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An exploration of the integration of environmental education by Natural Sciences and Technology teachers

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Abstract

This paper investigated how Natural Sciences and Technology teachers integrate environmental education into their teaching. Due to ongoing changes in the South African school curriculum, teachers have struggled to incorporate environmental education effectively. The study used an interpretative research paradigm and a multiple case study design, guided by the theoretical framework of social constructivism. It was conducted in the iLembe district of KwaZulu-Natal province in South Africa and involved three grade 6 primary school teachers specializing in Natural Sciences and Technology. Data collection methods included semi-structured interviews, observations, and document analysis, and the data was analyzed thematically. The findings revealed that some teachers had misconceptions about integrating environmental education. To address this, it is recommended that subject advisors take a more active role in promoting the integration of environmental education during content workshops. The study also found that teachers relied on instructional strategies that hindered effective integration. Therefore, teachers should explore a broader range of instructional strategies. Lastly, the study found that the support provided by departmental officials was insufficient, and it is suggested that they establish connections with other stakeholders to facilitate collaboration and reintroduce environmental education programs in schools.

Keywords: Curriculum, Environmental Education, Instructional Strategies, Integration

Introduction

Education plays a vital role in preparing learners to understand the current global crisis and to shape a sustainable future (Aada, 2024). To protect our planet, it is essential to undergo a profound transformation in the way we live, produce goods, consume resources, and interact with the natural world (Chu & Karr, 2017). "The incorporation of environmental education for sustainable development into all educational programs should be a fundamental and widespread endeavour," emphasized Audrey Azoulay, Director-General of the United Nations Educational, Scientific and Cultural Organization (UNESCO). This statement was made during the UNESCO World Conference on Education for Sustainable Development (ESD) held in Berlin, Germany, from May 17 to 19, 2021. Discussions at the event highlighted the ongoing and substantial nature of deliberations regarding the integration of environmental education on a global scale (Sikhosana, 2022a).

Despite being part of the curriculum, the actual implementation of environmental education remains a persistent challenge due to the lack of clear guidance on its nature and scope of integration (Phillips, 2022). This issue arises because some teachers have the freedom to select and prioritize lesson topics, even when they may lack significant exposure to environmental education (Badea, 2024). While the South African Curriculum Assessment Policy Statement (CAPS) does outline the incorporation of environmental education across various curricula (Munasi & Madikizela-Madiya, 2020), the curriculum presents limitations, mainly stemming from the lack of seamless alignment between the CAPS and the actual curriculum content (Hebe, 2019).

South African conservationists have actively pursued the incorporation of environmental education within school curricula, driven by the goal of preserving biodiversity (Kühn, 2022). They aim to ensure that environmental education integrates knowledge about the environment and conservation, woven into the school curriculum through various interactions and activities (Malatji et al., 2023). Despite this initiative, teachers face challenges in identifying the most effective approaches to integrating environmental education into the teaching and learning process (Jung & Santos, 2022), which poses a significant obstacle to addressing learners' adverse behaviour towards the environment.

It is essential to acknowledge that the effective integration of environmental education plays a pivotal role in advancing sustainability, offering significant potential to reshape and revitalize education towards sustainability (Sikhosana, 2020a). As a result, many nations are steadfast in their efforts to ensure the integration of environmental education across the school curriculum and various subjects (Loubser, 2014). For instance, Finland has demonstrated a strong commitment to environmental education and education for sustainable development by instituting programs and a national policy on environmental education in numerous schools (Whang, 2019). Similarly, an African nation like Ethiopia has enshrined environmental education in its policy, with a concerted endeavour to incorporate environmental education elements into the curricula of all school subjects (Gugssa, 2023).

The initiatives mentioned signify the recognition of environmental education as a proactive approach to environmental issues and challenges, and to integrate it into educational systems. In response, UNESCO (2020) has issued a call for environmental education and education for sustainable development to be an integral part of all education systems at every level by 2025. Similarly, the United Nations (2015) has continuously worked towards promoting the incorporation of environmental education in educational institutions, including schools, colleges, and universities. Given this context, this study aims to investigate how teachers specializing in Natural Sciences and Technology for sixth-grade learners in primary schools have integrated environmental education into their teaching and learning processes.

Aim and objectives

This paper aims to comprehend how Natural Sciences and Technology teachers integrate environmental education.

Objectives

a. To understand the integration of environmental education
b. To investigate the instructional strategies used to integrate environmental education

Literature review

The historical backdrop has played a crucial role in the incorporation of environmental education into South Africa's school curriculum post-1994. The following section is dedicated to examining the South African school curricula post-1994 and the methodologies utilized to infuse environmental education into the teaching and learning process.

a. Curriculum 2005

Post-apartheid South Africa introduced Curriculum 2005, also known as the Outcomes-Based Education (OBE) curriculum, as expounded by Gumede and Biyase (2016). In 1997, South Africa developed its distinctive OBE model, which placed the learner at the center and outlined the outcomes that learners should achieve throughout the teaching and learning process, as articulated by the Department of Basic Education (1997). Environmental education was incorporated into subjects such as Geography and Biology within Curriculum 2005. Its integration empowered teachers and learners to generate ideas and develop solutions for environmental education through hands-on activities, which were previously hampered by resource constraints.

b. National Curriculum Statement (NCS)

The NCS Grade R-12 embodies what learners should learn in South African schools in terms of knowledge, skills, and values, as outlined by the Department of Basic Education in 2004. The NCS aims to equip learners with knowledge and skills that are pertinent and meaningful in their daily lives. Introduced in South African schools by the Department of Basic Education in 2004, this curriculum adheres to several fundamental principles, including promoting high knowledge and high skills, ensuring progression in learning, upholding human rights, inclusivity, environmental and social justice, emphasizing credibility, quality, and efficiency, valuing Indigenous knowledge systems, and promoting active and critical learning. These guiding principles of the NCS curriculum provide a framework for the integration of environmental education within the broader curriculum, emphasizing the significance of principles such as human rights, inclusivity, environmental consciousness, and social justice (Department of Basic Education, 2004).

c. Curriculum and Assessment Policy Statement (CAPS)

CAPS is a comprehensive policy document introduced in 2011 by the Department of Basic Education, which supersedes the prior subject and learning area statements, as well as learning programs. One notable inclusion is the integration of environmental education across all school subjects from grade R (Reception year) to grade 12 (matric), guided by two fundamental principles outlined by the Department of Basic Education (2011). The first principle involves promoting human rights, inclusivity, and environmental and social justice by encompassing practices aligned with social and ecological justice and human rights as defined in the South African Constitution. The NCS for grades R to grade 12 is designed to be sensitive to diverse issues such as poverty, inequality, race, gender, language, age, disability, and other pertinent factors. The second principle revolves around valuing indigenous knowledge systems and recognizing the historical and cultural significance of indigenous knowledge systems in nurturing the core values enshrined in the South African Constitution.

Theoretical framework

The study employed Vygotsky's (1978) constructivist theoretical framework to provide a structure that supports the exploration of how Natural Sciences and Technology teachers integrate environmental education into their teaching and learning practice. Emphasizing the social aspect of learning, the role of conversation, interaction with others, and the application of knowledge, the use of social constructivism recognizes the essential aspects of the learning process, as acknowledged by Akpan et al. (2020). This theory also facilitated interactions with the teachers within their social settings, allowing for the synthesis of unique perspectives and experiences, as discussed by Sikhosana (2022b). Furthermore, it acknowledges that knowledge is a result of the mind's selection, sense-making, and reconstruction of experiences, as stipulated by Lohman and Hurst (2023). Interactions with teachers in this study will enable the reconciliation of new information, involving the construction, storage, and retrieval of information, allowing for close interactions and the integration of information, assumptions, and experiences to derive substantial findings. The principles of social constructivism, as outlined by Lohman and Hurst (2023), will guide the interaction with participants, emphasizing that knowledge is constructed through human activities and interactions with others and their environments, providing a framework for identifying gaps and insights in the study being investigated.

Method

Qualitative data collection techniques, including observations, semi-structured interviews, and document analysis, were utilized (Sutton & Austine, 2015) to acquire insights into the phenomenon under investigation, which in the context encompassed three grade 6 Natural Sciences and Technology teachers (Waltz & Moffit, 2021). The interpretivism paradigm was predominantly used in this qualitative study to seek understanding and interpret the diverse perspectives of individuals. In this study, the various perspectives of grade 6 Natural Sciences and Technology teachers within their social context were interpreted. A multiple case study design was adopted in this study. It provides an in-depth examination of a specific subject such as a person, group, place, event, organization, or phenomenon (McCombes & George, 2022). Therefore, a multiple case study was employed focusing on three primary schools located in the iLembe district of KwaZulu-Natal Province, South Africa.

Sampling method, selection criteria, and participants

The researchers chose purposive sampling to improve the quality and accuracy of the data by selecting participants who are most relevant to the research question (Sago, 2023). The selection was based on the qualifications, subject specialization, seniority, and grades taught. Three Grade 6 Natural Science and Technology teachers were included in the sample. The results were organized according to thematic patterns derived from the data analysis. To protect the participants' identities, pseudonyms were used throughout the data presentation, discussion, and findings:

- Case 1: Mrs. Thwala
- Case 2: Mr. Mthembu
- Case 3: Mr. Khuzwayo

Data was collected through a combination of observation, semi-structured interviews, and document analysis within three selected primary schools. Thematic analysis was used to achieve the objectives of developing themes and categories, interpreting these themes and categories supported by the data, and addressing research questions that transcend the participants' experiences (Villagas, 2023). Data collected was segregated by case with a specific theme and category in focus. Findings were based on the data extracted from interview transcripts and classroom observations of the three educators. The key themes focused on were:

- The integration of environmental education
- Instructional strategies used to integrate environmental education

Findings

CASE 1: MRS. THWALA

a. The integration of environmental education

The integration of environmental education in the teaching and learning process is a significant focus of this study. During semi-structured interviews, Mrs. Thwala emphasized that environmental education is primarily incorporated into the school improvement plan rather than being a prominent part of the curriculum. In this context, learners are taught about the importance of environmental care. Mrs. Thwala also mentioned that the school hosts visitors who guide learners on environmental preservation and tree planting. Furthermore, the school has an environmental committee that collaborates with parents and teachers responsible for teaching environmental education. This collaboration aims to further promote environmental education within the school.

During their observations, researchers noticed a significant garden on the school premises. Parents actively involved in the school's environmental education committee were seen participating in planting activities within the garden. Mrs. Thwala, during the semi-structured interviews, mentioned that they receive support from individuals in the environmental department. These individuals help with various environmental initiatives and commemorate significant environmental awareness days. Mrs. Thwala specifically stated, *"My school integrated environmental education; for instance, we have a greenhouse where we used to plant mushrooms, a garden where the community used to come and plant, and small plants that are being planted by the learners. We used to teach the learners how to plant and harvest food from the soil."*

While Mrs. Thwala acknowledged that their school incorporates environmental education, she noted that the execution of this integration is not entirely effective. She mentioned, *"The integration in my school is not adequate. We used to rely on just one person who knew and studied environmental studies at school. We used to chase that particular person around, only to find out that maybe on the other day, she doesn't find time to sit down with you because of the work that we have."* During classroom observations, researchers noted that Mrs. Thwala integrated environmental education into her teaching by emphasizing the following strands within the grade 6 Natural Sciences and Technology subject:

- Natural Sciences: Matter and Material
- Technology: Processing

She integrated environmental education into her teaching while covering the topic of Mixtures and water resources. This included addressing the content and concepts related to water pollution and the significance of wetlands, as outlined in the Natural Sciences and Technology Grade 6 CAPS document. The researchers also observed an environmental education calendar and posters in Mrs. Thwala's classroom, intended to foster environmental education. These posters aligned closely with the content outlined in the Natural Sciences and Technology Grade 6 CAPS document, ensuring they complement the lessons taught to the learners. Mrs. Thwala used the Platinum Natural Science and Technology grade 6 learner's book to deliver the content and concepts of water pollution while simultaneously incorporating environmental education. She also taught the content and concepts related to the significance of wetlands, utilizing various posters displayed in the classroom. According to the Natural Sciences and Technology Grade 6 CAPS, one of the recommended activities for teachers involves visiting a nearby wetland with learners. However, during classroom observations, researchers noticed that this specific task had not been carried out. Mrs. Thwala explained, *"We used to do it once a year during the field trip educational tours, but we don't have a wetland near the school."*

b. Instructional strategies used to integrate environmental education

For the effective integration of environmental education, it is important to be proficient in employing various instructional strategies. According to Mrs. Thwala, she does not rely on a specific instructional strategy for the integration of environmental education. She mentioned, *"We do not use a specific strategy. We normally focus more on theory rather than practice and tend to ignore hands-on activities. We used to conduct field trips and educational tours once a year."* Additionally, Mrs. Thwala stated, *"I used to teach the learners how to take care of the environment, for instance, by drawing charts with plants and environmental elements and showing the learners all the environmental aspects within the school premises."* However, during classroom observations, researchers noticed that Mrs. Thwala employed instructional strategies such as questioning and answering, teacher-centered instruction, and practical activities when delivering lessons on the topic of Mixtures and Water Resources. This included covering the content and concepts associated with water pollution and the significance of wetlands,

aligning with the guidelines outlined in the Natural Sciences and Technology Grade 6 CAPS document, and utilizing the school garden as a point of reference for the learners.

CASE 2: MR. MTHEMBU

a. The integration of environmental education

Mr. Mthembu mentions that their school integrates environmental education through their participation in the School Environmental Education Programme (SEEP). This program focuses on teaching students about environmental care, tree planting, and collaborating with other departments such as the Department of Economic Development, Tourism, and Environmental Affairs (DEDTEA), which helps engage students in recycling projects. In the process of incorporating environmental education, the school maintains an environmental education committee that works with students and the Extended Public Works Programme (EPWP) organization. According to Mr. Mthembu, this collaboration is particularly important for tree-planting efforts. The school also involves external stakeholders represented by individuals from the KwaZulu-Natal Department of Education and DEDTEA. These stakeholders play a key role in spearheading the SEEP, focusing on educating learners about recycling and tree planting. Mr. Mthembu also addressed the topic of water purification processes in the grade 6 Natural Sciences and Technology CAPS document during Term 2. This topic provided him with an opportunity to seamlessly incorporate environmental education into the teaching and learning process. However, Mr. Mthembu did not take the opportunity to explain how he embedded environmental education into his teaching and learning, as he held a misconception that the responsibility for integrating environmental education lies with the school.

b. Instructional strategies used to integrate environmental education

In this study, it was essential to understand the instructional strategies used by Mr. Mthembu in integrating environmental education. During interviews, Mr. Mthembu explained that he integrates environmental education by teaching students both inside and outside the classroom. He stated, *"In doing so... sometimes you have to take out your learners to the field so that they will be able to see when we're talking about how... how does a wetland purify water. Speaking about that in class is not enough; we should take them to a small wetland. We have a wetland just by the gate, which is a typical example. Sometimes we take our learners to the field."* During classroom observations in the grade 6 Natural Sciences and Technology class, the researchers noted that Mr. Mthembu primarily used a teacher-centered approach and a demonstration approach when teaching in the classroom. However, these instructional strategies did not effectively allow him to integrate environmental education when addressing the topic of water purification processes as outlined in the Natural Sciences and Technology Grade 6 CAPS document.

CASE 3: MR. KHUZWAYO

a. The integration of environmental education

In this study, it was crucial to grasp Mr. Khuzwayo's concept of environmental education. During the interviews, Mr. Khuzwayo stated that environmental education relates to the environment they teach about: *"Environmental education is an education about the environment that we're teaching,"* said Mr. Khuzwayo. His understanding seemed ambiguous, leading the researchers to question how he integrated it into teaching and learning, a pivotal aspect of the study. However, Mr. Khuzwayo expressed that there is insufficient information regarding the integration of environmental education: *"It is not enough in subjects,"* he stated. Mr. Khuzwayo appeared uncertain about how to integrate environmental education and mentioned the involvement of a school chairperson in the environmental committee: *"Yes, there is the chairperson for the environment. For now, it is not active,"* he said. Mr. Khuzwayo misunderstood, believing that only the chairperson of the environmental committee can integrate environmental education, not the teachers. He also mentioned that the school had received a green flag for the environment due to a learner winning a provincial environmental education competition in the past. This observation aligns with what the researchers noted at the school. Mr. Khuzwayo's belief that environmental education can only be integrated outside the classroom was reinforced when he mentioned taking learners on environmental tours and exposing them to different environmental concepts to aid their understanding.

b. Instructional strategies used to integrate environmental education

While it is possible to integrate environmental education using a variety of instructional strategies, it was essential for this study to examine the specific instructional strategies employed by Mr. Khuzwayo when teaching the following strands: "Matter and materials" for Natural Sciences and "Solids, liquids, gases, and mixtures" for Technology, as outlined in the grade 6 Natural Sciences and Technology Curriculum Assessment Policy Statement (CAPS) document. During the classroom observations, it became evident that Mr. Khuzwayo predominantly employed a teacher-centered approach and the question-and-answer method in his teaching. His primary concern

was to ensure the coverage of subject content, as he aimed to compensate for the time lost during content workshops, rather than integrating environmental education, which he had limited knowledge of.

Discussion

a. The integration of environmental education

Integration is a concept that lacks a singular, definitive definition, but according to Munasi and Madikizela-Madiya (2020), it entails the effective amalgamation of two or more elements. Therefore, understanding how environmental education is integrated was crucial for this study. Mrs. Thwala's view notes that environmental education is primarily incorporated into the school improvement plan rather than within the curriculum, with a focus on educating learners about environmental care. However, Munasi and Msezane (2024) offered a different perspective, suggesting that environmental education integration involves linking subject areas to broaden environmental education knowledge across various disciplines. Mrs. Thwala demonstrated a comprehensive understanding of the integration of environmental education. Her school effectively integrated environmental education within the school improvement plan, hosting environmentalists to educate learners and maintaining an environmental committee, a greenhouse for crop planting, as well as collaborating with DEDTEA to organize environmental projects and mark important environmental awareness days on the school premises. Mrs. Thwala seamlessly incorporated environmental education into Natural Sciences and Technology lessons by teaching topics such as water pollution and wetlands, as outlined in the CAPS document. The classroom environment also promoted environmental education, with the presence of environmental education calendars and posters serving as reminders for field trips aligned with the academic calendar.

The integration of environmental education involves incorporating environmental education themes into the school curriculum (Sikhosana, 2025). Mr. Mthembu emphasized that the integration of environmental education is a collaborative endeavor involving representatives from DEDTEA and the KwaZulu-Natal Department of Education. They assist schools in joining the School Environmental Education Programme (SEEP) to teach learners how to care for the environment. This approach aligns with the insights provided by Munasi and Msezane (2024), emphasizing the vital role of SEEP in the implementation and integration of environmental education. Mr. Mthembu's understanding of the principles of integrating environmental education is evident in his overview of the SEEP project, which actively involves DEDTEA and KZNDoE, and the school environmental committee collaborating with the EPWP organization to ensure the integration of environmental education within the school environment. Furthermore, Mr. Mthembu addressed the topic of "Processes to purify water" following the CAPS document, providing ample opportunities for effectively incorporating environmental education into teaching and learning. However, he was unable to do so due to the misconception that the responsibility for integrating environmental education lies with the school rather than individual teachers.

Environmental education has a longstanding history of integration into the school curriculum. Similarly, Makokotlela's (2020) study confirms that environmental education themes are interwoven into all school subjects within the curriculum. Nevertheless, Mr. Khuzwayo contends that the current level of integration of environmental education in the school curriculum falls short. This perspective suggests that Mr. Khuzwayo may not be aware that environmental education is interwoven throughout various school subjects. These observations imply that Mr. Khuzwayo may not possess enough knowledge about effectively integrating environmental education into teaching and learning. This became apparent when he asserted that the responsibility for integrating environmental education lies with the chairperson of the school's environmental education committee. However, the school's activities, such as being awarded a green flag in recognition of winning a provincial environmental competition, demonstrate that environmental education is indeed integrated within the school. Mr. Khuzwayo's belief that environmental education can only be integrated outside the classroom environment appears to be a misconception.

b. Instructional strategies used to integrate environmental education

The effective implementation of environmental education entails the utilization of a wide array of instructional strategies to facilitate knowledge transmission from educators to learners (Pitsoe & Sepeng, 2024). According to Sikhosana (2022b), instructional strategies encompass a collection of techniques and principles employed by educators in the teaching and learning process. These strategies serve as a framework for structuring lessons to achieve specific learning outcomes while accommodating diverse learning styles, as emphasized by Nkanyani (2023). Mrs. Thwala, however, expressed her preference for adapting her teaching methods to accommodate different learning environments, thus not adhering to a specific instructional strategy. Consequently, she employed instructional strategies such as questioning and answering, teacher-centered approaches, and practical activities when educating students on topics such as pollution, wetlands, and tree planting, while referring to the school garden.

The seamless integration of environmental education necessitates the application of diverse instructional strategies that actively engage learners in both practical activities and theoretical concepts, both within and beyond the classroom setting (Tshivhase, 2019). Mr. Mthembu opted for instructional strategies such as the teacher-centered approach and the demonstration approach. However, these strategies presented limitations in effectively integrating environmental education due to their misconceptions regarding the school's responsibility. It can be inferred that Mr. Mthembu's misconceptions placed him at a disadvantage as he missed the opportunity to employ a practical work approach, which could have involved taking learners to the school's wetland. This would have been feasible with a clearer understanding that the integration of environmental education is not solely the school's responsibility, but that teachers also have a crucial role to play in this regard (Okeke et al., 2024).

Tshivhase (2019) emphasized the employment of various instructional strategies for teaching environmental education, requiring active learning methods such as critical thinking, participation in practical activities, and fostering an engaged learning environment. In contrast, Mr. Khuzwayo predominantly employed a teacher-centered approach and relied on the question-and-answer method during his teaching. His instructional focus leaned more towards theory, posing challenges in effectively integrating environmental education (Mashabela & Thusi, 2023). Consequently, he found it challenging to maintain alignment with the content pace set by the CAPS document and the annual teaching plan (ATP). Mr. Khuzwayo admitted that he dedicated a significant amount of time to content workshops rather than focusing on the integration of environmental education.

Conclusions and recommendations

This paper aimed to investigate how Natural Science and Technology teachers in the iLembe district integrate environmental education. The research found that most teachers had good knowledge of environmental education, and some were successful in integrating it into their teaching. However, one teacher wrongly believed that integrating environmental education was solely the school's responsibility. It is recommended that subject advisors conduct workshops to help teachers improve their skills in integrating environmental education into their teaching. The research also revealed that teachers faced challenges such as time constraints and pressure to cover content, which affected their integration efforts. One solution proposed is to introduce environmental education as a separate school subject, enabling teachers to better understand and incorporate it into their teaching. The study also highlighted various instructional strategies used by teachers, including the question-and-answer method, teacher-centered approaches, practical activities, and demonstrations. However, some of these strategies were found to be ineffective, so teachers are encouraged to explore a wider range of instructional strategies to improve the integration of environmental education.

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Conflicts of Interest

No possible conflicts of interest exist concerning the research, authorship, or publishing of this paper. This paper emanates from a master's research.

Declaration

The authors confirm that the article has not been previously published.

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