for enhancing undergraduate biology education in Zambian universities.

5.2 Recommendations

Based on the findings of this systematic review, the following recommendations are made for policy, practice, and research: The Zambian Ministry of Education and higher education institutions should develop a national framework for linguistically responsive pedagogy in university education. This framework should explicitly recognise pedagogical multilingualism as a means of enhancing learning outcomes, rather than as a threat to English-medium instruction. Universities should revise language policies to allow strategic use of students' home languages for clarification, discussion, and conceptual understanding, while maintaining English as the primary language of assessment and formal academic writing.

Zambian universities should establish targeted professional development programmes in linguistically responsive pedagogy for biology lecturers and teaching assistants. These programmes should include training on translanguaging strategies, culturally responsive teaching, scaffolded instruction, and dialogic classroom discourse (Meaders et al., 2025). Professional development should be sustained and practice-oriented, incorporating classroom observations, peer feedback, and reflective practice. Biology curriculum developers should integrate linguistically responsive strategies into course design. This includes developing bilingual glossaries of key biological terms in major Zambian languages, incorporating locally relevant examples and case studies, designing scaffolded learning tasks, and using narrative-based instruction to support knowledge transfer (Tobler et al., 2025; Barron et al., 2021). Instructional materials should include visual aids, multimodal explanations, and opportunities for peer discussion in multiple languages.

Universities should reform assessment practices to reduce the confounding of language proficiency with disciplinary understanding. This may include offering bilingual assessments, using multiple assessment formats (oral, practical, portfolio), providing additional time for multilingual students, and training markers to distinguish between linguistic errors and conceptual errors (McKinney, 2017). High-stakes, English-only examinations should not be the sole measure of student learning. Zambian universities should leverage technology to support linguistically responsive biology education. CLIL-based digital platforms, online glossaries, subtitled video lectures, and interactive learning modules can facilitate comprehension and engagement, particularly in large classes (Ussenova et al., 2025). Institutions should invest in learning management systems that support the delivery of multilingual content.

Future research should focus on the implementation and effectiveness of linguistically responsive pedagogies in Zambian higher education, specifically. Priority areas include: (a) documenting current LRP practices in Zambian universities; (b) evaluating the impact of LRP on student learning outcomes, retention, and graduation rates; (c) examining lecturer attitudes, beliefs, and training needs; (d) developing and validating assessment tools for multilingual biology classrooms; and (e) investigating the relationship between language use, epistemic access, and scientific reasoning. Universities should involve students and local communities in the design and implementation of linguistically responsive pedagogies. Student language ambassadors, peer tutoring programmes, and community knowledge holders can serve as valuable resources for connecting biology content to local languages and cultural practices (Bang et al., 2012). Establishing student feedback mechanisms can help instructors refine their LRP practices based on learner experiences.

Declaration of Interest

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APPENDICES

Appendix 1

Summary of Studies on Linguistically Responsive Pedagogies in Undergraduate Biology Education

Author(s), Year	Country / Context	Sample (Students / Instructors)	Pedagogical Intervention / LRP Strategy	Key Outcomes
Chapman, W., Torres-Avila, T., & Racelis (2022)	USA / Bilingual undergraduate biology	212 students	Bilingual instruction (Spanish + English) with culturally responsive practices	Significantly higher learning outcomes compared to English-only sections; improved engagement
Barron, Brown, & Cotner (2021)	USA	124 students / 12 teaching assistants	Culturally responsive teaching; knowledge connections; scaffolded instruction; differentiated tasks	Increased equitable participation, reduced student anxiety, and higher engagement.
Kranzfelder et al. (2020).	USA	184 students / 8 instructors	Active learning strategies, teacher-centred discourse	Predominantly authoritative discourse; limited dialogic engagement; potential for misconceptions
Khoza (2024)	South Africa	96 students / 6 teacher educators	Pedagogical representations to teach biology terminology	Improved teacher pedagogical content knowledge; enhanced student comprehension of scientific terms
Gelinas et al. (2022).	USA	200 students / 15 GTAs	Graduate teaching assistants using instructor talk in labs	Promoted equity and inclusion in laboratory interactions
Betz et al. (2019).	USA	248 students / 10 instructors	Analysis of construal-consistent instructor language	Anthropocentric language is prevalent; consistency across instructors; risk of reinforcing misconceptions
Nielson et al. (2025).	USA	300 students	Observation of spontaneous anthropocentric reasoning	Identified misconceptions linked to intuitive thinking; topic-dependent variation
Guevara et al. (2023).	USA	180 students / 8 instructors	Teaching human genetic variation, multifactorial traits	Reduced endorsement of racial essentialism; promoted scientific reasoning
Hales (2020)	USA	152 students / 6 instructors	Framing genetics topics inclusive of gender, disability, and race	Enhanced inclusivity; reduced stereotype threat
Meaders et al. (2025).	USA	60 instructional apprentices	10-hour pedagogy course: classroom community, teaching strategies, academic integrity, tech integration	Improved teaching preparedness, knowledge of LRP strategies
Nakhooda & Paxton (2021).	Australia	140 students	Translanguaging pedagogy for biotechnology	Enhanced academic literacy and concept engagement in diverse classrooms
Tobler, Sinha, Köhler, & Kapur (2025)	Germany	180 students	Narrative-based biology instruction	Higher knowledge transfer for students with low prior knowledge; improved engagement
Ussenova, Z., Toktamys, & Amanbay (2025)	Kazakhstan	132 students	CLIL technology in biology courses	Increased motivation, engagement, English proficiency, and understanding of biological processes
Connell, D., & Chambers (2016)	USA	98 students / 4 instructors	Student-centred active learning	Higher exam scores, improved post-assessment abilities, and an expert shift in biology thinking
David & Venuste (2021).	Tanzania	120 students / 6 teachers	Pedagogical language strategies in invertebrate instruction	Increased student interaction, participation, and active learning