



Integration of Education for Sustainable Development in teacher education, Life Sciences classroom practices, during the Covid pandemic

SITHABILE NDELU

1434602

Supervisor: Dr. P. Mabenge

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School of Education

University of the Witwatersrand

Johannesburg, South Africa

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Abstract

Education for Sustainable Development (ESD) has been identified as a key vehicle for achieving the Sustainable Development Goals (SDGs), and teachers have a critical role to play in promoting ESD. This study investigates the integration of ESD in teacher education, specifically in the Life Sciences classroom during the Covid-19 pandemic. The study utilised qualitative research methods, including interviews with two Life Sciences teacher educators and open-ended questionnaires sent to ten prospective teachers. Data was also obtained from the teacher educators' course outlines and the Life Sciences Curriculum Assessment Policy (CAPS). The findings suggest that ESD integration is largely dependent on the teacher educator's agency, as the teacher training institution did not provide adequate institutional and pedagogical guidance for integrating ESD into teacher practices. The Covid-19 pandemic led to online learning, which restricted the practical application of ESD competencies in real-life change projects.

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Chapter 1-Introduction

This chapter explores the fundamental aspects of the study, starting with an introduction that lays the foundation for this study. The introduction includes several crucial components required for understanding the background and objective of this investigation. First, it presents an outline of the background, providing insight into the factors that prompted the investigation. Following that, the problem statement is articulated to identify the issues that the study intends to answer. In addition, the rationale behind the study is explained, emphasizing the significance of the study. The aim of the study is then stated, outlining the fundamental objective that this research seeks to achieve. Finally, the introduction chapter outlines the research questions that guide and frame the investigation.

1.1 Introduction

The constantly advancing and developing world is resulting in the depletion of natural resources. Pollution, climate change and exploitation of natural resources has been a critical concern. Sustainable development is a key to balancing the modern world development and maintaining natural resources for the upcoming generation. Sustainable development can also be defined as balancing the social, economic and natural resources (Prifti and Zenelaj, 2013).

In the call to achieve sustainable development, the United Nations (UN) formed 17 Sustainable Development Goals (17 SDGs). These goals include: “(1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (6) Clean Water and Sanitation, (7) Affordable and Clean Energy, (8) Decent Work and Economic Growth, (9) Industry, Innovation and Infrastructure, (10) Reduced Inequality, (11) Sustainable cities and communities, (12) Responsible consumption and production, (13) Climate action, (14) Life Below water, (15) Life on land, (16) Peace and Justice Strong Institutions and lastly (17) Partnership to achieve the goal” (United Nations, 2015). The above goals substantially reflect that sustainable development does not only impact the environment, but they also affect the economic and social spheres. These goals were composed by leaders from 193 countries who were not just theoretically exposed to the issues but experienced them in their own countries. The goals are the answer to a universal call to combat poverty and also to protect the earth and allow people to live in peace (United Nations, 2015).

The 17 SDGs launched by the United Nations in 2015 were a major event that united the world through a shared agenda (Hassani, Huang, MacFeely and Entezarian, 2021). However, it has been 9 years since the 2030 SDGs were drawn but according to the progress report, it is questionable that all the 17 SDGs will be achieved by the year 2030 (Fu, Wang, Zhang, Hou and Li, 2019). There are only 6 years remaining for the 2030 deadline. The time limitation sparks a sense of urgency to develop strategies that will assist in achieving the 2030 goal (Fu et al, 2019).

ESD was placed at the centre of the 2030 SDGs and recognised as a critical component of quality education and a critical enabler of SD. The United Nations' 2030 Agenda for Sustainable Development, adopted in 2015, clearly illustrates this goal and the significance of adequate educational response. Quality education is stated as a separate Sustainable Development Goal (SDG No. 4), and Target 4.7 on education covers ESD (Glavič, 2020).

The goal of education for sustainable development (ESD) is to provide people and societies with the abilities, principles, and information required to promote sustainable development. This strategy emphasizes how sustainable development principles can be integrated into the classroom to promote responsible behaviour, critical thinking, and active participation. ESD discusses important sustainability-related concerns and emphasises the significance of achieving the Sustainable Development Goals (SDGs).

The 17 interrelated SDGs listed in Agenda 2030 are perfectly in line with the fundamental principles of ESD. These objectives address social, economic, and environmental issues on a worldwide scale. The SDGs aim to bring about good change and guarantee a prosperous, and sustainable future for all by the year 2030 through collaborative efforts.

In this light, Education for Sustainable Development (ESD), particularly in teacher education, maybe the solution and a strategy that can be used to foster the goal taking into consideration the notion of 'Sustainability starts with Teachers' Lotz-Sisitka, Tshiningayamwe, and Urenje (2017). However, the notion to advocate and increase momentum in integrating ESD in classrooms was disrupted by the Covid-19 pandemic and all the other variants have also become a hindrance in realising the 2030 goal

(Müller, et.al, 2022.). This has brought a global set-back in the economic, social and environmental sustainability and its awareness. Nevertheless, there are already debates amongst research scientists of covid-19 becoming endemic, which means, we will have to get accustomed to it and as such. The world needs to adjust to the new normal way of doing things. Taking this into consideration, it was therefore important to investigate the integration of ESD in teacher education in the light of the covid pandemic era.

1.2 Background of the study

As a result of answering to sustainable development the United Nations, and the body under it, agreed in to launching “Education for sustainable development” (ESD) (Boeve-de Pauw, Gericke, Olsson and Berglund, 2015). “Education for Sustainable Development (ESD) has been viewed as education that helps people develop the attitude, skills, and knowledge to make well-informed decisions for the benefit of the present and future generations” (Anyolo, Kärkkäinen and Keinonen, 2018, p64). ESD aims to provide quality education that promotes thoughtful choices and values (Anyolo, Kärkkäinen and Keinonen, 2018).

In this study, education can be defined as formal schooling of learners in a classroom setting. It also defines teacher training and learning in a university setting. Education is recognised as a vital contributor in society. Education has the power to transform human behaviour through promoting accountability. Accountability enables individuals to make sustainable choices. ESD's main concern is about how education should teach people to live in the world; it involves thinking outside the textbook and classroom context, without destroying the environment for the future generation (Yasin and Rahman, 2011).

Classroom practices refer to the various methods, strategies, and activities that teachers use to facilitate learning in the classroom. These practices are designed to create an effective learning environment, engaging students and achieving educational objectives (Tomlinson, 2001). In the context of ESD, classroom practices involve the adapting teaching approaches, assessment strategies, and organisational methods to integrate sustainability concepts into the curriculum (Eilks, 2015; UNESCO, 2017; Tsakeni, 2018).

Didham and Ofei-Manu (2015) emphasizes that education should not be considered as a magical cure capable of quickly curing all world concerns. Instead, it should be viewed as a means of facilitating a deep and harmonious human development, which will eventually lead to the reduction of poverty, ignorance, war, and oppression. Furthermore, there is a notable correlation: for every additional year of education obtained, the GDP increases. It is critical to emphasize that this positive influence on economic growth is more pronounced when the emphasis is on education quality rather than simply expanding schooling duration (Didham and Ofei-Manu, 2015).

A crucial observation was discovered in a study undertaken by the EFA Global Monitoring Report (2011:8). It was projected that ensuring that all children in underdeveloped nations learn basic reading abilities might reduce world poverty by up to 12%. This emphasizes the critical role that education plays in poverty alleviation. Education has a significant effect that goes beyond poverty alleviation. It has been shown to improve health outcomes and is closely linked to political stability (EFA Global Monitoring Report, 2011; Center for Global Development, 2006). As a result, education is a powerful tool for implementing sustainable human development, offering several positive outcomes across the board.

Education is a critical vehicle for moving us toward sustainable development. It has the ability to balance the tensions between economic, social, and environmental development, allowing sustainable living (Didham and Ofei-Manu, 2015). According to Didham and Ofei-Manu (2015), the success of the Sustainable Development Goals (SDGs) is dependent on individuals' commitment to lifelong learning, the acquisition of new knowledge, and the adoption of values that empower them to address global challenges effectively.

Education for Sustainable Development (ESD) emerges as a critical strategy for achieving the SDGs. ESD encourages educational innovations that foster students' lifelong, collaborative, critical, and holistic learning experiences, thus contributing to the achievement of quality education. Quality education goes beyond simply transmitting knowledge; it is concerned with the relevance of knowledge in today's world and how it impacts individuals' decisions. Furthermore, effective education for sustainable development introduces in individuals a deep sense of duty as global

citizens, inspiring them to actively contribute to the pursuit of a sustainable future (Buckler and Creech, 2014).

Education for Sustainable Development (ESD) involves interlinking the social, economic, and environmental knowledge of sustainable development (Symons, 2008). The social pillar of ESD involves educating citizens. This pillar entails recognising the role of institutions and their impact on social change and educating individuals to resolve issues (Pigozzi, 2006). ESD promotes skills that fosters creative thinking to address the economic, social and environmental issues surrounding communities (Samuelsson and Kaga, 2008).

Teachers and teacher training institutions play a key role to promote ESD to students (McKeown and Hopkins, 2014). Teachers have direct access to students in the classroom and they could guide students to live sustainable lives (Esa, 2010). Teachers are able to transfer ESD themes to produce students who have the ability to bring social change (Kalsoom, Qureshi and Khanam, 2019). Studies have shown that integrating ESD into teacher education has a positive effect on promoting sustainable development awareness (Evans et al., 2020). ESD teacher training programs promote quality education at primary and secondary schools (Laurie, Tarumi, McKeown, and Hopkins, 2016). However, according to Atmaca (2017) teachers avoid ESD integration due to a burdensome workload. The research findings of Jumaní and Abbasi (2015), Kawai et al. (2022), and Mandikonza and Kawai (2023) indicate that ESD courses are not explicitly taught in teacher training.

In order to ensure that the above-mentioned conditions are met, a comprehensive curriculum should be introduced to the teachers in training. The teachers should be introduced to curriculum and a pedagogy that will inform individuals on how to live sustainable lives (Yasin and Rahman, 2011). Teacher education should promote critical thinking, inquiry based, interdisciplinary learning that is grounded on the pillars of ESD (Eilks, 2015).

Life Sciences, also known as biological sciences in other countries' curricula, is a discipline that studies life and its surroundings. Based on its fundamental nature and the content information it incorporates, this discipline provides distinctive opportunities to investigate sustainability (Hogan and O'Flaherty, 2021). Life Sciences scientific information and procedures are extensively verified for dependability and validity.

According to Hogan and O'Flaherty (2021), underline the crucial role of preparing children with scientific literacy to foster responsible citizenship. Scientific literacy consists of three components: content knowledge, procedural comprehension, and epistemological awareness. Students gain the ability to engage with socio-scientific issues and make informed decisions through scientific literacy (Liu, Lin, and Tsai, 2011).

Science education is critical to our society's and the planet's well-being. It functions as a catalyst for critical thinking and decision-making skills development, especially within the context of socio-scientific issues. The objective of scientific education is to develop students who are not only critical thinkers but also active knowledgeable citizens capable of making informed decisions. Similarly, (ESD) encourages the development of knowledge, beliefs, and skills that enable learners to make informed decisions, live sustainably, and address both local and global concerns (Hogan and O'Flaherty, 2021).

Thus, integrating ESD into Life Sciences education is an opportunity to produce scientifically literate individuals who are not only knowledgeable in the life sciences but also acquire the skills and values required to contribute to a more sustainable and informed society.

A significant number of biology key ideas are aligned with the Sustainable Development Goals (SDGs). There is a strand known as environmental studies within the Life Sciences Curriculum Assessment Policy Statement (CAPS), which explores into critical themes such as population ecology and the human impact on the environment: current crises (Department of Basic Education, 2011). This strand, along with several other topics within the subject, offers an excellent opportunity to study social, environmental, and economic issues from a scientific standpoint. Furthermore, researchers call for the support of pre-service teachers' in developing links between science and society. This assistance can be provided through teaching techniques that aim to enhance both understanding of sustainable development and scientific literacy (Hogan and O'Flaherty, 2021).

In essence, the Life Sciences curriculum provides a fertile ground for cultivating a scientific understanding of complex real-life issues such as sustainability and societal well-being. Equipping future teachers with the necessary resources and strategies to

bridge the gap between science and society is critical for training students to interact with modern-day issues, which aligns with the SDGs' broader objectives.

Teachers play an essential role in educating learners and shaping the country. If ESD is implemented well, the upcoming learners will grow up to be individuals that are conscious of the environment and well-being of others. This research also explored ESD integration during the Covid pandemic. Covid has caused a negative impediment in the social, economic and environmental progression (UNESCO, 2020; Beasy and Gonzalez, 2021).

The severe acute respiratory coronavirus was first discovered in Wuhan, China. Since then, the virus spread globally, by the 20th of May 2020, 4.8 million people were infected and over 300,000 people lost their lives (Ciotti, Ciccozzi, Terrinoni, Jiang, Wang, and Bernardini, 2020). Currently, there are approximately 704 million cases and a total of 7 million deaths globally. A pandemic status had been declared worldwide and most countries went under lockdown to curb the spread of the virus. Social distancing, wearing masks and frequent sanitization was enforced in order to try and reduce the infection rate. Due to the lockdown and the social distancing restrictions, education institutions were closed. Health and life were a priority as a result teaching and learning was disrupted.

'Approximately 1.6 billion learners, 98% of the world's student population, had their schooling interrupted during the pandemic (UNESCO, 2020, p. 7)' (Taylor, Singh, and Copsey 2020, p.101). Several issues rose as a result of the disruption of teaching and learning for teacher training education. The pandemic has also exposed the limitation in ESD programmes for example 'in India, ESD community-based programmes were disrupted due the Covid cases (Taylor, Singh, and Copsey, 2020). The example has shown that the education system was not ready to deal with such a pandemic. The pandemic has created a need to research ESD integration during this new normal.

The transition to online teaching and learning due to the Covid-19 pandemic restrictions reveals a number of obstacles. Many people had trouble accessing information and communication technology (ICT) infrastructure, and some educators lacked the essential ICT skills (Müller et al., 2022). This digital gap highlighted existing inequities in access to online learning and hindered equal educational distribution.

ESD integration was also challenged by the shift to online education. Traditional face-to-face experiential activities that are essential to ESD have become impossible in the virtual context. Developing sustainable competencies through online instruction proven to be a challenging task. Problem-solving and inquiry-based pedagogies are common in ESD, but many institutions lacked the expertise and experience required to adapt these pedagogical techniques to digital platforms. As a result, several educators moved their focus away from ESD (Müller et al., 2022).

However, the pandemic also prompted positive changes in teaching practices. Some educators embraced an interactive, participatory approach to teaching. Instead of merely delivering content, they assumed the role of facilitators of learning. Studies have shown that this shift toward a more interactive approach enhanced the sustainable consciousness of both preservice teachers and students in online educational settings (Müller et al., 2022; Beasy and Gonzalez, 2021). The COVID-19 pandemic has clearly had a huge impact on many parts of society, including education and teaching methods. Beasy and Gonzalez's (2021) explored at how the pandemic has created chances to rethink how we work, live, and educate, particularly in the context of Education for Sustainable Development (ESD). It emphasizes the significance of technology and alternate educational techniques in adjusting to changing conditions.

Furthermore, ICT was instrumental in creating learner-centred environments that fostered collaboration and deep engagement with content and practical skills (Tshiningayamwe, Silo, and Dirwai, 2020). This learner-centric approach is highly conducive to ESD in cases where resources and expertise permitted.

Despite these opportunities, it is critical to realize that ESD is not a required component of teacher preparation in the majority of nations. Furthermore, having official ESD plans, and worldwide programs does not ensure effective implementation (Müller et al., 2022). This demonstrates the importance of more extensive and systematic efforts to integrate ESD into teacher education programs and ensure its successful implementation at all levels of education.

There has been a considerable gap in research on ESD integration within teacher education institutions, as well as ESD integration during the pandemic and how it

affected ESD integration in teacher education institutions. Thus, this study investigated the ESD integration at teacher education institutions during the covid-19 pandemic.

The study was carried out in a higher education institution. Throughout the study, the university was referred to as a teacher training institution. The lecturers in this study are teacher educators, and they are referred to as such throughout the study. Data was collected during the peak of the covid pandemic in order to investigate the approach utilized to integrate ESD during covid.

1.3 Problem statement.

The Sustainable Development Goals (SDGs) deadline of 2030 is rapidly approaching. However, the world is dealing with an abundance of global crises, including the Covid-19 pandemic, persistent societal issues, and complex geopolitical conflicts. These issues appear to be imposing considerable pressures, potentially slowing progress toward the SDGs and perhaps driving us in the opposite way in certain cases.

While many countries acknowledge the importance of Education for Sustainable Development (ESD), the practical integration of ESD to enhance the quality of education systems remains an understudied area, necessitating further research. Monitoring and evaluating the benefits and achievements of ESD initiatives also exhibit inconsistencies. The alignment of educational institutions with the principles and goals of ESD remains a challenge (Buckler and Creech, 2014).

Moreover, ESD integration within higher education institutions is uneven and lacks standardization. Some institutions adopt proactive approaches to ESD integration, while others depend largely on the initiative of individual teacher educators. Even within a single institution, there can be disparities in the integration of ESD into teacher education programs, if indeed any integration occurs (Mandikonza and Kawai, 2023; Müller et al., 2022).

In the South African context, the Life Sciences Curriculum Assessment Policy Statement (CAPS) covers topics related to sustainability, such as human impact and biodiversity. CAPS' specific aims align with ESD competences. However, the absence of clear educational policies explicitly directing ESD limited its integration even before the covid pandemic. The Minimum Requirements for Teachers Education Qualification

(MRTEQ) mentions competences expected from teachers but offers minimal guidance on ESD (Mandikonza and Kawai, 2023).

The COVID-19 pandemic brought both challenges and opportunities to ESD integration. While there is existing research on ESD, there is a notable gap in studies that specifically investigate the opportunities and challenges associated with ESD integration at the peak of the pandemic. Investigating this aspect can provide valuable insights into how education systems adapted to the unique circumstances of the pandemic and its implications for sustainability education (Beasy and Gonzalez, 2021).

To address this research gap, this study examined how a particular educational institution and teacher educators responded to the obstacles posed by the pandemic while striving to maintain their ESD efforts.

Teachers and teacher education institutes play pivotal roles in ESD, serving as key agents for promoting and nurturing sustainability values. Effective ESD integration into teaching practices relies on thorough preparation and equipping of teachers through teacher education programs. This training is essential for cultivating a future generation that embraces sustainability as a core value.

In the South African context, teacher educators, commonly referred to as lecturers, play a crucial role in shaping educational practices. This study investigates how these teacher educators adapted their ESD practices during the Covid-19 pandemic, as their teaching environment transitioned from physical classrooms to online platforms. This research focused on ESD classroom practices resulting from this shift, specifically examining the teaching approaches, assessment methods, and organizational strategies used to integrate ESD. Additionally, the study explored how prospective teachers perceived and responded to these changes in ESD integration during the pandemic.

1.4 Rationale of the study

The fight towards sustainable development concerns everyone. It is not restricted to nor limited to a specific group. Education plays an essential role in educating individuals about sustainable development. It is essential to investigate Education for Sustainable Development in teacher education Life Sciences classroom practices.

Investigating ESD will assist with assessing the integration of ESD in the curriculum and classroom practices.

The study also investigated ESD during covid times. ESD integration strategies should be rethink in order to find ways to acclimatise the new normal. A mere digitalisation of content will not be sufficient (Taylor, Singh, and Copsey 2020). The catastrophe has affected every sphere of life leading to a re-evaluation of practices and policies. ESD practices and values could be used to rebuild a new post-COVID world (Taylor, Singh, and Copsey 2020) Research is still dearth in the aspect of rethinking ESD in during the Covid pandemic.

The findings will possibly assist relevant stakeholders to identify how ESD is being implemented in schools, if at all. The findings will also assist stakeholders to find out the impact of Covid and ways to rethink ESD implementation in teacher education. Through the findings that were obtained, recommendations were made to enhance the implementation of ESD in teaching and learning and possibly in the training of teachers.

1.5 The aim of study

This research investigated into the epistemological and pedagogical practices of higher education institutions, with a particular emphasis on the presence of Education for Sustainable Development (ESD) in instructional content, teaching techniques, and assessment procedures during the covid pandemic.

In addition, the research investigated the Life Sciences teacher educator's classroom practices to explore how ESD was integrated into their curriculum, particularly in the challenging environment of the COVID-19 pandemic.

1.6 Research question

Main research question

How have teacher educators adapted their online Life Sciences classroom practices to integrate ESD during the Covid pandemic?

Research sub-questions.

1. Which teaching approach, assessment and organisation did teacher educators use to integrate ESD into their classroom practices during the pandemic?

2. How have prospective teachers responded to ESD integration in Life Sciences education during the Covid pandemic?

Chapter Summary

This chapter established a foundation of the background of this study. Chapter one thoroughly analysed crucial components such as the study's background, problem statement, research rationale, purpose, and research questions. Through a thorough exploration of these factors, the study laid the foundation for investigating the integration of Education for Sustainable Development (ESD) into teacher education during the Covid pandemic.

Key words

Sustainable development (SD), Education for Sustainable development (ESD), Life Sciences curriculum, Covid-19 pandemic

Chapter 2 Literature review

Introduction

This chapter explores Sustainable Development and Education for Sustainable Development (ESD). It explores the implication of ESD in educational institutions and pedagogy, examines its integration into South Africa's educational contexts.

Furthermore, it also examines approaches for evaluating ESD implementation, identifies the competencies required for educators to effectively facilitate ESD, and investigates the ESD integration during the COVID-19 epidemic. Lastly, this chapter also establishes the conceptual framework that guides the study.

2.1 Sustainable development

The progression of society and the world has brought about consciousness of our surroundings. The key for making it through this time will be influenced by how we sustain the natural resources, the environment and at the same time developing the well-being and wealth of the population. The pressing issue is how to develop the well-being of the vast population while sustaining the natural environment and resources for the future generation? (Pauw, Gericke, Olsson and Berglund, 2015). This important issue has been constructed to a concept known as sustainable development (SD). Sustainable development means balancing the social, economic, the environment and

natural resources (Prifti and Zenelaj, 2013). Obtaining balance can be identified as a difficult progress. Sustainable development requires drastic changes especially human habit and existing behaviour.

A global agenda titled 'Transforming our World: the 2030 Agenda for Sustainable Development (Sustainable Development Goals)' was adopted in the year 2015, at the 70th United Nation General assembly, by the member states. The 17 SDG goals were introduced to transform the Millennium Development Goals (MDGs), which were also a set of global goals towards sustainability. Progress towards accomplishing MDGs was considerable however it was mostly dependent on certain regions and the country's goal (Sachs, 2012). The lessons learned in MDG implementation have been utilised by the UN members to form the SGDs (United Nations, 2015).

2.2 Sustainable development and Education for Sustainable Development.

UNESCO has been involved with environmental issues and education since the 1940s. The International Union for the Conservation of Nature (IUCN) was the first awareness NGO by the organisation to preserve the environment and the natural resources. UNESCO worked with Sweden in the year 1972 to launch the United Nations Environment Programme (UNEP) (Leicht, Heiss and Byun, 2018). UNESCO AND UNEP led a vision to use education as a vehicle to raise environmental awareness (Leicht, Heiss and Byun, 2018).

These two organisations have led four global conferences on environmental education since 1977. The first conference was held in Tbilisi, Georgia in the year 1977 October, the second "International Strategy for Action in the Field of Environmental Education and Training for the 1990s" was held in Moscow in August 1987. The third conference, "Environment and Society: Education and Public Awareness for Sustainability" was at Thessaloniki, Greece in the year 1997 December. The fourth conference on "Environmental Education towards a Sustainable Future" took place in November 2007, Ahmedabad, India (Leicht, Heiss and Byun, 2018, p 26).

The above conferences emphasised the importance of education in teaching environmental awareness. The first three conferences were mostly concerned about environmental awareness rather than social aspects and economic progress. On the other hand, the fourth conference in India highlighted the importance of education in all three pillars of sustainable development (UNESCO, 2014).

SDGs was adopted in the year 2015 and this led to pivotal discussion that education is a vehicle in attaining sustainable development (UNESCO, 2014). Among the vital elements of sustainable development, education was at the top four after food, water and energy (Leicht, Heiss and Byun, 2018). Education is important for achieving other development goals such as health, gender equality and environmental sustainability (UNESCO, 2014). As a result, Education for Sustainable Development (ESD) was launched as a solution to achieve sustainability. The main objective of ESD is to educate students about sustainability competences and to create individuals that will make sustainable conscious decisions in their everyday lives. This happens through a holistic interdisciplinary perspective of ESD that promotes a learner centred pedagogy (Pauw, Gericke, Olsson and Berglund, 2015).

ESD is identified as a key facilitator of sustainable development goals and a key element of SDG 4 (education). SDG 4 seeks to ensure that all the learners acquire knowledge that is required to promote sustainable development through ESD (United Nations, 2015). The Global Education Monitoring (GEM) report also supported and emphasised the importance of education. The SDGs have 17 targets, and each target involves education: learning, training and awareness of the core sustainable development goal (UNESCO, 2016a).

UNESCO, 2016a, highlighted that each SDG target goal entails education as a critical component (Leicht, Heiss and Byun, 2018). It is important to note that not every form of education promotes sustainable development. Education that only caters for economic development may increase unsustainable production and consumption (Ssossé, Wagner, Hopper, 2021). However, education can be utilised as a vehicle of the SDGs to achieve the 2030 SDG goals.

2.3 Education for Sustainable Development

UNESCO has prioritised Education, as it is a basic human right and a vehicle to drive sustainable development (Leicht, Heiss and Byun, 2018). ESD was constructed to overcome the environmental challenges and other sustainability issues that affect the economy and society. ESD is holistic and it demands transformation in education, including the subject content, learning outcomes, the learning environment and pedagogy (UNESCO, 2014). Education needs to address issues that affect the environment in a local and global context (Leicht, Heiss and Byun, 2018).

The aims of ESD are to prepare the learners for the constantly changing world. The learning outcomes of ESD include collaborative decision-making, critical and systematic thinking, creative thinking and taking responsibility for individual decisions that impact the environment (UNESCO, 2014a, 2014b, 2014c). ESD pedagogy involves an interactive learner centred learning that fosters critical thinking and transformative learning which will develop the values for a sustainable future (Leicht, Heiss and Byun, 2018). The traditional teacher centred lessons are no longer adequate as ESD is not restricted to schools but extends to the formal and informal context as education is a life-long process (UNESCO, 2014). It is essential for the work environment to be built upon the philosophy of sustainable development (Leicht, Heiss and Byun, 2018).

ESD has five priority action areas for ESD which include: “advancing policy; transforming learning and training environments; building capacities of educators and trainers; empowering and mobilizing youth; and accelerating sustainable solutions at local level” (Leicht, Heiss and Byun, 2018, p11). These actions are implemented in order to ensure that by the year 2030 all learners obtain knowledge that will promote sustainable development (Leicht, Heiss, & Byun, 2018; UNESCO, 2013a).

Education for Sustainable Development (ESD) aims to prepare learners for the constantly changing world. UNESCO has prioritized education as a basic human right and a vehicle to drive sustainable development (Leicht, Heiss, & Byun, 2018). Through education, ESD was constructed to overcome environmental challenges and other sustainability issues that affect the economy and society. Sustainable development is integrated into education, aligning with UNESCO's (2014) claim that ESD is a holistic and transformative type of education that addresses learning content and outcomes, pedagogy, and the learning environment. Moreover, education needs to address issues that affect the environment in a local and global context (Leicht, Heiss, & Byun, 2018). This is important because ESD is not limited to schools, and education is a lifelong process that extends to both formal and informal contexts (Jickling & Wals, 2008). Therefore, it is essential to adopt a learner-centered pedagogy that fosters critical thinking and reflection, as argued by Wals and Corcoran (2012), to develop values for a sustainable future. Additionally, sustainability pedagogies that utilize outdoor learning can be effective tools for ESD (Rickinson et al., 2004; Tilbury, 2011). Finally, key competencies in sustainability, as proposed by Wiek, Withycombe, and

Redman (2011), need to be integrated into academic program development to achieve the goals of ESD. In summary, ESD is critical for preparing learners to make decisions that impact the environment and create a sustainable future and requires a holistic and transformative approach to education.

2.4 ESD implication in educational institutions and pedagogy.

ESD is not only about teaching sustainable development or adding additional content to the curriculum and training. Learning institutions should identify themselves as places of learning sustainable development according to the principles of the SDGs (Leicht, Heiss and Byun, 2018). The institution's curriculum, university operations, student participation, leadership, community relations and research should be transformed to align with the SGDs (UNESCO, 2014a). The institution environment needs to enable teachers and learners to integrate sustainable living in their everyday lives (Leicht, Heiss and Byun, 2018). Olawale et al., (2022) emphasized that education systems should play a vital role in promoting sustainability and combating environmental degradation.

The classroom environment should promote learner-centred, action- oriented and transformative learning. ESD involves participatory teaching and learning methods that aims to educate learners to choose sustainable living (Leicht, Heiss and Byun, 2018). ESD aims to develop competences that will allow individuals to reflect on their own actions by taking into account the economic, social, and environmental impact on a local and global scale (Leicht, Heiss and Byun, 2018). The teachers' pedagogical approaches should involve creating collaborative real-world situations such as campaigns and service-learning projects that address sustainability issues. Students should also be exposed to vision-building that will enable them to think creatively and make innovative futuristic plans (Leicht, Heiss and Byun, 2018).

The above teaching approaches provokes learners to take action and to think sustainably. These approaches also allow students to work collaboratively. Learning institutions need to form partnerships locally and globally. The learners will learn through these real-life partnerships (Leicht, Heiss and Byun, 2018).

2.4.1 ESD integration in South Africa

According to Tsakeni (2018) South African literature acknowledges that education plays a large role in achieving sustainable development. The National Curriculum

Statement highlights social, economic transformation and environmental justice as key themes. These themes are linked to the three pillars of sustainable development (Tsakeni, 2018). The curriculum aims to prepare the learners to use scientific and technological skills to demonstrate responsible behaviour towards the environment and the community (Department of Basic Education, 2011, p.5). This aligns with the ESD goal of instilling students a sense of responsibility toward themselves and future generations (Tsakeni, 2018). ESD intends to produce young people who will have values and ethics to protect the environment and others (Tsakeni, 2018).

Tsakeni (2018), research findings demonstrate that sustainable development topics are included in the Curriculum and Assessment Policy Statement (CAPS) document. Tsakeni (2018), further states that pedagogical approaches such as project-based and experimental activities are crucial in order to expose the learners to experiential learning. Classroom activities should extend into the real-life situation (Tsakeni, 2018). Whole school driven ESD programmes and place-based pedagogy should be used to allow the learners to use local sustainable development issues to understand global level issues (Tsakeni, 2018).

Other scholars have similarly noted the importance of ESD in the South African context. Carrim and Chaunda (2019) argue that ESD can contribute to the attainment of sustainable development goals and promote responsible behaviour towards the environment and society. Jagger (2017) emphasizes the need for a transformative approach to ESD in South Africa that addresses the root causes of environmental problems. O'Donoghue (2019) highlights the role of ESD in promoting social justice and equity in the context of sustainable development. Tsakeni's (2018) research shows that sustainable development topics are included in the Curriculum and Assessment Policy Statement (CAPS) document. These findings are supported by other scholars who have noted the integration of ESD into the South African curriculum (Carrim & Chaunda, 2019; Jagger, 2017; O'Donoghue, 2019).

Tsakeni (2018) argues that South African literature emphasizes the crucial role of education in achieving sustainable development. The National Curriculum Statement identifies social, economic transformation, and environmental justice as the key themes that align with the three pillars of sustainable development. The curriculum aims to equip learners with scientific and technological skills to demonstrate

responsible behaviour towards the environment and community (Department of Basic Education, 2011). This aligns with the ESD goal of instilling in students a sense of responsibility towards themselves and future generations (Tsakeni, 2018).

2.4.2 Teaching approach and organisation of ESD

Teaching Approach

This involves the integration of sustainability concepts into various aspects of education to foster a deeper understanding of and commitment to sustainable development. These practices integrate sustainability into teaching approaches to prepare students for active roles in achieving sustainability goals (Leicht, Heiss and Byun, 2018).

The pedagogical methods used by teacher educators to deliver content, engage students, and facilitate understanding. These may include traditional lecture-based teaching, interactive group work, and experiential learning techniques. The ESD teaching approach involves integrating sustainability principles into classroom practices by aligning lesson plans and instructional methods with these principles. This may involve interdisciplinary teaching that links environmental, social, and economic issues with the subject matter (UNESCO, 2017). This approach incorporates sustainability topics across different subjects and disciplines. This approach helps students see the relevance of sustainability in various contexts and disciplines.

Organisation of ESD

Organization plays a crucial role in structuring and managing the learning environment to support the integration of ESD. This includes lesson planning, resource allocation, and time management, all of which help ensure that sustainability concepts are embedded throughout the curriculum. Effective ESD integration involves intentional curriculum planning, ensuring that sustainability concepts are embedded throughout the educational program. This includes the modification of units and planning lessons that align with sustainability goals. Furthermore, it also involves the integration of relevant topics into various subjects (Mandikonza & Kawai, 2023). Selecting and utilizing resources that support ESD, such as textbooks, digital tools, and community partnerships, is essential. Resources should be chosen to enhance the teaching of sustainability concepts and provide students with practical examples and tools (Müller et al., 2022). Organising the classroom to facilitate ESD involves creating a learning

environment that encourages collaboration, critical thinking, and engagement with sustainability issues. This may include setting up group work areas, managing time effectively, and fostering a culture of sustainability within the classroom (Buckler & Creech, 2014).

Before the COVID-19 pandemic, the integration of ESD into teacher practices in South Africa faced numerous challenges. These challenges included inadequate integration of ESD, teacher classroom practices lacked explicit ESD integration, and this could be a result of insufficient institutional guidance and standardized practices (Mandikonza & Kawai, 2023). ESD integration is inconsistent across institutions, there are often differences in how institutions and educators approached ESD (Müller et al., 2022). This inconsistency could be due to the lack of frameworks and policies for ESD within teacher education programs (Buckler & Creech, 2014).

2.5 Assessment of ESD

Assessment methods are critical in evaluating student learning and progress. The integration of ESD into assessments involves aligning evaluation criteria with sustainability competencies and ensuring that assessments reflect both knowledge and practical application.

In the context of ESD, assessment practices are designed to evaluate students' understanding of sustainability concepts and their ability to apply these in various contexts. This includes both formative assessments, which provide ongoing feedback to support student learning and adjust teaching strategies, and summative assessments, which measure overall understanding and application of ESD principles (William, 2011; Tsakeni, 2018). The transition to online learning during the pandemic required innovative assessment methods that could effectively evaluate student performance in a virtual environment.

There is dearth information about the assessment of the quality of ESD integration learning outcomes at an individual level (Leicht, Heiss and Byun, 2018). ESD is transformative and cannot be integrated into outdated paradigms (Ssossé, Wagner, Hopper, 2021). The outdated and traditional assessment techniques cannot be used to assess ESD (Ssossé, Wagner, Hopper, 2021). There is a need to assess the

learning outcomes on an individual and national level. These assessments will improve the quality of integration and delivery of ESD. Assessment should evaluate whether ESD implementation in the classroom is aligned with the institutional, national, and global educational priorities (Leicht, Heiss and Byun, 2018). The assessments will assist to develop formative assessment and direct teachers to clearer ESD pedagogical classroom practices (Leicht, Heiss and Byun, 2018).

Large- scale ESD assessments have been conducted. The exposure to sustainable development was assessed in the Organization for Economic Co-operation and development (OECD) countries. The PISA 2006 assessment found that 98 percent of schools included environmental topics in the school curriculum (Leicht, Heiss and Byun, 2018). The Civic and citizenship education study (ICCS) assessed 38 countries between the years 2008 and 2009 and found that there is a positive relationship between citizenship education and student active citizenship (Leicht, Heiss and Byun, 2018). This demonstrates that there is a direct relationship between teaching students about being active citizens and students participating in active citizenship.

Ssossé, et al, 2021 argues that ESD lacks legitimacy hence it is difficult to assess its effectiveness. ESD aims to create a positive impact on people and the planet however there is a lack of empirical reference that specifically links ESD to its benefits. Empirical evidence can be obtained through highlighting the gap in attitude, value, and skills between a group of people who benefitted from ESD and a control group that has not been exposed to ESD. Nevertheless, it is even more difficult to conduct an assessment on the impact of ESD when there is no clear pedagogy and dearth research on ESD integration in teacher training (Leicht, Heiss and Byun, 2018).

Nonetheless, large scale assessment contributes greatly to the development and visibility of ESD. However, ESD at an individual level is also essential as it can assist teachers to track the learner's achievement in order for them to meet the learning goals (Leicht, Heiss and Byun, 2018). It can also assist the learners to identify their strengths and areas to improve on. In other words, learners will also be able to track their own progress. Assessment can also provide feedback on the teaching and learning practices in schools (Leicht, Heiss and Byun, 2018). Teachers can identify their limitations, target areas for improvement and provide a local, national, and global

outcome. Assessment will also promote accountability and evaluation of ESD integration.

2.6 Competences for ESD educators

The Education for Sustainable Development (ESD) approach is an important component of the international declarations that emphasises the critical role of teacher education in supporting ESD. However, as Leicht, Heiss, and Byun (2018) point out, the integration of ESD into teacher preparation programs is still insufficient, and there is a significant lack of research on the subject. UNESCO ESD publications highlight the problem of addressing sustainability in an interdisciplinary approach within ESD teacher training and urge that sustainability be integrated into the curriculum. As supported by Albareda-Tiana et al. (2019), this method attempts to help aspiring teachers to develop sustainability competencies. Despite widespread recognition of the relevance of teacher education in advancing ESD, there is still a dire need to integrate sustainability learning into pre-service teacher education programs (Albareda-Tiana et al., 2019).

According to Imara and Altinay (2021), sustainable development competences cover a range of skills, values, and knowledge necessary for determining the complexities and uncertainties of sustainability issues. Albareda-Tiana et al. (2019) highlight that simply knowing about sustainability is not sufficient; educators must actively develop and demonstrate sustainability competencies in their daily lives. As a result, Education for Sustainable Development (ESD) aims to equip both educators and students with the necessary skills to contribute effectively to sustainable development. As stated by Imara and Altinay (2021), these competencies include an effective theoretical foundation and practical approaches that guide decision-making.

Key ESD competencies have been recognized by Wiek et al. (2011), Rieckmann (2012), Lambrechts et al. (2013), Lozano et al. (2017), and the UNESCO 2017 framework mentioned by Imara and Altinay (2021). These competences include, among several others, system thinking, critical thinking, collaboration, anticipatory skills, integrated problem-solving, interdisciplinary competence, and interpersonal skills (Imara and Altinay, 2021). Furthermore, the phrase 'key competency' refers to those skills that are important and valuable to everyone in a variety of contexts. Key competencies are essential skills that individuals can use to tackle the numerous

challenges that modern societies face (Lambrechts, et al., 2013). It is critical to identify the core competences required to encourage change agents among learners. However, it is also necessary to investigate how these competences may be integrated into various educational contexts and how educators can be supported in acquiring and transferring these competencies to their students (Imara and Altinay, 2021).

ESD integration is more than only knowledge acquisition and creation. It involves a shift in teaching methodologies as well as ESD-related methodological approaches. Learning from real-world problems, actively tackling future sustainability issues, embracing fundamental techniques, supporting integrative thinking, and encouraging active engagement are all part of this change (Albareda-Tiana et al., 2018).

Future teachers must have sustainability competencies in order to effectively support sustainable development, as their impact goes well beyond the classroom and can greatly contribute to the development of a more sustainable society. Teachers must not only be knowledgeable and capable of delivering persuasive arguments, but they must also demonstrate behaviour that is compatible with what is taught in the classroom. As a result, education targeted at promoting sustainability capabilities is acknowledged as a critical component in accomplishing the ESD goals (Albareda-Tiana et al., 2018).

There are several strategies for integrating ESD competences into teacher education, including interdisciplinary and cross-curricular methodologies, as well as transdisciplinary strategies that target holistic educational reform (Imara and Altinay, 2021). Furthermore, the most generally used technique is changing courses to include ESD material and competencies, facilitated by appropriate pedagogies (Imara and Altinay, 2021).

According to research, ESD competences are not a skill that can be taught directly but must be learned through practice. This highlights the need of using teaching methods that provide enough practical learning opportunities. Students and teachers should engage in innovative pedagogical approaches within a collaborative and open learning environment, facilitated by a variety of evaluation methodologies (Imara and Altinay, 2021).

In addition, studies indicate that ESD competences, such as learning outcomes and educational goals, might serve as standards for curriculum development (Imara and Altinay, 2021). While ESD capabilities are stated in curriculum and program descriptors, teacher educators frequently lack a clear roadmap for integrating ESD into their courses. Furthermore, ESD integration is not explicitly required in many institutions, which may encourage teacher educators to trivialise its value. As a result, there is an increasing demand for a uniform ESD framework to assess and lead the integration of ESD competences (Imara and Altinay, 2021).

Teachers need to develop key sustainable competencies in order to facilitate ESD. It is essential for teachers to know about sustainable development and understand ESD practices at the local, national and international level (Leicht, Heiss and Byun, 2018). Teacher education should develop an interdisciplinary perspective on global change. Teachers should be taught to reflect on formal and informal ways of applying sustainable development. They should also understand the elements of ESD, use transformative pedagogy that engages learners to think critically, creatively use ESD in their daily lives, evaluate and assess the learner's development (UNESCO, 2016a).

There is a real dearth in the assessment of ESD integration for pre-service teacher training (Leicht, Heiss and Byun, 2018). This creates a limitation in the development of the necessary knowledge and competences to participate in sustainable development. Teacher training institutions need to equip teachers with ESD competences. ESD should not be an additional course or an addition to curriculum, but it should be introduced as a transformative pedagogy (Leicht, Heiss and Byun, 2018).

Furthermore, studies have analysed pre-service teacher training programs and found that ESD competencies are lacking in the curriculum (Ochieng & Kanyeki, 2018; Ochieng & Kanyeki, 2020). As a result, candidate teachers may not possess the necessary knowledge and skills to teach ESD effectively. Therefore, it is essential that pre-service teacher training programs integrate ESD competences to better prepare future teachers for teaching ESD, this highlights the importance of ESD for achieving sustainable development in South Africa. However, the lack of ESD integration in pre-service teacher training programs limits the development of the knowledge and competencies necessary to participate in sustainable development (Kavai et.al, 2022).

Teacher training institutions need to equip teachers with ESD competencies to effectively introduce ESD as a transformative pedagogy.

2.7 ESD integration during Covid times

The Covid-19 pandemic has brought unprecedented challenges to the integration of ESD into educational institutions. The pandemic has forced institutions to rapidly transition to online learning, resulting in significant disruptions to education and limited opportunities for experiential and place-based learning (Olawale et al., 2022). The pandemic has also highlighted inequities in access to technology and resources, with disadvantaged communities being the most affected. These challenges have made it more difficult for institutions to effectively integrate ESD into their curricula and pedagogical practice (Olawale et al., 2022). Nevertheless, some institutions have been innovative in adapting their ESD practices to the online environment, such as offering virtual sustainability projects and promoting sustainability awareness campaigns through social media (Olawale et al., 2022). The pandemic has underscored the need for flexible and adaptive approaches to ESD integration in educational institutions that can respond to changing circumstances and the diverse needs of learners.

2.8 Conceptual framework

Sustainable development is founded on three pillars which include social, economic, and environmental (Eilks, 2015). The three- pillar model has been the foundation for handling educational issues that involve sustainability. The model has received various critics and one critic that stands out is that the model demonstrates independent domains of sustainability. The three- pillar model seems to be suggesting that the domains are not interlinked (Eilks, 2015). However, each pillar is interlinked. There are many other models that have been proposed however most of the models share a few elements in common (Eilks, 2015).

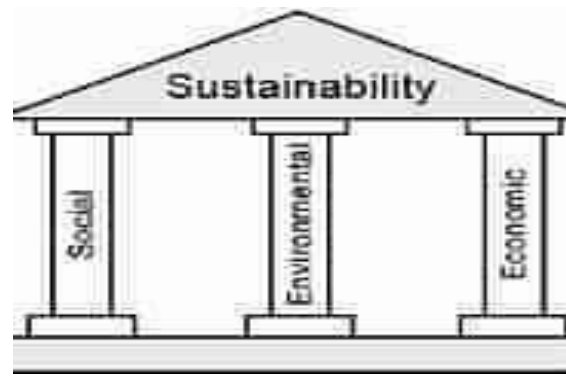


Figure 1 The three pillars of sustainability (Eilks, 2015).

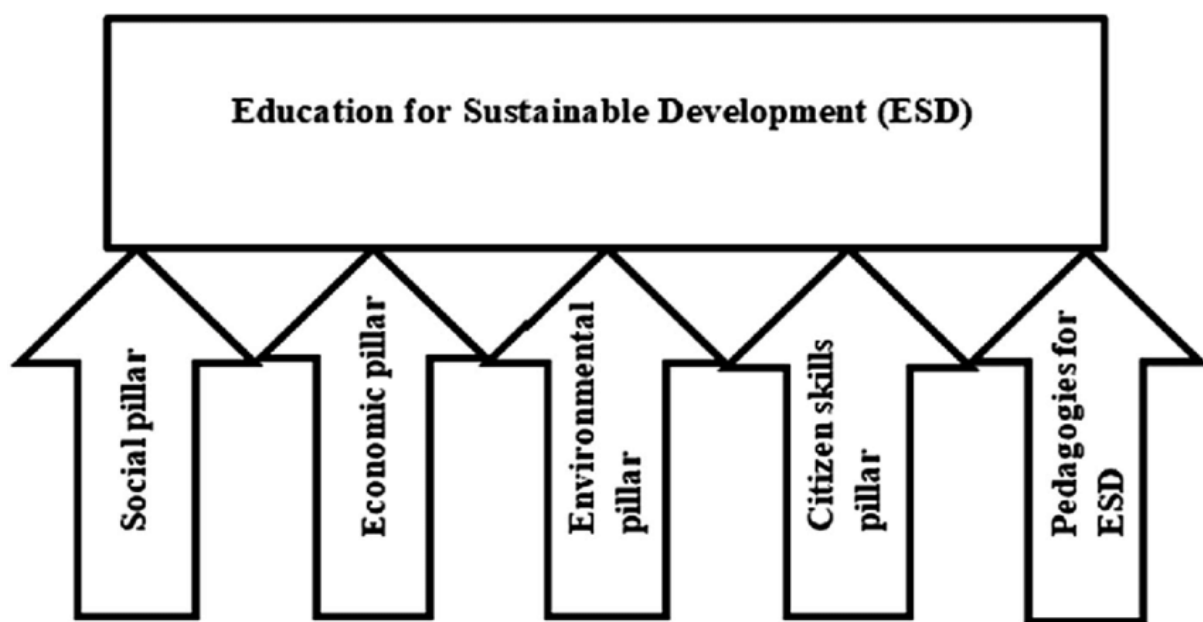


Figure 2 ESD pillars (Tsakeni, 2018)

Berglund and Gericke (2016), expanded the number of pillars to include the societal ideological perspective. ESD aims to teach young people who will have values and ethics that will protect the environment and others. This aim aligns with the citizen skill pillar as students will have an agency to become responsible citizens (Tsakeni, 2018). Citizen skills are fundamental for the implementation of sustainable development through education (Tsakeni, 2018). Citizen skills can be developed by using appropriate pedagogies (Tsakeni, 2018). Hence, pedagogies for ESD are an essential additional pillar to produce citizen skills (Tsakeni, 2018). These pillars are interlinked with one another and should not be considered as independent. The teachers need to consider these pillars when teaching life sciences.

In South Africa, the integration of ESD into the curriculum has been emphasized as a means of achieving sustainable development goals (Mncube, 2021; Tsakeni, 2018). The National Curriculum Statement identifies social, economic transformation, and environmental justice as key themes that align with the three pillars of sustainable development (Department of Basic Education 2011). The curriculum aims to equip learners with scientific and technological skills to demonstrate responsible behaviour towards the environment and community. This aligns with the ESD goal of instilling in students a sense of responsibility towards themselves and future generations (Tsakeni, 2018). ESD aims to develop ethical values that enable young people to protect the environment and others (Tsakeni, 2018).

This study was also guided by the UNECE model (Figure 3)



Figure 3 UNECE Competences for ESD (UNECE, 2012)

Educators are crucial for integrating ESD into teacher education and Life Sciences classroom practices, particularly during the Covid pandemic. Covid 19 posed both local and global challenges. The global standstill caused by the pandemic introduced a new normal, prompting a re-evaluation of not only ESD but also education in general. Utilizing the framework of the four pillars of learning—learning to know, learning to do, learning to live together, and learning to be—educators can facilitate the development of knowledge, skills, and values essential for fostering sustainable development.

The above Figure 3 demonstrates competences that the educators should entail. These competences include learning to know, learning to do, learning to live together and lastly learning to be (UNECE, 2012). Before exploring pedagogies (Figure 2), it is critical for teachers to possess these four competences.

Teacher training institutions need to ensure that teachers: 1. Learn to know, teacher educators and prospective teachers should grasp the meaning of ESD and its implications. This competency also involves understanding local and global challenges, with COVID-19 being a significant example affecting both the local and global spheres. Teaching this competency involves illustrating how local and global challenges intersect with sustainability issues.

2. Learn to do, teachers need to be introduced to pedagogies that are aligned with ESD, traditional teaching methodology cannot be used to teach ESD (Leicht, Heiss and Byun, 2018). 3. Learning to live together, this involves actively engaging with different groups and partnerships. The teacher training institutions need to make partnerships with ESD programmes and other communities to challenge unsustainable development practices. ESD promotes collaboration, critical thinking and solving real life situations (Eilks, 2015). 4. Learning to be in ESD aims to cultivate individuals with values, skills, and attitudes that take into account the social, economic, and environmental impacts in their daily lives (Eilks, 2015). This competency points out how individuals can integrate sustainability even in the face of local and global challenges, such as the COVID-19 pandemic. ESD should extend beyond the confines of the classroom and be integrated into our daily lives (Eilks, 2015).

For this study, the competencies of learning to be and live together were combined into a single category. This change was made to better fit the study's context, as learning to be and living together are interdependent. According to Vare et al. (2019), competency development is dependent on an individual's ability to demonstrate behaviour and attitude beyond their inherent capacity, representing both the internal and external demonstrative behaviours. This implies that the competency involves learning to be sustainable and fostering the ability to coexist harmoniously with others. Importantly, the competency is viewed not as a final state but as an ongoing practice (Vare et al., 2019).

To ensure that ESD is effectively integrated into educational institutions, teacher-training institutions must equip teachers with the necessary competencies. Leicht, Heiss, and Byun (2018) suggest that teacher training institutions need to ensure that teachers learn to know what ESD is and its impact, learn to do through pedagogies aligned with ESD, learn to be and live together through active engagement with different groups and partnerships, and learn to be through values, skills, and attitudes that consider the social, economic, and environmental impact in their everyday lives. The Covid-19 pandemic has also highlighted the importance of assessing the integration of ESD into educational institutions and adapting strategies accordingly (Olawale et al., 2022; Müller et al., 2022).

The competence in designing and implementing interdisciplinary learning activities that integrate concepts from different subject areas and foster critical thinking aligns with the pillar of learning to know. Educators who possess this competence can develop learning activities that promote inquiry-based learning and help students to develop a deep understanding of the interconnectedness of social, economic, and environmental issues. Similarly, the competence of designing and facilitating project-based learning activities that promote hands-on learning and practical skills development aligns with the pillars of learning-to-do. Educators who possess this competence can facilitate experiential learning activities that promote active and engaged learning and enable students to take action and implement solutions to sustainability challenges.

Overall, the competencies for educators in ESD align with the four pillars of learning and are essential for integrating ESD into teacher education and Life Sciences classroom practices during the Covid pandemic. Educators who possess these competencies can help prepare students to become active and responsible global citizens committed to creating a more just, equitable, and sustainable world.

Chapter Summary

This chapter explored Sustainable Development (SD) and Education for Sustainable Development (ESD). It explored the implications of ESD on educational institutions and teaching, as well as its integration into the South African context. It also explored ESD assessment along with ESD educator competencies. The chapter also discussed

ESD integration during the COVID-19 pandemic. Finally, it presented the framework, which included the three pillars of sustainability, five pillar of ESD and the four pillars of learning to know, learning to do, learning to be, and learning to live together.

Chapter 3- Research Methodology

Introduction

This chapter covers the research approach, research paradigm, research method, research technique, data collection procedure and analysis, research validity as well as the ethical considerations that were taken into account in this study.

3.1 Research approach

Research approach is a critical component of research. This study investigated the integration of Education for Sustainable Development in teacher education, Life Sciences classroom practices at a South African teacher education institution, during Covid times. The study intended to investigate how ESD was integrated in teacher education, through investigating the pedagogical practices, in a higher educational institution in the context of ESD objectives.

The study employed a qualitative research approach, specifically an interpretivist approach. Interpretivism emphasizes the importance of understanding the context of the data and recognizes that individuals can provide subjective insights about a phenomenon. This approach recognizes that there can be multiple realities within a particular context and seeks to capture these through qualitative research methods (Creswell, 2013).

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One of the aims of ESD is to promote critical thinking and the qualitative research method allows the participants to express their thoughts and viewpoints in depth. In addition, a qualitative research method was used to capture participants' subjective experiences and provide an in-depth understanding of their perspectives. This aligns with the goal of ESD, which emphasizes the importance of critical thinking and deep reflection on the complex issues related to sustainable development. Qualitative research methods are particularly useful for capturing the subjective experiences and

views of participants, which can help inform the development of ESD programs and curricula that are relevant and responsive to their needs. Therefore, the use of qualitative research methods is relevant to the research topic of integrating ESD in teacher education, particularly in the context of Life Sciences classroom practices during the Covid pandemic.

3.2 Research paradigm

This study adopted a qualitative (interpretivist) research approach in line with the research paradigm. Interpretivist research philosophy acknowledges the importance of context and multiple realities in a particular situation (Creswell, 2014). The use of qualitative research methods allows for the collection of rich, detailed data that could be analysed to develop an understanding of the phenomena (Merriam, 2015). A case study approach was adopted as an appropriate research design, given the focus of the study on the integration of Education for Sustainable Development in teacher education and Life Sciences classroom practices during the Covid pandemic (Baxter & Jack, 2008). A case study design allows an in-depth analysis of a specific situation or phenomenon, providing detailed insights into the context and experiences of participants (Yin, 2015). Through the combination of these research methods, this study aimed to generate a comprehensive understanding of the complex nature of the integration of Education for Sustainable Development in teacher education and Life Sciences classroom practices during the Covid pandemic.

Furthermore, the interpretivist research paradigm is highly relevant to the topic of integrating Education for Sustainable Development (ESD) in teacher education and Life Sciences classroom practices during the Covid pandemic. As an approach that focuses on context, interpretivism is well-suited to understanding the complex and varied factors that influence the integration of ESD in teacher education and Life Sciences classroom practices during the pandemic. The Covid pandemic brought about significant changes to the educational landscape, with many institutions adapting their teaching methods to suit remote learning environments. In this context, it is important to understand the perspectives and experiences of teachers and students regarding ESD integration, can be obtained through qualitative methods such as interviews and focus groups (Denzin & Lincoln, 2018). By adopting an interpretivist paradigm and using qualitative research methods, this study was able to explore the

subjective experiences and multiple realities of those involved in ESD integration in teacher education and Life Sciences classroom contexts during the pandemic.

3.3 Research method

The research method used in this study is qualitative, specifically employing a case study approach. A case study approach was adopted to allow an in-depth investigation of the context in which teacher educators integrated ESD into their teaching practices during the Covid-19 pandemic. This approach facilitated an exploration of the complexities and key aspects of ESD integration within online classrooms (Yin, 2018). Furthermore, focusing on teacher educators' experiences, this approach enabled the study to capture the specific challenges, adaptations, and strategies employed to integrate ESD principles into teaching approaches, assessments, and organizational methods.

The case study method goes beyond mere data collection; it enabled a holistic understanding of how ESD is integrated in the unique context of online teaching during the pandemic. This method provides rich, contextual insights that are essential for understanding the practical implications of ESD in education, addressing a significant gap in the literature regarding ESD implementation. The case study approach underpins the data generation techniques, such as interviews and questionnaires, ensuring that data is collected systematically and analysed within the context of the study. This method emphasizes the importance of examining specific cases to derive meaningful insights, thus guiding the research process from data collection to interpretation. It provides a comprehensive framework for understanding how teacher educators' classroom practices evolved in response to the demands of ESD during the pandemic (Merriam, 2009).

3.3.1 Sampling procedure

Purposive sampling is often employed in qualitative research to select participants based on specific criteria relevant to a research topic (Patton, 2002). In this study, purposive sampling was used to ensure that the selected participants were representative of the population and could provide informative insights into the integration of Education for Sustainable Development in teacher education and Life Sciences classroom practices during the Covid pandemic. By selecting participants who have experienced and can offer a unique perspective on the topic, the study can

increase the credibility of the data and reduce the risk of bias. Moreover, the use of purposive sampling enabled triangulation of data from multiple sources, which allowed for the comparison and validation of data (Cresswell and Plano Clark, 2011).

Dittmar and Eilks (2019) argued that triangulation of data can increase the validity and reliability of qualitative research and enable researchers to gain a more complete understanding of the research topic. Therefore, the use of purposive sampling in this study is justified and can provide a comprehensive insight into the integration of Education for Sustainable Development in teacher education and Life Sciences classroom practices during the Covid pandemic.

3.3.2 Population, sampling procedure and sample size

The population sample entailed 10 prospective teachers, 5 undergraduate and 5 Postgraduate Certificate in Education (PGCE) prospective teachers from a teacher training institution. Two Life Sciences teacher educators were interviewed; these teacher educators taught both the undergraduate and PGCE Life Sciences courses. Their course outlines were analysed for ESD integration and competences.

3.4 Research techniques

Data was collected through different methods which included teacher educators' interviews, open-ended questionnaires to Life Sciences prospective teachers, analysis of the Life Sciences course outlines and the Curriculum Assessment Policy Statement (CAPS) documents.

3.4.1 Research tools

3.4.1.1 Google forms- open-ended questionnaire

Self-reports are techniques used by qualitative researchers to collect data. This data collection technique was used by asking participants to answer questions based on their own experiences (Vanderstoep and Johnson, 2008). This was done through surveys and questionnaires.

This study adopted the self-report technique to collect data. Data was collected through a google forms questionnaire which entailed open-ended questions. The

questionnaire allowed the prospective teachers to express their opinions about the integration of ESD during the covid pandemic.

The limitations of self-reports in research have been well documented. Researchers who rely on self-reports must recognize that participants tend to report their attitudes and behaviour in a positive light and that the accuracy of these reports can be compromised by factors such as memory biases and social desirability (Vanderstoep & Johnson, 2008; Tourangeau & Yan, 2007). Additionally, self-reports may not provide a complete picture of a person's experiences and behaviour. Furthermore, Vazire (2006) noted the self-other knowledge asymmetry (SOKA) model, which suggests that individuals' self-reports are limited by their inability to fully access their internal mental states. Despite these limitations, self-reports remain a powerful and convenient way to collect data on many aspects of the human experience (Vanderstoep & Johnson, 2008) and the validity of the data is enabled through triangulation.

3.4.1.2 Semi structured Interviews

Interviews are powerful and popular tools for researchers seeking to gain a deeper understanding of an individual's experiences and perspectives. Structured interviews are a commonly used type of interview in which the interviewer asks a set of prescribed questions in a controlled manner (Vanderstoep & Johnson, 2008). Semi-structured interviews involve a set of prepared questions but allow the interviewer the freedom to explore unexpected responses and investigate deeper into interesting topics (Vanderstoep & Johnson, 2008; Seidman, 2013).

The art of conducting effective interviews involves not only asking good questions but also creating a comfortable and supportive environment for both the interviewer and interviewee (Vanderstoep & Johnson, 2008; Rubin & Rubin, 2012). Interviewers may also rely on intuition and improvisation to adjust the direction of the interview and uncover valuable insights (Kvale 2007; Seidman 2013).

This study adopted semi structured interviews. The teacher educators were asked a series of questions, but follow-up questions and clarification were asked at any point during the interview. Semi structured interviews allowed individuals to express their perceptions and views about ESD. The semi structured interviews enabled the researcher to have an interview structure, and it allowed the teacher educators to elaborate on their answers. The teacher educators were able to express their

perception on ESD and how they integrated it into their own teaching during the covid pandemic.

The interview explored the teacher educators' understanding of ESD. It also investigated why and how they integrated ESD. It entailed questions that probed on how ESD is integrated in the curriculum. What ESD meant to individuals informed the pedagogies and epistemologies that the teachers applied to their teaching.

3.4.1.3 CAPS document and Course outline document analysis

Document analysis involves the interpretation and identification of written text. This involves the researcher interpreting selected texts. Each text interpretation should be valid to the extent that it reflects the meaning that is ascribed to the text by the interpreter (Vanderstoep and Johnson, 2008). Text analysis could be based on existing documents or transcriptions of previous verbal data (Vanderstoep and Johnson, 2008). This research adopted an interpretive document analysis to analyse the Life Sciences course outlines developed and used during Covid-19 pandemic and the Further education and training (FET) Life Sciences CAPS document grade 10-12 (Department of Basic Education, 2011). Bowen (2009) states that document analysis is used to understand and interpret empirical knowledge.

The Curriculum and Assessment Policy Statement (CAPS) is a curriculum framework implemented in South Africa to standardize education across the country. Introduced in 2012, CAPS provides detailed guidelines for what should be taught in each subject and grade, as well as how students should be assessed. It is useful for teachers because it offers clear and structured content, allowing them to plan their lessons with specific learning outcomes in mind. CAPS also ensures consistency across schools, helping teachers to align their teaching with national standards and expectations, thus contributing to improved educational quality and equity (Department of Basic Education, 2011).

The Life Sciences Curriculum Assessment Policy Statement (CAPS) is a critical document that outlines the curriculum standards and assessment criteria for Life Sciences education in South Africa. Analysing this document was crucial for understanding how ESD principles are integrated into the curriculum and how they align with the broader educational goals.

The CAPS document provides official guidelines and expectations for the teaching of Life Sciences, including sustainability topics such as human impact and biodiversity (Department of Basic Education, 2011). Analysing the CAPS enabled the study to assess how these sustainability topics align with ESD competencies and identify gaps or opportunities for improvement in ESD integration. Furthermore, the validity of using CAPS as a data source is supported by its role as an authoritative educational document that sets standards for teaching and assessment. Document analysis of CAPS enabled the study to reflect on how ESD principles are embedded in official curriculum guidelines (Vanderstoep & Johnson, 2008).

Course outlines are essential for understanding how teacher educators plan and execute their ESD-related teaching practices. The course outlines reflect teaching practices and pedagogical approaches used by educators. Analysing these outlines enabled the study to investigate ESD integration and how they align with the CAPS document and broader ESD goals. The course outlines from Life Sciences teacher educators provide detailed descriptions of how ESD is embedded in the teaching practices of individual educators.

3.5 Data collection procedure

The data collection procedure happened at a higher educational teacher training institution. Two Life Sciences teacher educators were interviewed and ten google form open-ended questionnaires were sent to Life Sciences prospective teachers. The participants were selected randomly based on those who volunteered to participate in the study. The open-ended questionnaires were sent to undergraduate and PGCE prospective teachers. The teacher educators' interview and the open-ended questionnaire items were similar to allow the triangulation of data. The number of participants was the limitation of the study. The sample size was small, limited to ten prospective teachers and two teacher educators.

3.6 Data analysis

Data Analysis involves systematic techniques for interpreting and organizing data to address the research questions. The methodology for analysing the interview and questionnaire data involved systematic categorization and coding, which ensured a structured approach to interpreting how ESD was integrated into teaching practices.

In this study, the data analysis was guided by the ESD conceptual frameworks which includes the five pillars of ESD, the three pillars of sustainability and UNECE ESD competency for teachers. ESD integration was analysed by using the social, environmental, and economical, citizen skills and pedagogy for ESD pillars (Eilks, 2015). These pillars are interlinked and worked in conjunction with one another (Eilks, 2015).

The analysis of ESD integration was guided by several conceptual frameworks to ensure a comprehensive evaluation. Central to this were the Five Pillars of ESD which are the social, environmental, economic, citizen skills, and pedagogy. These interconnected pillars were used to categorize and interpret data, ensuring that different dimensions of ESD were considered in the analysis. The study also utilized the Three Pillars of Sustainability—economic, environmental, and social—to assess how these aspects were addressed in teaching practices. By integrating these sustainability pillars, the analysis aimed to capture the multi-faceted nature of ESD integration.

The UNECE ESD Competencies for Teachers, which include learning to know, learning to do, learning to be, and learning to live together, further structured the analysis. These competencies provided a framework for categorizing data based on knowledge about ESD, practical integration, engagement with different groups, and the adoption of citizenship skills. By aligning the data with these competencies, the study aimed to evaluate the extent to which teacher educators and prospective teachers understood and implemented ESD during the pandemic.

Learning to know emphasizes understanding sustainability concepts, which directly connects to how teacher educators designed their online lessons and their classroom practices to include ESD principles (UNECE, 2012). By analysing how teacher educators integrated sustainability knowledge into their online teaching, one can assess how well the "learning to know" component was applied in the context of remote education during the pandemic. While learning to do highlights the practical application of sustainability knowledge through actionable outcomes or practical actions. Investigating assessment strategies explores how teacher educators used assessments and other methods to evaluate students' understanding and application of ESD concepts (UNECE, 2012). Examining how educators adapted their

assessment practices to support and measure the practical application of ESD principles during online instruction aligns with this competency.

The learning to live and be together competency highlights the development of social skills and values essential for collaborative and inclusive practices. Exploring how prospective teachers responded to ESD integration can shed light on the impact of these pedagogical changes (UNECE, 2012). By analysing prospective teacher's responses, one can assess the integration of ESD in the online environment during the pandemic.

The competencies of "learning to know," "learning to do," and "learning to live and be together" as outlined by UNECE are closely linked to key Education for Sustainable Development (ESD) themes, creating a framework that guides the integration of sustainability into education. "Learning to know" involves acquiring knowledge and understanding sustainability concepts, which directly relates to ESD themes like the environmental, economic and the social pillars of sustainability. This competency equips prospective teachers with the foundational knowledge necessary to make informed decisions about sustainable practices. "Learning to do" emphasizes practical application, encouraging prospective teachers to develop skills and engage in actions that promote sustainability. It aligns with theme of active citizenship, where students are empowered to apply their knowledge in real-world contexts. Lastly, "learning to live and be together" focuses on fostering social skills and values, promoting inclusivity, empathy, and collaboration, which are critical in addressing ESD themes related to social justice and global citizenship. Together, these competencies create a holistic approach to ESD.

Data collection involved open-ended questionnaires and interviews, which were categorized according to the UNECE ESD competencies. This categorization allowed for a structured analysis of how well participants grasped and applied ESD concepts. Specific themes related to each competency were identified and examined, providing insights into the level of integration of ESD practices in teaching. The data analysis process included transcribing interview data verbatim, capturing detailed examples of ESD integration.

The transcriptions were then analysed using thematic analysis to identify common themes and patterns related to ESD. This approach provided a thorough examination of the data, highlighting key aspects of ESD practices and identifying areas for improvement. To ensure a comprehensive understanding of different perspectives, data from questionnaires and interviews were analysed separately. This separate analysis facilitated a detailed exploration of responses, enabling the identification of consistent themes and discrepancies across different data sources.

Document analysis involves interpreting and identifying the meanings within written texts. For this study, the analysis of CAPS and course outlines was utilised to reflect how these documents support ESD integration in teacher education.

The interpretation of these documents was carried out with a focus on how well they support and align with ESD. Comparing document analysis findings with data from interviews and questionnaires provided a comprehensive understanding of ESD integration and validated the accuracy of the research findings (Vanderstoep & Johnson, 2008).

The open-ended questionnaire and interview questions were categorised into the three different competencies which include: learning to know, learning to do, learning to be and live together. These competencies cover knowing about ESD, knowing how to integrate ESD into teaching, learning to engage with different groups and disciplines and lastly adopting citizenship skills that will challenge unsustainable practices. The interview questions also explored how ESD was integrated during the pandemic.

The questionnaire and interview data were analysed separately to gain a comprehensive understanding of the research topic (Vanderstoep & Johnson, 2008). The interview data was transcribed verbatim to provide specific examples and details that supported the description of the data (Kvale & Brinkmann, 2009). In addition, the researchers identified common themes and contradictions that emerged from different data collection methods to increase the validity of the findings (Patton, 2015).

To further ensure validity, the data obtained from the questionnaires and interviews were compared with other sources, such as the CAPS document, and Life sciences teacher educators' course outlines (Vanderstoep & Johnson, 2008). This approach helped provide a context for the research findings and validate the accuracy of the data collected through triangulation.

In addition, researchers have engaged with new and compelling interpretations of the data to increase the validity of the research findings (Creswell, 2014). By analysing the data from multiple perspectives, the researchers were able to develop a deeper understanding of the research topic and establish the validity of the findings.

3.7 Validity of research

Validity is a critical aspect of research as it ensures that the data accurately reflect what the study aims to measure (Vanderstoep & Johnson, 2008). Without validity, the study results are meaningless. To achieve validity, the researcher employed triangulation, a technique that involves using multiple data sources or methods to investigate the same phenomena (Vanderstoep & Johnson, 2008; Creswell, 2014; Denzin & Lincoln, 2011).

This study used data source triangulation, which involved gathering data from both teacher educators and prospective teachers. By collecting data from multiple sources, the researcher was able to cross check and verify the results, strengthening the validity and reliability of the data (Vanderstoep & Johnson, 2008; Creswell, 2014; Denzin & Lincoln, 2018). To enhance the validity of the findings, the data were compared with additional sources such as the Life Sciences (CAPS) and course outlines from teacher educators. This triangulation process helped to validate the accuracy of the data and provided contextual background for the findings (Patton, 2015; Vanderstoep & Johnson, 2008).

Reliability refers to the consistency of research results across different times, groups, or measurement instruments (Vanderstoep & Johnson, 2008). In other words, reliable measures should yield similar results when used under different conditions. To ensure the reliability of the results, this study employed multiple data collection methods for the same phenomenon. The use of similar interview questions for teacher educators and open-ended questionnaires for prospective teachers further enhanced the validity of the study as it allowed for consistent and comparable data collection across both groups.

3.8 Ethical considerations

This research study abided by the ethical procedure and principles. I received ethical clearance from the Wits School of Education. I also received permission to analyse the course outlines from the lecturers. The objective of the study was explained to the

participants. The participants signed consent forms that stated that they agree voluntarily to take part in the research and that they could withdraw from the research at any point. Furthermore, the participants remained anonymous, and data collected was kept confidential. Interviews were audio recorded after the participant had agreed to be recorded.

Chapter summary

This chapter explored the research approach, research paradigm, research method, data collection procedure and analysis, research validity as well as the ethical considerations. This study adopted a qualitative approach and data was collected through open ended questions, interviews, analysis of course outlines and CAPS document. The participants included 10 prospective teachers and 2 teacher educators. Data triangulation was used to ensure validity. The study adhered to the ethical procedures.

Chapter 4- Data Analysis, presentation and interpretation

4.1 Introduction

The chapter presents results obtained from an investigation of ESD integration in teacher education during the Covid pandemic. The purpose of this chapter is to present data results obtained from the prospective teachers' open-ended questionnaires, teacher educators' semi-structured interviews, course outlines and lastly the Life Sciences CAPS document.

The framework used in this study consisted of UNECE competencies for educators, the three pillars of sustainability, and the five pillars of ESD. The competencies provided a structured approach to categorizing responses based on what educators need to know, do, and how they interact with others in the context of ESD. This alignment ensured that the data analysis was comprehensive and relevant to the core competencies required for effective ESD integration (UNECE, 2012). The inclusion of economic, environmental, and social sustainability pillars helped in assessing how well the responses addressed these critical aspects of ESD. This alignment ensured that

the analysis covered all dimensions of sustainability, reflecting the comprehensive nature of ESD (Berglund & Gericke, 2016). By grouping the codes into the five ESD pillars (social, economic, environmental, citizenship skills, and pedagogies), the analysis was able to explore how different aspects of ESD were integrated into teaching practices. This categorization provided an understanding of how each pillar was represented in the data (Tsakeni, 2018).

4.2 Representation of Data

The research data analysis was guided by the UNECE competences for educators, the three pillars of sustainability and the five pillars of ESD (UNECE, 2012; Berglund and Gericke, 2016; Tsakeni, 2018).

The interview and the questionnaire data results were represented using a table. The table was divided into three columns. The first column represented the competencies for educators in Education for Sustainable Development. These competencies included: learning to know, learning to do, learning to live together and learning to be (UNECE, 2012). The interview and the questionnaire questions were categorised into the three different competencies respectively. The questions were categorised based on how they linked to each competency, questions that related to a particular competency were grouped into one competency.

The interview and the open-ended questionnaire were transcribed and decoded. The codes are represented in the third column. The codes are grouped into the five ESD pillars. These pillars include: the social, economic, environmental, citizenship skills and the pedagogies for ESD.

4.3 Open-ended questionnaire data from prospective teachers

How have prospective teachers responded to ESD integration in Life Sciences education during the Covid pandemic?

Responses are colour coded and grouped into ESD pillars. Below are their colour representations.

Yellow- citizenship skills pillar

Blue- Social pillar

Green -Environmental pillar

Pink- Pedagogies for ESD**Orange - economic pillar**

The responses in the table below do not align consistently with the ten participants. Some participants provided similar responses, which were subsequently grouped under one response.

Table 1 Prospective teachers (PT) open-ended questionnaire data

Competences	Questions	Responses (codes)
Learning to know	1.What is ESD?	1.Knowledge, skills and values Change societies⇒ Citizen skills Preserve environment⇒Environmental pillar Awareness about global challenges⇒ Social pillar
	2.What is your opinion on integrating ESD in your teaching?	2.Good initiative Rises awareness. Encourages sustainability. Encourages environmental sustainability
Learning to do	3.How do you integrate ESD in the teaching of Life Sciences?	3.Teaching global challenges Investigations on waste management. Encourage recycling.
	4. Why do you think it is important to integrate ESD in the classroom?	4.Sustainability depends on the young Prepare students to be active citizens. Raises awareness.

	5. How has Covid affected the integration of ESD?	5. No excursions or practical work More assessments and less teaching
Learning to be and live together.	6. Why do you think it is important to integrate ESD in the classroom? 7. What can be done to ensure that ESD is integrated better during the Covid times	6. Sustainability depends on the young Prepare students to be active citizens Raises awareness 7. Include practical work Virtual tours

The data above was divided into three columns. The first column represents the ESD competences framework. The second column presents the open-ended questionnaire questions, categorized according to their relevant competences. The final column includes the codes derived from the respondents' responses, based on the pillars of ESD. The learning to know competency employed the three fundamental pillars of sustainability, which include social, environmental and economic, to identify codes from the respondents (Berglund and Gericke 2016). For the learning to do, learning to be and live together, Tsakeni's (2018) five pillars of ESD was utilized. It's crucial to note that these five pillars of ESD also include the three basic pillars of sustainability, including the environment, social, and the economy. Teacher trainers need to comprehend the three fundamental pillars of sustainability and their interdependency

with the pillars of ESD before considering the pedagogies for ESD and the citizenship skills included in Tsakeni (2018).

4.3.1 Learning to know.

4.3.1.1 According to PTs what is ESD?

Most of the participants had a partial understanding of what is meant by ESD. Three participants limited their answers to only the social pillar and the other three restricted ESD to only the environmental pillar.

Below are the some of the responses from the participants.

'Education that changes knowledge and perspective about certain things in our societies.'

'Education for sustainable development is teaching both old and young people to preserve the environment and its resources for future generations'.

'According to my own understanding, it's type of Education which ensures that learners acquire knowledge and develop skills that will promote social, economic and environmental justice.'

'ESD is the kind of Education that encourages change in knowledge, skills and values in the society'.

'It is education meant to bring understanding of conservation of nature while developing the environment.'

'Education that guarantees the society's functionality'.

'ESD involves the protection and conservation of the environment.'

ESD is made up of three fundamental pillars, the social, economic and environmental pillars. These pillars are interdependent and interlinked to one another.

These results demonstrate that about 6 out of 10 prospective teachers (PT) did not understand the holistic nature of ESD, often focusing on one aspect (social or environmental). ESD comprises three pillars (social, economic, environmental), and participants didn't consistently recognise the interdependence of these pillars. While Learning to Know is fundamental, not all participants demonstrated a clear grasp of ESD, indicating a gap in understanding.

4.3.1.2 PT opinion on integrating ESD in your teaching?

Participants responses

'It's a good initiative as it will help students to be exposed to more insightful knowledge.'

PT1 perceives ESD as beneficial for exposing students to valuable knowledge. This positive sentiment aligns with the general view that ESD enriches students' learning experiences by broadening their understanding of sustainability issues (UNESCO, 2017). The emphasis here is on the potential for ESD to enhance educational content, suggesting a recognition of ESD's role in providing students with relevant, real-world insights.

'ESD is a good initiative of education, Life Sciences especially grade 11 content is bombarded with environmental studies hence I feel it encourages learners to sustain their environment.'

PT2 acknowledges the integration of environmental studies within the Life Sciences curriculum and sees ESD as an effective way to reinforce environmental sustainability. This response highlights the relevance of ESD in reinforcing existing curriculum content related to environmental issues. However, it also implies that ESD is perceived primarily through the lens of environmental sustainability, which may limit its broader application across other ESD pillars.

'ESD is a good way to raise awareness in learners and open them up to methods and ways of living that will keep the environment safe and ensure economic sustainability.'

PT3 views ESD as a means to promote both environmental safety and economic sustainability. This response reflects an understanding of ESD's broader scope, incorporating both environmental and economic aspects. It indicates a positive perception of ESD's potential to educate students about sustainable living practices and economic considerations.

'ESD integration is not easy as with the curriculum it is largely dedicated to certain content in the subject. The content to be taught is packed and leaves little room for ESD integration.'

PT4 identifies curriculum constraints as a significant challenge to ESD integration. The

response underscores the difficulty of fitting ESD into an already full curriculum, reflecting a common issue where existing content does not easily accommodate new initiatives. This response points to the need for curriculum flexibility to allow for effective ESD implementation.

'I think it's a good concept, particularly because it's eco-friendly.'

PT5 expresses a positive view of ESD, focusing on its eco-friendly aspects. This statement aligns with the environmental pillar of ESD but does not fully address the social and economic dimensions. The response suggests that while there is an appreciation for the environmental benefits, a broader understanding of ESD's comprehensive goals might be lacking.

'Integrating it in my teaching will teach learners about how to care for the environment, and therefore how the impact of global warming can be minimised'.

PT6 sees ESD integration as a means to educate students about environmental care and mitigating global warming. This response highlights the environmental focus of ESD integration and its potential impact on student awareness and action regarding climate change. It underscores the importance of integrating environmental education within teaching practices.

Most responses expressed a positive perception of ESD, considering it a good initiative that fosters social values and skills for sustainable living. These positive opinions were often confined to the environmental pillar of ESD. However, this emphasis on the environmental aspect raises concerns about a potential limitation in understanding the broader scope of ESD, which includes the social and economic pillar.

'ESD integration is not easy as with the curriculum it is largely dedicated to certain content in the subject. The content to be taught is packed and leaves little room for ESD integration.'

The PT expressing challenges due to curriculum constraints underscores the necessity for a flexible and accommodating curriculum that can effectively facilitate ESD integration. The negative implications of restricting ESD primarily to the

environmental pillar are evident in the PT's response. The PT mentioned difficulty integrating ESD due to curriculum constraints, specifically in environmental topics.

It is crucial to recognise that ESD comprises not only environmental but also social and economic pillars. This limited awareness of ESD's holistic concepts may impact the prospective teachers' ability to integrate ESD effectively into their teaching practice. The PTs mentioned that they think ESD integration will assist in sustaining the environment.

'ESD is a good way to raise awareness in learners and open them up to methods and ways of living that will keep the environment safe and ensure economic sustainability.'

However, this PT mentioned that ESD raises awareness, and it helps to sustain the environment and the economic sustainability. Positive perception on ESD integration could possibly have a positive impact on the teachers' ESD integration into their teaching practices. Despite these challenges, the positive perception of ESD's potential impact on sustainability, as mentioned by the PTs, could serve as a positive factor for their integration efforts.

Emphasising the importance of a comprehensive understanding of ESD, particularly in the foundational learning-to-know competency, is essential to address these challenges and enhance effective integration strategies. This response also addresses the pedagogies pillar, emphasizing teaching learners' methods of living that ensure the sustainability of the environment.

4.3.2 Learning to do.

4.3.2.1 How do PTs integrate ESD in the teaching of life sciences?

Most respondents indicated that they integrate ESD by teaching about environmental issues and emphasizing the importance of caring for the environment.

Some of the responses

Conducting investigations and case studies that are context based that learners can relate to such as waste management but also linking topics such as respiratory system to issues in the environment that may result in complications in the respiratory system.

The PT mentioned that they can integrate a topic on waste management, linking it to topics such as respiratory diseases that result from pollution. This approach demonstrates the interconnectedness of ESD, bridging both the environmental and the social pillars.

*Teaching learners about the benefits of following a balanced diet when covering nutrition and also teaching about the importance of sustainability and taking care of the **environment** when covering environmental studies, this may also include teaching learners about recycling and reusing as much as they can.*

The PT mentioned above covers the social pillar by teaching about a balanced diet and the importance of nutrition. Additionally, the environmental pillar is addressed as the prospective teacher teaches about recycling and reusing to sustain the environment.

*As the teacher I may also need to model that **practice** for them and encourage them to do the same for example the container that I use to pack my lunch could be recycled etc*

The PT mentions that they model sustainability for the learners. This response briefly addresses the learning to be and learning to live together competencies as the prospective teacher emphasizes being an example to learners, illustrating that sustainable living extends beyond the classroom.

*I ensure that for every topic taught, learners can **apply** it and they understand the social, environmental or economic values which are linked to the concept.*

Additionally, another PT highlights the importance of applying sustainability values and competencies across the social, environmental, and economic pillars. The PT emphasizes that for every topic taught, learners need to understand the ESD values associated with that topic.

*By **teaching** learners about their different Global challenges as well as the different solutions. Though to some extent I feel it is not feasible.*

This PT mentions that they integrate ESD by teaching learners about global challenges, which include the Covid-19 pandemic, and solutions. Furthermore, the

prospective teacher adds that this proposed approach is not possible. This response indicates that this prospective teacher has not grasped the holistic understanding of ESD and is not informed on how to integrate ESD into teaching effectively. This could be attributed to limited pedagogical approaches in teacher education, and this, in turn, has a ripple effect on PTs.

These responses support the idea that some of the prospective teachers restrict ESD to the environmental pillar, demonstrating partial knowledge about ESD. It's important to emphasize that ESD cannot be effectively taught using traditional strategies, and it goes beyond being just additional information in the curriculum. However, some prospective teachers mentioned that they will employ practical **teaching methods** to help learners apply knowledge.

4.3.3 *Learning to be and live together.*

4.3.3.1 Why do you think it is important to integrate ESD in the classroom?

All the respondents understood the importance of ESD. They all believe that ESD prepares the students to become responsible citizens in the society.

*The world we live in now is already damaged, for example (**global warming/depletion of the ozone**) all caused by human activities/carelessness. If we as teachers don't emphasize the importance of ESD then the future creatures might not have a world to live in.*

Because sustainability for the future generations depends on us as the current generation.

*If we are not sustainable that will have a negative impact on our **ecosystem** and on the future generations.*

The responses from the above PTs highlight the impact of a lack of sustainability and how it has affected the world we live in. They state that the future generation depends on the current generation. Therefore, it is important to impart and raise awareness about sustainability issues to consider the future generation.

*To raise awareness and **citizenship education**.*

*To impart learners with knowledge, skills, values and attitudes to make **responsible decisions** concerning **society** and the **environment**.*

*To get learners thinking about their **role in the society**, their own carbon footprint and what they can do to better the **economy** and **environment**.*

*This is because learners must be groomed to be **responsible citizens** who contribute to the development of the country, not just in any way, but in a responsible way. Relate the knowledge to the environment.*

*To prepare learners to be **active participants of society** who understand the importance of maintaining harmony between humans, the environment whilst developing it.*

The above responses highlight the role of teachers in producing learners who will acknowledge their role in society and be active participants in living sustainable lives that will positively impact others. ESD brings about awareness to the learners so that they acknowledge their carbon footprint and contribute to solutions.

The last response raises the idea of preparing the learners to be active participants and understand living in harmony with others and the environment. These responses highlight the key role of the citizenship skills pillar.

4.3.4 Integration of ESD in teacher training curriculum.

Question 8 -Has the university included ESD in the curriculum?

8 out of the 10 PT participants emphasized the notion that their teacher training institution did not include ESD in the curriculum. It is possible that ESD integration in the institution is embedded, and the prospective teachers might be struggling to identify its presence. This stresses the importance of explicit integration of ESD to avoid confusion among prospective teachers. However, two participants stated that ESD has been integrated into the institution. These two PTs indicated that the institution exposed them to the meaning of ESD.

No, I don't remember being taught ESD at university level.

No, I have no recollection of that being done.

I am not sure.

I am not sure.

No, I do not recall.

No.

I'm not really sure since it was online learning, I think they need to work on it.

I am not sure. This is because, in lectures, I have only heard relevant concepts taught and the value of the lesson was not communicated so much and how it can help the students to be responsible citizens.

This participant's response solidifies the notion that ESD might be embedded in their course: "I have only heard relevant concepts taught." This participant cannot pinpoint ESD integration in the curriculum, but they can recall certain ESD concepts. However, they stated that the significance of the ESD lesson and integration was not emphasized. The participants were not taught how to apply these concepts to their own teaching. It is important to note that a successful integration of ESD relies not only on incorporating it into the curriculum but also on equipping teachers with a deep understanding of its value and practical application in their teaching. Without this foundational knowledge, the intended goals of ESD may not be effectively achieved.

Yes, they have. By looking at what ESD is and what its integration means. By looking at methods of ESD integration and STEM. I do believe that STEM integration goes together with ESD integration.

Yes, by integrating the local and global contexts when preparing students to respond to the changing world.

These two respondents stated that the teacher training institution included ESD in its curriculum. The first response draws a connection between STEM and ESD, emphasizing that the PT was taught the meaning of ESD and its integration. Furthermore, the PT mentions being exposed to methods of integrating ESD and STEM.

The second PT mentions the importance of considering both local and global contexts, preparing students to respond to change. The PT mentions being exposed to integrating these different contexts into their teaching to produce learners capable of bringing solutions. This response emphasizes that the PT was exposed to the role of teachers as agents of change, teaching students' citizenship skills.

4.3.5 ESD integration in the CAPS document.

Six participants stated that the CAPS does not integrate ESD. This represents more than half of the prospective teachers who are unable to identify any ESD integration in the CAPS document. This suggests that PTs were unable to recognise how ESD has been integrated into the CAPS document, possibly due to its embedded nature. The responses indicate that PTs struggled to identify such integration.

An additional two prospective teachers did not know whether the CAPS document integrates ESD. They neither agreed nor disagreed; they were uncertain. This uncertainty may indicate that prospective teachers have only partial knowledge of ESD, making it challenging for them to identify any integration. On the other hand, two prospective students agreed that the CAPS document does integrate ESD, they also mentioned topics categorised under environmental issues and other subjects.

No.

Not at all

They don't, because they only use examples that are only applicable in certain contexts.

No, it does not.

No.

No.

Two respondents agree that the CAPS document does integrate ESD. Both PTs responded that the environmental studies strand integrates ESD.

To an extent yes, CAPS for Life Sciences and not necessarily for other subjects, Life Sciences has the environmental studies strand as well as nutrition so I could say that it integrates ESD by default.

This response identified that although ESD is integrated, it does not explicitly mention ESD. The PT mentions that the CAPS document includes ESD through topics such as environmental studies and nutrition.

The CAPS does talk about ESD integration particularly when you look at the environmental section and human impact section of the Life Sciences CAPS document.

Similarly, to the previous response, this PT also identified that the environmental section of the CAPS document addresses issues of sustainable development, and the human impact section also covers ESD integration.

I don't know.

I am not sure.

Two respondents were uncertain about the answer. They couldn't identify ESD integration in the CAPS document because they were unsure about its presence or absence.

4.3.6 The impact of Covid on the integration of ESD.

Participant responses

*There were **no excursions and explorations** during Covid-19.*

*Less contact meant that **practicals** could not be conducted anymore.*

The PTs mentioned that all classes were conducted online, making it challenging to implement ESD related practicals and excursions. Thus, it made it difficult to apply ESD integration practically due to the social distancing restrictions.

People were also not eating a lot of take outs and those who could practiced subsistence farming.

The above response from the PT highlights the positive environmental impacts observed during the COVID-19 pandemic, such as reduced eating out and they also add that there was an increase in sustainable farming. However, the response does not explicitly address how Education for Sustainable Development (ESD) was integrated during this period.

*I am not sure how it has affected the integration of the ESD because during the lockdowns there weren't many interactions with the **environment** and that was somewhat beneficial because it meant no littering or pollution of the environment.*

It hasn't I feel lockdown have helped sustain our universe, the more people are locked at home, the less deforestation, and air pollution thus sustaining our environment.

The two responses indicate agreement that the environmental pillar benefited from the pandemic, with reduced air pollution and deforestation due to quarantine measures.

However, similar to previous responses, there is no explicit mention of how Education for Sustainable Development (ESD) was integrated into the curriculum or how the pandemic impacted ESD integration.

Teachers are more focused on assessment than teaching. It is hard for them to teach every topic in the syllabus, some topics such as ESD have been removed to allow for a lessened syllabus so as to finish the academic year.

The PT feels that the teacher educators (TEs) were more focused on covering content rather than integrating ESD during their lessons. They also felt bombarded with information and expressed a sense that some topics were removed to complete the academic year. This response suggests that ESD integration was neglected during the pandemic.

Because everything is done virtually

Less contact and class time \making it difficult to integrate ESD.

The learning has been online, therefore, it makes it difficult to see if learners are learning and really integrating the knowledge

The above response indicates that all activities were conducted virtually, making ESD integration challenging due to the absence of physical contact. The PTs express that this virtual setting made it difficult for both TEs and PTs to assess whether students were truly learning or applying ESD knowledge. In summary, according to these PTs, ESD integration was challenging for both TEs and PTs during the pandemic.

4.4 Teacher Educator (TE) interview data

Table 2 TE interview data

Category	Question	Responses (codes)
Learning to learn	1.What is ESD?	1 Contextual approach to education Role of human beings. Economic, Environmental pedagogies

Learning to do	2. What is your opinion on integrating ESD in your teaching?	2. Important to equip learners with citizenship skills Social responsibility Sustainable living
	3. How do you integrate ESD in the teaching of life sciences?	Pedagogies for ESD 3. Align topics with SDGs Integrate sustainability issues. Practical activity Cooperative learning Project based assessment
Learning to be and to live together.	4. Why do you think it is important to integrate ESD in the classroom?	4. Sustainability starts with teachers
	5. Has the university included ESD in the curriculum? If so, how?	5. No- it is integrated through an individual's personal agency Partially- mentioned aspects of SD.
	6. Does the CAPS document integrate ESD? If so, how?	6. Yes partially CAPS aims. Life sciences topics
	7. How has Covid affected the integration of ESD?	7. Unable to do practical work Affected cooperative learning and Project based assessment
	8. What can be done to ensure that ESD is integrated better during the Covid pandemic?	8. Solve real life problems Cooperative learning

Section 4.4 aims to explore the following research question:

How did teacher educators adapt their Life science classroom practices to integrate ESD during the Covid pandemic

4.4.1 Learning to know.

4.4.1.1 What is ESD?

The teacher educators gave thorough descriptions of ESD, including its social, economic, and environmental foundations. They effectively deconstructed the nature of ESD and highlighted its multifaceted character. They also elaborated on how ESD provides learners with vital skills. The replies from the teacher educators demonstrated a thorough understanding of ESD, emphasizing its connection to teaching skills for sustainable living.

Teacher educator 2 `ESD is a contextual approach to education where learners are equipped with skills and attitude to live sustainably`

This response from Teacher Educator 2 defines ESD as a contextual approach in which students get equipped with skills to become responsible citizens. Additionally, this viewpoint underlines the significance of the citizenship skills pillar within ESD.

4.4.1.2 Opinion on integrating ESD in your teaching?

Both teacher educators expressed positive views and opinions regarding the integration of ESD into their teaching. They shared a positive perspective on ESD, emphasizing its significance in imparting life skills and fostering a sense of citizenship responsibility among learners.

Teacher educator 1 `ESD equips the learners with citizenship skills`

TE 1 gives emphasis to the influential role of teachers in achieving ESD objectives. Additionally, TE 1 asserts that ESD fosters citizenship abilities, with teachers playing a pivotal role in equipping learners with essential citizenship skills.

Teacher educator 2 `ESD is compulsory for everyone, everyone should take responsibility for the sustainability goals`.

TE 2 emphasizes everyone's common duty toward sustainability goals. ESD is essential, as everyone should play their part in contributing towards the sustainability goals.

In summary, both Teacher Educators were explicit and intentional in integrating ESD into their teaching approach. They were knowledgeable about ESD and saw it as an approach to bring about sustainability. They strongly believed that integrating ESD into teaching would help produce a generation that makes sustainable, responsible decisions.

4.4.2 Learning to do.

4.4.2.1 How TEs integrate ESD in the teaching of Life Sciences?

The teacher educators identified the extended five pillars of ESD, including the social, economic, environmental, citizenship pillars, and pedagogies for ESD. According to these pedagogies, the educators mentioned aligning content with the SDGs, integrating sustainability issues, involving cooperative learning, conducting practical teaching, and incorporating project-based assessment. These pedagogies cover the learning to know, learning to do, learning to be and live together competencies. Prospective teachers are taught about the SDGs and are encouraged to apply practical work collaboratively to live sustainably and practice responsible citizenship skills in their society.

Below are the pedagogies that the TE mentioned during the interview:

“Integration of Sustainability Issues”

TE1 stressed the significance of integrating sustainability issues into teaching. This involves encouraging prospective teachers (PTs) to think about sustainability beyond the classroom, fostering a mindset that extends to the real-world implications of their teaching.

“Practical Activity and project-based assessment”.

Furthermore, TE 1 encouraged PTs to go beyond theoretical discussions of sustainability. They were prompted to visit schools, identify sustainability issues, and initiate change programs to address these issues practically. TE 1 highlighted the importance of project-based assessments. This involves PTs working in pairs on projects that are centered around ESD content. The emphasis is on practical, hands-on learning to reinforce ESD principles.

“Cooperative Learning”

TE2 emphasized the importance of cooperative learning. TE 2 encouraged PTs to work together, share ideas, and collaboratively think about ways to address sustainability issues. The focus is on fostering collaboration and the sharing of ideas among students.

“Aligning Topics with SDGs”

Both TE1 and TE2 emphasized the importance of aligning their content with the Sustainable Development Goals (SDGs). They believe that this alignment showcases the interconnectedness of topics with global sustainability goals, providing students with a broader perspective.

These strategies align with the extended pillars of ESD, covering the social, economic, environmental, citizenship, and pedagogies for ESD. The pedagogical approaches not only address the theoretical aspects of ESD but also emphasize practical, real-world applications. The inclusion of SDGs ensures that students understand the global context of their studies and how it relates to broader sustainability objectives.

4.4.3 Learning to be and live together.

4.4.3.1 Why do TEs think it is important to integrate ESD in the classroom?

Both the teacher educators and acknowledged the significance of ESD, emphasizing its role in equipping students with values and skills that foster sustainable decision-making.

TE 1- ‘sustainability starts with teachers’ The teachers play a big role in educating the community and generations.

TE 1 emphasizes that sustainability starts with teachers, positioning them as vehicles in educating communities and future generations. The idea is that when teachers are educated about sustainability, they can effectively impart this knowledge to their students, fostering positive change.

TE 2- ‘teacher education is the key source of knowledge’ Teachers have a big influence in society.

Similarly, TE 2 highlights the pivotal role that teachers play as agents of change. The response emphasizes that teachers are not only a source of knowledge but also hold influence in society. Integrating ESD in teacher education is seen as a means to

empower prospective teachers to equip their students with the necessary skills for ensuring sustainability.

4.4.3.2 ESD integration in the Teacher education curriculum?

Both the teacher educators partially disagree. The teacher educators stated that ESD integration is not explicitly visible in the university policy and that ESD integration in course programs is dependent upon the individual's personal agency. The teacher training institution embraces ESD however there is no clear translation on how ESD can be integrated into various courses.

Teacher educator 1- *'ESD integration is not visible in the handbook, but it's integrated through personal agency.'*

According to TE 1, the integration of ESD in the course is driven by personal agency. The teacher educator has the flexibility to rearrange the course outline to align with the ESD framework. Notably, the integration of ESD is not mandatory, and it is not explicitly outlined in the given handbook. The integration of ESD is influenced by the personal convictions and values of the teacher educator.

Teacher educator 2- *'the university prospectus embraces sustainability issues such as gender equality.'*

TE 2 highlighted that the university prospectus incorporates sustainability issues, including gender equality. However, the mere acknowledgment of sustainability in the prospectus doesn't necessarily imply the integration of ESD into the Teacher Education program. The TE also mentioned that the course outline aligns with ESD competencies. Still, there is a lack of specific guidelines for teacher educators on how to translate this policy into their teaching practice. While the TEs may have the desire to integrate ESD, the absence of clear directives might hinder their ability to effectively do so.

4.4.3.3 ESD integration in the CAPS document.

The teacher educators agreed that the CAPS document integrates ESD through its curriculum aims. They specifically identified topics such as ecology, environmental studies, and human impact on the environment. TE 2 added that the nature of the Life Sciences subject involves many issues related to sustainability. While ESD may not be explicitly mentioned, numerous topics and aims in the CAPS document point towards sustainable development. Further details on these points will be presented in the CAPS document analysis.

4.4.3.4. The impact of Covid on the integration of ESD?

The pandemic presented more challenges than opportunities for the Teacher Educators (TEs). Teaching itself became more challenging, let alone the integration of ESD.

TE 1 expressed that Covid significantly impacted the practicality of content delivery.

“Covid affected the practicality of content”.

The challenge lied in translating theoretical knowledge into practical applications. The teacher educator faced limitations in observing the PTs' change project, which was intended to involve the school learners, as they couldn't implement the project due to the lockdown. ESD extends beyond the four walls of the classroom, involving bringing solutions to sustainability issues and acting on them. However, due to the restrictions that resulted from the pandemic, the PTs had to keep their projects as mere ideas in their courses instead of making a difference in schools. TE 1 experienced a setback due to the pandemic.

Similarly, TE 2 encountered difficulties in virtually pairing PTs to perform tasks together due to connectivity issues.

“Students struggled with connectivity issues”.

Prospective teachers faced connectivity challenges, which subsequently affected assessments. For TE 2, students struggled with connectivity and network issues. It appears that this could be a general issue that every TE struggled with, regardless of their integration of ESD. This challenge is not unique to ESD integration; surely, TE 1 also struggled with this issue. However, TE 2 also mentioned that one competency of ESD is collaboration, and it is crucial for PTs to share ideas and come up with solutions.

Covid's impact on the practical aspects was evident. TE 1 couldn't assess the hands-on project assigned to prospective teachers. As an alternative, a non-practical approach was implemented, consequently affecting the integration of ESD.

While the overall approach to teaching remained consistent, the shift from physical to online learning during the pandemic brought about notable changes, such as the adjustment of the change project assessment and the virtual pairing.

4.5 The organisation, teaching approach and assessment used during the pandemic to integrate ESD.

4.5.1 The organisation of the teacher educators' course outlines

4.5.1.1 Course outline aims and schedule of activities- Teacher Educator 1.

The course outline data was divided into three categories which include: the course aim, schedule of topic and assessment of ESD. The data was analysed using the UNECE (2012) competencies and the five pillars of ESD (Tsakeni,2018).

Before commencing the analysis of course outlines during the pandemic, it is vital to mention that the pre-COVID course outlines will not be included in this analysis as they are essentially similar. The changes observed will be in the teaching approach and assessment, which will be analysed later in this chapter.

Below are the course aims. The course aims to assist students in acquiring knowledge and skills that will help prospective teachers develop a positive attitude towards Life Science and the world. It aims to help students apply this knowledge in society and in their everyday lives. These aims are categorized as the social and citizenship skills pillars. Prospective teachers are equipped to use their knowledge to make socially responsible decisions and to be active citizens. These aims align with the learning to be and learning to live together ESD competencies.

Below is a page extracted from the TEs' 1 course outline. Figure 5 represents the aims of the course.

Overview/aims of the course

This course, which is part of the Postgraduate Certificate in Education aims to help students to acquire knowledge, develop teaching skills and competencies, and to develop positive attitudes towards science, towards the living world in particular and towards the teaching and learning of Life Sciences. It is designed to prepare pre-service FET Life Science teachers through the development of the following competences:

- **subject (content) knowledge:** a comprehensive knowledge of your discipline i.e. knowledge of main concepts and principles; awareness (and experience of) ways in which new knowledge is discovered in the sciences; and ability to apply and use that knowledge in your own life and in society.
- **knowledge of learners and their world:** a knowledge of learners' preconceptions, of their experiences in everyday life, and of the difficulties they experience in learning in the Life Sciences. A knowledge of and ability to use analogies and examples that are meaningful to the learner and help them make connections between the Life Sciences and their world.
- **teaching methodology (pedagogy):** knowledge of, and insight into, different methods of and approaches to teaching
- **pedagogical content knowledge:** the ability to select and use appropriate teaching strategies and materials to enable learners to understand concepts and processes in the Life Sciences and use these concepts and processes in their everyday life.

Figure 4 Course outline.

Schedule of activities- TE 1

The schedule illustrates that the students were taught online due to the pandemic. On the 11th of March, TE 1 presented the first introduction lecture on Sustainability and Education for Sustainable Development. This lesson is categorised under the Learning to know competency. This lesson is categorized under the Learning to know competency. The aim of the lesson is to expose the prospective teachers to sustainability and ESD. It includes ESD learning objectives, covering the nature and fundamentals of ESD. The prospective teachers are explicitly introduced to the definition of sustainability and the related objectives.

Schedule of Activities

PGCE Life Sciences 2021				
Tuesdays (online) 14h15 – 16h00			Thursdays (online) 10h15 – 12h00	
OBSERVATIONAL TEACHING EXPERIENCE (Observation): 01-05 March 2021				
9 March	Feedback from Observational TE Introduction & Planning		11March	Sustainability and Education for Sustainable Development: Orientation towards assignment 1 http://www.globalgoals.org/ : UNESCO (2017a). Education for Sustainable Development Goals. Learning objectives. Paris: UNESCO
16 March	Critical analysis and interpretation of FET CAPS documents	Online Subject competence test Grade 10 terms 1 and 2	18March	Details of Assignment 2 Unit and Lesson Planning (Brain storm and Tut)

Figure 5 Schedule of activities TE1

4.5.1.2 Course outline aims and schedule of the topic- Teacher Educator 2.

The course aims for Teacher Educator 2 are similar to those presented in the previous analysis of Teacher Educator 1. Both aim to develop students' citizenship skills and help them cultivate a positive attitude toward Life Science and the world. The course aims for both Teacher Educators align in focusing on developing prospective teachers' citizenship skills and fostering a positive attitude toward Life Science and the world. There were no specific aims directly linking ESD integration to the Covid pandemic.

7	15 Sep		~~Electric Circuits~~		Enzymes
8	29 Sep		~~Organic chemistry~~		Environment and Sustainability Education
9	06 Oct		~~Stoichiometry~~		Reproduction

Figure 6 Schedule of activities TE 2

Figure 7 represents two courses, physical sciences on the left and Life Sciences on the right. The physical sciences topics have been struck out as they do not relate to this study. On the 29th of September, TE 2 taught about the Environment and Sustainability Education. This introduction is categorised under learning to know competency.

4.5.2 Assessment of ESD during COVID- TE 1

Below are the detailed assessment requirements. Prospective teachers were required to implement their change projects during their teaching practicums. The change project enabled prospective teachers to engage in hands-on, real-life practical activities. This assignment seamlessly integrated the social, environmental, and citizenship pillars. Furthermore, prospective teachers were able to exercise the four competencies: learning to know (identifying Sustainable Development Goals in the CAPS document), learning to do (creating a change project using the identified SDGs), learning to live together (bringing about change in their practicing schools), and lastly, learning to be (developing citizenship skills through the assignments).

Figure 8 shows the instruction and the criteria of the assignment.

Assignment 1: Education for Sustainable Development and Change Project [30]

1. This assignment is to be completed in pairs.
 - Analyse the CAPS document and identify the SD goals emphasized in the different topics. (Choose one Grade; 10, 11 or 12).
 - Which of these SDGs can you focus on in your possible change project we discussed in class tutorial? Elaborate. (1Page, font 12, spacing 1.5)
2. Think of a project related to specific SDG/s and in line with a topic in the CAPS syllabus which will be taught during the time you will be on TE in Block 3.
 - This change Project/s should be an initiative that you as a teacher can do in your practising school in line with the topics you will be teaching, these projects are then aligned with relevant SDGs. The whole Idea is to integrate Education for Sustainable Development.
 - The Change Projects must be orientated towards sustainability and integrating ESD.
 - Project can be in the form of hands-on project, practical, assessment, integration of culture and indigenous knowledge into curriculum, community, school or classroom engagement, and science and technology innovations for sustainability. (2pages, font 12, spacing 1.5)

Due date: April (Long-term project)

	0-2	3-4	4-5	6-8
CAPS document analysis	No SDG goals identified	SDG goals identified in 1 strand	SDG goals identified in 2 strands	SDG goals identified in 3 to all strands
SDG goals of focus	No SDG goals for project identified	SDG goals for project identified	SDG goals for project identified and justified	
Project identified	No project identified	A project identified	A project identified and justified	
Project ESD orientation description	Project orientation not described or unclear	Project orientation described clearly	Project orientation described clearly and justified	
Aspects covered <i>Hands-on, practical, assessment, integration of culture, indigenous knowledge into curriculum, community, school or classroom engagement, and science and technology innovations for ESD</i>	0-2 of the aspects covered	Up to 4 aspects covered	Up to 7 (Max 7marks)	
Total /30				

Figure 7 ESD assessment TE1

Assignment 1, ESD and change project, faced challenges in full implementation during the pandemic due to social distancing regulations. Therefore, the assessment had to be modified and limited to an online platform.

Block 1

Assignment 1: Education for Sustainable Development

(30)

This assignment is to be completed in pairs. Analyse the CAPS document and identify the SD goals emphasized in the different topics. Which of these SDGs can you focus on in your possible change project we discussed in class? Elaborate.

Due date: 23 April (Long-term project)

Figure 8 Updated assignment.

The organisation of the course before and during the pandemic

Organisation of the Course Before and During the Pandemic: The course outline remained unchanged before and during the pandemic, with the course aims and schedule of activities remaining consistent across these periods. However, the pandemic did impact the assessment approach in Teacher Educator 1's course. Due to restrictions, prospective teachers couldn't engage in practical, hands-on change projects as initially planned. Instead of visiting schools, an assessment in pairs was organised.

ESD Integration and Assessment During Covid: The course outlines and teacher educators' interviews indicated that prospective teachers attended virtual classes during the pandemic. Connectivity issues made cooperative learning and group work challenging. Pre-planned assessments could not be executed as intended.

Due to the pandemic, students couldn't go to schools for the change project implementation, shifting to online attendance and assignment completion. This posed restrictions for both teacher educators and prospective teachers. However, ESD integration did occur through the learning to know, learning to live together, and learning to be competences. Unfortunately, the learning to do aspect and authentic, real-life projects couldn't be fully executed.

4.5.3 Assessment of ESD during COVID- TE 2

Figure 10 below represents the activity that was given to the prospective teachers after the topic introduction. The activity aimed to allow the prospective teachers to reflect on the pedagogical content knowledge and ESD.

Purpose of this activity

Through engagement with literature the group will strive to establish what can be considered as pedagogical content knowledge for the discipline which includes ESD. The session will provide readings from which students will reflect on how to relate (topic specific) pedagogical content knowledge and ESD. From these readings students will discern what content knowledge is for ESD and what would constitute pedagogical knowledge for ESD in a topic of choice.

Activity

Identify a topic that you may teach. Read the suggested articles and answer questions that follow:

1. What would constitute science content knowledge for this topic
2. How can the science content for this topic be structured to mainstream education for sustainable development content outcomes (including key competences for sustainability)?
3. How can the pedagogical outcomes of this topic be structured so that they contribute to mainstreaming ESD (including key competences for sustainability)?
4. How can a teacher work with the UNESCO Education for Sustainable Development: Learning Objectives in order to achieve content and pedagogy for ESD?

Figure 9 ESD activity TE 2

The prospective teachers engaged in an activity where they identified the components of science knowledge related to a specific topic. For the assessment, Teacher Educator 2 paired prospective teachers to identify Sustainable Development Goals (SDGs) from the CAPS document. They assessed how the content aligned with

Education for Sustainable Development (ESD) and identified pedagogical outcomes contributing to ESD. Teacher Educator 2 employed various approaches to assess ESD. This activity explored the competencies of learning to know, learning to do, and learning to be. The prospective teachers were introduced to the concept of ESD and how to apply ESD practices in their classrooms, focusing on the pedagogies for ESD pillars.

4.6 Analysis of the National curriculum policy (Life sciences CAPS document)

The Curriculum and Assessment Policy Statement (CAPS) document comprises of general aims, which can be classified into various competencies and pillars of ESD. It serves as a critical resource for comprehending the Life Sciences curriculum in South Africa. The data within this document is divided into three categories: curriculum aims, purpose, and schedule (strands). Within the Life Science curriculum policy (CAPS), various strands, including Diversity, Change and Continuity, and Environmental Studies, are identified. These strands enable students to explore diverse populations and ecosystems. In grades 11 and 12, the topic of Population Ecology delves into human impact, covering the social, environmental, and citizenship pillars.

4.6.1 The CAPS aims.

Aim 1.3a emphasizes the learning to do competency, emphasizing that learners should acquire and apply knowledge in their local contexts. It also addresses the social pillar of ESD. The curriculum aims to assist learners in developing skills and values valuable to both society and the global community.

Aim 1.3b and c fall into the categories of learning to be and live together, and the citizenship skills pillar. This aim advocates for active, responsible, and meaningful participation in society, fostering unity despite diversity. Learners are encouraged to make positive contributions to society, think critically for social transformation, and develop skills that make them sensitive to societal diversity.

1.3 General aims of the South African Curriculum

- (a) The *National Curriculum Statement Grades R-12* gives expression to the knowledge, skills and values worth learning in South African schools. This curriculum aims to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives.
- (b) The *National Curriculum Statement Grades R-12* serves the purposes of:
- equipping learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with the knowledge, skills and values necessary for self-fulfilment, and meaningful participation in society as citizens of a free country;
 - providing access to higher education;
 - facilitating the transition of learners from education institutions to the workplace; and
 - providing employers with a sufficient profile of a learner's competences.
- (c) The *National Curriculum Statement Grades R-12* is based on the following principles:
- Social transformation: ensuring that the educational imbalances of the past are redressed, and that equal educational opportunities are provided for all sections of the population;
 - Active and critical learning: encouraging an active and critical approach to learning, rather than rote and uncritical learning of given truths;
 - High knowledge and high skills: the minimum standards of knowledge and skills to be achieved at each grade are specified and set high, achievable standards in all subjects;
 - Progression: content and context of each grade shows progression from simple to complex;

Figure 10 General aims of SA curriculum.

Aim d: The curriculum aims to cultivate learners who will utilize science and technology to address environmental issues. Learners are expected to develop problem-solving skills and comprehend the interconnectedness of the world. This aim can be classified under the categories of learning to be and live together and learning to do. It recognizes the social, environmental, and citizenship skills dimensions of ESD.

LIFE SCIENCES GRADES 10-12

- Human rights, inclusivity, environmental and social justice: infusing the principles and practices of social and environmental justice and human rights as defined in the Constitution of the Republic of South Africa. The National Curriculum Statement Grades R-12 is sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors;
- Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution; and
- Credibility, quality and efficiency: providing an education that is comparable in quality, breadth and depth to those of other countries.

(d) The National Curriculum Statement Grades R-12 aims to produce learners that are able to:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively as individuals and with others as members of a team;
- organise and manage themselves and their activities responsibly and effectively;
- collect, analyse, organise and critically evaluate information;
- communicate effectively using visual, symbolic and/or language skills in various modes;
- use science and technology effectively and critically showing responsibility towards the environment and the health of others; and
- demonstrate an understanding of the world as a set of related systems by recognising that problem solving contexts do not exist in isolation.

(e) Inclusivity should become a central part of the organisation, planning and teaching at each school. This can only happen if all teachers have a sound understanding of how to recognise and address barriers to learning, and how to plan for diversity.

The key to managing inclusivity is ensuring that barriers are identified and addressed by all the relevant support structures within the school community, including teachers, District-Based Support Teams, Institutional-Level Support Teams, parents and Special Schools as Resource Centres. To address barriers in the classroom, teachers should use various curriculum differentiation strategies such as those included in the Department of Basic Education's *Guidelines for Inclusive Teaching and Learning* (2010).

LIFE SCIENCES GRADES 10-12

- Knowledge Strand 3: Environmental Studies;
- Knowledge Strand 4: Diversity, Change and Continuity.

These Knowledge Strands and the topics within each knowledge strand should not be studied separately or independently. The Knowledge Strands do not need to be taught in the same sequence each year, nor do all four Knowledge Strands have to be covered in each year. This categorisation is simply a tool for organising the subject content and they are also not weighted equally. When teaching Life Sciences, it is very important to help learners to recognise the links between related topics so that they acquire a thorough understanding of the nature and inter-connectedness of life. These links must also be made across grades.

Life Sciences: Concept and Content Progression

Strands	Life at molecular, cellular, and tissue level	Life processes in plants and animals	Diversity, change and continuity	Environmental studies
Grade 10	• Chemistry of life - Inorganic compounds - Organic compounds • Cell - unit of life • Cell division (mitosis) • Plant and animal tissues	• Support and transport systems in plants • Support systems in animals • Transport system in mammals	• Biodiversity and classification • History of life on Earth	• Biosphere to ecosystems
Grade 11		• Energy transformations to support life: photosynthesis • Animal nutrition • Energy transformations: respiration • Gas exchange • Excretion	• Biodiversity - classification of microorganisms • Biodiversity - plants • Reproduction - plants • Biodiversity - animals	• Population ecology • Human impact on environment: current crises
Grade 12	• DNA code of Life • RNA and protein synthesis • Meiosis	• Reproduction in vertebrates • Human reproduction • Nervous system • Senses • Endocrine system • Homeostasis	• Darwinism and Natural Selection • Human evolution	• Human impact on environment: current crises Grade 11

The content framework focuses on ideas, skills and concepts as well as connections between them, rather than on listing the facts and procedures that need to be learned. It also does not prescribe particular instructional strategies or methodologies. Instead, educators have the freedom to expand concepts and to design and organise learning experiences according to their local circumstances, including the availability of resources.

Figure 11 Life Science CAPS content.**2.4 The Purpose of Studying Life Sciences**

- *The development of Scientific Knowledge and Understanding*

Scientific knowledge and understanding can be used to answer questions about the nature of the living world around us. It can prepare learners for economic activity and self-expression and it lays the basis of further studies in science and prepares learners for active participation in a democratic society that values human rights and promotes acting responsibly towards the environment.

- *The Development of Science Process Skills (Scientific Investigations)*

The teaching and learning of science involves the development of a range of process skills that may be used in everyday life, in the community and in the workplace. Learners can gain these skills in an environment that supports creativity, responsibility and growing confidence. Learners develop the ability to think objectively and use different types of reasoning while they use process skills to investigate, reflect, synthesise and communicate.

- *The Development of an Understanding of Science's Roles in society*

Both science and technology have made a major impact, both positive and negative, on our world. A careful selection of scientific content and the use of a variety of methods to teach and learn science should promote the understanding of science as a human activity as well as the history of science and the relationship between Life Sciences and other subjects. It also helps learners to understand the contribution of science to social justice and societal development as well as the need for using scientific knowledge responsibly in the interest of ourselves, society and the environment. Moreover, understanding science also helps us to understand the consequences of decisions that involve ethical issues.

Figure 12 Purpose of studying Life Science**4.6.2 The purpose of the curriculum**

Section 2.4 of the Life Science curriculum outlines its purpose, highlighting that learners are equipped for the economic pillar while learning values and skills that foster citizenship. The subject encourages students to become creative and responsible towards the environment, while aiding them in understanding the impact of unsustainable and unethical issues.

Chapter summary

This chapter presented the study's findings on the integration of ESD into teacher education during the COVID pandemic. The data was obtained through open-ended surveys distributed to prospective teachers, semi-structured interviews with teacher educators, evaluation of course outlines, and analysis of the Life Sciences CAPS document. The analysis was conducted using the ESD conceptual framework as well as the UNECE framework of learning to know, learn to do, learn to be, and live together.

Chapter 5 Data discussion

5.1 Introduction

This chapter provides a discussion of the results obtained from the investigation of ESD integration in teacher education during the COVID-19 pandemic. The data presents insights into how teacher educators adapted their Life Science classroom practices to integrate Education for Sustainable Development (ESD) during the Covid pandemic.

The primary objective of this chapter is to present a summary of the findings. This research study drew upon the framework proposed by UNECE (2012) on competencies for educators in Education for Sustainable Development, the three pillars of sustainability and the five pillars of ESD (Berglund and Gericke, 2016; Tsakeni, 2018) to guide the data analysis and interpretation of results. The interview and open-ended questionnaire questions were formulated similarly to allow for the triangulation of results. The questions were categorized into three competencies: learning to know, learning to do, learning to be and live together. These competencies cover understanding ESD, integrating ESD into teaching, engaging with diverse groups and disciplines, and adopting citizenship skills to challenge unsustainable practices.

5.2 Discussion of findings

5.2.1 Learning to know.

The results indicate that most prospective teachers' knowledge of ESD is limited to the environmental pillar, potentially leading to a misconception that ESD can only be taught on specific topics. However, ESD is interdisciplinary and interconnected, extending beyond a singular theme (Imara and Altinay, 2021). Many prospective teachers seemed to lack an understanding of the holistic nature of ESD, which can be interrelated with other topics through the social and economic pillars.

Teacher educators, on the other hand, demonstrated a holistic and in-depth understanding of ESD, exploring its social, economic, and environmental dimensions and how education can be a vehicle for sustainability. However, there appears to be a mismatch in the ESD learning to know competency between teacher educators and prospective teachers.

The findings highlight the need for improved education and clarification regarding the holistic nature of ESD. There's an opportunity for teacher educators to emphasize the interconnectedness of the social, economic, and environmental pillars to cultivate a comprehensive understanding among prospective teachers.

While there is a positive perception toward ESD, the predominant focus on the environmental aspect and concerns about curriculum constraints areas for improvement. The gap between the pedagogies of teacher educators and prospective teachers regarding ESD persists, suggesting that prospective teachers have not fully grasped the depth of ESD. However, some prospective teachers recognised the importance of practical teaching and the application of ESD knowledge.

5.2.2 Learning to do.

Some PTs suggested commendable ways to integrate ESD into their classroom practices however most limited their practices to only the environmental pillar. This limited knowledge restricted the PTs integration as they limited their practical efforts to the environment however sustainable development also has the social and economic pillar.

The prospective teachers seem to struggle to understand the holistic concept of ESD and how to integrate ESD into their teaching practices. This could be due to the fact that teacher training institutions allow teacher educators to integrate ESD into their practices based on their personal interest and agency. Furthermore, other research studies have analysed prospective teacher training programs and found that ESD competencies are lacking in the curriculum. As a result, prospective teachers may not possess the necessary knowledge and skills to teach ESD effectively (Ochieng & Kanyeki, 2020).

The TEs adopted strategies to integrate ESD into their teaching practices. Both educators highlighted the alignment of their course topics with the SDGs, demonstrating the interconnections and relevance of their content. TE 1 further emphasised the importance of integrating sustainability issues in lessons, aiming to foster critical thinking beyond the classroom (Albareda-Tiana et al., 2018). TE 1 implemented a practical change project, requiring students to apply their knowledge in real-life issues at their practising schools (Tsakeni, 2018).

Similarly, TE 2 emphasized the significance of practical activities, cooperative learning, and project-based assessments for the effective integration of ESD. TE 2 particularly highlighted that cooperative learning occurs through the sharing of ideas among students, promoting a collaborative and interactive learning environment.

These strategies not only align with global sustainability goals but also promote hands-on, experiential learning, encouraging PTs to think critically and apply their understanding in practical situations. The combination of aligning with SDGs, integrating sustainability issues, and incorporating practical projects showcases a comprehensive approach to ESD integration in their teaching practices (Rickinson et al., 2004; Tilbury, 2011).

5.2.3 Learning to be and live together.

Both PTs and TEs recognise the importance of ESD in equipping students with essential citizenship skills. TEs emphasised that sustainability starts with teachers, positioning teachers as vehicles for driving sustainability in society (Lotz-Sisitka, et.al.,2017). Through ESD integration, teachers can not only enhance their own understanding but also impart this knowledge to students, contributing to the development of individuals capable of leading sustainable lives.

PTs reiterated the significance of teachers in shaping learners who are conscious of their roles in society and actively engage in sustainable practices that positively impact others. ESD, as acknowledged by PTs, plays a vital role in creating awareness among learners about their carbon footprint and encouraging them to contribute to sustainable solutions.

These responses collectively highlight the critical role of the citizenship skills pillar in ESD. The focus on preparing learners to be active participants in society, fostering an understanding of harmonious coexistence with others and the environment, aligns with the goals of ESD to promote responsible and informed citizens (Hogan and O'Flaherty, 2021).

5.2.4 ESD integration in the course outline.

The research data obtained from the TEs course outlines and interviews suggested that they integrated ESD in their teaching during the Covid pandemic. The course outline embraced the four competences which included the learning to know, learning to do, learning to live together and learning to be (UNECE, 2012). TE 1 had an activity

that included a change project which should have been implemented at the prospective teacher practising schools. According to Leicht, Heiss and Byun (2018) the teachers' pedagogical approaches should involve creating collaborative real-world situations such as campaigns and service-learning projects that address sustainability issues. The teacher educator that included the change project made use of the above pedagogical approaches thus integrating ESD.

Schedule for the topic

The TEs scheduled specific dates to teach ESD topics, implying that ESD integration depended on the teacher educators' initiative. However, the lack of integration between topics before and after the ESD-specific sessions could hinder prospective teachers from recognising the interdisciplinary nature of ESD. Understanding that ESD goes beyond traditional classroom boundaries is crucial (Imara and Altinay, 2021).

Comparatively, both TEs and PTs acknowledged a lack of clear ESD integration at their teacher training institution. ESD integration appeared to be driven by individual teacher educators' agency, potentially leaving gaps in students' ability to identify the integration.

Despite the commendable initiative of teacher educators in explicitly teaching ESD, there's a notable lack of clear guidelines on how to integrate ESD into teaching practices or instructions for PTs on integrating ESD into their practice. The absence of a uniform tool for investigating ESD integration could potentially pose a challenge. However, the positive efforts and explicit ESD integration in the two TEs' course outlines, along with commendable assessment practices, reflect a commitment to fostering sustainability competencies among future teachers. TE 1, for instance, covered multiple competencies, such as learning to know, learning to do, and learning to be and live together. Students were actively involved in implementing a change project, engaging practically with solutions. In contrast, TE 2 focused on learning to know and do, teaching PTs about sustainability and guiding them on identifying sustainability in the CAPS. Despite challenges and variations, the data suggests a positive ESD integration effort.

5.2.5 ESD integration in the CAPS document.

The Curriculum and Assessment Policy Statement (CAPS) document embraces ESD in its general aims and purpose section. The national curriculum policy aims to

produce learners equipped with citizenship skills for sustainable living. The course outline of teacher educators aligns with the CAPS document, indicating a connection between their goals and the national curriculum. The CAPS document identifies social, economic transformation, and environmental justice as key themes, aligning with the pillars of sustainable development. It includes strands such as Environment Studies, covering topics like Human Impact on Earth. While elements of ESD are present, the document lacks clear guidelines on how teacher educators and prospective teachers can integrate ESD into their pedagogies.

The primary goal of the Life Science curriculum is to promote the four competencies and the pillars of ESD. Aim 1.3a emphasizes the 'learning to do' competency, stressing the importance of acquiring and applying knowledge in local contexts. Aims 1.3b and c fall under the 'learning to be' and 'learning to live together' categories, relating to the citizenship skills pillar. These aims encourage students to contribute positively to society, think critically, and achieve social transformation. The curriculum's purpose in Section 2.4 aligns with these aims, highlighting the students' preparedness for the economic pillar and the promotion of citizenship skills. Both the aim and purpose emphasize similar learning goals.

The TEs course outlines align with the national curriculum's aims and purpose, aiming to equip students with values and skills for citizenship and sustainability. While the CAPS document embraces the ESD competencies and principles in the aims and objectives, issues arise from the lack of explicit integration efforts into teacher education. Most PTs could not identify any ESD integration in the CAPS document. This lack of awareness among PTs is concerning, given that the CAPS document is a crucial part of their teaching resources.

5.2.6 ESD integration during the pandemic.

Before the COVID-19 pandemic, the integration of ESD was implicitly embraced in the teacher training institution, largely relying on personal agency. However, the pandemic brought about more challenges than opportunities. The transition from physical to online platforms, as observed in the study (Müller et al., 2022), was not just a simple shift. Mere digitisation of content, as noted by Taylor, Singh, and Copsey (2020), proved insufficient. Institutions struggled with the lack of experience and expertise in online teaching.

The teaching approach itself did not fundamentally change before and during COVID; the venue shifted from physical to online. The course outline demonstrated a few changes, reflecting some adaptation to the new normal. TE 1 adjusted the assessment, reconstructing the change project to focus solely on content and ideas instead of practical implementation in schools. TE 2 faced challenges in the cooperative approach due to issues of accessibility and connectivity, a universal problem during the pandemic affecting teachers irrespective of ESD integration. Despite these challenges, both TEs and PTs maintained a positive perception of ESD integration. However, PTs, during COVID, felt overwhelmed with content and assignments.

The findings reveal that the teacher training institution was not adequately prepared for the shift to online teaching and struggled to integrate ESD effectively. Simply transferring ESD topics to online platforms without reevaluating policies and practices, as suggested by Taylor, Singh, and Copsey (2020), may not be sufficient in the current and post-COVID world.

Unfortunately, the pandemic drastically transformed education, impacting the practicality of ESD integration. The course outline showed that lessons were conducted virtually, preventing the physical implementation of change projects in schools. While PTs could only design projects theoretically, the restriction on practicality had a negative impact on the learning to do competency. Cooperative learning, an integral part of ESD, faced challenges in organising PTs into groups due to connectivity and access issues, highlighting the broader inequities in technology access (Olawale et al., 2022).

5.3 Summary of findings.

According to interviews with TEs and an analysis of course outlines, it appears that the integration of ESD relies heavily on the agency of individual TEs. This finding aligns with Mandikonza and Kawai's (2023) study. Moreover, there is a gap that exists as the topics on the course outlines that were before and after TE1 and TE2 topics do not explicitly integrate ESD. Despite the commendable efforts of TEs to integrate ESD, the lack of a clear link in the course outline's schedule of activities may contribute to a knowledge disconnect for PTs. This gap might explain why PTs struggled to connect the CAPS with ESD and to understand the broader applicability of ESD across various subjects and contexts (Jickling & Wals, 2008). Implicitly teaching ESD without

highlighting its relevance and practical integration in teaching might hinder PTs from effectively applying ESD concepts in their future classrooms. Based on the goals of ESD, PTs should not only gain knowledge but also develop the skills to impart sustainable practices to their students.

Both TEs and PTs acknowledge a lack of clear ESD integration in the university curriculum. The integration seems to depend on personal agency, raising concerns about consistency and clarity in ESD education. An implicit approach to ESD could lead to difficulties for students in identifying and understanding its integration. The institutional environment needs to actively promote sustainable living among both teachers and learners to ensure effective ESD integration (Leicht, Heiss, and Byun, 2018). Relying solely on personal agency might be demotivating and restrictive, emphasising the need for institutional support in promoting ESD.

While both TEs and PTs express a positive attitude towards ESD integration and recognise its importance in pedagogy, challenges arose during the COVID-19 pandemic. The pandemic seemed to have a negative impact on the perspective of TEs and PTs regarding ESD integration. This highlights the need for strategies to counteract unpredictable challenges, ensuring the continuity of ESD integration in teacher education programs.

In conclusion, the findings highlight the importance of explicit teaching of ESD, institutional support, and adaptability in overcoming challenges for effective integration in teacher education programs. Addressing these aspects will contribute to better preparing future teachers for teaching ESD, aligning with the broader goals of sustainability in education systems.

Chapter 6 Conclusion

6.1 Introduction

The final chapter addresses the research questions, discusses the implications of the study, outlines its limitations, provides recommendations, and presents the conclusions drawn from the research findings.

6.2 Addressing Research Questions

This study aimed to investigate how teachers adapted their Life Sciences classroom practices to integrate ESD during the Covid pandemic. Two sub-research questions were formulated to tackle this research question:

Research Sub-questions:

1. **Which teaching approach, assessment, and organisation did teacher educators use to integrate ESD into their classroom practices during the pandemic?**

Both teacher educators demonstrated a holistic understanding of ESD, considering its social, economic, and environmental pillars. They viewed ESD as a vehicle for equipping students with citizenship skills. The educators provided comprehensive definitions of ESD and expressed positive opinions about its integration into teaching. Personal agency played a role in their ability to integrate ESD into their teaching practices, compensating for the perceived lack of explicit ESD integration in their teacher training institutions. The educators emphasized the role of teachers as key sources of knowledge and influence in society, with explicit teaching approaches such as alignment with SDGs, integration of sustainability issues, practical activities, cooperative learning, and project-based assessments.

Despite challenges posed by the pandemic, teacher educators employed creative approaches to align their teaching with sustainability goals and promote active student engagement in ESD practices. Challenges included practical hindrances in applying theory to practice due to the pandemic, connectivity issues affecting virtual pair work and assessments, and limitations in conducting practical, hands-on change projects.

2. **How have prospective teachers responded to ESD integration in Life Sciences education during the Covid pandemic?**

The investigation into how prospective teachers responded to ESD integration during the pandemic revealed a generally positive perception and impact. However, most prospective teachers demonstrated a limited, often singular, understanding of ESD, primarily associating it with the environmental pillar. This restricted comprehension hindered the "learning to do" competency, limiting their practices to the environmental

aspect. Challenges arose in identifying embedded ESD integration in the CAPS document, yet some prospective teachers could establish links and identify specific topics integrating ESD. While commendable examples of ESD integration were noted, overall, most prospective teachers struggled to recall instances of ESD integration in their teacher training institution, emphasizing a gap in teaching the value and integration of ESD. Moreover, the pandemic posed challenges, leading to feelings of being overwhelmed with information and assessments. All activities were conducted virtually, making ESD integration challenging due to the absence of physical contact. The PTs expressed that this virtual setting made it difficult for both TEs and PTs to assess whether students were truly learning or applying ESD knowledge.

6.3 Recommendations

Learning to Know:

It is crucial to explicitly integrate ESD into teacher training programs. This ensures that prospective teachers can identify and understand ESD principles beyond the environmental pillar. A broad understanding of ESD is essential for effective integration into teaching practices. There is a need to strengthen training programs for prospective teachers, providing them with a holistic understanding of ESD that covers all its pillars. This improvement will empower PTs to integrate sustainability into their future classrooms.

Learning to Do:

In the face of challenges like connectivity issues, it is important to facilitate virtual collaboration for assessments, especially during crises. This approach addresses practical concerns related to connectivity and enables prospective teachers to collaborate effectively.

There is a need to promote the inclusion of real-life change projects in teacher training. This hands-on approach enhances the practical aspects of ESD education, allowing prospective teachers to apply sustainable principles in real life situation. Teacher educators should not only integrate ESD into their teaching practices but also educate prospective teachers on modelling sustainability in their lives. This ensures that sustainability becomes a way of living for educators.

Learning to Be and Live Together:

Institutions should play an active role in promoting ESD integration. This involves providing support, fostering an environment that challenges educators to integrate ESD, and actively participating in sustainability initiatives. This can happen by creating an environment that encourages collaboration and the sharing of ESD ideas among teacher educators. ESD is fundamentally about cooperation and shared solutions, and this collaborative approach enhances the effectiveness of integration.

Finally, there should be accountability for teacher educators regarding ESD integration. Furthermore, clear guidelines need to be provided for both teacher educators and prospective teachers on how to integrate ESD into their teaching practices effectively.

6.4 Implication of study.

The findings of this study have implications for both teacher education institutions and policymakers. Firstly, there is a need for ESD training and development programs for teacher educators. These initiatives should aim to enhance their understanding of ESD principles and provide practical strategies for ESD integration into their teaching practices.

Furthermore, the teacher training curriculum itself should explicitly integrate ESD. Prospective teachers need to be equipped with skills and knowledge during their training to effectively integrate ESD into their future teaching. To enable this process, clear guidelines from both the teacher training institution and national curriculum are essential. These guidelines would serve as a guide for educators, ensuring a standardised and effective approach to ESD integration.

Considering the challenges posed by the Covid-19 pandemic, it becomes crucial to explore and adopt technology-assisted teaching and learning methods. Integrating technologies can help reduce disruptions in the integration of ESD during unforeseen circumstances.

6.5 Limitation of study

The study had limitations that should be considered when interpreting its findings. Data collection occurred during the peak of the Covid-19 pandemic, and various social distancing restrictions were enforced. Collecting data during this period posed limitations, as face-to-face interactions were not possible, thus hindering the observation of body language and lectures. Additionally, getting participants for the

study was challenging due to the pandemic. The small sample size of teacher educators and prospective teachers involved in Life Sciences may not be fully representative of the broader population in education.

Moreover, this study focused on one training institution, and its findings are specific to the practices and perspectives within that institution. These findings may not be applicable to other educational institutions with potentially different structures, policies, and approaches to ESD integration. Therefore, future research with a broader and more diverse sample would contribute to a more comprehensive understanding of ESD integration across various subjects and institutions. Future research should also consider assessing the effectiveness of ESD training and professional development initiatives for teacher educators. Additionally, exploring the impact of ESD integration on teaching and learning outcomes across various subject areas and contexts would provide valuable insights. The study conducted by Evans et al. (2012) supports the positive impact of integrating ESD into teacher education, indicating a potential for further exploration and implementation.

6.6 Conclusion

In conclusion, this study examined the integration of Education for Sustainable Development (ESD) in teacher education, focusing on Life Sciences classroom practices during the Covid-19 pandemic. The study found that the integration of ESD largely depended on the agency of individual teacher educators, with a lack of institutional and pedagogical guidance provided by teacher-training institutions. The Covid-19 pandemic has further worsened this issue, limiting the practical application of ESD competencies through online learning. As such, teacher-training institutions need to transform their pedagogies and curricula to prioritise ESD integration and ensure that teachers are adequately prepared to promote sustainability even in the light of the pandemic challenges.

This study highlights the importance of the idea that 'Sustainability Starts with Teachers', put forward by Lotz-Sisitka, Tshiningayamwe, and Urenje (2017), and emphasises the need for accountability structures at learning institutions to effectively integrate ESD into teacher education. Ultimately, prioritising ESD integration in teacher education is crucial for achieving the Sustainable Development Goals (SDGs).

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Appendices: 4. Research instruments

Appendix 1

Teacher Educators interview

1. What is ESD?

2. What is your perception on ESD? What is your opinion on integrating ESD in your teaching?
3. How do you integrate ESD in the teaching of Life Sciences?
4. Why do you think it is important to integrate ESD to teacher education?
5. Has the Wits School of Education included ESD in the curriculum? If so how?
6. Does the CAPS document integrate ESD? If so how?
7. How has Covid affected the integration of ESD?
8. What can be done to ensure that ESD is integrated better during the Covid times?
9. According to your view, do you think ESD has been integrated to the curriculum?
10. What recommendation could you give in order to improve ESD integration?

Appendix 2

Open-ended questionnaire to prospective teachers

1. What is ESD?
2. What is your perception on ESD? What is your opinion on integrating ESD in your teaching?
3. How do you integrate ESD in the teaching of Life Sciences?
4. Why do you think it is important to integrate ESD in the classroom?
5. Has the Wits School of Education included ESD in the curriculum? If so how?
6. Does the CAPS document integrate ESD? If so how?
7. How has Covid affected the integration of ESD?
8. What can be done to ensure that ESD is integrated better during the Covid times?
9. According to your view, do you think ESD has been integrated to the curriculum?
10. What recommendation could you give in order to improve ESD integration?

Ethics clearance

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG



WSoE
Wits School of Education

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON- MEDICAL)**CLEARANCE CERTIFICATE****PROTOCOL NUMBER: 2021ECE089M****PROJECT TITLE**

Integration of Education for Sustainable Development in teacher education Life Sciences classroom practices, during Covid times.

INVESTIGATOR**SITHABILE NDELU****SCHOOL/DEPARTMENT OF INVESTIGATOR****DATE CONSIDERED****18 October 2021****DECISION OF THE COMMITTEE**

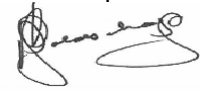
Approved unconditionally

RISK LEVEL**EXPIRY DATE**

Date of submission of the Research Report

ISSUE DATE OF CERTIFICATE**26 October 2021****CHAIRPERSON**

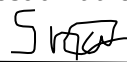
Dr. Paul Goldschagg



cc: Dr Portia Mabenge

DECLARATION OF INVESTIGATORTo be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.


Signature**Date** 19 /11 /2021

