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Integrating Environmental Education into Grade 11 Life Sciences Classrooms: Challenges and Pedagogical Opportunities

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Abstract. This study investigates the integration of environmental education into Grade 11 Life Sciences classrooms in South Africa, with a focus on the challenges and opportunities experienced by teachers. In the context of escalating concerns about climate change and biodiversity loss, environmental education plays a vital role in promoting ecological literacy and responsible citizenship. The Life Sciences curriculum—emphasizing ecosystems, conservation, and sustainability—offers a natural entry point for embedding environmental themes. However, effective integration is often constrained by time limitations, insufficient professional development, inadequate resources, and curriculum requirements. Using a qualitative interpretivist approach, the study engaged eight Life Sciences teachers from rural schools in the UMkhanyakude District of KwaZulu-Natal. Data were gathered through semi-structured focus group interviews and analyzed thematically. The findings indicated that while teachers acknowledge the importance of environmental education, they encounter systemic barriers, particularly a lack of training and material support. Nonetheless, the study identified meaningful opportunities to enhance learner engagement, critical thinking, and real-world problem-solving by adopting ecosystem-based and sustainability-focused pedagogies. Grounded in constructivist learning theory and Vygotsky's Zone of Proximal Development, the research underscored the value of active, context-based learning in equipping learners to confront environmental challenges. The study concluded that successful integration of environmental education requires targeted teacher support, greater curricular flexibility, and the adoption of localized, experiential learning strategies to bridge the gap between scientific knowledge and environmental action.

Keywords: Environmental Education; Life Sciences; Grade 11; Curriculum Integration; Sustainability, Ecosystems

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1. Introduction

Environmental education plays a vital role in shaping learners' understanding of ecological systems and their relationship with the natural world. As concerns about climate change, biodiversity loss, and environmental degradation continue to intensify, the integration of environmental education into Life Sciences classrooms has become increasingly important (Skogen, Helland & Kaltenborn, 2018). Life Sciences, by its very nature, encompasses a broad array of topics—such as ecosystems, conservation, and sustainability—that align closely with the core principles of environmental education (Ducarme & Couvet, 2020). However, integrating environmental education into the Life Sciences curriculum presents both challenges and opportunities for teachers (Damoah & Adu, 2019).

A major challenge is the limited instructional time within an already content-heavy curriculum, as highlighted by Ajani (2021). The extensive scope of the Life Sciences syllabus often compels teachers to prioritize traditional biological concepts, making it difficult to incorporate environmental themes without sacrificing content depth (Munasi & Msezane, 2024). Additionally, environmental topics are sometimes perceived as peripheral to the core Life Sciences curriculum, leading to their marginalization in classroom instruction (Matsekoleng, 2023).

The complexity and interdisciplinary nature of environmental issues—such as climate change, sustainable development, and environmental justice—also present pedagogical challenges. Many teachers may feel ill-equipped or insufficiently trained to address these topics in a scientifically accurate and engaging manner (Beach, 2023). As such, professional development and enhanced teacher preparation are essential for the effective integration of environmental education.

Despite these obstacles, there are significant opportunities for enriching the Life Sciences curriculum through environmental education. One such opportunity lies in cultivating environmentally conscious learners who are equipped to engage with pressing ecological issues (Corpuz et al., 2022). Research indicates that when effectively implemented, environmental education enhances learners' environmental awareness, fosters sustainable behaviors, and deepens their understanding of the interconnectedness of natural systems (Yadav et al., 2022).

Moreover, environmental education serves as a powerful vehicle for developing critical thinking and problem-solving skills, as learners engage with complex, real-world challenges (Shutaleva, 2023). By incorporating local environmental issues into classroom discussions, teachers can create more meaningful, relevant, and engaging learning experiences, thereby making Life Sciences instruction more dynamic and impactful.

Guided by these considerations, this empirical study sought to answer the following research question**: What are the key challenges and potential opportunities in integrating environmental education into Grade 11 Life Sciences classrooms?**

2. Literature Review

2.1 The Conceptualisation of Environmental Education in the South African Curriculum

Environmental education in the South African curriculum is grounded in the nation's commitment to promoting sustainable development and fostering environmental awareness among learners (Demoah & Omodan, 2022). It is integrated across various subjects, including Life Sciences, with the aim of cultivating environmental responsibility and a deeper understanding of ecological systems. This integration aligns with South Africa's broader educational objectives, which focus on building a more just, equitable, and environmentally conscious society (Adeniyi et al., 2024). Central to this conceptualisation is the perspective offered by Rukmana et al. (2023), who argue that environmental education not only imparts factual knowledge about nature but also fosters the development of values, skills, and attitudes that empower learners to contribute meaningfully to environmental sustainability and preservation.

The South African curriculum emphasizes a holistic and interdisciplinary approach to environmental education. Topics such as climate change, biodiversity conservation, and resource management are woven into subject content, especially within Life Sciences. Importantly, the curriculum acknowledges and incorporates indigenous knowledge systems, recognizing the environmental wisdom embedded in local communities (Cindi, 2021). It promotes practical, hands-on learning experiences that enable learners to explore environmental issues in relation to both natural processes and human activities (Arbuzova & Alexandrova, 2024). This approach is intended to equip learners with the skills and knowledge needed to make informed, environmentally sound, and socially responsible decisions within their communities.

Furthermore, environmental education in South Africa aligns with international sustainability agendas, including the United Nations' Sustainable Development Goal 4, Target 7 (SDG 4.7). This goal calls for all learners to acquire the knowledge and skills necessary to promote sustainable development, encompassing education for sustainable lifestyles, human rights, gender equality, a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity (Lotz-Sisitka, 2024). Achieving this goal requires nurturing learners' critical thinking and problem-solving abilities while helping them understand the interconnections between environmental issues and social justice (Southworth, 2022). It also involves raising awareness of the roles played by individuals, communities, and governments in addressing environmental challenges (Hnatuyk et al., 2024).

By integrating environmental education into the curriculum, South Africa aims to prepare learners to navigate and respond to complex environmental challenges. At the same time, it seeks to foster a culture of sustainability, environmental justice, and responsible citizenship, as outlined in national education policy documents (Reddy, 2021).

The figure below illustrates key Life Sciences concepts that relate to environmental education. It also highlights the associated challenges and

opportunities these concepts present for teaching and learning within Life Sciences classrooms.

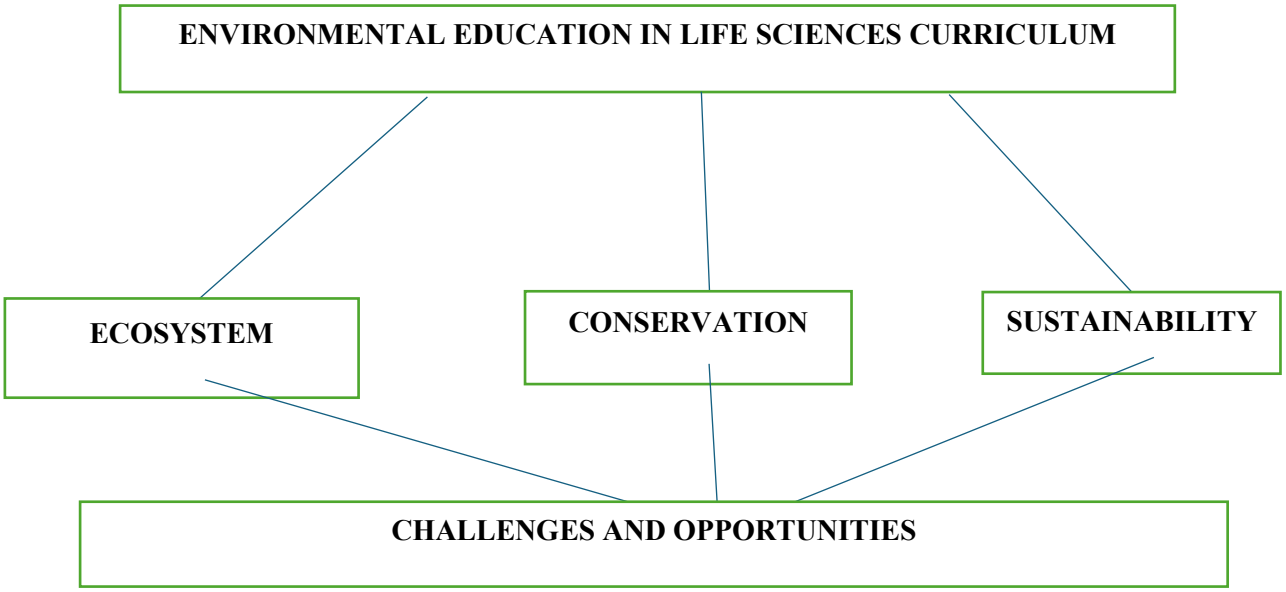

Figure 1: Environmental Education concepts in the Life Sciences curriculum

2.2 The Concept of Ecosystems in Environmental Education

The concept of the ecosystem is foundational to environmental education, particularly within the Life Sciences curriculum. An ecosystem encompasses all living organisms in each area, along with their physical environment, emphasizing the intricate relationships between biotic (living) and abiotic (non-living) components. Introducing ecosystems in education enables learners to grasp the complexity of natural systems and the interdependence of species (Kumar & Mina, 2021). By exploring how organisms interact with one another and with their surroundings, learners come to understand that disruptions in one part of an ecosystem can have wide-ranging and sometimes irreversible consequences (Ayotte-Beaudet et al., 2023). This foundational knowledge cultivates a deeper appreciation for ecological balance and underscores the vital role humans play in either supporting or undermining that balance (Hariram et al., 2023).

Integrating ecosystem concepts into the Life Sciences curriculum also provides opportunities for learners to explore a variety of ecosystems—such as forests, wetlands, deserts, and oceans—and understand their unique structures and functions (Damoah, Khalo & Adu, 2024). This exposure enhances learners' understanding of biodiversity, which refers to the variety of life forms within these ecosystems and highlights the importance of habitat preservation. Additionally, learners are introduced to the concept of ecosystem services—such as water purification, pollination, and climate regulation—that are essential for sustaining life on Earth (Nedkov et al., 2022). Understanding these services helps learners recognize the far-reaching impacts of human activities like deforestation,

pollution, and urbanization on biodiversity and ecosystem functionality (Shutaleva, 2023).

Teaching about ecosystems within the framework of environmental education equips learners with critical thinking skills necessary to analyse environmental problems and propose viable solutions (Chavula et al., 2024). It encourages reflection on how ecosystems function and how human behaviour can either exacerbate or mitigate environmental degradation (Piscitelli & D'Uggento, 2022). Through this lens, learners are empowered to become active participants in sustainability, conservation, and environmental stewardship. By integrating the concept of ecosystems into Life Sciences education, the Department of Basic Education seeks to nurture a generation of scientifically literate citizens who are motivated to protect and restore the natural world.

2.3 Conservation and Sustainability in Environmental Education

Conservation and sustainability are interrelated concepts that are fundamental to the long-term health and well-being of our planet (Hajian & Kashani, 2021). Conservation refers to the protection, preservation, and responsible management of natural resources to prevent their depletion or degradation (Ikeke, 2021). It focuses on maintaining biodiversity, safeguarding ecosystems, and ensuring that future generations have access to the same natural resources enjoyed today.

Sustainability, by contrast, centres on meeting the needs of the present without compromising the ability of future generations to meet their own needs (Ruggerio, 2021). It integrates environmental, economic, and social dimensions to achieve a balanced approach to development and ecological preservation. Together, conservation and sustainability address pressing global challenges such as climate change, habitat loss, and overexploitation of natural resources, often operating synergistically to promote a healthier and more resilient planet (Afifa et al., 2024).

The significance of conservation and sustainability extends beyond the environmental sphere into the broader context of human society. According to Mondal and Palit (2022), sustainable practices promote the efficient and responsible use of essential natural resources—such as water, energy, and raw materials—through initiatives like renewable energy deployment, waste reduction, and sustainable agriculture. Conservation efforts, through the protection of biodiversity and natural habitats, help preserve critical ecosystem services that humans depend on, including clean air, potable water, and reliable food sources.

These efforts also bolster economic resilience, as industries such as agriculture, fisheries, and tourism rely heavily on the stability and productivity of natural ecosystems (Mejjad et al., 2022). Thus, sustainability is not solely an environmental imperative but also a cornerstone of social equity and economic viability, ensuring that communities can flourish without exhausting the resources upon which they rely (Purvis, Mao & Robinson, 2019).

Within the Life Sciences curriculum, integrating the concepts of conservation and sustainability is essential for cultivating a generation of environmentally conscious and responsible citizens (Damoah, Khalo & Adu, 2024). Through education, learners are introduced to the challenges posed by unsustainable resource use, environmental degradation, and climate change, as well as the potential solutions to these problems (Nilsson Dahlström, 2025). This knowledge equips learners to make informed choices and to advocate for sustainable practices in both their personal lives and professional pursuits.

Furthermore, conservation and sustainability education can inspire creativity and innovation, encouraging learners to explore technologies and systems that support eco-friendly living (Gani, Razali & Burhansyah, 2023). Ultimately, the aim is to instil a mindset that prioritizes long-term ecological integrity over short-term gains, thereby contributing to a more sustainable and equitable future for all life on Earth.

2.4 Challenges in Integrating Environmental Education into Life Sciences Teaching

Life Sciences teachers face numerous challenges in integrating environmental education into their classrooms, with one of the most significant being the lack of adequate teaching resources and materials (Munasi & Msezana, 2024). Many South African schools lack access to up-to-date textbooks, digital tools, and instructional aids that effectively support the teaching of environmental concepts. Even when such resources are available, Parry and Metzger (2023) note that they are often fragmented or misaligned with the curriculum, making it difficult for educators to design cohesive and meaningful lessons on environmental topics.

This shortage is particularly acute when addressing complex issues such as climate change, sustainable development, or biodiversity conservation, thereby limiting teachers' ability to deliver comprehensive and accurate content (Timm & Barth, 2021). As a result, educators may rely on outdated or incomplete information, which not only constrains the depth of learners' understanding but may also perpetuate misconceptions about critical environmental issues.

Another major challenge is the limited availability of professional development opportunities specifically tailored to environmental education (Fischer et al., 2022). While many teachers possess general awareness of environmental issues, they often lack the pedagogical training necessary to integrate these topics into their teaching practices effectively. This includes the ability to design interdisciplinary lessons, foster critical thinking, and facilitate discussions around complex or controversial topics such as climate change denial, environmental justice, or ecological ethics (Ahmad, 2024; Breitenmoser et al., 2024).

Without targeted training and continuous professional support, teachers may feel ill-equipped to engage learners in meaningful dialogue or action-based learning (Geldenhuys & Oosthuizen, 2015). Furthermore, a lack of confidence and expertise can hinder the implementation of innovative teaching strategies that encourage environmental stewardship and learner advocacy (Wahelo, Mengistu, & Merawi, 2025).

External systemic factors such as time constraints and curriculum demand further complicate the integration of environmental education in Life Sciences classrooms (Munasi & Msezana, 2024). Teachers often operate within rigid curricular frameworks that prioritize the completion of prescribed content for summative assessments (Leek et al., 2024). This pressure can result in environmental education being treated as peripheral or supplementary, rather than a fundamental component of scientific literacy.

Moreover, the emphasis on preparing learners for standardized examinations frequently leaves little room for exploring broader, interdisciplinary environmental issues (Shafiyeva, 2021). Despite acknowledging the value of environmental education, teachers may struggle to allocate sufficient time for its inclusion amidst competing academic priorities (Damoah & Adu, 2019). Addressing this challenge calls for systemic reforms, including more flexible curricula and an educational paradigm that values environmental education as integral to holistic learner development and global citizenship (Zickafoose et al., 2024).

3. Theoretical Framework

This study is grounded in Constructivist Learning Theory, which offers a robust framework for examining the integration of environmental education into Grade 11 Life Sciences classrooms. Central to constructivism is the understanding that learning is an active, socially mediated process in which learners construct knowledge based on their prior experiences and interactions with others (Vygotsky, 1978). In the context of environmental education, this implies that learners do not passively receive information about environmental issues; rather, they actively engage with these issues by drawing on existing knowledge and personal experiences to make sense of new concepts (Fru & Ndaba, 2023). Integrating environmental education within the Life Sciences curriculum thus fosters a more meaningful and personalized learning experience, enabling learners to move beyond rote memorization toward deeper conceptual understanding (Damoah & Adu, 2019).

Viewed through a constructivist lens, environmental education in Life Sciences supports inquiry-based learning, where learners are encouraged to ask questions, explore issues, and propose solutions to real-world environmental problems (Kumar, 2021). This approach positions learners as active participants in the learning process. For instance, they may engage in project-based activities, such as investigating the impact of pollution in their local communities or evaluating the effectiveness of local recycling programs. Such hands-on engagement allows learners to apply scientific principles in authentic contexts, enhancing their understanding of environmental concepts and reinforcing the relevance of science in addressing pressing global challenges (Acut, 2024).

The theoretical framework is further strengthened by Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD), which posits that learners achieve deeper understanding when supported by more knowledgeable others (MKOs), such as teachers or peers. In the context of environmental education, teachers play

a crucial role in scaffolding learning by guiding students through complex and abstract topics—such as climate change, ecological balance, and sustainability—while fostering collaborative and dialogic learning environments (Imran & Almusharraf, 2024). Strategies such as group discussions, peer collaboration, and teacher-facilitated activities enable learners to co-construct knowledge and make interdisciplinary connections within Life Sciences (Damşa & Ludvigsen, 2016).

Constructivism also emphasizes the role of reflection in the learning process (Saleem et al., 2021). As learners engage with environmental content, they should be encouraged to critically reflect on their personal values, behaviours, and beliefs regarding environmental issues. Reflective activities—such as class debates on environmental policy, journal writing, or group discussions on ethical dilemmas—can prompt learners to consider not only the scientific but also the social, cultural, and ethical dimensions of environmental challenges (Howell, 2021). This reflective engagement cultivates environmental responsibility and empowers learners to become informed, proactive citizens who are motivated to contribute to sustainability efforts (Howell, 2021).

By embedding constructivist principles into Life Sciences instruction, educators can create dynamic and inclusive learning environments that nurture both scientific literacy and environmental stewardship (Chand, 2024). Ultimately, this approach aims to develop a generation of learners who are not only knowledgeable about environmental issues but also committed to meaningful action in support of a sustainable future.

4. Research Methodology

4.1 Research Design

This study employed a qualitative case study design grounded in the interpretivist paradigm to explore how environmental education is integrated into Life Sciences classrooms. The interpretivist approach was deemed appropriate because it prioritizes understanding the subjective meanings, perspectives, and lived experiences of individuals within their unique social, cultural, and educational contexts (Pervin & Mokhtar, 2022). Such a lens was essential for capturing the nuanced ways in which Life Sciences teachers conceptualize and enact environmental education in their everyday teaching practices. The case study methodology allowed for an in-depth investigation of a bounded system—namely, a group of Life Sciences teachers working in rural secondary schools within a specific educational district (Priya, 2020).

This design facilitated a detailed examination of the contextual realities that shape how environmental education is interpreted and implemented in different classroom settings. Recognizing that the integration of environmental content is not uniform but instead shaped by individual teacher beliefs, school resources, community values, and curriculum demands, the qualitative case study design enabled the researcher to holistically capture these complex and interconnected factors. By adopting this approach, the study aimed to generate rich, descriptive insights that go beyond generalizations and instead provide a textured understanding of the opportunities and constraints teachers face when integrating

environmental education. Ultimately, this design aligns with the study's goal of contributing to a context-sensitive understanding of pedagogical practice in South African Life Sciences classrooms.

4.2 Sampling

A total of eight Grade 11 Life Sciences teachers participated in the study. These participants were purposively selected from eight different secondary schools located in the UMkhanyakude District of KwaZulu-Natal, South Africa. The schools were selected based on their geographic location within the UMkhanyakude District of KwaZulu-Natal, South Africa, which is a predominantly rural and under-resourced area. This district was deliberately chosen due to its relevance to the study's focus on environmental education and sustainable development—issues that are particularly pertinent in rural settings where communities are closely dependent on local ecosystems. Selecting schools from this context allowed for the investigation of how contextual factors influence the teaching and integration of Life Sciences content related to environmental issues.

Purposive sampling was employed to ensure the inclusion of information-rich participants who possess specific knowledge and experience relevant to the research objectives. The eight Grade 11 Life Sciences teachers were selected because they are directly responsible for teaching environmental education topics as part of the Life Sciences curriculum. Their professional insights and classroom experiences were deemed essential for understanding the implementation challenges and pedagogical approaches within the specific educational and ecological context of the district. This sampling technique was thus appropriate for capturing deep, context-specific qualitative data from individuals with firsthand experience. Selection criteria included their subject specialization in Life Sciences and their ability to provide meaningful insights into the integration of environmental education in their teaching practice.

4.3 Data Collection

Data for this study were collected using semi-structured focus group interviews, a qualitative method well-suited for capturing in-depth insights and shared experiences. This approach provided a flexible yet focused platform for participants to reflect on and articulate their experiences, challenges, and strategies regarding the integration of environmental education within the Life Sciences curriculum. Two focus groups were constituted, each comprising four Grade 11 Life Sciences teachers selected from different secondary schools in the UMkhanyakude District of KwaZulu-Natal.

The group setting fostered dynamic discussions, enabling participants to build upon each other's contributions and reveal nuanced understandings of their pedagogical decisions and curriculum interpretations. This interaction facilitated the exploration of underlying beliefs and contextual factors influencing classroom practice. To maintain confidentiality and protect participants' identities, pseudonyms were assigned. For instance, the teacher from School 1 was identified as LST1, with subsequent participants labelled sequentially up to LST8. This

systematic coding ensured anonymity while allowing for clear reference in the analysis of data.

4.4 Data Analysis

The data were analyzed using thematic analysis, following the six-phase framework developed by Braun and Clarke (2006). This method enabled the identification of recurring patterns and the development of meaningful themes across participants' responses. To enhance the trustworthiness of the findings, strategies such as member-checking were employed. Participants were given the opportunity to review and confirm the accuracy of the interview transcriptions and the researchers' interpretations. The research was conducted in schools situated in the UMkhanyakude District, a predominantly rural area facing significant socio-economic challenges. These include widespread poverty, limited infrastructure, and restricted access to educational resources. Such contextual realities directly influence teaching practices and pose substantial barriers to the effective integration of environmental education into Life Sciences classrooms.

Table 1: Profile of the research participants and research sites

Participants and Schools	Qualification(s)	Age	Number of years as a teacher
Life Sciences Teacher, School 1	B.Ed.	32 years	8 years
Life Sciences Teachers, School 2	B.Ed.	29 years	6 years
Life Sciences Teacher, School 3	BSc + PGCE	35 years	11 years
Life Sciences Teacher, School 4	B.Ed.	30 years	8 years
Life Sciences Teacher, School 5	B.Ed. Honours	47 years	18 years
Life Sciences Teacher, School 6	B.Ed.	38 years	13 years
Life Sciences Teacher, School 7	B.Ed.	41 years	15 years
Life Sciences Teacher, School 8	B.Ed.	35 years	12 years

Keys: B.Ed.- Bachelor of Education, BSc-Bachelor of Science, PGCE- Postgraduate Certificate in Education.

Table 1 presents the demographic details of the participants and the research sites. The study was conducted in eight secondary schools, which were purposively selected from a rural community within a specific education district. At each school, one Grade 11 Life Sciences teacher was selected to participate. To maintain confidentiality, pseudonyms were assigned to both the participants and the research sites: LST1 represents the Life Sciences teacher from School 1, LST2 from School 2, and so on, with LST8 representing the teacher from School 8.

4.5 Trustworthiness of the Data Results

To ensure the trustworthiness of the data, the study adhered to the four qualitative criteria—credibility, transferability, dependability, and confirmability (Guba &

Lincoln, 1985). Credibility was enhanced using semi-structured focus group interviews, which allowed for rich, in-depth reflections and dialogue among participants. This format fostered collaborative meaning-making and gave participants the opportunity to clarify and elaborate on their responses. Prolonged engagement during the focus groups and member checking—where participants were invited to review and verify the accuracy of the transcribed data—further supported credibility. Transferability was addressed by providing a detailed contextual description of the study setting—the UMkhanyakude District of KwaZulu-Natal—and the educational context in which the participants operate. This allows readers to assess the extent to which the findings might be applicable to similar settings, particularly in other rural, under-resourced contexts.

Dependability was ensured through consistent application of the research design. A clear audit trail was maintained, including the development and use of a semi-structured interview guide, recording and transcription of interviews, and systematic coding procedures. The study design and data collection methods were thoroughly documented, enabling future researchers to replicate or adapt the process. Confirmability was upheld by maintaining neutrality throughout the research process. Researcher reflexivity was practiced reducing bias, and all findings were grounded in the data. Direct quotes from participants were used to support thematic analysis, allowing the teachers' voices to remain central to the interpretation. Additionally, pseudonyms (e.g., LST1 to LST8) were assigned to participants to ensure anonymity while preserving the integrity of individual responses.

4.6 Ethical Considerations

The study adhered to rigorous ethical standards to ensure the protection and dignity of all participants. Ethical clearance was formally obtained from the researchers affiliated institution prior to the commencement of the study. In addition, official permission to conduct the research was secured from the relevant educational authorities in the UMkhanyakude District of KwaZulu-Natal. All participants were fully informed about the purpose, procedures, and potential implications of the study. Informed consent was obtained from each participant, ensuring that their involvement was entirely voluntary and based on a clear understanding of their rights. Participants were also assured that their responses would remain confidential and that all identifying information would be anonymized using pseudonyms. Furthermore, they were informed of their right to withdraw from the study at any stage without any adverse consequences. These ethical safeguards were implemented to foster a respectful and trustworthy research environment.

5. Findings

Verbatim participant quotes were used to present the findings, organized according to the themes that emerged from the data. Through these verbatim quotes of the participants, the sections below present the data findings according to the themes as they emerged from the data. The themes were Life Sciences teachers' conceptualisation of environmental education, Opportunities for

integrating environmental education in Life Sciences classrooms, and Challenges to the effective integration of environmental education.

5.1 Theme 1: Life Sciences teachers' conceptualisation of environmental education

This theme explored how Grade 11 Life Sciences teachers understand and interpret the concept of environmental education. It highlighted their individual and collective perceptions, definitions, and the significance they attach to environmental education within the Life Sciences curriculum.

Teachers' understandings of Environmental Education varied, reflecting both content- and values-based approaches. While some teachers conceptualised environmental education narrowly, mainly as teaching environmental content such as ecosystems, others saw it as an opportunity to promote sustainable thinking and responsible action among learners.

For instance, Life Sciences teachers during the interviews were asked,

> *"What do they understand about the concept of environmental education and how is it important to integrate it into the teaching and learning of Life Sciences*?".

The following verbatim quotes indicated how teachers conceptualise environmental education:

> *"Environmental education in the context of education refers to the way we understand the interaction of all living organisms with their immediate environment, especially human beings. Environmental education should play a role in such a way that it teaches learners to be by relating the taught content with their daily contact activities and everything around them"* **LST1**

> *"Environmental education in life sciences incorporates real-life scenarios of the environment and how to take care of the natural world. The role of environmental education is to expose learners to real-life scenarios or situations and allow them to solve real-life problems concerning the environment"* **LST2**.

> *"Environmental education in Life Science is teaching learners about things that happen in nature. This helps the learners to better understand the world so that they can also sustain and protect living organisms"* **LST4**

> *"Environmental Education is when teaching a life science topic that links with environmental issues and shows how they interact. The role of Environmental education is to help learners to have a rigid and right knowledge about that topics and use knowledge from the classroom to understand and solve problems outside the world"* **LST8**

The participants expressed varying yet interconnected understandings of the concept and role of environmental education in the Life Sciences curriculum. LST1 highlighted the importance of contextualizing environmental education by

relating content to learners' daily experiences, emphasizing a human-centred interaction with the environment. Similarly, LST2 viewed environmental education as a tool for engaging learners with real-life environmental problems, suggesting its role in fostering problem-solving skills and environmental consciousness. LST4 echoed this view by underscoring the value of helping learners understand natural phenomena to promote the protection and sustainability of living organisms. Meanwhile, LST8 focused on the link between classroom learning and real-world application, emphasizing the importance of equipping learners with accurate and relevant knowledge to address environmental challenges beyond the school setting.

Collectively, these responses suggest a shared recognition among the teachers of the importance of contextual relevance, real-life application, and learner empowerment in environmental education. The emphasis on connecting curricular content to learners' immediate environments and societal issues reflects an underlying belief in the transformative potential of environmental education. It becomes evident that these teachers perceive environmental education not as an abstract curricular component, but as an essential, integrative tool for fostering environmental stewardship and informed citizenship among learners. This also aligns with the broader goals of Education for Sustainable Development (ESD), which seeks to bridge knowledge and action through critical reflection and socially responsive pedagogy.

The emerging data from LST1, LST2, LST4, and LST8 revealed a shared understanding that Environmental Education in Life Sciences is more than content knowledge. It involves connecting scientific concepts to real-world environmental issues. Teachers emphasized the role of environmental education in encouraging awareness and responsibility among learners. For instance, LST1 highlighted the importance of relating environmental education to learners' "*daily contact activities*", suggesting an experiential and contextualized approach.

Similarly, LST2 viewed environmental education as a platform for problem-solving, where learners are exposed to "*real-life scenarios*" and engage in critical thinking. This aligns with the view of Ruiz-Mallén et al. (2022), who assert that environmental education should be transformative, encouraging learners to understand and act upon environmental issues. The emphasis on real-life application reflects the shift from traditional didactic teaching to more learner-centred and action-oriented education.

Moreover, LST4 and LST8 stressed the ecological content and the behavioural outcomes of environmental education. LST4 saw environmental education to "*help learners understand the world*" and protect life, while LST8 emphasized developing "*rigid and right knowledge*" to solve environmental problems. These views suggest that teachers value both conceptual understanding and practical application, echoing the framework of Education for Sustainable Development (ESD), which promotes the integration of knowledge, skills, values, and actions.

The recurring theme of using Life Sciences content to support environmental stewardship illustrates that teachers recognize the interdisciplinary and holistic nature of environmental education. However, while these perspectives are encouraging, literature also notes that the depth of integration often depends on teachers' own conceptual clarity and training (Lotz-Sisitka, 2004), suggesting a need for more structured support in professional development.

5.2 Theme 2: Opportunities for Integrating Environmental Education in the Life Sciences Classroom

This theme focused on the positive aspects and possibilities identified by teachers for successfully embedding environmental education in their teaching. Teachers highlighted several opportunities for integrating environmental education, particularly where the curriculum naturally aligns with environmental issues. Topics such as biodiversity, human impact on the environment, and ecosystems were mentioned as key entry points. Teachers also emphasized the value of using local environmental issues and outdoor learning to enhance relevance and engagement. For instance, LST5, LST6 and LST3 alluded:

> *"The opportunities are that learners can relate what they are learning, and by doing so, they will develop critical thinking and be part of community members who are ensuring a healthy environment in their communities"*. **LST5**

> *"Issues like climate change, deforestation, or pollution provide tangible examples of ecological principles, biodiversity, and human impact on ecosystems. Secondly, learners can analyse causes, effects, and solutions to these issues, thus enhancing problem-solving and scientific inquiry skills. Moreover, local environmental issues encourage learners to explore their surroundings, conduct fieldwork, and collaborate with community organizations to solve the issues"*. **LST6**

> *"I see learners who will become responsible community members, learners who will be able to take part in preserving our environment and find possible solutions to the issues of the environment such as littering or air and water purification. First, it is to include environmental education into the curriculum again and support local and global non-government organization that deals with environmental issues"*. **LST3**

LST5 emphasized the pedagogical value of environmental education in fostering learners' ability to relate theoretical content to practical realities. The teacher observed that this alignment promotes critical thinking and a sense of civic responsibility, as learners begin to see themselves as active contributors to environmental well-being in their communities. This insight reflects the broader educational goal of nurturing environmentally literate citizens who can engage meaningfully with sustainability efforts at a grassroots level. Similarly, LST6 pointed out the didactic potential of using real-world environmental issues—such as climate change, pollution, and deforestation—as teaching tools.

These examples, according to the participant, offer concrete illustrations of scientific concepts like biodiversity and human-environment interaction, which can enhance learners' problem-solving capabilities and inquiry-based learning skills. Notably, the mention of fieldwork and community collaboration signals a shift toward experiential learning approaches, reinforcing the idea that environmental education should extend beyond classroom walls to foster local engagement and interdisciplinary understanding.

LST3 further supported this notion by envisioning learners as future environmental stewards who are equipped to address environmental challenges such as littering and pollution. The teacher advocated for the systematic reintegration of environmental education into the curriculum, paired with partnerships involving NGOs. This perspective highlights a recognition of the multi-stakeholder nature of environmental education, suggesting that effective implementation requires both institutional commitment and collaboration with civil society.

Taken together, these responses underscore a shared belief among the teachers that environmental education is not merely content to be delivered but a transformative process that empowers learners to become proactive, informed agents of change. This aligns with global imperatives under Sustainable Development Goal 4.7, which emphasizes the importance of education in promoting sustainable lifestyles and global citizenship. Furthermore, the teachers' comments suggest a strong endorsement of place-based and participatory pedagogies as essential components of environmental education within the Life Sciences curriculum.

The data from LST3, LST5, and LST6 indicated that Life Sciences classrooms offer rich opportunities to integrate Environmental Education in ways that promote critical thinking, community engagement, and responsible citizenship. LST5 emphasized that when learners relate content to real-life issues, they become critical thinkers and active participants in promoting environmental health. Similarly, LST3 viewed environmental education as a tool for empowering learners to take responsibility for their communities, particularly through addressing local challenges like littering and pollution.

These views align with Sarid and Goldman (2021), who argue that environmental education should develop learners' capacity to think critically and act meaningfully in their local contexts. Moreover, integrating environmental education into the curriculum supports the aims of Education for Sustainable Development (ESD), which encourages learners to become active contributors to a more sustainable future.

LST6's contribution highlighted the pedagogical potential of real-world environmental issues such as climate change and pollution in teaching scientific concepts like biodiversity and human impact on the environment. This approach encourages problem-solving, inquiry, and collaboration skills, as learners investigate causes and propose solutions. Fieldwork and partnerships with

community organizations also reflect principles of constructivist learning theory, which emphasizes that learners build knowledge actively through interaction with their environment and through social engagement (Vygotsky, 1978).

Through exploring their communities and engaging with real-life issues, learners construct meaning based on their experiences, which deepens understanding and supports long-term learning. This aligns with the view that Environmental Education should be rooted in meaningful contexts that allow learners to connect scientific knowledge with everyday life. This practical and community-based model of environmental education allows learners to not only understand ecological principles but also apply them, creating a bridge between classroom knowledge and environmental action.

5.3 Theme 3: Challenges to the Effective Integration of Environmental Education

This theme outlined the barriers and constraints teachers experience when integrating environmental education into their Life Sciences classrooms. Despite recognizing the value of environmental education, teachers reported several significant challenges that affect its integration into Life Sciences teaching. The most common concern was the pressure to complete the syllabus, which leaves little room for broader discussions or experiential learning. Other challenges included a lack of teacher training, insufficient resources, and minimal department support. When teachers were asked about the challenges they encounter in the integration of environmental education in their teaching and learning, they responded:

> *"The limited class time is the burning issue that causes struggles in unpacking the environmental topics prepared to be taught. This somehow makes me prioritize core concepts and leave out the environmental topics not fully attended to. These strict curriculum requirements limit the flexibility to incorporate environmental topics; this covers the pressure I get for setting standardized tests, leading to a narrow focus on testable content".* **LST7**

> *"The schedule (ATP) and the subject advisors rush us as teachers to finish the content, so it is sometimes impossible to successfully incorporate environmental education in the life sciences classroom"* **LST 5**

> *"Inadequate professional development and knowledge about environmental concepts and teaching strategies from us as teachers pose a huge challenge. Limited opportunities for outdoor learning due to context settings or safety concerns"* **LST2**

LST7 highlighted a pressing systemic issue: limited instructional time, which constrains teachers' ability to fully explore environmental education themes within the Life Sciences curriculum. The participant noted that the pressure to focus on "core" and "testable" content often leads to the marginalization of environmental topics. This reflects a tension between curriculum demands and pedagogical intentions, suggesting that the current assessment-driven model may

inadvertently undermine the broader educational aims of environmental literacy and sustainability education.

Echoing this concern, LST5 pointed to the Annual Teaching Plan (ATP) and external pressures from subject advisors as additional constraints. The teacher's remarks underscore how curricular pacing pressures reduce the practical feasibility of integrating environmental education into daily teaching. The lack of temporal flexibility can lead to superficial coverage of environmental issues or their exclusion altogether, highlighting a structural misalignment between policy ambitions and classroom realities.

LST2 introduced another dimension of constraint: insufficient professional development and teacher preparedness. The teacher admitted to lacking the necessary pedagogical knowledge and content expertise to confidently teach environmental concepts. Additionally, logistical barriers—such as contextual limitations and safety concerns—hinder experiential and outdoor learning opportunities, which are often crucial for meaningful engagement with environmental content. This response points to the need for capacity-building initiatives and supportive learning environments that allow teachers to implement innovative, context-sensitive approaches to environmental education.

Collectively, these reflections illustrate that the successful integration of environmental education in Life Sciences is hindered not only by curriculum rigidity and time constraints but also by institutional and infrastructural gaps in teacher training and support. These findings suggest that for environmental education to be fully actualized in South African classrooms, a multi-level systemic shift is required—one that includes curriculum reform, time allocation adjustments, and sustained investment in teacher professional development.

The responses from LST7 and LST5 highlighted curriculum pressure and time constraints as major barriers to the effective integration of Environmental Education in Life Sciences. LST7 described the struggle to balance environmental content with standardized assessments, often leading to the prioritization of examinable topics over environmental education. Similarly, LST5 mentioned that the Annual Teaching Plan (ATP) and subject advisors create a fast-paced teaching schedule, limiting flexibility. These insights align with Reddy (2021), who argues that curriculum structures and assessment-driven teaching often restrict teachers from engaging in holistic, contextualized learning such as environmental education. Environmental education becomes marginalized despite its relevance and importance when the curriculum is overly prescriptive.

LST2 further emphasized challenges related to teacher preparedness and lack of resources, noting inadequate professional development and limited access to outdoor learning opportunities. This resonates with findings by Lotz-Sisitka (2004), who found that many South African teachers feel under-equipped to integrate environmental education due to insufficient training and support.

Additionally, the lack of safe or accessible outdoor spaces in urban and rural contexts reduces opportunities for experiential and place-based learning, which are essential for meaningful environmental education, as noted by Ellington (2021). These findings underscore the need for systemic support, including teacher training, curriculum reform, and resource provision, to ensure environmental education is effectively integrated into Life Sciences education.

6. Discussion of Findings in Relation to Previous Studies

The findings of the present study offer valuable insights into how Life Sciences teachers conceptualize, experience, and implement Environmental Education (EE) in the context of the South African curriculum. These findings resonate with and extend the existing body of literature, particularly when examined through the lens of constructivist learning theory. Theme 1 revealed that teachers viewed EE as a way of making content more relatable, meaningful, and action-oriented—highlighting its relevance to everyday life and social responsibility.

This interpretation aligns with the constructivist perspective, which asserts that learners construct knowledge through experiences grounded in real-world contexts (Vygotsky, 1978). Vygotsky's theory of the *Zone of Proximal Development* (ZPD) underlines the role of social interaction and cultural context in shaping cognition, which supports the emphasis teachers placed on connecting environmental content to learners lived experiences.

Similar findings are reported by Howell (2021), who found that reflective and active learning strategies in EE enhance learners' understanding of sustainability by making learning socially embedded and context sensitive. Likewise, Damşa and Ludvigsen (2016) emphasized that knowledge is co-constructed through interaction and collaborative inquiry, which mirrors the responses from teachers who described EE as a platform for exploring real-life problems collaboratively.

Theme 2 highlighted the potential of EE to foster critical thinking, problem-solving, and learner engagement, particularly through community-based projects, fieldwork, and discussion of contemporary issues like climate change and pollution. These findings support Payne's (2006) view that EE provides a fertile ground for interdisciplinary, inquiry-based learning that goes beyond content acquisition to engage students in ethical and civic dimensions of science. Similarly, Kumar (2021) found that inquiry-based learning approaches in the humanities—paralleling practices in Life Sciences—empowered students to generate solutions to real-world problems, reinforcing constructivist pedagogy. Chand (2024) further supports this through a focus on the contributions of Bruner, Piaget, and Vygotsky in facilitating learning that is developmental, active, and problem-centred.

Moreover, Fru and Ndaba (2023) in their study of South African secondary schools, reported that teachers often recognized the transformative potential of EE, especially when linked to learners' immediate environments, thus reinforcing local relevance and environmental responsibility—findings directly echoed in the present study. Theme 3 exposed a series of structural and institutional challenges

such as curriculum overload, rigid pacing schedules (ATP), lack of professional development, and inadequate resources. These findings are in line with Doychinova (2023), who reported that many educators face systemic constraints that inhibit the implementation of constructivist strategies in EE, often forcing a reversion to traditional didactic approaches. Furthermore, research by Acut (2024) stresses the importance of real-world immersion and teacher support in fostering EE practices. Without this, teachers often struggle to facilitate experiential learning. Howell (2021) similarly identified that institutional constraints such as assessment pressures and insufficient planning time compromise the depth and quality of EE integration. The study also aligns with the critique by Payne (2006), who noted that curriculum theory often fails to account for the realistic teaching conditions that educators face, especially in under-resourced contexts. In such settings, EE becomes marginalized, thereby contradicting the aims of sustainability education.

The findings suggest a disconnect between pedagogical intent and systemic structure. While Life Sciences teachers in this study demonstrated an understanding of EE's potential, their implementation is restricted by curriculum design and a lack of institutional support. This mismatch has been observed in multiple contexts, as noted by Damşa and Ludvigsen (2016), who emphasized the necessity of coherent institutional frameworks that support co-construction of knowledge. This study contributes to the literature by reinforcing that for constructivist EE to thrive in schools, there must be:

- Policy reform that allows greater curriculum flexibility (Payne, 2006),
- Continual professional development that enhances pedagogical content knowledge in EE (Fru & Ndaba, 2023),
- And resource investment to support field-based and experiential learning (Acut, 2024).

7. Implications for Future Practice

The findings of this study underscore the importance of providing Life Sciences teachers with targeted support to effectively integrate Environmental Education through constructivist approaches. For future practice, professional development initiatives must be designed to equip teachers with practical strategies for connecting environmental content to learners' real-life experiences and local community contexts. By emphasizing the relevance of environmental education to students' everyday lives, teachers can foster deeper engagement and understanding of the material.

In addition, curriculum designers should consider providing greater flexibility within the Annual Teaching Plan (ATP), allowing more room for inquiry-based, learner-centred environmental learning. Such flexibility would enable teachers to move beyond rigid content delivery and focus on fostering critical thinking and problem-solving skills in their students.

Moreover, schools can strengthen the impact of environmental education by forging partnerships with local environmental organizations. These

collaborations can support fieldwork and community-based projects that align with the constructivist aim of making learning both meaningful and active. Through hands-on experiences, students can engage directly with environmental issues, reinforcing the connection between classroom learning and real-world applications. Ultimately, these actions can create a more supportive, flexible, and engaging environment for integrating Environmental Education into Life Sciences classrooms, leading to more effective and impactful learning experiences for students.

8. Conclusion

This study highlighted the significant challenges and opportunities associated with integrating environmental education into Grade 11 Life Sciences classrooms in South Africa. Despite the clear alignment between Life Sciences and environmental themes such as ecosystems, conservation, and sustainability, teachers face numerous barriers, including time constraints, insufficient professional development, lack of resources, and rigid curriculum structures.

These challenges hinder the effective delivery of environmental education, which is critical in addressing the growing concerns surrounding climate change and biodiversity loss. However, the study also revealed that there are meaningful opportunities for enhancing student engagement, critical thinking, and real-world problem-solving through the adoption of context-based, experiential learning strategies. Teachers who can connect environmental issues to learners' everyday lives and local contexts create more relevant and impactful learning experiences, encouraging students to become active participants in addressing environmental challenges.

The findings emphasized the importance of a constructivist approach to teaching, grounded in Vygotsky's Zone of Proximal Development, which promotes active, inquiry-based learning. For successful integration, it is essential to provide Life Sciences teachers with targeted professional development, curriculum flexibility, and access to appropriate resources. Additionally, fostering partnerships with local environmental organizations can further enrich the learning experience by providing students with hands-on opportunities to explore environmental issues.

Ultimately, the study concluded that the integration of environmental education into Life Sciences classrooms requires a holistic approach, combining systemic support for teachers, greater curricular flexibility, and localized, experiential learning opportunities. These steps are crucial to bridging the gap between scientific knowledge and environmental action, equipping learners to tackle the pressing environmental challenges of the future.

9. Recommendations for Integrating Environmental Education into Grade 11 Life Sciences Classrooms

Based on the findings of this study, several recommendations were proposed to enhance the integration of environmental education into Grade 11 Life Sciences classrooms, particularly within the South African context:

9.1 Enhance Teacher Professional Development

One of the primary challenges identified in this study was the lack of sufficient training and professional development for teachers in environmental education. It is recommended that professional development programs be implemented to equip teachers with the knowledge and practical skills needed to effectively integrate environmental education into their classrooms. These programs should focus on both the scientific content and pedagogical strategies that support a constructivist approach to learning. Teachers should also be trained to link environmental education to learners' local contexts, thus making the content more relevant and meaningful.

9.2 Curricular Flexibility and Integration

The study found that the rigid structure of the Life Sciences curriculum, along with time constraints, limits opportunities for teachers to address environmental education thoroughly. To address this, curriculum designers should allow greater flexibility within the Annual Teaching Plan (ATP) to facilitate the integration of environmental themes. This flexibility could include reallocating time for inquiry-based, experiential learning activities, enabling students to explore environmental issues in-depth without compromising other important aspects of the curriculum. Additionally, environmental education should be seen as integral to the Life Sciences curriculum, not as a peripheral topic, to encourage its consistent inclusion in teaching.

9.3 Adopt Inquiry-Based, Contextualized Pedagogies

Teachers who have successfully integrated environmental education into their classrooms often use inquiry-based, context-rich pedagogies. It is recommended that teachers adopt these strategies to engage students in hands-on, real-world problem-solving activities. These pedagogies align with constructivist learning theory, encouraging learners to explore environmental issues through fieldwork, community engagement, and collaborative inquiry. Teachers should be supported in incorporating local environmental issues into their lessons, fostering a deeper connection between learners and the content.

9.4 Foster Partnerships with Environmental Organizations

To enrich the learning experience, schools should consider establishing partnerships with local environmental organizations and community groups. These partnerships can provide valuable resources, such as fieldwork opportunities, guest speakers, and access to environmental education materials. These collaborations can further support the experiential and contextual learning approaches advocated in this study, providing students with authentic experiences that link classroom learning to real-world environmental challenges.

9.5 Provide Adequate Resources and Support

The study highlighted the lack of resources as a significant barrier to integrating environmental education effectively. To address this, it is essential for schools and educational authorities to allocate sufficient resources for environmental education, including teaching materials, technology, and fieldwork opportunities. Schools should also provide teachers with access to professional networks,

support groups, and online resources where they can share best practices and collaborate on innovative teaching methods.

9.6 Create a Collaborative, Supportive Learning Environment

Teachers expressed the need for a more collaborative and supportive environment in which they can share ideas, challenges, and resources. Establishing teacher learning communities, where Life Sciences teachers can come together to discuss strategies for integrating environmental education, could be beneficial. Additionally, school leadership should provide regular opportunities for peer observation and feedback to strengthen teachers' confidence and ability to implement environmental education effectively.

By implementing these recommendations, the integration of environmental education into Grade 11 Life Sciences classrooms can be significantly improved, creating a more dynamic and impactful learning experience for students. With the right support structures in place, teachers will be better equipped to foster environmental awareness, critical thinking, and responsible citizenship among their students, preparing them to address the pressing ecological challenges of the future.

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