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Addressing Challenges and Implementing Professional Development for Integrating Education for Sustainable Development into Life Science Education

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Abstract

Goal 4 of the United Nations Sustainable Development Goals (UNSDGs) emphasizes the need for Education for Sustainable Development (ESD) in formal school settings and stresses the urgency of providing teachers with professional development to improve education quality by 2030. This article explores challenges faced by Life Science teachers, particularly in grade 11, in integrating EE/ESD into their curriculum. Using a qualitative research design with an interpretivist paradigm, the study used purposive sampling to gathers insights from four grade 11 Life Science teachers and three Life Science Subject advisors from Vhembe East district in Limpopo province, South Africa, through face-to-face interviews. Data were analysed thematically, supported by literature review and two theories underpinning this study. The findings reveal substantial challenges, encompassing curriculum and pedagogical issues, along with support-related challenges. Additionally, the study identifies a lack of tailored professional development mechanisms and opportunities for integrating EE/ESD into the Life Science curriculum. The findings emphasize the need for policymakers and education stakeholders to design context-specific professional development frameworks, emphasizing ongoing, inclusive initiatives to empower Life Science teachers with essential knowledge and skills, bridging the existing gap.

Keywords: Environmental education; sustainable development; integration; professional development

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1. Introduction

As the world grapples with the urgent need for environmental consciousness, global initiatives have set the stage for integrating Environmental Education (EE) and Education for Sustainable Development (ESD) into school curricula (in this paper EE and ESD will be used interchangeably, hence written as EE/ESD). However, this integration poses significant challenges for teachers worldwide. Teachers in diverse regions, including Norway, Ontario, and South Africa, have identified persistent obstacles hindering the seamless infusion of EE/ESD principles into their teaching practices.

In Norway and Ontario, teachers, as highlighted by Lauzo and Seo (2021) confront issues ranging from resource shortages to open-ended curricula and a lack of guidance, hampering their efforts to effectively incorporate EE/ESD. Similarly, Mokhele (2011) sheds light on the South African scenario, where teachers encounter hurdles such as insufficient support from provincial and district offices and a deficit in essential competencies. Sikosana, Mudau, and Msezane (2020) emphasize that EE/ESD struggles to find its place in the teaching and learning process due to challenges like overcrowded classrooms and a scarcity of instructional materials.

While South Africa has responded to global calls for environmental education through initiatives like the Belgrade Charter, Tbilisi Declaration, and Sustainable Development Goals (SDGs) (UNESCO, 2015), the translation of these global imperatives into effective classroom practices within the South African context remains complex. The Curriculum Assessment Policy Standard (CAPS), implemented in 2012, highlights the Department of Basic Education's (DBE) commitment to embedding EE/ESD principles in all South African public schools (DBE, 2011:5). However, the specific challenges faced by South African teachers in implementing these principles merit a thorough investigation.

Against this backdrop, this study aims to explore the challenges encountered by Life Science teachers, particularly in grade 11, in integrating EE/ESD into the curriculum. Building on Mokhele (2011)' identification of deficiencies in teachers' knowledge and teaching practices, we seek to shed light on the contextual and structural constraints faced by teachers. By addressing this gap in the literature, we hope to contribute valuable insights that can inform targeted professional development initiatives and systemic changes needed to facilitate successful EE/ESD integration in South African schools.

The research unfolded in the distinctive setting of Limpopo Province. Limpopo Province, located in the northern part of South Africa, borders SADC countries like Botswana, Mozambique, and Zimbabwe. With a vast geographical expanse of 125,754 square kilometers and a population of 5,779,090, it stands as South Africa's fifth-largest province. Characterized by a hot subtropical climate and notable natural reserves like Kruger National Park, Limpopo's historical richness is evident in indigenous groups,

historical landmarks, and economic strengths. Economically, Limpopo is known for minerals, agriculture, and tourism, yet grapples with challenges such as poverty and unemployment. The environmental context is crucial, featuring biodiversity, environmental challenges, and sustainability efforts. Administratively, Limpopo is subdivided into districts, with a specific focus on the rural areas of Vhembe District, particularly Vhembe East under the Thulamela Municipality, where Life Sciences teachers and subject advisors actively contribute to the educational landscape.

Environmental Education (EE)/Education for Sustainable Development (ESD) are pivotal components of quality education that address global environmental challenges. In South Africa, the effective integration of EE/ESD into the Life Science curriculum faces substantial challenges. Teachers encounter obstacles such as insufficient knowledge and skills, limited resources, time constraints, and large class sizes (Tsotetsi, 2021; Ntuli et al., 2022). These challenges are not unique to South Africa and are echoed in other regions, including Nigeria, where inappropriate teaching strategies and insufficient content knowledge hinder EE learning (Aladejebi, 2020).

Furthermore, Damoah (2019) identifies a lack of clarity and policy guidelines in the Curriculum and Assessment Policy Statements (CAPS) document, resulting in confusion among teachers. An exam-oriented approach to teaching, coupled with teachers limited environmental knowledge, further impedes the seamless integration of EE/ESD into subjects (Munasi & Madikizela, 2020; Damoah, 2019). The government's efforts to develop a clear curriculum with defined goals and content, coupled with enhancing teachers' capacities, are hindered by these challenges. Continuous professional development is crucial for EE/ESD teachers to interpret subject curricula effectively and cultivate personal professional agency (Ever, 2012). Addressing these challenges requires a strategic approach to improve environmental literacy and resource sustainability in schools. Against this backdrop, the following research questions were formulated:

- What challenges do Grade 11 Life Science teachers face when integrating EE/ESD into their curriculum?
- Which professional development initiatives are available for supporting Grade 11 Life Science teachers in integrating EE/ESD into their curriculum?

2. Theoretical frameworks

This paper follows a combination of two theories: The Educational Change Theory developed by Michael Fullan and the Social Learning Theory developed by Albert Bandura. Fullan's educational theory, applied in this study, explains the factors influencing the implementation of educational change. This framework aids in addressing gaps related to overcoming challenges faced by Life Sciences teachers when integrating EE/ESD into their subject curriculum. Michael Fullan's Educational Change

Theory outlines a three-phase process for significant educational changes. The initiation phase involves introducing innovations, with key factors including the quality and accessibility of innovation, advocacy from central administration, and community support (Fullan, 2007). The implementation phase focuses on executing proposed changes, necessitating shifts in practice, beliefs, and the use of new materials. Factors influencing implementation encompass characteristics of educational change, local factors, and intangible factors such as government involvement (Fullan, 2001; Fullan & Stigelbauer, 1991; Rogers, 2003). The institutionalization phase ensures that changes become permanent, leading to sustained outcomes like attitude change and improved problem-solving capacity, crucial for the long-term success of educational innovations (Fullan, 2007).

Bandura's social learning theory addressed the gap of professional development initiatives are available for supporting teachers in integrating EE/ESD into the Life Science curriculum. Albert Bandura's Social Learning Theory highlights observational learning, emphasizing that individuals acquire knowledge by observing others. The theory incorporates three themes: environmental, personal, and behavioural factors (Bandura, 1986). Bandura outlines four stages in this learning process: attention, retention, reproduction, and motivation. Attention requires noticing and focusing on the behaviour to be reproduced, while retention involves remembering the observed behaviour. Reproduction entails replicating the behaviour, and motivation influences whether it will be reproduced (Nabavi, 2012).

3. Literature review

3.1. Challenges encountered by teachers in the integration of environmental education/education for sustainable development.

In the realm of environmental education (EE)/education for sustainable development (ESD), the challenges faced by teachers in integrating these elements into the curriculum become apparent. Marpa (2020) highlights the pervasive hurdles stemming from insufficient teacher knowledge, skills, and technological resources, hindering the seamless integration of EE/ESD into lessons. These challenges resonate globally, from India, Thailand, and Japan (Laiphrakpam et al., 2019), to Nigeria (Aladejebi, 2020) where constraints such as resource scarcity and rigid educational structures compound the impediments. Within the South African educational context, Tsotetsi (2021) and Sikhosana (2019) delineate challenges arising from curriculum coverage constraints in the Curriculum and Assessment Policy Statement (CAPS) document, coupled with time constraints and a lack of integration guidelines. The absence of support from schools and district offices further exacerbates the struggles faced by teachers (Damoah and Adu,

2019). Moreover, Bopape et al., (2021) highlight the consequential absence of integration guidelines within the curriculum, amplifying the difficulties encountered by teachers. The South African educational landscape introduces contextual nuances that compound these challenges, as illustrated by Molapo (2014) emphasizing the generic nature of lesson plans provided by education departments. The implications of these challenges extend beyond immediate pedagogical concerns, impacting the development of environmentally literate citizens. The inadequate understanding of EE/ESD among teachers (Sikhosana, 2019) and the lack of environmental literacy (Masemene & Msezane, 2021) highlight the critical need to address these challenges within the curriculum. Bridging these gaps becomes not only an educational imperative but also a key factor in nurturing environmentally literate citizens who can actively contribute to sustainable development.

3.2. Professional Development for EE/ESD Integration

Amid the above challenges, the role of professional development (PD) emerges as a linchpin for addressing the multifaceted obstacles encountered by teachers in integrating EE/ESD. Antley (2020) defines PD as continuous education and career training post-entry into the teaching profession, emphasizing its significance in cultivating new abilities, staying current with trends, and advancing careers. Innovative strategies within PD programs, as highlighted by Darling-Hammond et al., (2017) transcend traditional models, incorporating collaborative approaches like lesson study and professional learning communities (PLCs). An exemplary PLC, Fundisa for Change, empowers teachers in environmental and sustainable education (Thenga et al., 2020) showcasing a departure from conventional workshops. Specific training programs, characterized as Teacher Professional Development (TPD), become instrumental in enhancing subject-matter knowledge and teaching practices (Thenga et al., 2020; Nkhahle, 2021). The discussion contextualizes these PD programs within the South African landscape, recognizing historical challenges and the need for targeted in-service teacher training (Mestry et al., 2009; Dada et al., 2009).

Simultaneously, the integration of EE/ESD into the Life Science curriculum involves the crucial role of Life Science subject advisors. these advisors, as defined by Stephen (2018) and Sithole (2020) are subject specialists situated in district or circuit offices, tasked with facilitating curriculum implementation, improving the teaching environment, and providing leadership in curriculum development and policies at the school level. Drawing from these definitions, a Life Science subject advisor is characterized as a specialist specifically focused on facilitating Life Science curriculum implementation and enhancing teaching and learning processes. According to the Educational Labour Relations Council (ELRC) collective agreement (2017) subject advisors, including those for Life Science, are mandated to interpret, monitor, and

implement policies in schools, providing crucial support and development to teachers. The Department of Basic Education (DBE) further highlights the role of subject advisors, emphasizing their responsibility to support curriculum implementation and ensure quality teaching and learning, including the integration of EE/ESD into the Life Science curriculum.

The role of the Life Science subject advisor extends beyond policy interpretation, monitoring, and implementation. They actively assist teachers in incorporating EE/ESD into the curriculum by offering guidance, facilitating workshops, and establishing professional learning communities (PLCs). The subject advisor's involvement in interpreting environmental policies ensures that teachers effectively integrate EE/ESD content into their lessons, addressing a significant challenge identified in the literature. Through professional development workshops, subject advisors help teachers develop pedagogical content knowledge (PCK) related to EE/ESD, fostering discussions and guiding the integration of new technologies for more engaging and effective teaching. In essence, Life Science subject advisors emerge as indispensable figures, playing a pivotal role in bridging gaps and forming a comprehensive framework that overcomes challenges and facilitates the successful integration of EE/ESD into Life Science education.

4. Methodology:

This study employed a qualitative research approach within an interpretivist paradigm to investigate the behaviour and attitudes of Life Science teachers and subject advisors regarding the integration of EE/ESD into the Life Science curriculum. Grounded in the interpretive paradigm, the study aimed to comprehend the participants' experiences and perspectives on how they integrate or support the integration of EE/ESD into the Life Science curriculum (Cohen et al., 2018). Adopting an explorative multiple case-study design, the research focused on exploring the pedagogical content knowledge (PCK) of Life Science teachers, examining how professional development supports this knowledge, and subsequently enhances the integration of EE/ESD into the Life Science curriculum (Yin, 2017). Purposive sampling was employed to select four schools from the Vhembe East District, each contributing one Grade 11 Life Sciences teacher, and three subject advisors, with data collected through document analysis, semi-structured interviews, and participant observation.

Data triangulation was emphasized, combining document analysis, one-on-one semi-structured interviews, and participant observation to provide a comprehensive understanding of the research topic (Creswell, 2015). For this paper data was I present data collected from interviews only. Thematic data analysis, following Braun and Clarke (2006) framework, systematically organized and analyzed the extensive dataset, comprising official documents such as the Curriculum and Assessment Policy Statement (CAPS) document, Annual Teaching Plans (ATPs), and textbooks, alongside insights

obtained from interviews and participant observation. Rigor and trustworthiness were maintained through member checking, ensuring the accuracy of transcriptions and consistency across data collection methods, interview guides, and observation tools. Ethical considerations were diligently addressed, obtaining clearance from the University of South Africa's College of Education Ethics Review Committee and securing permission from relevant educational authorities, district managers, principals, subject advisors, and teachers. Pseudonyms were employed to safeguard participant confidentiality, reinforcing the credibility and conformability of the study (Daniel, 2019).

5. Results

In this section we present the findings of the study. The findings are presented according to the themes that emerged from the analysis:

- The challenges faced by teachers in integrating EE/ESD into the Life Science curriculum.
- The professional development mechanisms for integrating EE/ESD into the Life Science curriculum.

5.1. Challenges faced by teachers in integrating EE/ESD into the Life Science curriculum

These two sub-themes are curriculum and pedagogical challenges and timing and support issues. The findings of these sub-themes emerged from interviews with the Life Science teachers and the subject advisors which is represented below:

- curriculum and pedagogical challenges,
- support related challenges.

5.1.1. Curriculum and pedagogical challenges

Time Constraints and Curriculum Challenges

Teachers and subject advisors indicated that the integration of EE/ESD into the Life Science curriculum is fuul with notable challenges, primarily centered around time constraints. These challenges are hindering successful integration of EE/ESD into Life Science lessons Mr. Sabawa who is a Life Science teacher succinctly captures the primary challenge, stating:

> *"The challenge here is time..."*

He suggests that establishing a standalone subject for environmental sciences could be more conducive to overcoming these time limitations:

> *"I think that time is not conducive... if we do have another subject that deals with environmental sciences, maybe if it is called environmental sciences even at our level, at the high school level, it is going to be better."*

Mr. Makhokha who is also a Life Science also elaborates on the challenge of teaching complex concepts within limited class time:

> *"So, the other challenge, as I have said, is that there are other concepts that you cannot teach in class, and we cannot teach outside of the school environment; we just have to explain them, like eutrophication, or use the projector because we do not have enough time to cover such concepts."*

Mr. Joseph, the subject advisor, highlights the impact of the timing of environmental studies, noting that it occurs towards the end of the year when there is minimal learning motivation:

> *"First, one of the main challenges that I have observed is the timing to the topic/strand of Environmental studies. Because it comes last towards the end of the year, and towards the end of the year there is no learning, to be honest with you."*

The above findings reveal a consistent and pervasive struggle with time constraints, influencing the depth of coverage, teaching methodologies, and learner engagement in the integration of EE/ESD into the Life Science curriculum. perspective from participants highlights the broader implications of timing on the entire teaching and learning process, calling attention to the need for a strategic reconsideration of the temporal aspects of curriculum implementation.

5.1.2 Pedagogical Challenges

Pedagogical challenges are prominently identified in the integration of EE/ESD into the Life Science curriculum. Subject advisors in this study express concerns about the theoretical orientation of teachers newly introduced to teaching Life Sciences. Mr Shonisani a Life Science subject advisor explained that these teachers lack practical experience, he said that:

> *"Unfortunately, the teachers who are introduced now to teaching this Life Sciences are lacking the practical experience of the subject; they are too theoretical."*

Mr. Shonisani further highlights a broader issue of EE/ESD being taught in isolation from real-life situations, stating:

> *"So there are a lot of challenges because these people teach this topic in isolation from the real situation that the topic has to address."*

This isolation raises concerns about the effectiveness of the teaching approach, suggesting that a more integrated and contextually relevant method could enhance the learning experience.

Mr. Joseph who is also as subject advisor sheds light on specific challenges faced by teachers, emphasizing on the interdisciplinary nature of environmental studies with other subjects. He explained that teachers who don't have a background of subjects relate

to environmental studies have challenges in integrating EEE/ESD in Life Science curriculum:

> *"We had some challenges about how to teach this topic, especially from teachers who did not study geography. Because these environmental studies integrate with geography, so most teachers who did not do geography use to have challenges."*

The above findings highlight the need for a more experiential, integrated, and interdisciplinary approach to teaching EE/ESD in the Life Science curriculum. The emphasis on practical experience, and contextual relevance, calls for targeted interventions in teacher training programs to address these specific pedagogical gaps.

Exam-Oriented Teaching

During the interviews, the challenge of exam-oriented teaching emerges as a significant obstacle in the integration of EE/ESD into the Life Science curriculum. Mr. Nkhumeleni, a Life Science teacher candidly acknowledges the prioritization of exam results over environmental knowledge, stating:

"To tell you the truth, we teach learners to focus on obtaining good results or passing."

This admission highlights the prevailing emphasis on achieving academic success rather than fostering a genuine understanding of environmental issues among learners. Mrs. Mususumeli who is also a Life Science teacher further highlights the impact of exam-oriented teaching, noting:

> *"The challenge is that we are teaching them to pass."*

Despite recognizing the importance of application in learning objectives, she points out the inherent conflict with exam-focused objectives:

> *"Once they learn, the aim is that they know. We have learning objectives, and one of the objectives is application, so one of the reasons for teaching is that learners should be able to apply their knowledge."*

This tension between encouraging application and the pressure to prioritize exam outcomes poses a significant challenge for teachers. Mr. Sabawa a Life Science teacher further emphasizes the prevailing focus on exam results over environmental concerns, stating,

> *"Most people do not care about the environment. Because the main aim of these learners at school, even the department in itself is encouraging us that learners must pass."*

The above findings highlight the broader systemic pressure on teachers to prioritize exam results, potentially undermining the broader goals of EE/ESD of producing EE/ESD literate leaners. The findings above shows that the pervasive influence of exam-oriented teaching poses a substantial barrier to the holistic integration of EE/ESD into the Life Science curriculum.

5.1.3. Support Related Challenges

Lack of Financial Support for School Trips

During the interview, one of the formidable challenges hindering effective integration of EE/ESD into Life Science curriculum was lack of financial support for school trips. Mr. Nkhumeleni who is a Life Science teacher shares concerns about the lack of financial support for school trips, noting that principals often perceive such excursions as time-wasting and are reluctant to allocate funds. Despite recognizing the importance of taking learners outside the classroom for environmental awareness, financial challenges hinder these efforts, he said that:

> *"Everywhere I have ever taught, the principals are not willing to assist us with funds specifically related to the school trips as such, it becomes hard for me as a teacher to organize school trips for Life Science learners to go and teach them outside the classroom. But I believe that is one way we can make learners aware of the environmental impacts".*

Mr. Joseph who is a subject advisor also expands on the financial challenges, pointing out a skewed prioritization of sports and entertainment trips over educational excursions. He observes a lack of emphasis on environmental education:

> *"I do not know if it's ignorance or is it our education that makes us be ignorant because we do not really go deep to the level of having environmental excursions/trips. the only excursions are soccer trips, they just call it educational tours but without any questioner or anything pertaining to leaning. its like we are living in a world where people love entertainment and dancing, that's where you find them happy. But if we were also investing on having environmental excursions is where we can pick up a lot of things".*

Another subject advisor, Mr. Shonisani suggests a potential solution to the financial constraints, emphasizing the need to channel funds from the Department of Basic Education (DBE) to schools more effectively:

> *"So, the problem is to direct the funds in the right direction. So, if maybe the school managers can channel money yearly according to the needs of a particular subject, say this year I am focusing on geography and next year I am focusing on Life Sciences, after 5 years each subject can have the necessary resources".*

The findings above highlight that lack of financial support for school trips is a significant impediment to providing learners with valuable, real-world experiences that

complement the theoretical aspects of environmental education. The participants' experiences collectively emphasize the need for a revaluation of budgetary priorities at both the school and departmental levels. Adequate financial support is crucial to facilitating hands-on learning experiences that enhance learners' understanding of environmental concepts and foster a deeper connection to the subject matter.

5.1.4. Lack of Support from Subject Advisors and the Department of Basic Education

During the interviews, teachers express that there is lack of support from subject advisors and the DBE and this emerges as a critical challenge in the effective implementation of EE/ESD in the Life Science curriculum. Mr. Sabawa expresses disappointment, highlighting the general and inadequate nature of support provided by subject advisors. When asked if subject advisors support him to integrate EE/ESD into his lesson he replied:

> *"No, there is no support. They will just come and generalize. Their support is general. They do generalize, but mostly these are natural scientists or what? Or maybe environmental studies. Most of them do not include it."*

Mr. Nkhumeleni echoes the sentiment of inadequate support from subject advisors, emphasizing their preoccupation with learner performance rather than assisting teachers in improving their teaching methods:

> *"No, there is no support from them; they will just come and tell you that what you did is not correct or is not what was required. They only worry about the performance of the learners."*

Mr. Makhokha adds to this narrative, expressing a lack of support from subject advisors over his nine years of teaching Life Sciences, particularly in the critical area of environmental studies:

> *"So, in terms of support from the subject advisors, I haven't received any support in my nine years of teaching Life Sciences. I have never received any support about how to teach environmental studies."*

Mrs. Mususumeli, also expressed that there is lack of support from subject advisors and the DBE. She mentioned that subject advisors do not come for grade 11 and only provide support for grade 12. When asked if subject advisors supported her to teach EE/ESD topics, she stated that:

> *"Not on this topic. They support grade 12, not grade 11. In grade 11, they just come and say the learners are failing".*

Mrs Mususmeli also mentioned that there is no support for grade 11, leaners but subject advisor's support is targeted on grade 12 leaners. When asked if subject advisors her in integrating EE/ESD in grade 11, she said that:

> "*No, they do not come for grade 11; they just generalize. But in grade 12, I remember last term they did item analysis and found topics that were difficult for learners, then they came and helped us learn how to teach such topics. In grade 11, they do not come. In grade 12, I remember attending a workshop where they also covered related aspects; they taught us about the content that learners were failing, but they didn't do this in grades 11 or 10"*

Mrs Rose, the subject advisor indicated that they do visit schools however, she basically focusses on leaners books to check for assessment. She stated:

> *"Basically, what we do when we visit, because usually, this is done during school support visits most of the time. So, what we do is that when we arrive at the school, I will ask for the documents like CAPS, ATPs, the exam guidelines, and then also ask for the learners book to check the assessments. So based on the questions that are used in the assessment, we can check whether the questions that are used address the aspects that are indicated in the documents that I have indicated, like the ATP and the exam guidelines".*

Furthermore, Mr Joseph who is also a subject advisor also mentioned that they do not support grade 10 and grade 11 because as subject advisors they are grade 12 oriented. He said:

> *"The issue of support in the department, is difficult, but because it is in grade 11, we do not really focus on grade 11 for support and you find that the topic is not in grade 12 formal tasks, you might just find that sometimes in June exam we put it but aaaaah. What I can say is that supports for internal grade, grade 10 and 11 is limited because as subject advisors is like we are grade 12 orientated. We mainly focus in grade 12 exam results".*

The finding above shows a pervasive challenge in integrating EE/ESD into the Life Science curriculum due to a lack of support from subject advisors and the Department of Basic Education (DBE). Teachers express dissatisfaction with the general and inadequate nature of support, emphasizing a systemic gap in addressing the specific needs associated with EE/ESD integration. Subject advisors acknowledge a grade 12-oriented focus, limiting support for lower grades and revealing a potential misalignment in priorities.

5.1.5. Lack of Support from School and Colleagues

During the interviews, when teachers were asked about support they receive from school management and colleagues in integrating EE/ESD into their lesson, they shared different perspectives. Mr. Nkhumeleni's reflections on the support landscape reveal a

profound sense of isolation and lack of support. He laments the prevailing mindset among colleagues, where teaching responsibilities are considered individual challenges, stating that:

> *"There is no support from my colleagues. I am saying this because if you are teaching Life Science in grade 11, everyone believes that it is your duty alone to teach that subject, and they offer no help. I remember asking for assistance on one of the topics that gives me headaches. I was told that it is my subject and I need to figure out a way to know how to teach each topic".*

However, another teacher, Mrs. Mususumeli experiences a more nuanced form of support from colleagues in other subjects, particularly agriculture and geography.

> *"I do receive content support from other subject teachers, such as agriculture and geography teachers, but unfortunately, one teacher retired, but there is no support from the school management, only district level; they do send question papers and notes at the district level."*

The findings above show that teachers vary in the support they receive for integrating EE/ESD, with one expressing isolation due to a lack of assistance from colleagues and another experiencing nuanced support from colleagues in other subjects. Concerns arise about the sustainability of collaboration following the retirement of a supporting teacher, highlighting potential challenges in maintaining such efforts. Limited support from school management is evident, primarily received at the district level.

5.2. Professional Development Mechanisms for Integrating EE/ESD into the Life Science Curriculum

Need for Professional Development

During the interviews, participants indicated that there are no professional development mechanisms to support the integration of EE/ESD into Life Science curriculum and hence there is a need for professional development. When asked if he has participated in professional development programs that were aimed at developing teachers on how to teach EE/ESD-related topics Mr Sabawa replied that:

> *"I have attended many workshops, but not with regard to environmental education specifically. They used to generalize."*

Similarly, Mr. Nkhumenleni's experience reveals a notable gap in his participation in workshops dedicated to Life Sciences grade 11:

> *"I do not remember going to any workshop and being workshopped on how I should teach, it being any topic in Life Sciences grade 11, If you can check this year, I have never attended any workshop or meeting for Life since grade 11. I think the workshops that have been held this year are only for grade 12, not grades 10 and 11".*

However, Mr Nkhumeleni expressed desire for workshops to acquire new strategies and approaches emphasizes the potential benefits:

> *"Workshops are helpful, and I believe I can learn a lot from them because I can also learn new strategies and ways of approaching these topics that can be helpful to me and my learners as well."*

Mrs Mususumeli indicated that:

> "*I have attended some workshops for grade 12 and not for grade 11. It was just that it was talking about life processes".*

Mr Makhokha also said that he does not remember attending any workshops or training which is related to EE/ESD topics. He Said:

> *"I do not remember attending or having any professional development on environmental studies; in all the works that I have attended, I do not remember one that was focused on the professional development of teaching environmental education".*

He further said:

> *"Currently, most of the Life Sciences workshops that I have attended have focused on the annual teaching plan, how the strands are structured, and how we should teach them. In their order, they are not going into details on the how part but just showing us the order in which we need to teach the strands. Then the second one, I think, was an analysis of the results. They were talking about the performance of the learners. Those are the workshops that I have attended; they focused on those themes".*

When asked the grade he replied:

> *"No, this was only concerning grade 12. They have not done anything concerning grades 10 and 11. The focus is on grade 12 only".*

The findings above reveal a notable absence of professional development mechanisms supporting the integration of EE/ESD into the Life Science curriculum. Teachers expressed a generalization in workshops, lacking specific focus on environmental education. The desire for workshops to acquire new strategies and approaches was emphasized. The predominant focus on grade 12 in workshops raises concerns about the neglect of professional development for grades 10 and 11.

Professional Development Opportunities

The study sheds light on the existing landscape of professional development opportunities for Life Science teachers in the context of integrating EE/ESD into the curriculum. Mr. Joseph who is a subject advisor acknowledges the existence of professional development opportunities provided by the DBE for Life Science teachers. He said that:

> *"With professional development opportunities, and workshops we focus on grade 12 teachers, we do not have enough capacity to have such for grade 10 and 11. If you go to lower grades then you have enough capacity. And also if you check our schools, some are small schools, you cannot call one the teacher for grade 10 then again call the same teacher for grade 11 and 12. Unless if you are going to workshop them on content, but on how to teach (pedagogy) the principles applies throughout".*

He also said:

> *"So, I want to come back to the issue that the professional development are there but the facilitators sometimes do not have enough knowledge about that or it might be that teachers are not given enough time to go and attend such professional development opportunities".*

However, he mentions that these opportunities mainly focus on grade 12 teachers and there is limited capacity for workshops for grade 10 and 11:

> *"Since this topic is not in grade 12, and our workshops mainly focus on grade 12 we do not have professional development opportunities for this topic but we do have for topics covered in grade 12".*

Mr. Shonisani's account provides a contrasting perspective, emphasizing the abundance of workshops and support in the Vhembe region. His active efforts to involve teachers in research and orientation initiatives showcase a regional commitment to enhancing teacher competence. He said:

> *"Eeeh, we cannot say it is there; we cannot say it is not there. It depends on the area because, you know the problem is that we are supposed to work with them based on their needs, and unfortunately, most of the teachers feel that once it is established that there is a gap in this area, they will be looked down upon."*

Mrs. Rose's perspective introduces the idea that higher learning institutions might offer avenues for professional development, albeit with a lack of specific awareness regarding DBE-provided opportunities for Life Science teachers. She emphasizes the importance of collaborative efforts among colleagues to improve teaching methodologies, suggesting a recognition that professional development can be sought through collective endeavors among teachers:

> *"I am not aware of that in the department, but I know that in the teaching of higher learning, when we encourage them to register, there are instances where*

they can improve. But as for the department, that is not something I am aware of, because most of the time we sit down as colleagues to say how we can improve the teaching of maybe environmental studies and how we can assist teachers. Besides that, I do not know about any programs".

The findings above unveil varied perspectives on professional development opportunities for Life Science teachers integrating EE/ESD. While one perspective acknowledges existing opportunities with a focus on grade 12 due to capacity constraints, another emphasizes abundant workshops in a specific region, highlighting teachers' reluctance. A mention of potential gaps in facilitators' knowledge and teachers' time constraints is noted. Additionally, the idea that higher learning institutions might offer avenues for professional development is introduced, indicating varying degrees of awareness and challenges in accessing such opportunities.

6. Discussion

The challenges faced by Life Science teachers in integrating EE/ESD into the curriculum are deeply rooted in a global context, as highlighted by Marpa (2020) and echoed in diverse educational landscapes, from India and Thailand to Nigeria. The recurrent theme of time constraints, emphasized by Mr. Sabawa and Mrs. Musumeli, aligns with Fullan (2007) 's educational change theory which highlights the importance of addressing timing challenges and setting clear goals for successful educational change. The complexities of curriculum coverage constraints in the South African CAPS document, coupled with a lack of integration guidelines, mirror the challenges outlined by Tsotetsi (2021) and Sikhosana (2019) pointing towards a broader need for systemic changes in educational structures.

Pedagogical challenges, such as inadequate teacher preparation and reluctance to incorporate real-life examples, resonate with the literature emphasizing the imperative for professional development to enhance teachers' capacity and overcome implementation hurdles. The inadequacy of teacher knowledge, skills, and technological resources, as highlighted by Marpa (2020) highlights the critical need for ongoing professional development initiatives. This aligns with Antley (2020) definition of professional development as continuous education post-entry into the teaching profession, emphasizing its role in cultivating new abilities and advancing careers.

The prevailing exam-oriented teaching approach, prioritizing results over holistic learning experiences, resonates with Munasi and Madikizela-Madiya (2020) observations and aligns with Fullan's theory on the characteristics of educational change and factors affecting institutionalization. The study suggests that this approach may hinder learners' comprehensive development and application of EE/ESD knowledge in daily life, emphasizing the need for a shift in pedagogical approaches.

The identified challenges in integrating EE/ESD into the Life Science curriculum point to systemic issues that hinder effective environmental education. Financial constraints for school trips highlight the need for a revaluation of budget priorities at both school and departmental levels, aligning with Fullan's emphasis on the importance of support structures during educational change (Fullan, 2007). Lack of support from subject advisors and the DBE reveals a systemic gap in addressing the specific needs associated with EE/ESD integration, emphasizing the pivotal role of subject advisors, as defined by Stephen (2018) and Sithole (2020), in interpreting environmental policies and actively assisting teachers in curriculum incorporation. The absence of integration guidelines within the curriculum, highlighted by Bopape et al., (2021), highlights the challenges faced by teachers and emphasizes the necessity for comprehensive support structures. Furthermore, the lack of support from school management and colleagues highlights the need for a shift in the prevailing mindset among teachers, promoting a more collaborative approach to curriculum implementation. Addressing these challenges requires systemic changes in budget allocation, support structures, and professional development initiatives to foster effective EE/ESD integration into the Life Science curriculum.

Comparatively analyzing professional development mechanisms reveals persistent challenges in aligning opportunities with the specific needs of teachers aiming to integrate EE/ESD into their lessons. The dissatisfaction expressed by Mr. Sabawa with existing workshops emphasizes the need for more personalized and dynamic approaches, echoing Bandura (1986) Social Learning Theory. The absence of grade-specific workshops poses a significant challenge, indicating the necessity for ongoing, accessible, and tailored initiatives. The study highlights the dynamic nature of teachers' learning journeys, emphasizing the critical need for targeted initiatives that consider the challenges faced at different career stages.

The demand for inclusive and well-tailored professional development opportunities, especially for teachers in grades 10 and 11, highlighted in the literature, aligns with Bandura's theory, emphasizing the necessity for comprehensive and flexible professional development frameworks (Bandura, 1986). The study highlights the importance of ongoing, targeted, and inclusive professional development mechanisms to empower Life Science teachers effectively. The findings emphasize the imperative role of personalized, dynamic, and grade-specific initiatives in addressing the multifaceted challenges encountered during the integration of EE/ESD into the Life Science curriculum. The study contributes to the ongoing discourse by highlighting the need for systemic changes, comprehensive support structures, and innovative professional development approaches to foster successful integration.

In this context, the challenges identified in accessing suitable professional development for EE/ESD integration underline the broader need for adaptive and tailored initiatives. The dissatisfaction expressed by teachers aligns with Bandura's

theory, emphasizing the significance of personalized approaches in effective professional development. The absence of grade-specific workshops points to a crucial gap that requires ongoing and accessible initiatives. The study not only reveals challenges in accessing suitable opportunities but also stresses the dynamic nature of teachers' learning needs throughout their careers. The call for inclusive and well-tailored professional development resonates with the broader literature, emphasizing the imperative role of such initiatives in empowering Life Science teachers effectively. Ultimately, the findings contribute to the discourse on the necessity for systemic changes, comprehensive support structures, and innovative approaches to enhance successful EE/ESD integration in the Life Science curriculum.

7. Conclusions

In conclusion, addressing the challenges associated with the integration of EE/ESD into the Life Science curriculum necessitates a multifaceted approach, emphasizing targeted professional development, a shift in institutional culture, and the establishment of comprehensive support structures. This strategy aligns with both Fullan's theory of successful educational change and Bandura's Social Learning Theory, acknowledging the dynamic nature of teachers' learning journeys. The study's insights contribute significantly to the ongoing discourse, stressing the importance of systemic changes to facilitate the effective implementation of EE/ESD. Policymakers and education stakeholders should incorporate these findings when designing context-specific professional development frameworks, emphasizing ongoing, inclusive initiatives tailored to empower Life Science teachers with the knowledge and skills essential for successful integration.

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