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UNIVERSITY OF THE
WITWATERSRAND,
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The development of ESD competences during the teaching and learning of the topic Cell Biology among Life Sciences pre-service teachers at a South African university

A research report submitted to the Faculty of Humanities, School of Education, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Education

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ABSTRACT

Education for Sustainable Development (ESD) is the contribution of the world's education to sustainable development, and more importantly, a sustainable world. To achieve a sustainable world, people need to learn their ways out of unsustainability through the development of sustainability competences, which themselves are developed through education (education for sustainable development competences). This study sought to investigate a selected lecturer's practices in the development of ESD competences during the teaching and learning of the topic Cell Biology among Life Sciences pre-service teachers. Data were generated using lesson observations, semi-structured interviews, and document analysis of the course outline. Qualitative data analysis was used to deductively analyse the data. Findings indicate that the lecturer uses a socio-cultural learning perspective to develop ESD competences. They further indicate that student initiative and participation, and interactive learning materials provide the lecturer with opportunities to adequately develop ESD competences. On the other hand, there are challenges including limited space and time, and lack of adequate e-resources that affect the development of ESD competences. The recommendation is that ESD be incorporated holistically and interdisciplinary into the curriculum and that a socio-cultural learning approaches be used as a medium to develop sustainability competences.

KEYWORDS

Sustainable Development (SD), Education for Sustainable Development (ESD), ESD competences, Pre-service teachers (PSTs), Life Sciences, Cell Biology, Lecturer, Socio-cultural learning.

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DECLARATION

I, Irving Sithole declare that this research report is my own work. It is being submitted for the partial fulfilment of the Degree of Master in Education (Science Education) at the University of the Witwatersrand, Johannesburg, South Africa. It holds no previous record of submission or examination for any degree in any other University



CERTIFICATION BY SUPERVISOR

We certify that Irving Sithole prepared this research report and that it has been examined and approved as meeting the required standard of scholarship for the fulfilment of the degree of Master's in Education.

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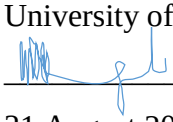


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Signature:

Date: 31 August 2021

CHAPTER 1: INTRODUCTION OF THE STUDY

1.0 Introduction

Education for Sustainable Development (ESD) is the contribution of the world's education to sustainable development (SD), and more importantly, a sustainable world (Agbedahin, 2019). The call for sustainability comes in the wake of unsustainability, and to get out of unsustainability, people need to learn their ways out of unsustainability (Mandikonza & Mukundu, 2017). To get out of unsustainability, people need sustainability competences (UNECE, 2012). These competences must be developed in learning contexts. Hence the need for ESD. Furthermore, there is an uncontested call to develop competences for ESD, which, as raised earlier, are the conduit for competences for sustainability (UNECE, 2012).

ESD competences are developed during the teaching and learning processes (Eiks, 2015). This study investigated the development of ESD competences among Life Sciences 1st Year pre-service teachers (PSTs) during the teaching and learning of Cell Biology at a university setting.

1.1 Background

Bachelor of Education (B.Ed.) programme's objectives advocates for the need to produce "quality teachers who are knowledgeable, skilled, who love learning, and who can empower the lives of thousands of children" (University of Witwatersrand, 2018, p. 1). Taking from this, teacher training institutions are therefore concerned about the sustainable development of the societies which their graduates will render their services to-with exceptional quality. The existence of sustainably developed communities lies in the reception of schooling systems to create platforms through which sustainability issues can be interrogated as put forth in Section 1.0.

The first "official" inception of sustainability research dates back to 2001 (Kates, Clark, Corell, Hall, & Jaeger, 2001), making it two decades since the academic field began to address the real-world sustainability issues and challenges. Over these years, academic scholars have engaged in profound debates in trying to establish a 'quality education' platform through which sustainability issues can be addressed. Section 29 of the Republic of South Africa's constitution recognizes access to quality education as a basic human right. The same position is foregrounded by many United Nations declarations including: the *Universal declaration on Human Rights (*1948), *Decade of Education for Sustainable Development* (2005) and the *Sustainable Development Goals '2030 Agenda'* (2015) (Agbedahin, 2019).

Quality education is a vital tool for social transformation, thus allowing people to live in harmony (Mandikonza & Mukundu, 2017). To realise this, the United Nations' Educational, Scientific and Cultural Organisation (UNESCO**)** education sector identified education for sustainable development (ESD) as a vital tool towards the realisation of quality education (UNESCO, 2012). Therefore, ESD as an indicator of quality education is expected to take a holistic approach and be transformational (United Nations, 2017). For education to be transformational, educators and students must help each other develop and exhibit sustainability competences (UNECE, 2012).

ESD competences which are unique for educational purposes come because of a teacher or a lecturer's ability to cater for and exhibit ESD competences in the classroom (UNECE, 2012). The notion of sustainability entails the harmonious existence of people who promote positive interactions between themselves, natural environments surrounding them, and the economies that sustain their well-being (Agbedahin, 2019). Sustainability is requisite for sustainable development. There is no sole accepted definition of sustainable development, but the widely agreed definition refers to "development that meets the needs of the present generation without compromising the potential (and/or ability) of future generations to meet their own needs" (UN, 1987, p. 4).

ESD is the vehicle for developing sustainability thinking, values and practice. ESD "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity" (UNESCO, 2018, p. 4). ESD includes content, values, teaching methods and practices which facilitate learners to take deliberate actions for a sustainable future (Anyolo, 2018). A deepening worry is that there is no explicit guideline advocating for the holistic and interdisciplinary approach of ESD in the B.Ed. curriculum (in general), and other teacher training curricula (Evans et al., 2012; Schudel, 2017).

However, the Life Sciences course outline of the study through which this study finds interest raises interest to mainstream knowledge for ESD (WSoE, 2020). "The course aims to encourage students to acquire knowledge, develop skills and competencies, and to develop positive attitudes towards science, especially towards the living world and towards the teaching and learning of science" (WSoE, 2020, p. 3). This study investigated Life Sciences lecturer's classroom engagements during the teaching and learning of the topic Cell Biology to look at how ESD competences are developed.

Like any other academic concept, Cell Biology studies should be used as a medium to interrogate and address sustainability knowledges ESD is supposed to be holistic and interdisciplinary (UNESCO, 2014), hence it becomes prudent for sustainability knowledge to find relevance through Cell Biology interactions. Therefore, a learning experience (in Cell Biology) provides opportunities for ESD competences to be developed. Thus, making it prudent for this study to focus on the topic Cell Biology. The section on Cell Biology is presented through lecture, tutorial and practical sessions.

During lecture sessions, lecturers use Cell Biology content knowledge as a medium to develop ESD knowledge and competences (WSoE, 2020) by imbedding critical sustainable development issues including hunger, poverty, inequality, democracy, climate change, peace, etc. For example, during practical sessions and assessments, lecturers make use of these issues to promote hypotheses formulation, critical thinking, decision-making and problem-solving skills among other sustainability student competences. Hence, this study focused on establishing the development of ESD competences in 1st Year Life Sciences Cell Biology sessions.

This is because the Cell Biology content, like other academic concepts bears the responsibility to interrogate sustainability issues (Anyolo, 2018). Over the past years, investigations around ESD knowledge, attitudes and values in teacher training institutions have been profound (Eiks, 2015). However, such initiatives (research investigations into ESD practices) have not fully influenced curricula to cater for ESD incorporation holistically. Evans et al (2012) and Schudel (2017) found that PSTs lack ESD attitudes, values, knowledge, skills, and competences.

1.2 Problem statement

Despite global endless calls for ESD to play an integral role in promoting and achieving quality education (UN General Assembly, 2015), most learning experiences in institutions of learning are still not producing the quality of learners envisaged to be products of quality learning experiences (upholding ESD principles) (Schudel, 2017). The inability to produce learners who uphold ESD principles could be due to teachers' implicit ESD knowledge, values and attitudes, and lack of ESD competences, among other issues (Anyolo, 2018). According to Schudel (2017), research indicates that teacher training institutions have not done justice to their PSTs in the wake of endless calls to teach for sustainability.

South Africa is no exception of this shortfall (Schudel, 2017). Hence it becomes of paramount importance for research to investigate potentials of teacher training institutions across the globe

to produce quality teachers who resonate well with ESD principles, values and attitudes. Implicit engagement with sustainability knowledge in the classroom due to the failure of curricula across teacher training institutions to promote ESD practices has resulted in the production of poor quality sciences teachers who fail to facilitate critical learning experiences that can bring about social transformation (Evans et al., 2012). Thus, a recent attention in science education research to explore ESD practices in teacher training institutions has become prudent (Sinakou, Donche, Boeve-de Pauw, & Van Petegem, 2019).

This makes it of paramount importance to continue with the quest to investigate how institutions of higher learning could better transform their curricula (or science education curriculum in particular) in order to develop teacher training environments at the forefront of producing quality teachers (Bertschy, Kunzil, & Lehman, 2013). Quality teachers exhibit and promote critical learning by encouraging the development of ESD competences (UNESCO, 2018).

1.3 Rationale

According to (Bertschy et al., 2012), the production of 'quality' teachers who embody an explicit scope of ESD does not only lie in the receptiveness of the curriculum to cater for ESD competences, but also depends on the ability of lecturers to prepare, deliver, and subsequently help develop PSTs' competences for ESD. Consequently, an investigation into how Life Sciences lecturers develop ESD understandings and competences becomes important. This is because it provides a depth understanding of the existence of pre-service teachers and newly graduates with implicit ESD competences (Evans et al., 2012). More critically, it provides an opportunity for science education curriculum across teacher training institutions to look at how ESD competences can be incorporated and be practiced in order to produce quality science teachers (Eiks, 2015).

Furthermore, lecturers' usual classroom practices stand to be examined, and transformed to cater for among others, critical learning experiences resonating with quality education objectives, such as problem-setting, critical thinking, problem-solving and decision-making skills (Anyolo, 2018). Research in science education is yet to fully explain underlying factors behind PSTs' implicit understanding and exhibition of ESD knowledge (Schudel, 2017). Thus, the space for investigating ESD competences and understandings in sciences teacher training institutions remains broadened (Anyolo, 2018).

1.4 Aim and objectives of the study

The purpose of the study was to investigate the practices of a selected lecturer in the development of ESD competences during the teaching and learning of the topic Cell Biology among Life Sciences pre-service teachers at a South African university.

To explore this aim, this study sought to:

- Investigate the development of ESD competences are developed among preservice teachers during the teaching of Cell Biology.
- Establish opportunities and challenges experienced by a selected lecturer when developing ESD competences during the teaching of topic Cell Biology among 1st Year pre-service teachers.

1.5 Research questions

This study attempted to answer the following questions:

Main question

What are a selected lecturer's practices in the development of ESD competences during the teaching and learning of Cell Biology in Life Sciences at 1st Year level?

Sub-questions

1. Which competences for ESD is the selected lecturer developing among preservice teachers during the teaching and learning of Cell Biology in Life Sciences?
2. How are these competences for ESD developed among preservice teachers during the teaching of Cell Biology in Life Sciences?
3. What are the opportunities and challenges (affordance and hindrances) that the lecturer experienced when developing ESD competences among preservice teachers during the teaching of Cell Biology in Life Sciences?

1.6 Assumptions and delimitations

Assumptions

ESD knowledge forms part of the Life Sciences curriculum (WSoE, 2020). This makes it crucial for Life Sciences lecturers to resonate well with the importance of incorporating ESD principles (and competences) during teaching, thus proving them to have an insight knowledge

about how ESD competences can be developed during the teaching of Cell Biology, and to be trusted that they will contribute truthfully.

Delimitations

Given that this study drew inspiration from two ESD competences frameworks (see Section 2.3.1 and 2.3.2), other ESD competences that do not fall within the scope of the two frameworks may not be explored. As a result, findings of this study may not find appropriate ground to be a representative of other ESD competences studies that use different ESD competences framework/s.

1.7 Chapter Summary

This chapter provided the ESD background that informs this study, the need to develop sustainability knowledge through ESD, the impact that the outcomes will have on educational research and practice, the aims and objectives, and the assumptions, limitations and delimitations related to the study's quest.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This sections reviews literature related to education for sustainable development (ESD) competences. The literature includes sustainable development (SD), education for sustainable development (ESD), its relationships to environmental education (EE) and quality education, frameworks for ESD competences, and lecturer's practices as a response to an action-oriented pedagogy.

2.1 The nature and history of Sustainable Development

With the exponential increase in human population on earth, and limited quantity of natural resources available, individuals and societies need to act in responsible ways to preserve the available natural resources for future generations (UN General Assembly, 2015). This requires individuals to be responsible actors in their environments, who resolve challenges, respect cultural diversity, and contribute to creating a more sustainable world (UNESCO, 2018). This entails the adoption of the notion of a SD. The concept of SD may be relatively new but can be traced back to thousands of years in many different indigenous cultures, and for several centuries in academic investigations and publications (Waas, Huge, Verbruggen, & Wright, 2011).

This concept in the 1960's and 70's was used to describe human interactions with the natural environments to bring about a universal conservation of ecological systems (UNESCO, 2016). This is because ecological systems were under threat, perpetuated by unsustainable utilisation of natural resources because of increasing populations and the rise of industries (UNESCO, 1972). The United Nations World Conservation Strategy conference (1980) refined the concept SD by extending its definition from only talking about conservation of natural resources to addressing the need to use an integrated approach, which balances socio-economic and political development with the environmental conservation framework (IUCN-UNEP-WWF, 1980).

There is no solitary consented explanation for SD (Evans et al, 2012). The generally endorsed definition refers to "development that meets the needs of the present generation without compromising the potential (and/or ability) of future generations to meet their own needs" (UN, 1987, p. 4). Significantly, it is seen as an organizing principle with an objective "to meet human developmental goals, while at the same time sustaining the ability of natural systems to provide

the natural resources and ecosystem services upon which the economy and society depend" (Kates, Thomas, & A, 2005, p. 15).

Sustainable development demands the bridging of existing gaps between the well-being of all persons, their economies and surrounding natural environments at local and global levels (UNESCO, 2016). This principle is referred to as the three SD pillars (the people, natural environments, and socio-economic frameworks) advocating for social transformation where all people live in harmony in the present and future times (UN General Assembly, 2015). The triple bottom line (TBL) framework (Rubinstein, 1998) identifies and resonates with the three pillars of SD: environment, society, and economy (Elkington, 1998). TBL speaks about the use of a sustainable integrated approach as a response to labour exploitation, and irresponsible exploitation of natural resources at the expense of profit making.

Hence, it calls for economic development through the existence of responsible utilisation natural resources, and development of societies through fair wages (Elkington, 1998). The Human Development Report (2016) foregrounds SD to be about an intergenerational socio-economic and environmental justice and argues that the seventeen (17) 2030 SDGs should be at the forefront of achieving such justice (UNESCO, 2016). Due to the unavailability of a clear roadmap to achieve a lifelong sustainable development of societies, an effective and comprehensive implementation of the seventeen SDGs is believed to bring about sustainability in the globe by 2030 (UN General Assembly, 2015).

The "17 SDGs are: No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth; Industry, Innovation and Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life below Water, Life on Land; Peace, Justice and strong Institutions, and Partnerships for the Goals" (UNESCO, 2017, p. 6).

2.2 Education for Sustainable Development (ESD)

To address the seventeen SDGs and achieve the socio-economic and environmental justice, ESD has been identified as vital tool to drive the SD project. (UNESCO, 2016). ESD "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while

respecting cultural diversity" (UNESCO, 2018, p. 4). There is mounting pressure from the international community to incorporate ESD in the curriculum (Agbedahin, 2019).

Therefore, curricula across teacher training institutions should be embedded with a systematic integration or inclusion of crucial SD issues, raised in the seventeen SDGs (UNECE, 2012).. A classroom experience embedding addressing the seventeen SDGs critically contributes to the existence of the five interrelated cardinal pillars. Thus, providing a basis for ESD to incorporate a visionary type of education (qualitative) which seeks to empower all peoples of all ages and races across the universe, and encourage them to be responsible citizens who construct and ensure a harmonious existence of their societies and economies in the present and tomorrow, while on the other hand maintaining responsible engagement with the natural environments (UNECE, 2012).

Moreover, ESD provides possibilities for each student to obtain the skills, attitudes, values and knowledge imperative in providing a sustainable present and future conditions for everyone in this universe (UNESCO, 2018). For this to happen, ESD should take a holistic approach and be interdisciplinary across all subjects (UNESCO, 2018). This will ensure that student ESD competences such as critical thinking, problem-setting, advanced communication, critical thinking, problem-solving, citizenship and decision-making skills are developed in the classroom (UNESCO, 2017). A development of these competences will allow teacher (and other) graduates to become active agents of transformation in their communities and bring about harmony in the present and future timelines, locally and globally as required by the 2005 United Nations ESD Draft (UNECE, 2012).

2.2.1 Education for Sustainable Development (ESD) and Environmental Education (EE)

EE and ESD are two slightly different concepts but find common ground in calling for ESD to be incorporated across all institutions of learning across the universe. This narration is well established from the *1977 Tbilisi Declaration*, which stated that EE should advocate for a balanced and developed universal communities at local and global levels, among other objectives (UNESCO-UNEP, 1977). The conference endorsed the following prime goals which resonate with UNESCO (2017) objectives for ESD:

- "To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas.
- To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; and

- To create new patterns of behaviour of individuals, groups, and society as a whole towards the environment" (UNESCO-UNEP, 1977).

2.2.2 Education for sustainable development (ESD) and education quality

Quality education is a basic human right according to Section 29 of the constitution of the Republic of South Africa, and it is "assigned priority number four (4) on the 2030 Agenda for Sustainable Development Goals by the United Nations' Educational, Scientific and Cultural Organization" (UNESCO, 2017, p. 18). The SDG 4 (Quality Education) "aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNESCO, 2017, p. 18) by 2030, subsequently act as a tool to bring about social transformation by producing responsible graduates who will critically develop and envision change in their communities, and across their borders (UNESCO, 2018).

Empowering pre-service teachers is central to professional development (UNECE, 2012). With the lecturer's ability to cater for the development of the ESD, pre-service teachers will graduate into agents of transformation across the education systems. By agents of transformation, this study refers to educators that are transformative in their practice, such that they uphold and practice sustainability advances during the course of their work (Mandikonza & Mukundu, 2017). "Effective educational transformation is dependent upon educators being motivated to bring about change, as well as being capable of and supported in doing so" (UNECE, 2012, p. 10).

The production of quality teachers who embody ESD competences lies in the availability of receptive curricula in teacher training institutions (Gough, 2006). The UNESCO (2004) report identifies six areas which are seen to provide potency in debate of quality education. The areas are:

- inclusive, relevant and appropriate educational aims
- breadth and pertinence in the content of curriculum
- the availability of appropriate learning time, and its use
- effective pedagogical approaches
- suitable medium of instruction language/s
- reliable, regular and convenient assessment, both formative and summative

The report asserts that these areas enable the clarification and identification of the challenges encountered in quality education.

2.3 Frameworks of education for sustainable development education (ESD) competences

Unifying themes or frameworks for key ESD competences are not frequently discussed or used in literature (Wiek et al., 2011). “Laundry lists without transparent selection criteria dominate the discourse” (Wiek et al., 2011, p. 205). Hence, it becomes unavoidable to realise that the ESD field is still in search of enriching concepts that would be used to relate and ingrate ESD competences in a significant manner. The few proposed, discussed or applied frameworks are influenced by the inspiration to cater for transformative learning through the development of sustainability competences. They include: Values, Knowing, Skills, Understanding (Parkin et al., 2004; Sterling & Thomas, 2006; Segalas, et al., 2009); Gestaltungskompetenz (de Haan, 2006; Barth et al, 2007; van Dam-Mieras et al., 2008); Key competencies in sustainability (Wiek et al., 2011); Competences in Education for Sustainable Development (UNECE, 2012), etc.

This study gathers interest in the two latter publications as they have each developed comprehensive sustainability frameworks speaking to both an educator and students’ ESD competences. Their contributions unite towards an overarching key sustainability competence, including this and this, as recognized by UNESCO (2017,2018). This overarching or comprehensive competence is basically conceptualised as having sustainability values, attitudes, principles, skills and knowledges to enact sustainability solutions to the current and historical unjust, irresponsible actions towards the harmonious existence of sustainable development integrated pillars, including society, economy, and ecological systems, whilst encouraging forth peace and partnerships within across communities (Wiek et al., 2011).

2.3.1 Framework I: Competences in Education for Sustainable Development

The rationale behind this framework is a comprehensive approach to sustainability research and educational practice. This framework provides a coherent approach to classroom practice that guides the significance of interrogating sustainability issues, such that students (UNECE, 2012). ESD competences for this framework are presented in Figure 1. Figure 1 is followed by detailed explanations of each competence in the form of Figure 2 (Holistic Approach indicators), Figure 3 (Envisioning Change indicators) and Figure 4 (Achieving transformation indicators).and followed by detailed explanations in Figure, 2 Figure 3 and Figure 4. The column headings represent significant features of ESD including:

- A holistic approach- encourages critical and thinking integration and practice.
- Envisioning change- tracks different futures, draw and learn from previous experiences and inform present engagements, and
- Achieving transformation- strives to change the way people learn, and to change the schooling systems (UNECE, 2012).

	HOLISTICAPPROACH	ENVISIONING CHANGE	ACHIEVE TRANSFORMATION
The educator understands…	The basics of systems thinking.	The root causes of unsustainable development.	Why there is a need to transform the education systems that support learning.
The educator is able to…	Work with different perspectives on dilemmas, issues, tensions and conflicts.	Facilitate the evaluation of potential consequences of different decisions and actions.	Assess learning outcomes in terms of changes and achievement in relation to SD.
The educator works with others in ways that…	Actively engage different groups across generations, cultures, places and disciplines.	Encourage notions of alternative futures.	Help learners clarify their own and others' world views through dialogue and recognise that alternative frameworks exist.
The educator is someone who…	Is inclusive of different disciplines, cultures and perspectives, including indigenous knowledge and worldviews.	Is motivated to make a positive contribution to other people and their social and natural environment, locally and globally.	Is a crucially reflective practitioner.

Figure 1: UNECE (2012) ESD competences-expand on explanation

The clustering of ESD competences in Figure1is classified across four categories including learning to know, learning to do, learning to live together, and learning to be. Each of the classifications houses the three competences altogether (UNECE, 2012).

1. "Learning to know refers to understanding the challenges facing society both locally and globally and the potential role of educators and learners (The educator understands....);
2. Learning to do refers to developing practical skills and action competence in relation to education for sustainable development (The educator is able to....);

3. Learning to live together contributes to the development of partnerships and an appreciation of interdependence, pluralism, mutual understanding and peace (The educator works with others in ways that....);
4. Learning to be addresses the development of one's personal attributes and ability to act with greater autonomy, judgement and personal responsibility in relation to sustainable development (The educator is someone who....)" (UNECE, 2012, p. 13).

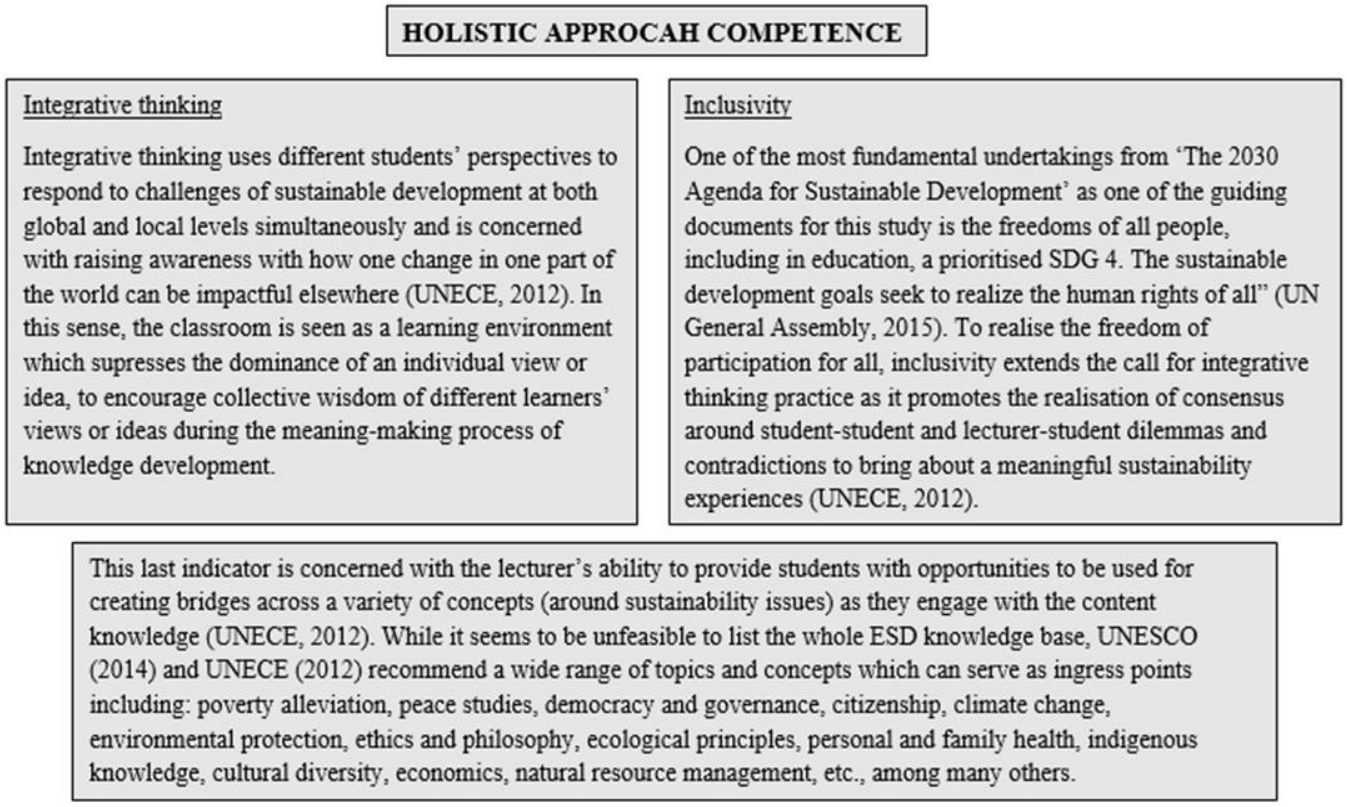


Figure 2: Holistic Approach competence indicators

ENVISIONING CHANGE COMPETENCE

Learning from the past

"By reflecting on the past, we can find common threads, general components of situations that we can use to create lessons and ideas for the future" (Eikenberry, 2021, p. 2). Hence, it becomes significant for education to use historical events to raise awareness about sustainability during the course of classroom interactions (UNECE, 2012; Liu & Qi, 2021. 'Learning from the past' talks about thorough engagements and critical analysis of past failures and successes relating to issues of sustainable development including economic, environmental, social and cultural issues (UNECE, 2012).

Inspiring engagement in the present

Classroom call for the development of ESD competences comes in the wake of unsustainable practices (i.e. gender discrimination, environmental degradation) (Sinakou et al, 2019). As a response to unsustainability, education should promote sustainability practices (UNECE, 2012; Liu & Qi, 2021), hence we talk of this ESD competence indicator. Inspiring change in the present is concerned with pedagogical interventions that seek to conscientise students to be sustainable agents (address the needs of all) in society in the present times (UNECE, 2012).

Exploring alternative futures

In addition to the ESD medium, as an identified SDG 4: Quality Education indicator (UNESCO, 2018) to provide sustainable development solutions in the present life as discussed above, educators (upholding ESD principles) also bear the responsibility to conscientise their students about future sustainability solutions. "ESD should address the needs of all people in the present as well as those of future generations" (UNECE, 2012, p. 17). "Exploring alternative futures leads to the identification of new pathways as an important step towards sustainable development" (UNECE, 2012, p. 17). The new pathways, or sustainability future solutions are identified by drawing from students' creative thinking skills and through the gathering of scientific evidence (UNECE, 2012).

Figure 3: Envisioning Change competence indicators

ACHIEVING TRANSFORMATION COMPETENCE

Transformation of what it means to be an educator

The famous Behaviourism notion of saying that 'the teacher is the centre of knowledge' is crippling educational systems across the universe, as it has (in the past) (Mudaly, 2018). Hence the need to regard educators as recipients of transformation. Transformation of what it means to be an educator' is concerned with the receptiveness of the educator to reflect and/or introspect on his/her pedagogical procedures, and is underpinned by the positive relationship/s between the educator and the students (UNECE, 2012).

Transformative pedagogy

In a democratic dispensation like the Republic of South Africa, guided by Section 29 of its constitution (see Section 1.1). Agents of change refers to educators that are transformative in their practice, such that they uphold and practice sustainability advances during the course of their work (Mandikonza & Mukundu, 2017). UNECE (2012) propels transformative pedagogy with the students' ability to reflect on the prior learning experiences as they prepare to face new challenges and explore possible living alternatives in the context of sustainable development.

Transformation of the education system

It becomes a worrying concern when sustainability practitioners pursue the widely held (but inadequate) view that education for sustainable development (ESD) is only about the relaying of sustainable development (SD) knowledge and adding new content to subject matters and training (UNESCO, 2017)Schools and institutions of higher learning should picture themselves as environments for experience and learning for SD (yes), but should also strive hard to orient all their activities towards sustainability principles (UNESCO, 2017). Therefore, for "ESD to be more effective, the educational institution as a whole has to be transformed" (UNESCO, 2017, p. 53). Transformation of the education system stresses the need for the formal education system to bring about change

Figure 4: Achieving Transformation competence indicators

2.3.2 Framework II: Key competencies in sustainability

The rationale behind this framework is a comprehensive approach to sustainability research and problem solving that requires the integration of the five key competencies (Wiek et al., 2011, p. 206) to bring about critical learning experiences, and the subsequent development of the content and sustainability knowledge. This framework enriches the aim of this study (see Section 1.4), as it employs different approaches related to sustainability research to interrogate and solve unsustainability problems that the universe faces (Wiek et al., 2011). The employment of these approaches has led to the construction of five key sustainability competences including: systems-thinking, normative, anticipatory, strategic and interpersonal. These competences provide a comprehensive basis through which the interrogation and development of sustainability knowledge can be profound for both the students and the educator, as opportunities to develop problem solving approaches to unsustainability becomes prudent (Wiek et al., 2011). Figure 5[1] portrays the manner through which the five-key sustainability (ESD) competencies are linked and integrated to interrogate and provide sustainability solutions, as a comprehensive framework for ESD competences. Detailed explanations entailing the five competences are given after the Figure 5.

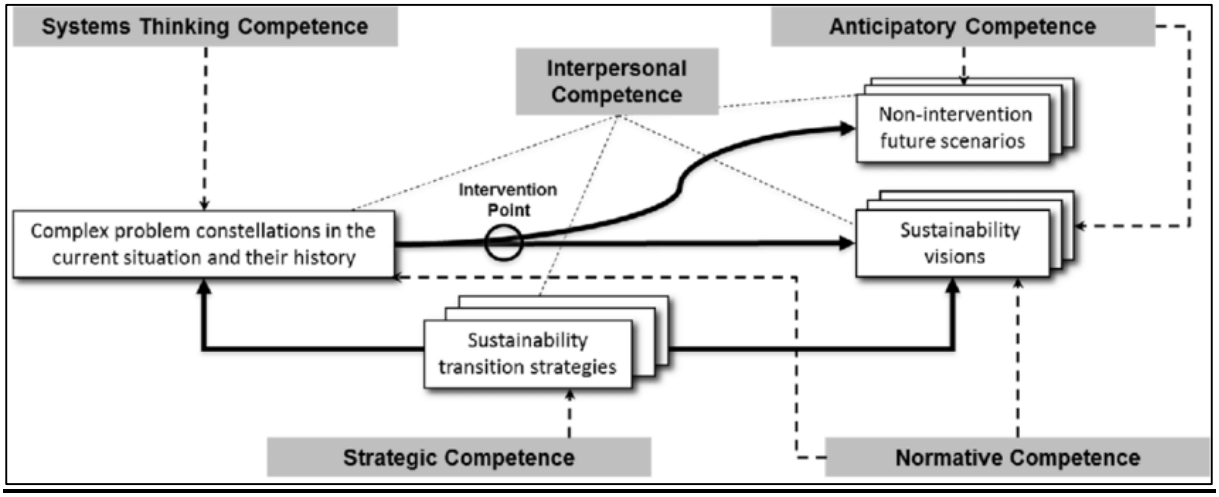


Figure 5: Wiek et al (2011) key sustainability (ESD) competences

Systems-thinking competence

According to Gibson (2006), Clayton and Radcliffe (2006) and Kates et al (2001) "the concept of sustainability calls for the utilisation of comprehensive skills to address complex-systems or

[1] This study does not necessarily investigate how the links between the competences become prudent, but how the competences are developed in the classroom. There will be instances where the links will be exhibited as sustainability issues are interrogated.

what we refer to as pillars of sustainable development including: the environment, the economy and society" (Wiek et al., 2011, p. 207). Sustainability comprehensive skills include problem-setting, problem-solving and critical thinking skills, among others (Sadaf & Hassan, 2019). System thinking competence "is the ability to collectively analyse complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks" (Wiek et al., 2011, p. 207).

Normative competence

It becomes of critical importance for sustainability practitioners to be cognisant of the key pillars of sustainable development at all times, such that they uphold ESD principles, values and attitudes which are necessary for establishing a sustainable present and future livelihood for all peoples (Wiek at al., 2011; WWF-UK, 2012; UNESCO, 2014, 2016, 2017). The key pillars include an integrated approach and heathy existence of the people of this universe, their economies, and the natural environments that surround them, and more importantly the ability to foster peace and partnerships between and across communities (UNESCO, Global Sustainable Development Report 2016, 2016).

Hence, the development of the normative competence becomes necessary. The normative competence is the ability to collectively specify, map, reconcile, negotiate and apply sustainable development principles, targets, goals and values, drawing from both current and/or future unsustainable practices relating to equity, justice, ethics socio-ecological systems (Wiek et al., 2011)

Anticipatory competence

Generally, anticipation is the state of being jovial about something forthcoming (Merriam-Webster, 2021). According to Gibson (2006), "the concept of sustainability calls for long-term future orientation and envisioning ("sustaining" "needs of future generations"), the anticipation and prevention of harmful unintended consequences, and the imperative of intergenerational equity" (Wiek et al., 2011, p. 209). The anticipatory competence is concerned with the ability to collectively analyse, evaluate and construct profound pictures and ideas about sustainable futures (Wiek et al., 2011). "The term ''pictures'' has been used (similar to ''stories'' or ''images'') as an open notion to include qualitative information, quantitative information, narratives, imagery, etc." (Wiek et al., 2011, p. 209).

Strategic competence

The reality of ESD having had a slacking start can be attributed to the notion of 'sustainability theory without practice'. An adequate development of sustainability knowledge lies in the reception of envisaged sustainability practitioners to transform such knowledge into action (Wiek et al., 2011). Hence, strategic competence calls for theory to be put into practice. Strategic competence is the ability to 'link knowledge to action', in other words this "competence is about being able to get things done" (Wiek et al., 2011, p. 210).

Interpersonal competence

Interpersonal refers to communications or relationships between people (Berger, 2008). Therefore, for the interpersonal competence to be developed, teaching and learning approaches should foster collaborative work. interpersonal competence is the ability to enable, motivate and facilitate participatory and collaborative sustainability research and problem-solving during learning and teaching where advanced communicating skills are encouraged (Wiek et al., 2011).

2.4 Action-oriented pedagogy for education for sustainable development

Education for sustainable development pedagogies have the ability to transform education across all learning phases, according to research (Laurie, Nonoyama-Tarumi, McKeown, & Hopkins, 2016). Such transformation can be promoted through one or more of the following action-oriented transformative pedagogy (Figure 6).

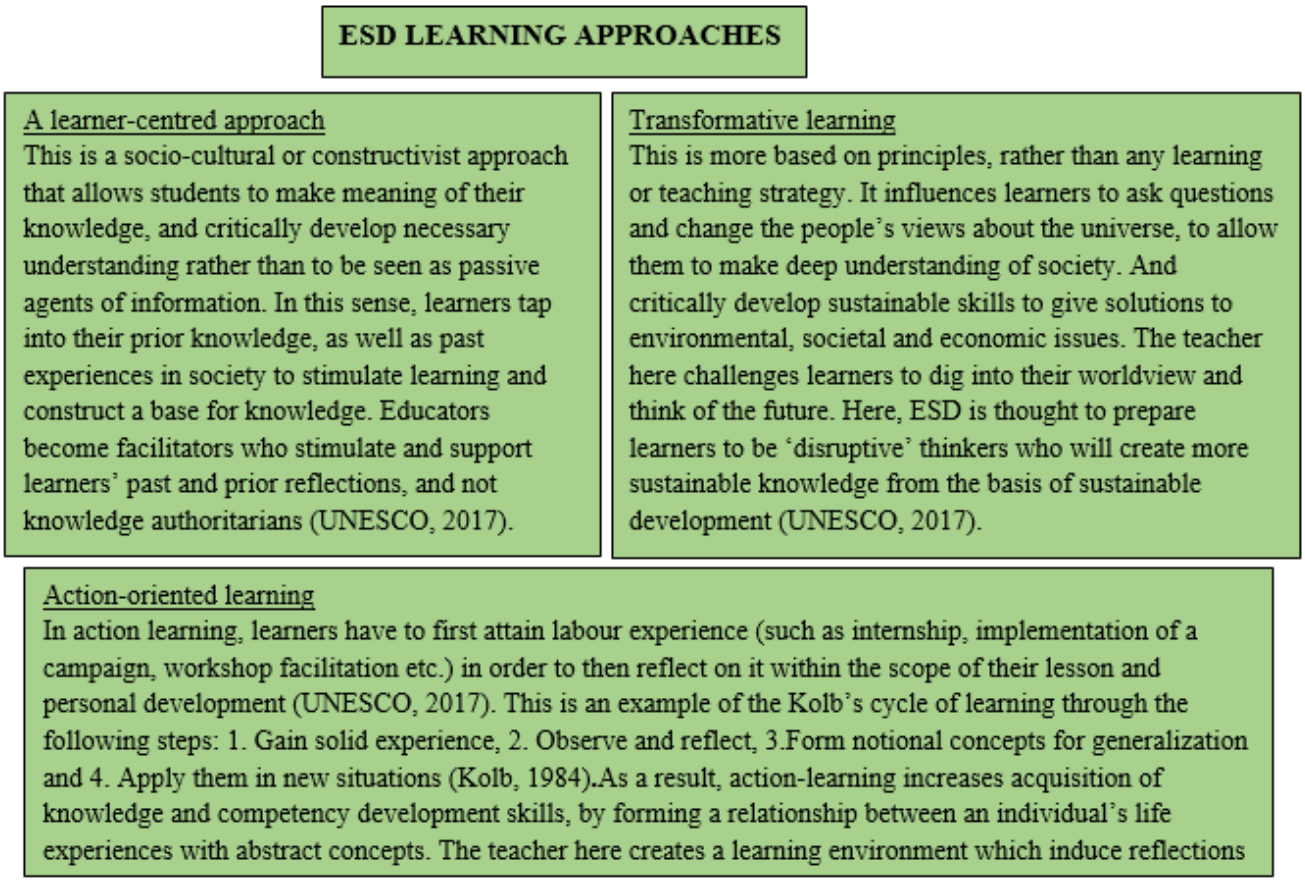


Figure 6: ESD learning approaches

2.5 Chapter Summary

This section reviewed literature related to education for sustainable development (ESD) competences and the subsequent understandings which arise in the student population as a result of the development of such ESD competences. The literature includes sustainable development (SD), education for sustainable development (ESD), its relationships to environmental education (EE) and quality education, frameworks for ESD competences, and lecturer's practices as a response to an action-oriented pedagogy.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.0 Introduction

Research methods are essentially techniques in which data collection and analysis can partake (Opie, 2004-khoza). However, the research methods must line up with the research questions and are regulated by the research paradigm. According to Morrell and Carroll (2010) argue that "educational researchers need to think about the research methods that they will use in their studies" (Khoza, 2016, p. 18). In this chapter, I present the research design and methodology. I start by giving an overview of the research approach employed in the study. I then present the paradigmatic considerations of my research, followed by the research design informing the study. I then outline how the potential participant was selected. Then, I give an overview of the data generation techniques and link them to the research questions, and then explain how the obtained data was analysed. Ethical considerations are also explained.

3.1 Research approach

This research employed a qualitative research design. "Qualitative research is a process of naturalistic inquiry that seeks in-depth understanding of social phenomena within their natural setting" (University of Utah, 2016, p. 1). As opposed to a quantitative research approach concerned with numbers, a qualitative research approach allows a researcher to discover the "whys" and "hows" of an aspect in an investigation (Hoepfl, 1997), which in this case is the development of ESD competences. Given that this research approach does not draw inspiration from numerical values (Cohen & Crabtree, 2006), a qualitative approach provided my research with a base to investigate the nature and quality of ESD competences developed during the teaching and learning of the topic Cell Biology in Life Sciences 1st Year group.

There is an array of understanding ESD knowledge, attitudes, and values (Evans, et al., 2012), subsequently leading to different teaching strategies being employed to develop ESD competences in the classroom (UNECE, 2012). Therefore, a qualitative research approach provided my investigation with an in-depth understanding of how (and why) the topic Cell Biology can be used as a medium or platform to develop critical ESD competences which will shape pre-service teachers (PSTs) to become the agents of transformation as demanded by the communities which they will render their career services to. "Qualitative methods are, for the most part, intended to achieve depth of understanding" (Palinkas, et al., 2015, p. 534) using an analytical approach which uses codes to unfold relationships and patterns between the conceptual knowledge and/or positions of the participants (Hoepfl, 1997). Quantitative

approach (numerical data) would not satisfy the quest for this research; thus, a qualitative design possesses the capacity to produce reliable and valid results.

3.2 Research paradigm

This study finds interest in the use of an interpretive paradigm, also referred to as a constructivist paradigm. “This approach makes an effort to ‘get into the head of the subjects being studied’ so to speak, and to understand and interpret what the subject is thinking or the meaning s/he is making of the context” (Kivunja & Kuyini, 2017, p. 33), and draws from qualitative data to provide a clearer and precise understanding of the phenomenon in question (Andrade, 2009), which in this case is the development of ESD competences. Therefore, an interpretive paradigm provides this research with an in-depth understanding of the position/s of the lecturer about the development of ESD competences during the classroom discourse of Cell Biology in Life Sciences.

“Every effort is made to try to understand the viewpoint of the subject being observed, rather than the viewpoint of the observer” (Kivunja & Kuyini, 2017, p. 3). By doing so, the lecturer position/s and his/her interpretations of the development of ESD competences will find a ground to be expressed. The interpretive design is appropriate for this study because it focuses on the sense-making of participant’s views (Andrade, 2009), meaning that it assists in exploring the lecturer’s pedagogical practices to develop ESD competences. Moreover, this approach allows the researcher to make meaning of the data by using their own thinking and reasoning skills to process the data informed by the participant’s views (Kivunja & Kuyini, 2017).

Through this research paradigm, I was able to independently construct meanings of the data collected. Within this paradigm, “there is the assumption that the researcher and their subjects are engaged in interactive processes in which they intermingle, dialogue, question, listen, read, write and record research data” (Kivunja & Kuyini, 2017, p. 34). This study followed this interpretive process and used a semi-structured interview, the Life Sciences course outline and lesson observations.

3.3 Research design

This investigation utilized a case study method. This is a case of integrating ESD knowledge and (particularly) competences during the teaching and learning of the topic Cell Biology (in Life Sciences) in a science education division at a university in the Republic of South Africa. A case study research design is often expressed in Life and Social Sciences and is defined as

an in-depth investigation which is about a person, or a unit (or a group of persons) with an objective to assess information relating to numerous variables (Merriam, 1998). Case studies in research investigations can be holistically utilized to address issues of critical importance, which in this case, is ESD competences-tools for social transformation.

Using a case study, I was able to gain an in-depth understanding of how the development of ESD competences are catered for, and subsequently developed. By drawing from observations, interviews, and document analysis (course outline), this case study stood to provide a broad and stronger evidence capacity to give-off reliable qualitative reliable data representation, rather than to draw conclusions from one subjective source. As a result, the research questions were explored in a comprehensive manner, and subsequently lead to a more in-depth understanding of the development of ESD competences.

3.4 Sampling and population

Purposeful sampling technique was used to identify a potential participant. "Purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources" (Palinkas, et al., 2015, p. 534). A 1st Year Life Sciences (Cell Biology) lecturer was identified as an interviewee participant for this investigation. This is because he represents an "information-rich" case and stands to enrich this study with an in-depth understanding of how ESD competences are developed, as opposed to gathering data from other lecturers who are not teaching the topic in question.

Purposeful sampling is concerned with identifying and selecting a person or a group of persons that are specially experienced about or knowledgeable with a phenomenon or a concept of interest (Cresswell & Plano Clark, 2011), which in this case is Cell Biology, and the development of ESD competences. Other lecturers might be aware of the critical issues that need to be addressed to develop ESD competences and be thoughtful of teaching and assessment strategies that can be employed to conscientise pre-service teachers to become agents of change, but may be general and not directly draw from concepts and issues within Cell Biology that stand to be used to develop necessary ESD competences. Hence, the selection of a Life Sciences Cell Biology lecturer to gather data for this study from.

3.5 Data generation techniques

Interview

Semi-structured questions were employed to collect data and to explore the objectives of this study. The lockdown pronouncement by the President of RSA (Hon. Ramaphosa) due to the devastating existence of the Covid-19 pandemic which limits movement and social contact. Consequently, a contact-to-contact interview is unlikely to happen. Therefore, the interview was conducted through an electronic/online means. Microsoft Teams platform was used for the interview. "Microsoft Teams is a unified communication and collaboration platform that combines persistent workplace chat, video meetings, file storage, and application integration" (Wikipedia, 2020, p. 1).

During semi-structured interviews, the respondent and the interviewer engage in a formal interview, in which the interviewer uses a pre-developed "interview guide" to follow and gather the required information (Bernard, 1988). "The semi-structured interview guide provides a clear set of instructions for interviewers and can provide reliable, comparable qualitative data" (Cohen & Crabtree, 2006, p. 1). The benefit of this data generative tool is that questions are well-prepared in time, and also allows the researcher or interviewer to be prepared ahead in time and be competent during the interview (Bernard, 1988). Moreover, informants or interviewees enjoy the freedom to express their views or positions in their self-terms.

Semi-structured interviews often enrich investigations by providing comparable, reliable and valid qualitative data (Cohen & Crabtree, 2006). Through this interview, I sought to unfold how the lecturer encourages critical learning by promoting critical thinking skills, hypotheses formulation skills, and problem-solving skills to trigger the development of the ESD competences including: Holistic Approach, Envisioning Change, Achieving Transformation, Systems-thinking, Normative, Anticipatory, Strategic, and Interpersonal. Data obtained through the interview provided light to the three research questions conjunction with data obtained from the lesson observations.

The interview was video-recorded to ensure that the views of the informant are well represented, as opposed to taking of notes during an interview. Note-taking during an interview may not necessarily capture everything, but the use of an audio recording device allows the interviewer to transcript tapes for analysis and develop an accurate position/s of the informant (Cohen & Crabtree, 2006).

Observations

In addition to the interview, four (4) lessons (amounting to 4 hours) of the learning and teaching of Cell Biology in Life Sciences at 1st Year level were observed. The lockdown pronouncement by the President of RSA (Hon. Ramaphosa) due to the devastating existence of Covid-19 prohibits me from observing the lesson directly, as contact classes have been put on hold. Therefore, I utilized video-recorded Cell Biology lessons which are part of an ongoing study with Protocol Number: H18/03/12. Data collected through these observations was used to triangulate data collected in the interview and the course outline, and specifically help respond to the research questions (see Section 1.5), as I was able to physically explore how the lecturer develops the ESD competences he would have spoken about during the interview.

"Semi-structured interviews are often preceded by observation" (Cohen & Crabtree, 2006, p. 2). This is to produce accuracy and reliability of data. The observations will be generally guided by the research questions. By doing so, only indicators of the development of ESD principles and values such as critical-thinking skills, hypotheses formulation, and critical problem-solving skills and will be looked at.

Course Outline

An analysis of the course outline through which this study finds interest was performed to gather data in relation to sub-question no.1. The document analysis also provided assistance to sub-questions no. 2 and 3 as the focus was on exploring the predetermined ESD competences that the lecturer sought to develop.

3.6 Data analysis

"Data analysis in qualitative research is defined as the process of systematically searching and arranging the interview transcripts, observation notes, or other non-textual materials that the researcher accumulates to increase the understanding of the phenomenon" (Wong, 2008, p. 15) . Therefore, qualitative data analysis (QDA) approach was employed in this study to enhance the understanding of the development of ESD competences during the learning and teaching of Cell Biology in Life Sciences at 1st Year level. "QDA is the range of processes and procedures whereby we move from the qualitative data that have been collected, into some form of explanation, understanding or interpretation of the people and situations we are investigating" (Sunday, 2015, p. 3).

Upon completion of the observations and the interview, the recorded videos and field notes were transcribed into word text. The original content was not modified. The manual analysis of the transcribed data occurred using a deductive approach which uses an organizing framework comprising of themes for the coding process (Bowen G. A., 2019) (Braun and Clarke, 2006). According to Thomas (2006) "the framework, often referred to as a start list (Miles and Huberman, 1994), is applied in the analysis in anticipation that certain core concepts are in the data" (Azungah, 2018, p. 392).

Develop a start list: A start list provides "initial focus in identifying certain key aspects of the data that directly relate to the research questions" (Azungah, 2018, p. 393). Table 1 provides an overview of the start list which guided the deductive analysis of the data. Column 1 provides the research questions that inform this study, and column 2 provides the key categories that are related to each research question. Column 3 details the rationale that informs the relationship between column 1 and 2.

Research sub-question	**Start list (category)**	**Rationale for category**
1. Which competences for ESD is the selected lecturer developing among pre-service teachers during the teaching of Cell Biology in Life Sciences?	Educator competences	Provides a track of educator competences developed
2. How are these competences for ESD developed among pre-service teachers during the teaching of Cell Biology in Life Sciences?	Pedagogical interactions	Provides a track of the methods and materials used to develop the competences in response to sub-question 1
3.What are the opportunities and challenges (affordance and hindrances) that the lecturer experienced when developing ESD competences among pre-service teachers during the teaching of Cell Biology in Life Sciences?	Classroom atmosphere	Provides a track of issues that inform the development of the competences

Table 1:Category Start list for the development of ESD competences

Data coding-The Wiek et al (2011) and UNECE (2012) frameworks were used to develop themes and codes in relation to the indicators that inform each of the proposed ESD competence (see appendix 2). After the development of the codes, data transcriptions (course outline, lesson observations and interviews) were deductively analyzed and excerpts (evidence) related to a particular theme were grouped accordingly.

3.7 Ethical considerations

Conducting research in education requires participation of human beings and must be conducted in an ethical manner (Opie, 2004). This means the researcher must be transparent and provide adequate clarity to his/her participants about the details of the study. To do so, I explained to the participants what the research is about, sought their consent to use the Cell Biology lessons' recordings and the course outline, and also assure them that: 1. in no ways will their lives be put in danger; 2. their dignity will not be compromised; 3. but they will be respected. To achieve this, the lecturer participating during the interview was labelled with letters of the alphabet to uphold confidentiality and anonymity.

The video recordings from the interview and the lesson observations, as well as the transcribed data will not be shared with anyone but will only be shared with directly interested parties such as the supervisors. Upon completion of this study, the data will be password-encrypted and stored in the supervisor's computer drive. This ensures that the privacy of the participants is upheld. If a need arises for the data to be used for other research purposes, the participants' consent will be requested. Permission will be obtained from the participants, and from the university's Human Research Committee (HREC Non-Medical). Participants will be provided with consent forms which will explain the depth of the study.

They will also be made cognisant of the fact that they can withdraw their participation at any point and time, and that their identities will be kept private as their names will not be used during data transcription, but only random alphabets will be attached to their participations.

3.8 Chapter summary

In this chapter, I presented the research design and methodology. I started by giving an overview of the research approach employed in the study. I then presented the paradigmatic considerations of my research, followed by the research design informing the study. I then outlined how the potential participant was selected. I then gave an overview of the data generation techniques and link them to the research questions, and then explained how the obtained data was analysed. Ethical considerations were also explained.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This study sought to investigate the practices of a lecturer in the development of ESD competences during the teaching and learning of the topic Cell Biology, among Life Sciences pre-service teachers at a South African university. See Section 1.5 for research questions. The data presentation in this section was deductively explored (see Section 3.6). According to Bowen (2003), "researchers taking a deductive approach develop hypotheses based on some theory or theories, collect data that can be used to test the hypotheses, and assess whether the data collected support the hypotheses" (Jaleniauskiene, 2017, p. 2). In the context of this study, the Wiek et al (2011) Key Competences for sustainability framework and the UNECE ESD competences framework were used to hypothesize that the investigated lecturer develops ESD competences during the teaching and learning of Cell Biology at a university level.

The classroom practices of the lecturer and his views on the development of ESD competences explored from the interviews, the lessons and the course outline analysis were used to match the indicators of ESD competences in the two ESD competences frameworks. This was done to locate which ESD competences was the lecturer developing, and how he does so. The data are presented in this chapter in three sections. The first section shows the results responding to sub-question 1. The second section shows the results to sub-questions 2 and the last section responds to the last sub-question.

4.1 Developed competences for Education for Sustainable Development

This section will present ESD competences that were triggered by the investigated lecturer and developed during the course of the Cell Biology lessons' proceedings.

4.1.1 The development of Holistic Approach competence

This ESD competence is concerned with the basic systems of integrative thinking and action around the sustainability of interrelated issues of sustainable development, including the environment, the economy and society, both in the present and future times (UNECE, 2012). The development of this ESD competence materialises across three spheres, including integrative thinking, inclusivity, and dealing with complexities.

4.1.1.1 The development of the Holistic Approach competence indicator: Integrative thinking

The lecturer demonstrated aspects of integrative thinking (see Section 2.3.1, p. 13). In the classroom, this reality becomes viable through 'interaction' when inputs from students with different values, beliefs and knowledges are put together and used to think of sustainability solutions (UNECE, 2012). When asked about the teaching approaches he uses to develop ESD competences during his lessons, the lecturer gave this response.

> *Lecturer: Learning emerges out of interaction. It recognises prior knowledge, you mentioned earlier. What is it that (different) learners can bring into context for learning for sustainability?*

The integration is illustrated by the ability to note that learning develops out of interactions in the classroom and these classroom interactions would make use of prior knowledge on sustainability, to bring new levels of understanding concerning both the content knowledge and knowledge for sustainability. The development of the integrative thinking ESD indicator by the lecturer provides opportunities for the pre-service teachers (PSTs) to develop critical decision-making skills, as the product of integrating different PSTs' ideas and conceptions often leads to a consensus output about the matter of interest. Moreover, the lecturer during lesson 1 proceedings used group formations to promote collaborative work.

The evidence below is an excerpt from Lesson 1 proceedings.

> *Lecturer: And then I'll be organising you into groups, or you organise yourselves into groups that will actually come and present here, but that is an organisation for tomorrow.*

In this quotation the lecturer noted that the organisation of PSTs into groups would facilitate the interactions that would develop new knowledge. Part of the interactions involved PSTs presenting on the outcomes of their interactions. The lecturer therefore recognized that PSTs would learn through interactions and through making presentations of what they learnt in groups. This is a demonstration of integrative thinking which brings together the concepts learnt, the methods of developing understanding of the concepts and the methods of sharing what the PSTs understood. Moreover, the lecturer caters for integration as he encourages the PSTs to engage one another briefly as evident below.

> *Lecturer: Take one minute to classify yourselves, which kingdom do you belong to? May you please complete those. Talk to your neighbour.*

It becomes apparent that his subscription to the notion of interactive learning approach by using different PSTs' content prior knowledges paves a way for 'learning for sustainability' to be viable. Thus, the cell biology lecturer demonstrates certain aspects of integrative thinking, but it would have been more impactful if he gave an indication of how raising awareness about sustainability in the classroom can have profound effect elsewhere. Interestingly, when questioned about his beliefs on ESD competences, he thinks of the impact the classroom interactions can have outside the school, as evident in the quotation below.

> *Lecturer: So, when you develop ESD competences, you want your learners to develop competences that enable them to see themselves within the wider world, and then how can they help respond to issues in that (present) world.*

The lecturer raises interest in developing competences that enable PSTs to fit in the wider world, that means they must apply the knowledge in various contexts. In this integrative thinking, knowledge developed in school is envisaged to be useful to the PSTs' lives and lives of others in the world. Therefore, the lecturer's interest in providing PSTs with opportunities to develop ESD competences through an integrative learning approach could imply that he adequately developed integrative thinking.

4.1.1.2 The development of the Holistic Approach competence indicator: Inclusivity

The lecturer's reception to provide PSTs with opportunities to engage him alluded to his conscious interest in considering inclusivity (see Section 2.3.1, p. 13) in his teaching. The lecturer promotes inclusivity in his Cell Biology lessons as he extends the receptiveness for PSTs' initiative and collaborative work on or about the development of the Cell Biology content knowledge. This inclusivity comes true during his first Cell Biology lesson when he encourages his PSTs to develop content for exocytosis, which they are going to present before him, as stated below.

> *Lecturer: You are going to teach me that. I don't understand what exocytosis is. You are going to tech me that next week.*

By making PSTs to teach back to others in class, he is recognizing them and their worth, as well as making them feel that they are part of and can contribute to the teaching and learning process. This approach is an indication of an active learning process where PSTs are active agents of the meaning-making of knowledge and is underpinned by the socio-cultural learning theory (Brooks & Brooks, 1999). Moreover, he goes on to promote inclusivity as he provides

platforms for PSTs to engage one another, irrespective of their individual (different) understandings of the content knowledge. During lesson no.2, the lecturer put it clear that he is a continuous learner. Hence, he provides the PSTs with opportunities to teach him to, as evident below.

> *Lecturer: I'd like to continue to learn to do better. Okay, I'm a learning teacher. Even though this my 20th year of teaching. I'm learning every day.*

The following response was given by the lecturer when asked about the effective teaching approaches he uses to develop ESD competences.

> *Lecturer: I was saying learners are supposed to be free to interact…We recognise that they bring issues, they bring experiences, and they bring knowledge.*

Through this quotation, the lecturer brings out the importance of using any prior learning and home experiences related to the content knowledge (as a medium to raise awareness about sustainability) that the pre-service teachers may have and use such experiences to encourage social cohesion in the classroom, and more importantly, promote citizenship education. Citizenship education among other issues develops PSTs into becoming responsible social and academic beings by promoting inclusive learning (Ozden, 2020). Hence, the lecturer develops the ESD competence inclusivity, and encourages the PSTs to be inclusive social and academic beings.

4.1.1.3 <u>The development of the Holistic Approach competence indicator: Dealing with complexities</u>

The Cell Biology lecturer develops this indicator (see Section 2.3.1, p. 13) as he makes use of sustainability concepts outside the Cell Biology content knowledge to structure and teach the PSTs. The response below was given when the lecturer was asked about ESD competences that can be developed outside the Cell Biology content knowledge, and it considers two sustainability issues (environmental health and promoting social cohesion).

> *Lecturer: In a community they may focus on waste management, because when learners are in community, they are not recognised as learners, they are recognised as members of the community, they learn to live together*.

In this quotation, the lecturer invites the concept of waste management (existing outside the Cell Biology context) which has a profound effect on environmental health, and the mitigation

of climate change effects, to stress the need for people within communities to learn to live together (promotion of social cohesion or citizenship). As the people learn to live together, they also develop sustainability solutions on how to mitigate and deal with the devastating effects of climate change which are caused (among many others) by irresponsible dumping of solid waste.

> *Lecturer: If I take 5% and I'm going to drink a crate of alcohol, 24 beers or 12 quarts, how much labour am I giving to my liver?... And what have you heard about the effects of heavy drinking? And then they will tell you about addiction and liver cirrhosis and so on. And then what about yourself? How do you feel about the consumption of alcohol?... And what have you heard about the effects of heavy drinking? And then they will tell you about addiction and liver cirrhosis and so on. And then what about yourself? How do you feel about the consumption of alcohol?*

The use of this case study by the lecturer does not only afford the pre-service teachers (PSTs) an opportunity to gain in-depth understandings about the processes of exocytosis and the functions of the liver during detoxification of alcohol, but also allows them to develop knowledge about the dangers of excessive alcohol consumption, a critical sustainability issue that RSA and the world at large strive to address on daily basis. Human health is a sustainability concept, and is assigned priority no: 3 on the 2030 Agenda for Sustainable Development (UN General Assembly, 2015). Thus, the lecturer develops the 'dealing with complexities' ESD indicator, and conscientises the PSTs to think about sustainability issues, including alcohol addiction and its dangers to both the person, and the people societal fiscus which he exists on.

To develop the Holistic Approach competence, the lecturer encourages student-student and student-lecturer interactions-a socio-cultural learning approach and promotes inclusivity and incorporates complex concepts outside (but related to) the Cell Biology context to aid with raising awareness around sustainability issues.

4.1.2 The development of Envisioning Change competence

This ESD competence is concerned with the need to engage historical unsustainable practices, develop conscious sustainability values and principles in the present, whilst also thinking of future sustainable development solutions through which scientific evidence becomes prudent in the navigation for such solutions (UNECE, 2012). The development of this ESD competence materialises across three spheres including learning from the past, inspiring engagement in the present, and exploring alternative futures.

4.1.2.1 The development of Envisioning Change competence indicator: Learning from the past

The Cell Biology lecturer's attempt to cater for this ESD indicator (see Section 2.3.1, p. 14) is prudent, as he subscribes to PSTs' prior experiences relating to sustainability to engage the content, and also flexes to use the Cell Biology platform to address historical unsustainable development practices. The response below was given by the lecturer when asked whether PSTs bring into class any ESD competences developed before Cell Biology lessons.

> *Lecturer: my students are likely to have brought in a bit of prior knowledge which … is coming out of their home and school context.*

This quotation views Life Sciences PSTs not as empty buckets, but, as learning agents who possess some pre-conceptions and ideas about the content knowledge. These pre-conceptions and ideas provide a basis for the lecturer to locate the PSTs' position/s about the content knowledge and employ necessary pedagogical interventions as per the demands of the PSTs prior understandings. However, there is no evidence of relating such prior experiences to historical unsustainable practices, nor the reception to utilise such experiences to raise awareness about sustainability. Therefore, I seek to use the following excerpt from Section 4.1.1.1 as a basis for the lecturer to fully develop the 'learning from the past' ESD competence indicator.

> *Lecturer: Learning emerges out of interaction. It recognises prior knowledge, you mentioned earlier. What is it that (different) learners can bring into context for learning for sustainability?*

Through this quotation, the lecturer envisages to use the PSTs prior learning and home experiences as a basis to inform his pedagogical discourse (the development of Cell Biology content), but more importantly, as a basis to engage their historical experiences of both unsustainable and sustainable practices. By doing this, the different learners' prior understandings have a profound impact on the development of integrative thinking. The engagements during integrative thinking allows the PSTs to gain competences for sustainability and address the unjust practices of their communities. Hence, the development of the 'learning from the past' ESD competence indicator by the lecturer.

4.1.2.2 The development of Envisioning Change competence indicator: Inspiring engagement in the present

To develop this indicator (see Section 2.3.1, p. 14), the Cell Biology lecturer in this instance provides resonance with the course outline, and pictures himself as an ESD educator who uses his pedagogy to encourage the PSTs to be creative and be thoughtful of issues surrounding sustainability. This has a positive effect as it allows the pre-service teachers to develop into agents of change (sustainably) within and outside the school environment, as they interact with other people who may seem to be practising or promoting unsustainability. The supporting statement below is an extract from the Life Sciences course outline.

> *Course outline: The course aims to encourage students to acquire knowledge, develop skills and competences, and to develop positive attitudes towards science, especially towards the living world and towards the teaching and learning of science.*

The lecturer, through the course outline resonates with UNESCO (2018) as he perpetuates the academic knowledge (Natural Science) as a vital tool to raise sustainability awareness. He uses the content knowledge to 'encourage PSTs to develop skills and competences (for sustainability)'. This happens as PSTs are critically invited to face the reality of the 'unjust' and irresponsible practices of those they live around and with. Upon doing so, the lecture's pedagogical interventions prepare them to develop ESD attitudes, values and principles which are necessary tools for creating a better and sustainable universe for all in the present living time. The extract below formed part of the lecturer's response on the question pertaining to ESD competences that can be developed outside the Cell Biology concepts and/or content knowledge.

> *Lecturer: When you identify yourself as a sustainability educator, and you have the agency to work with sustainability issues, you have the agency to motivate others to see that the world they live in is not okay.*

This response provides congruence to the latter course outline extract, where the lecturer sought to conscientise the Life Sciences pre-service teachers to be sustainability practitioners. The lecturer develops the 'inspiring engagement in the present' ESD competence indicator through his ability to locate the requirements of a sustainability practitioner (educator). Such requirements include being able to: 1. Have agency for ESD-one's internal ability for sustainability action (Caiman & Lundegard, 2014), and 2. Locate unsustainable practices. Being able to see that the practices of yours and/ or of those around you are irresponsible,

enables you to quickly develop agency to provide sustainable solutions for the immediate present time, as foreseen by the lecturer in the course outline and also on the interview response explored above.

Moreover, when asked to comment on self-beliefs about ESD competences, the lecturer proved to have the desire to develop the PSTs into sustainable practitioners in the present times, but not only within the radius of their school environment, but also extend the sustainable development spirit into their communities, and beyond, as indicated below.

> *Lecturer: So, when you develop ESD competences, you want your learners to develop competences that enable them to see themselves within the wider world, and then how can they help respond to issues in that (present) world.*

This quotation speaks directly to the agency for sustainability that the lecturer (through the course outline and the subsequent response from the interview discussed above) spoke about. The lecturer once again talks about locating the unjust and irresponsible historical and present practices that we usher upon ourselves, nature and the economy. As a subsequent response to such practices, the lecturer calls for sustainability solutions in the present world. Hence, he adequately develops the 'inspiring engagement in the present' ESD indicator and creates a path through which the holistic approach competence can be developed by himself, and by the pre-service teachers.

4.1.2.3 <u>The development of Envisioning Change competence indicator: Exploring alternative futures</u>

To develop this ESD competence indicator (see Section 2.3.1, p. 14), the Cell Biology lecturer shows good understanding of the necessity to develop the PSTs' abilities (i.e., creative thinking) to relate with critical sustainability issues as they navigate for alternative futures in their active engagement with the Cell Biology content. The statement below arose when the lecturer was asked about the relationship between Cell Biology content knowledge and ESD competences.

> *Lecturer: So, if they understand the cell, they know they should be able to relate how the organisms relate within themselves, as well as relate with the surrounding and the outer world…all of us produce hormones…when we are talking about natural science it doesn't end here in the four corners, it goes into our society…these are the issues we deal with in education and in society.*

The lecturer through this statement seeks to use the cell biology content knowledge of hormones as a learning platform to interrogate and engage burning issues in society, such as the South Africa's Caster Semenya's testosterone case[2], which demands PSTs' creative thinking skills, as the issue does not only find residue with the content knowledge, but also with respect for human nature-a sustainability concept. Upon doing so, the lecturer envisages to use this case to conscientise the PSTs to think about futuristic solutions that our societies are in dire demand for. As a result, such sustainability solutions would include respect for human nature and anti-discrimination on the basis of gender. There are male athletes (i.e. Michael Phelps) who also have biological advantages over their competitors, but have not been subjected to the discrimination that Caster is a customer to.

> *Course outline: Students are expected to appreciate the role of science in our everyday lives…treat all living things humanely*

The lecturer suggests that Natural Science needs to develop an understanding of the individual's physiological understanding and reach out to society and Cell Biology can be a vehicle for that process. Thinking about the use of the knowledge to the individual in their lives and how they can use it in the society suggests that PSTs are likely to live differently as members of society in the future, as they develop competence to 'treat all living things humanely', including those who are subject to discriminatory practices like that which Caster Semenya is a recipient of.

To develop the achieving transformation competence, the lecturer encourages active participation of his PSTs and creates platforms for them to develop sustainability solutions for their immediate present times, encourage them to think about sustainable futures, and taps into PSTs' prior learning and home knowledges to interrogate sustainability issues. Hence, the lecturer adequately develops the envisioning change competence.

4.1.3 The development for achieving transformation competence

This ESD competence is concerned with the need to transform our educational spaces and systems for them to become areas of sustainable development practices (UNECE, 2012). The development of this ESD competence materialises across three spheres including

[2] Caster Semenya is a female athlete who has a lot of testosterone and this created lots of discussions among the athletics governing body (IAAF) on whether she should compete as a female or not. As a consequence, she, and other female athletes with similar hormonal levels to hers have been forced to take medication to reduce their testosterone levels if they are allowed to participate in some of the IAAF events. The matter is now before international courts where she is challenging the IAAF's decision.

transformation of an educator, transformation of pedagogy, and transformation of the whole education system.

4.1.3.1 The development of Achieving Transformation competence: Transformation of what it means to be an educator

To develop this ESD competence indicator (see Section 2.3.1, p. 14), the Cell Biology lecturer in this study exhibits a greater understanding of the need to encourage transformative pedagogy, because he asks PSTs to evaluate his pedagogical interventions, and puts it on record that he is not the sole holder of knowledge, but also wants to learn from the PSTs as evident when he catered for the ESD indicator-inclusivity. The comment below providing evidence of the above claim is an extract from Cell Biology lesson no: 4.

> *Lecturer: It's more like an evaluation of what I'm doing. So that I keep improving on the work that I'm doing. The way that I'm working with you now is coming out of people's work in the past, other learners that I interacted with, who gave me their feedback…*

The educator/ lecturer demonstrated that he seeks continual improvement in his practice. That means he is keen on, and amenable to transformation that tends to help him improve on what he does in class. With this practice, he can also develop the PSTs into becoming reflective future educators who will seek the guidance of their students to improve their pedagogy. This practice then allows him to develop the transformation of what it means to be an educator ESD competence indicator for himself, as well as for the PSTs who are ideally educators as they go into teaching experience over the years of their B.Ed. career.

4.1.3.2 The development of Achieving Transformation competence indicator: Transformative pedagogy

To develop this ESD competence indicator (see Section 2.3.1, p. 14), the 'democratic' lecturer provides opportunities for PSTs to reflect and introspect their work and try to better their engagements once more as they navigate for more impactful practices to promote consciousness around sustainability issues. This was evident, as it resonates with the course objectives, in Cell Biology lesson no:3 when a student pleaded with the lecturer to present their work once more after she realised her group presentation lacked some of the most important factors the lecturer had just touched about proper PowerPoint presentation formulations.

Course outline: Build a framework of knowledge based on reading, observation, experience and reflection

The lecturer seeks to create a platform through which the PSTs can develop the Cell Biology knowledge using critical requirements of an ESD learning platform. Such requirements include scientific research, observations of scientific activities (such as experiments) and the ability to reflect on past learning experiences. Through this, the lecturer caters for the transformation of the pedagogical processes of the Life Sciences interactions.

Lesson no. 3 Dialogue:

Student: I was asking if we could repeat the presentation because we didn't have what you've just mentioned in thought when we presented?

Lecturer: Uhm that is a genuine concern, and this is a democracy. Would you like the groups that presented to go over their presentations?

Students: Yes

The democratic nature of the lecturer comes as he engages with the PSTs before taking a decision, and binds to the will of the majority. This move is underpinned by the Leninist concept of democratic centralism. Democratic centralism is practice in which decisions are made centrally and bind to most of the participating individuals. His approach finds congruence with the socio-cultural learning theory as he does not see himself as the authority of knowledge but provides his PSTs with opportunities to be active agents of the development of the content knowledge over numerous times. Thus, the development of 'transforming pedagogy' ESD competence indicator becomes prudent.

4.1.3.3 The development of Achieving Transformation competence indicator: Transformation of the education system

To develop this ESD competence indicator (see Section 2.3.1, p. 14), the lecturer provides congruence to the idea of using the Cell Biology interactions as a platform for developing student teachers into sustainability practitioners in their lives and future endeavours. When the lecturer was asked about what entailed education for sustainable development, he provided the following response.

Lecturer: Education for sustainable development (ESD) is that field of knowledge which enables learners to interrogate sustainability issues, how they can live sustainably in the world, and what they can contribute to the sustainability of this world.

The lecturer's ability to declare the incorporation of ESD during the learning and teaching of Cell Biology as a move to enable the PSTs to interrogate irresponsible and unjust practices of this universe well resonates with the UNECE framework guidelines on transforming the purpose of the education system. The lecturer further provides a room to explore sustainable solutions that the PSTs can develop as a response to the unsustainable models that this universe suffers from as a result of human behaviour, including theirs. Regarding his beliefs about the development of ESD competences, the lecturer said the following:

Lecturer: There are ESD competences that can be developed…where everyone is learning new competences and understanding sustainability and ESD and their role in society… [they are] going to be teachers that are going to develop ESD competences in their learners.

In this quotation the lecturer further raises the need for the PSTs to develop ESD values, attitudes and principles as they play a critical role in determining the kind of a society their livelihoods will be part of. Such society would obviously be a sustainable one. An important taking from the lecturer is that he sees beyond the classroom reality and wants the PSTs to develop sustainability skills and competences that will enable them to be futuristic sustainability practitioners when they become educators and be able to transform the schooling system the minute they are in charge of their classrooms.

An amalgamation of the two responses provides us with an indication about the lecturer's understanding of the ESD concept to be used as a medium for developing sustainability educators or practitioners during and outside the classroom. Reality. By encouraging sustainable interactions as underpinned by the 2030 Agenda for Sustainable Development, the lecturer develops the 'transformation of the education system' as a complete ESD competence, and also provides the PSTs with opportunities to gain sustainability skills, principles, values and attitudes as envisaged by the lecturer through the course outline (see Section 4.1.2.2).

To develop the Achieving Transformation competence, the lecturer subscribes to a reflective pedagogical approach, encourages reflective learning for the PSTs, and provides opportunities

for the PSTs to develop ESD values, principles and attitudes to wholly transform the education system.

4.1.4 The development of Systems-thinking competence

To develop this competence (see Section 2.3.2), the Cell Biology lecturer expresses difficulties with the use of Cell Biology content knowledge as a medium to promote problem-solving skills around issues of sustainability, but to prove his flexibility, he utilises case studies as a platform to encourage complex problem-solving skills. The evidence below was given when the lecturer was directly questioned about how he encourages problem-solving skills during his Cell Biology lessons.

> *Lecturer: Problem solving is difficult to develop in Cell Biology, because it is more like a theoretical concept…The next thing that you can simply do is to build cases.*

In this quotation the lecturer expresses the difficult nature of using the Cell Biology content knowledge as a medium to cater for the development of the pre-service teachers' problem-solving skills. The development of problem-solving skills takes a central position in the development of the system-thinking competence. However, as a dynamic-flexible educator, he seeks to use case studies as an alternative to cater for the development of problem-solving skills. One of the case studies include alcohol abuse and human health, as analysed in Section 4.1.1.3. The supporting evidence (below) was gathered when the lecturer was asked about the teaching materials, he uses to develop ESD competences during the teaching and learning of Cell Biology.

> *Lecturer: Play out a video of a case, they look at it and they watch it with certain questions and they respond to the questions*

In this quotation the lecturer explains how he uses case studies to cater for the PSTs development of problem-solving skills. He plays out a case study video enriched with questions which the PSTs engage and navigate solutions to such questions. Hence, the development of problem-solving skills. Note: The case studies in other instances come in the form of a text (not always in videos) as put forth in Section 4.1.1.3 where a case around alcohol abuse and human health sustainability issues was utilised by the lecturer to trigger the PSTs development of problem-solving abilities.

To develop the Systems-thinking competence which proved to be difficult for him based on the development of problem-solving skills, the lecturer uses case studies as an alternative

pedagogical intervention to promote creativity, and the subsequent development of problem-solving capabilities.

4.1.5 The development of Normative competence

To develop this competence (see Section 2.3.2), the lecturer exhibits profound reception to engage with critical sustainability issues and further provides a detailed resonance to the importance of the sustainable existence of socio-ecological systems as a medium for sustainability. The following response on the lecturer's reception to engage with sustainability issues was explored when the lecturer was asked about ESD competences that can be developed outside the content of Cell Biology.

> *Lecturer: I think all of the ESD competences that I can put together actually can be developed inside the context of teaching. I'm thinking about learning to know, which is development of content. Learning to do, which is more like the practical side of the implementing what has been known. And learning to be, which is more like identity-ethics.*
>
> *Lecturer: …and they get together, and that is learning to be (live) together through the response to a crisis, and then in that process, they are also learning to do*

The two quotations above detail the lecturer's reception to the idea of mapping sustainability issues and creating opportunities for the PSTs to resonate with principles of sustainable development. He does so by creating opportunities to engage with the four classifications of the UNECE ESD competences framework. They are learning to know, learning to do, learning to live together and learning to be (see Section 2.3.1). The lecturer provides resonance to the idea of raising some of the sustainability issues within the four classifications of ESD competences using socio-ecological relationships.

The development of the normative competence is implicit without the interrogation of socio-ecological dynamics (Wiek et al., 2011), hence the lecturer, in the quotation below stresses the need for humans to sustainably utilise natural environments with respect. Further evidence to this assertion is put forth in Section where the lecturer sought the use of waste management case study to promote environmental protection in the wake environmental degradation caused by irresponsible dumping of solid waste.

> *Course outline: Show appreciation of and respect for all of our natural resources*

To develop the Normative competence, the lecturer engages with sustainability issues (i.e. ESD classifications), and satisfactorily provided the PSTs with opportunities to engage with ecological systems in a sustainable manner.

4.1.6 The development of Anticipatory competence

To develop this competence (see Section 2.3.2), the Cell Biology lecturer provides reception to the notion of envisioning a sustainable future as he provides a room for the PSTs to develop sustainability skills (i.e. gender equality[3]) which could help them respond to issues of concern in the future, and the evidence below was explored when the lecturer was asked to elaborate on his beliefs about the development of ESD competences.

> *Lecturer: So, when you develop ESD competences, you want your learners to develop competences that enable to see themselves within the wider world, and then how can they help respond to issues in that world.*

In this quotation the lecturer seeks to provide the PSTs with opportunities to "picture" how human unsustainable practices harm the harmonious existence of sustainable development principles. And as a response to picturing such unsustainability tendencies, the lecturer provides palatability in transforming the PSTs to develop agency to respond in a sustainable manner. This is evident in the evidence (on the footnote below) as the lecturer locates gender inequality in academia, and conscientises his female PSTs to study beyond their junior B.Ed. degree and pursue postgraduate studies, compete with their male counterparts and form part of academia which is currently male dominated.

The male PSTs are also at the same time conscientised to support females in pursuing post-graduate studies-in the name of prompting gender-equality (a sustainability concept). To develop the Anticipatory competence, the lecturer encourages his PSTs to think about sustainable solutions for tomorrow, by promoting gender equality, among other sustainability issues that this universe needs an urgent response to as we navigate for futuristic solutions which will render this universe a harmonious place to live in.

[3] Lecturer: Yes, and is not only about 'wathintha umfazi'but it is about umfazi (woman) being strong, being imbokodo (a rock) and most of the time, you women you underrate yourselves. And we are doing this to show you that hey guys it is possible, and you're not a woman…I'm trying to talk to the ladies here, my ladies, not Your ladies. My ladies, I'm trying to say that when you come in as a first year student, do not see four years as a the out route, see 7,8, 9 years as an out route, that you have entered the pathway, that you have started the pathway, and that pathway must continue until your name has changed. Some will Miss, some will remain Mrs, some will change to DRs, or Dr full stop. That's what we want, we want more DRs amongst you.

4.1.7 The development of Strategic competence

To develop this competence (see section 2.3.2), the lecturer engages the Cell Biology content as a medium to promote 'getting things to be done' as he subscribes to the notion of 'learning to do'-one of the ESD competences classifications. The supporting statement (below) arose when the lecturer was asked to speak about the development of ESD competences outside the Cell Biology content, a question he provided an antagonistic answer to, as he believed that almost 'all' ESD competences can be thought of and subsequently developed using Cell Biology lessons.

> *Lecturer: I think all of the ESD competences that I can put together actually can be developed inside the context of teaching … I'm thinking about … learning to do, which is more like the practical side of the implementing what has been known.*

In this quotation the lecturer, the lecturer sees the Cell Biology platform as a vital tool to develop a wide range of ESD competences, and specifically refers to the desire to develop the 'learning to do' ESD classification. This classification, as the lecturer puts it, transforms theoretical knowledge into practice. In other means, PSTs stand to put the sustainability knowledge they gather trough the Cell Biology platform into action. In Section 4.1.3.3 Excerpt 2, the lecturer talks about developing the PSTs into future sustainability educators, such that they act upon the sustainability knowledge during their career practice.

To develop the Strategic competence, the lecturer promotes the 'learning to do' ESD classification which seeks to put sustainability theory into practice as the PSTs are encouraged to be sustainability practitioners, both in their current times, and even when they go into school practice as educators.

4.1.8 The development of Interpersonal competence

To develop this competence (see Section 2.3.2), the lecturer encourages collaborative learning, which uses learner interactions as a medium for meaning-making. In essence, the learners can engage with the content and develop ESD competences by learning from one another. The evidence below was provided by the lecturer when asked about teaching approaches that are effective for the development of ESD competences during the teaching and learning of Cell Biology.

> *Lecturer: Learners should be free to interact, should be free to contribute…learning is socio-cultural…Learning emerges out of interaction.*

In this quotation the lecturer puts it categorically clear that learning is an outcome of participation. As different PSTs participate, different pre-conceptions and ideas related to Cell Biology and sustainability knowledges stand to be used by the PSTs to find common consensus as they actively engage one another. This quote extends the integration and inclusivity catered for by the lecturer in Section 4.1.1.1 and 4.1.1.2 respectively, as critical indicators of encouraging advanced communication skills when interrogating sustainability issues. The statement below, which reiterates his response under Section 4.1.4, was given when the lecturer was questioned about how he encourages problem-solving skills during his Cell Biology lessons.

> *Lecturer: Problem solving is difficult to develop in Cell Biology, because it is more like a theoretical concept…The next thing that you can simply do is to build cases.*

Thorough this quote, as put forth in Section 4.1.4, the lecturer seeks to use case studies as a medium to cater for the development of pre-service teachers' problem-solving skills which form part of the determining factors of an adequate development of the interpersonal competence. To develop the Interpersonal competence, the lecturer encourages participation of all PSTs who possess different beliefs, values and knowledges. This is an indicator of an inclusive learning approach.

4.2. How ESD competences were developed

This section will present teaching procedures used by the lecturer to develop the (above) presented ESD competences during the teaching and learning of the topic Cell Biology.

The lecturer who participated in this study, from time to time makes comments about interactive learning, socio-cultural approach, group work, etc., thus rendering him to be a subscriber of a socio-cultural learning approach-encourages learners to work together and learn from one another; and uses materials such as PowerPoints and videos to help him develop ESD competences during his Cell Biology lessons.

When the lecturer was asked about effective pedagogical strategies that can be employed to develop ESD competences. He responded as follows:

> *Lecturer: You find that freedom is one of those issues that are emphasised in ESD … where learning is socio-cultural and depends on language, how learners interact.*

In this quotation the lecturer stresses that he subscribes to the pedagogical paradigm of constructivism or a socio-cultural learning theory depending on a particular scholar's choice. Both terms refer to an active learning process where the PSTs are hands-on in a mutual setting when developing knowledge. For the lecturer, this is the most effective approach an educator can use to promote a liberating educational discourse which is inclusive. The lecturer was further asked whether his Cell Biology lessons are effectively responding to the manner in which he plans for such lessons, and he responded that developing ESD competences is easier for him when he interacts and comes into contact with the PSTs, an indicator of a socio-cultural learning perspective.

The quotation below from lesson 4 fury her provides evidence to the lecture's reception to use interactive case studies, and promote peer-discussions.

> *Lecturer: Okay, the picture, what is displayed in picture? And how is it displayed? Talk to your neighbour for half a minute.*
>
> *Lecturer: You need to think about interactive material. So if you're going to use a PowerPoint, you're not going to use it to tell the learners, but to guide the learners. You can use a video as a stimulant.*

When the lecturer was questioned about teaching materials that could be embedded in the effective teaching approaches used to develop ESD competences, he stated (as evident in the quotation above) that the importance of using interactive materials such as videos and PowerPoint presentations provide him with opportunities to interact with the PSTs. During the interactions, he becomes a facilitator of knowledge, and provide the PSTs with opportunities to be active agents of learning, and not be programmed recipients of the content who make no meaningful contribution.

From his responses, it becomes apparent that the lecturer uses a socio-cultural learning approach and interactive learning materials to stimulate the pre-service teachers' collaborative working skills (as active agents of learning) to develop Cell Biology content, and ESD competences. Collaboration is one of the competences of sustainability as decisions and action have to be undertaken through collaborative agency in the community and society (UNESCO, 2017).

4.3. Challenges and opportunities faced by the lecturer

This section will (first) present the factors that seem to play a role in disturbing the explicit development of ESD competences. Secondly, it will also present the pre-service teachers' activities that aided the investigated Cell Biology lecturer to cohesively develop ESD competences.

4.3.1. Challenges that affect the development of ESD competences

Lecturers, like other educators are often met with challenges when developing ESD competences in their classrooms. The Cell Biology lecturer who participated in this study is of no exception to this reality. The extract below was obtained when the lecturer was asked about the constraints that destructs his Cell Biology lessons and the subsequent development of ESD competences.

> *Lecturer: Usually is time, we don't have time and also technology. We depend so much in technology such that we have limited ways of presenting the content and we also have limitation in terms of the space that we are teaching that may not allow adequate group work.*

In this quotation the lecturer notes time constraints (considering that he has a lot of PSTs to deal with over a limited period) as a hindering factor towards the development of ESD competences in an effective manner. Technology has taken over most of the learning interactions (the use of PowerPoint presentations, online assessments, online classes), which is a good thing at the present times of the 4^{th} industrial revolution, but lecturer notes the less availability of technological resources mostly at the side of the PSTs who often lack computers/smartphones and internet connection as a stumbling factor during the development of ESD competences.

4.3.2. Opportunities that aid the development of ESD competences

Even during such challenges coming through and subsequently hindering an effective development of ESD competences during the teaching and learning of Cell Biology, there are opportunities that arise and assist the lecturer to develop some of the ESD competences. When the lecturer was asked about opportunities that arise when developing ESD competences during the learning and teaching of Cell Biology, he responded that PSTs' seeking clarity questions provided him with opportunities to connect with the PSTs and seek other useful pedagogical interventions, rather than just presenting lecturer notes as evident in the quotation below.

Lecturer: When students ask questions of clarity, then I'm able to leave the mainstream presentation approaches, and then I can use other approaches. I find this breakthrough, all the time it comes out of my relationship within the students. Are they free to ask questions of clarity, are they free to contribute? So all of those, their contributions, their questions, their interactions are opportunities for mainstreaming ESD.

In this quotation the lecturer sees the pre-service teachers' initiatives, such asking questions of clarity as some of the interventions that positively impact his quest to mainstream sustainability knowledge during the learning and teaching of Cell Biology. He further expresses an important issue that has troubled many learning processes-the relationship between him and the PSTs. His ability to work friendly interact with the PSTs in a professional manner lubricates the learning process as the PSTs are free to interact and contribute towards the development of knowledge.

When lecturer was asked about how such opportunities further assist him during the development of ESD competences, he indicated that he gets opportunities to abandon the mainstream teaching procedures and be able to attend to PSTs' initiatives and discussions, as evident in the statement below.

Lecturer: I find opportunities useful because in many cases they help me to go to extend which I had not freely planned for.

The development of ESD competences during the pedagogical discourse of Cell Biology is met with challenges including time constraints, the number of PSTs to attend to and availability of e-resources such as the internet. On the other hand, opportunities (i.e. PSTs' initiatives) do also arise, and aid the lecturer to effectively develop competences for ESD.

4.11 Chapter Summary

In conclusion, from the data presentation and analysis, one can deduce that, for the first research question (see Section 1.5), the results provide an indication of the ESD competences developed. This became prudent as the Cell Biology lecturer showed great interest for the development of almost all the combined ESD competences from the two frameworks. The competences are: holistic approach, envisioning change, achieving transformation, systems-thinking, normative, anticipatory, strategic and interpersonal.

For the second research question (see Section 1.5), the results indicated that the lecturer subscribes to a socio-cultural learning theory which promotes active learning (PSTs initiatives and collaborative work), as also aided using interactive learning materials.

For the last research question (see Section 1.5): the results indicated that space, time and shortage of technological resources to be some of the challenges that hinder the Cell Biology lecturer from developing ESD competences more effectively. On the other hand, the lecturer regarded PSTs clarity seeking questions and follow-up discussions as important opportunities that assist him to develop ESD competences during the teaching and learning of Cell Biology in Life Sciences. The summary of findings deduced from the results are presented in the next chapter.

CHAPTER 5: DISCUSSION OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

5.0 Introduction

In this chapter, I use the findings from the previous chapter to discuss the: 1. ESD competences developed among pre-service teachers; 2. pedagogical strategies employed during the development of such ESD competences; 3 Challenges and opportunities that hinder and aid the development of ESD competences during the teaching and learning of Cell Biology in Life Sciences. The discussion will be followed by the study's conclusion, a discussion of the study's limitations, and a list of recommendations.

Summary of findings

Despite hindrances during the teaching and learning process of the topic Cell Biology, the following findings could be deduced from the narratives in the previous chapter:

1. The selected lecturer uses socio-cultural learning approaches to develop ESD competences including: Holistic Approach, Envisioning Change, Achieving Transformation, Systems-thinking, Anticipatory, Normative, Strategic, and Interpersonal.
2. Interactive learning materials are significant enablers for the development of ESD competences. The interactive learning materials include case studies, videos and PowerPoint presentations.
3. Pedagogical approaches such as students' initiatives and participation play a significant role in the development of ESD competences.
4. Time constraints, space and limited e-resources pose the potential to disturb the adequate development of ESD competences.

Note: Finding 1 is linked to Research Sub-question 1, Finding 2 & 3 are linked to Research Sub-question 2, and Finding 4 is linked to Research Sub-question 3.

5.1 Competences for ESD developed among preservice teachers during the teaching and learning of Cell Biology in Life Sciences

Socio-cultural learning approaches are key to the development of ESD competences, including: Holistic Approach, Envisioning Change, Achieving Transformation, Systems-thinking, Anticipatory, Normative, Strategic, and Interpersonal. In this section, I respond to the first

research-sub-question (see Section 1.5) as I discuss the ESD competences that have been developed during the teaching and learning of Cell Biology. The discussion also takes into account the second sub-question (see Section 1.5) as I outline the utilisation of socio-cultural learning approaches as a mechanism used by the lecturer to develop such ESD competences.

5.1.1 The development of the Holistic Approach competence

The results indicate that the lecturer engages the pre-service teachers and develops this ESD competence during his Cell Biology lessons across three indicators including: Integrative thinking, inclusivity, and dealing with complexities.

5.1.1.1 The development of the Holistic Approach competence indicator: Integrative thinking

From the results, it can be deduced that a multifaceted learning interaction is catered for by the lecturer, and subsequently leads to the development of the 'integrative thinking' ESD competence indicator. The lecturer expressed the significance of an interactive practice during learning (see Section 2.3.1, p. 13). In the context of a socio-cultural learning perspective (Finding 1), a learning process becomes profound when students are provided with opportunities to engage one another and find common consensus in an integrative manner (Epstein & Peck, 2018).

Through this approach (socio-cultural learning), the lecturer emphasised that "*learning emerges out of interaction*", and further links this response to the knowledges, views, and ideas about 'learning for sustainability' that different learners can bring in the classroom (see section 4.1.1.1). The direct link of an envisaged interactive learning environment and raising awareness about sustainability issues proves the lecturer to be an ideal example of a holistic educator. This is because he provides resonance with the importance of providing students with opportunities to learn from one another irrespective of their individual positions about their Cell Biology knowledge understandings. "At its most fundamental, sustainable development connects individuals and groups to other people" (UNECE, 2012, p. 16).

The latter statement provides us with the importance of promoting sustainability principles in the classroom where different leaners' ideas are used during the development of content knowledge, as learning emerges out of interaction (UNESCO, 2017). Question of interest: How did the lecturer encourage interactive learning to enhance integrative thinking during the teaching and learning of Cell Biology? To provide light to this question, I use the following interactive education recommendations from The ARMA International Centre for Education to explore the lecturer's interactive pedagogical styles:

- “Encourage student participation
- Use questions that stimulate response, discussion, and a hands-on experience
- Use teaching aids that press for answers, and capture/hold the student’s attention
- Set up a workgroup environment
- Involve yourself as well as the student” (Resilient Educator, 2018, p. 3).

During the proceedings of lesson 1 the lecturer encouraged group formations (see Section 4.1.1.1 excerpt 2). It is within those groups that student participations (finding 3) were encouraged. Moreover, the lecturer familiarised himself with the use of interactive teaching aids (i.e. diagrams, see Section 4.2 excerpt 2 and Finding 2) to stimulate PSTs’ classroom initiatives and discussions. Interactive teaching materials picture diagrams, charts, graphs, and case studies enhances the learning discourse (Epstein & Peck, 2018).

5.1.1.2 The development of the Holistic Approach competence indicator: Inclusivity

To develop this indicator (see Section 2.3.1 p. 13), the lecturer employed a socio-cultural learning perspective (Finding 1) and provided the PSTs with opportunities to be active participants of the knowledge development (see Section 4.1.1.2 excerpt 1). It is through this context that I see him fit to have been a sustainability practitioner who encouraged inclusivity, a critical indicator of the Holistic Approach competence. Educators bear the responsibility for inclusivity to be realised during classroom proceedings (WWF-UK, 2012).

He/she does so by encouraging his/her students to work together and provide a room for all views to be entertained until common wisdom is found amongst the views and ideas of the students (WWF-UK, 2012; UNECE, 2012), as evident in Section 4.1.1.2.

Generally, the lecturer is thought to be the most knowledgeable one in the classroom (Mariage, Englert, & Garmon, 2000). This notion is underpinned by the Behaviourism learning approach which stresses that learning is a behavioural change triggered by the stimulus activities of the teacher (Delprato & Midgley, 2016). However, the lecturer in this study took a different direction and proved his palatability to create a positive ‘inclusive’ learning environment and encourage the PSTs to be active agents of the learning process. Active engagement of students during the development of knowledge underpins the socio-cultural learning perspective (Epstein & Peck, 2018).

Through this active learning process which sought to promote inclusivity, the pre-service teachers (PSTs) got an opportunity to amalgamate the (different) individual ideas and views they had about different cellular organelle processes to develop common understandings about

the content they were going to put up for their presentations. Such individual views and/or ideas are a product of the PSTs' prior learning experiences. The lecturer put forth the possibilities of the Cell Biology pre-service teachers coming into class with some prior or home knowledge. The excerpt below is from Section 4.1.2.1.

> *Lecturer: my students are likely to have brought in a bit of prior knowledge which … is coming out of their home and school context*.

Given the proximity of students' prior knowledge to the development of Cell Biology knowledge, the lecturer's provision of an inclusive learning discourse becomes viable, as each student's prior understandings are provided with platforms to partake in the development of the content knowledge, as well as the development of sustainability understandings. Students' dialogue and initiatives allow the learning process to tap into different students' prior knowledges and perceptions and create a common scenario for the development of knowledge (Brooks & Brooks, 1999). Moreover, the learning process bears the responsibility to tap into students' prior learning experiences relating to sustainable development and use such experiences to conscientise the students about the need for sustainable solutions for the world we live in (UNESCO, 2017).

By utilising the socio-cultural learning approach to develop knowledge (Finding 1), the lecturer also created a platform through which the freedom of participation for all was catered for. ESD as a critical resemblance of quality education bears the responsibility to promote freedom of participation, such that all students are actively involved in the learning process an in inclusive manner (Agbedahin, 2019).

5.1.1.3 <u>The development of the Holistic Approach competence indicator: Dealing with complexities</u>

To develop this indicator (see Section 2.3.1, p. 13), the investigated lecturer extended the Life Sciences curriculum scope of investing too much energy on the talk about the detoxification of alcohol through lysosomal activity and went as far as to be cognisant of human health issues, about the possible damage one's liver can be exposed to due to excessive drinking (see Section 4.1.1.3 excerpt 2). With this reality, the investigated lecturer can be said to be resolute with the need to develop the Holistic Approach competence, as he uses concepts outside the Cell Biology context to create bridges across a range of ideas and concepts (UNECE, 2012), to conscientise Life Sciences pre-service teachers about the critical significance of upholding sustainable development principles.

Citizenship (education) is one of the most emphasised sustainability concepts (UNESCO, 2018), thus, making it unfeasible to not discuss the elements of it identified from the results. From the evidence given in Section 4.1.1.3 "*learners … are recognised as members of the community, they learn to live together*", the lecturer critically proved to be cognisant of an important classification of ESD competences 'Learning to live together', and what stands up from this is that he uses a concept outside the context of Cell Biology to find ways through which an important sustainability issue such as social cohesion (or citizenship) can be addressed and encouraged among the pre-service teachers.

According to Qualifications and Curriculum Authority (1998), citizenship education is defined as the "process of students' acquisition of social and moral responsibility, social participation, and political literacy" (Ozden, 2020, p. 151). Such an approach used by the lecture qualifies into the definition of Citizenship Science (see Section 4.1.1.2), an indicator of a socio-cultural learning theory (Finding 1) which seeks to promote positive student-student and student-lecturer relationships. By extending beyond the curriculum, the lecturer demonstrated evidence for teaching aspects of citizenship science. Hence, the lecturer develops the Holistic Approach innovator 'Dealing with complexities' using concepts outside the Cell Biology context to create bridges for addressing issues of sustainable development, which are inevitable given the demands of quality education through the ESD medium.

5.1.2 The development of Envisioning Change competence

The results indicate that the lecturer develops this ESD competence during his Cell Biology lessons across three indicators including: learning from the past, inspiring engagement in the present, and exploring alternative futures.

5.1.2.1 <u>The development of Envisioning Change competence indicator: Learning from the past</u>

To develop this indicator (see Section 2.3.1, p. 14), the results indicate that the investigated Cell Biology lecturer provides resonance with the use of pre-service teachers' prior knowledge to develop the content knowledge, whilst addressing sustainability issues (see Section 4.1.2.1). One question of interest would be "how did the he utilises the PSTs' prior knowledge to advantage the knowledge development process?" The formation of groups (in lesson 1, see Section 4.1.1.1 excerpt 2) and stimulation of PSTs' initiatives (see Section 4.1.1.2), allowed the lecturer to afford the PSTs with opportunities to relate their prior cellular organs' understanding to the group presentations they had to do. It was after presentations that the lecturer would then intervene and teach about the presented cellular organ.

Tapping into students' prior experiences as an indicator of constructivism and/or socio-cultural learning approaches greatly impacts and enriches the learning process, as both the educator and the students are involved in the development of knowledge (Brooks & Brooks, 1999), particularly because the 'learning from the past' ESD competence indicator has been catered for (UNECE, 2012). However, an adequate development of the 'learning from the past' ESD indicator seeks relevance from the use of prior home and learning experiences to fully interrogate sustainability issues (UNECE, 2012). So far, as guided by the evidence in Section 4.1.2.1 excerpt 1, the lecturer's approach does not render him an opportunity to fully develop this ESD competence as the PSTs' prior experiences have only been afforded an opportunity to inform the development of the content knowledge of Cell Biology, and not to conscientise the PSTs about sustainability issues.

Interestingly, seeking the lecturer's wisdom in Section 4.1.1.1 excerpt 1 proves the lecturer to be a flexible sustainability character. The flexibility comes as he envisages to use the PSTs prior learning and home experiences as a basis to inform his pedagogical discourse (the development of Cell Biology content), but more importantly, as a basis to engage their historical experiences of both unsustainable and sustainable practices. This surely paved a way to trigger the PSTs critical thinking skills to explore their historical experiences with issues of sustainability and further developed sustainability solutions to such experiences. For an example, the PSTs are likely to have directly or indirectly experienced scenarios of children and women being on the receiving end of abusive husbands, fathers and/or male relatives whose actions were triggered by excessive alcohol consumption drinking and drunkenness.

Therefore, the lecturer's ability to ask about the significance of the PSTs prior living and learning experiences in relation to sustainability knowledge provides opportunities for the PSTs to locate the wrongs and unjust practices of those they live with, such that they develop capabilities to reprimand them should they seek to abuse others. The claim in the latter statement finds congruence with ESD principles. As a medium to attain quality education, ESD provides students with opportunities to learn from one another and develop sustainability knowledge which will allow them to be agents of change in their communities (UNESCO, 2017). This is an exact foresight of the investigated lecturer who sought to interrogate the PSTs prior experiences in the context of 'learning for sustainability'.

Moreover, the lecturer's reception to interrogate the PSTs prior experiences in relation to sustainability knowledge also provides the PSTs with opportunities to integrate their stories,

and further develop an understanding of an array of issues they may not have necessarily being able to attain individually. Finding 1 of this study indicates that the lecturer uses a socio-cultural learning perspective to develop ESD competences. As with other developed competences, the lecturer's ability to cater for the utilisation of the PSTs' prior experiences related to both the content knowledge and sustainability knowledge promotes integrative thinking, as discussed in Section 5.1.1.2.

Integrative thinking is an indicator of a socio-cultural learning perspective, as it uses different students' conceptions to find common consensus about knowledge, and promotes social cohesion during learning (UNECE, 2012). Hence, the development of the 'learning from the past' becomes adequately catered for as the lecturer was able to seek the use and integration of the PSTs' past experiences related to the content knowledge, and sustainability issues to conscientise the PSTs to be sustainability practitioners in society.

5.1.2.2 The development of Envisioning Change competence indicator: Inspiring engagement in the present

To develop this indicator (see Section 2.3.1, p. 14), the results indicate that the investigated Cell Biology lecturer pictured himself as an ESD educator who uses his pedagogy to encourage pre-service teachers (PSTs) to be creative and be thoughtful of issues that concern sustainability principles, values, and attitudes. The lecturer put forth that when one identifies himself/herself as a sustainability educator, they possess the agency (capacity to act) to work with sustainable development issues and stimulate the students to realise that the world they are living in is not okay, but actually living in one that is perpetuating unsustainable practices that will bear negative impact for them, their natural environments, and as well as their economies (see Section 4.1.2.2).

Educators while developing ESD competences should be cognisant of the need to conscientise their students about sustainable solutions for their immediate present lives as an impactful response to u just and irresponsible functions of the human species (Sadaf & Hassan, 2019). For example, the Cell Biology educator stresses that the Life Sciences PSTs should develop into becoming sustainable trainees, and subsequently, sustainability educators (see Section 4.1.2.2). What does this mean? He envisages the Life Sciences PSTs to be agents of change within and outside (in their communities) the school environment.

Agents of change in this context refers to people who will provide solutions by strongly fighting against unsustainable practices including environmental degradation, all forms of

discrimination, lack of basic services (i.e. access to health, education, shelter etc.), corruption, economic exploitation, gender-based violence, etc. (UNESCO, 2014, 2016, 2018). The solutions spoken about may include encouraging equality, inclusivity, responsible utilisation of natural resources, ethical governance, access to quality education, humanity, and many others (UNESCO, 2014, 2016, 2018). The Cell Biology provides clear congruence to the assertions above (the need to develop just and sustainability solutions to current and historical unjust practices at the expense of SD pillars), and I invite you to the evidence given in Section 4.1.2.1.

The statement above, particularly this quote "how can they respond to issues in that (present) world" positions the lecturer in the centre of trying to explore sustainable solutions in response to how the human species performs unjust practices in this universe at the expense of sustainable development pillars including: the economy, the environment, society, peace and partnerships. The lecturer used peer discussions (see Section 4.2 excerpt 2), group work (see Section 4.1.1 excerpt 2) and student-lecturer interactions (section) (Finding 1) as a medium to conscientise the PSTs to: 1. Think of excessive drinking and the danger it causes to human health (see Section 4.1.3 excerpt 2) and promote responsible drinking;

2. Develop positive attitudes towards upliftment of women and the abolishment of gender discrimination within the academic field (see Section 5.1.3.3); and respect for humanity, and natural processes in the case of the injustices Caster Semenya suffers from (see Section 5.1.2.3). By catering for the development of such sustainability solutions, the lecturer inspires sustainability engagement for the PSTs immediate lives, as well as his. Therefore, develops the inspiring engagement in the present ESD indicator.

5.1.2.3 The development of Envisioning Change competence indicator: Exploring alternative futures

To develop this indicator (see Section 2.3.1, p. 14), the results indicate that the Cell Biology lecturer exhibits a good understanding of the necessary need for Life Sciences PSTs to develop creative thinking skills and utilise them to think of possible future sustainability solutions that will not only play a critical role in their lives, but also in the lives of many other of people of the universe (see Section 4.1.2.3). From the evidence provided in Section 4.1.2.3, one can deduce that the lecturer wants his students to use the Cell Biology content knowledge and link such knowledge to the relationships that are shared by living beings. The relationships may

include, morphological, anatomical; or physiological similarities and differences that organisms possess.

But what is of most critical importance from the evidence supporting the results, is that the lecturer sought to use some of the pressing issues in society (such as the Caster Semenya testosterone saga) as a case study in an interactive learning environment (Finding 1) to conscientise the PSTs about the need to explore alternative solutions for the future in the wake of unjust practices, both within the educational field, as well as in society. Thus, encouraging sustainable solutions for the future. Already, by using the Caster Semenya high levels of testosterone, a biological event that Caster had no powers to preside over, the lecturer sits well in a position to be a sustainability educator who brings his PSTs' attention to the unjust, and unsustainable discriminatory treatment that the International Associations of Athletics Federations (IAAF) employed towards South Africa's world champion Caster Semenya.

Part of the 'alternative future solutions' that the lecturer developed into the social conscious of the PSTs may include encouraging them not be discriminative, encourage them to respect biological process (no one chooses upon birth the features they may have), encourage them to conscientise others about mutual respect (see Section 4.1.2.3), etc. The development of such sustainability solutions do not come spontaneously, but only arrives when the lecturer encourages creative thinking and decision-making skills during his lessons (Sadaf & Hassan, 2019). And already, by linking the Caster Semenya issue (which is already before international courts) to the Cell Biology content proves that the lecturer is not only interested in the mainstream development of scientific (Life Sciences) knowledge but is strongly interested in raising awareness about sustainable development. Subsequently, future sustainability solutions to the unsustainable ills of our communities are developed.

5.1.3 The development of Achieving Transformation competence

The results indicate that the lecturer develops this ESD competence during his Cell Biology lessons across three indicators including: transformation of an educator, transformation of pedagogy, and transformation of the education system.

5.1.3.1 The development of Achieving Transformation competence: Transformation of what it means to be an educator

To develop this indicator (see Section 2.3.1, p. 14), he results indicate that the investigated Cell Biology lecturer exhibits a greater understanding of the need to encourage transformative pedagogy. This is because, apart from considering his pedagogical approaches and

interventions to be the 'best' and not be a subject of interrogation, he provides a platform (lecturer evaluations) through which his students can use to provide feedback on his teachings and how he engages with the Cell Biology content. With this reality in mind, my cognitive abilities have just reminded me of my Life Sciences PGCE lecturer who used to say that the educational system normally suffers from educators with 1 year teaching experience, and 19 years of repetitive teaching approaches. The investigated lecturer shared similar views with the latter statement as evident in Section 4.1.1.2 excerpt 2:

According to Haidary (2013), research on 'grade repetition and teacher experience' has found lack of reflective pedagogy and repetition of similar pedagogical practices to be less-progressive, as the teaching and learning process in not a 'one shoe fits all' scenario. The PGCE lecturer would make the 'teaching experience' statement each time she wanted to emphasize on the importance of PSTs to resonate with the need to reflect on their teaching after each lesson, as part of the conclusive section of the lesson plan. As this crosses my mind, I then see the investigated Cell Biology lecturer as a transformative educator who invites the Life Sciences PSTs to engage him from time to time and assist him in transforming the manner in which he teaches, as he reflects on the submissions shared by the PSTs.

To achieve classroom transformation, educators bear the responsibility to encourage students to raise questions of concern and reflect on the educator pedagogical practices and interventions (UNESCO, 2017). More interestingly, the lecturer puts it to the PSTs that the pedagogical strategies he is using to teach them is a result of past PSTs evaluations (see Section 4.1.3.1). Educators who uphold and develop the '*Transformation of what it means to be an educator*' are "educators who are able to change their own practice as critical reflective practitioners" (UNECE, 2012, p. 17).Earlier on (see Section 4.1.3.1), I resonated Finding 1 'the lecturer uses the socio-cultural learning approach to develop ESD competences' with the need to be cognisant of the fact that the lecturer is not the sole holder of knowledge (as argued for by followers of Behaviourism), but that the development of knowledge in the classroom becomes a true reality when the lecturer engages the students as active participants of the learning process (Mudaly, 2018). This assertion finds interest as the adequate development of the 'transformation of what it means to be an educator' also demand for the existence of positive relationships of interaction between the educator and students (UNECE, 2012). The results in support of this claim indicate that the investigated Cell Biology lecturer provides opportunities for the PSTs to be active participants during the development of Cell Biology content knowledge, thus the development of the ESD indicator. The lecturer through Section 4.1.1.2

excerpt 2 invites a group of PSTs to teach him and the entire class about the exocytosis process. **Note:** equal opportunities to promote 'inclusivity' were given to other PSTs to present about other cellular organelles.

Any educator that provides opportunities for students to actively participate in the development of knowledge (Finding 1 indicator) bears potential the ESD indicator 'Transformation of what it means to be an educator' (UNECE, 2012). This ESD indicator stresses the importance of positive learning interactions between the students and their educators (UNECE, 2012).This move is seen as a critical component of an ideal ESD learning environment because it requires educators "to present themselves as fallible human beings rather than people with all the answers" (UNECE, 2012, p. 17). This exonerates the claim that educators are not the authority of knowledge (Brooks & Brooks, 1999), as claimed by followers of the Behaviourism learning approach.

However, it must be on record that educators play an extreme role in the development of knowledge as they guide or facilitate the entire process of developing knowledge (Brodie, 2014).

5.1.3.2 The development of Achieving Transformation competence indicator: Transformative pedagogy

To develop this indicator (see Section 2.3.1, p. 14), the results indicate that the lecturer develops the ESD competence indicator 'Transformative pedagogy' by providing the PSTs with opportunities to reflect on their past learning experiences in the wake of developing concrete content and sustainability knowledge (see Section 4.1.3.2). Given that the ESD indicator 'Transformation of pedagogy' is developed by educators when they draw from students' prior experiences to develop content knowledge and explore alternative solutions for sustainable development (WWF-UK, 2012), it becomes of paramount importance to resonate the investigated Cell Biology lecturer with this reality. This is because the lecturer foresaw the Life Sciences classroom interactions as a platform to develop concrete Cell Biology knowledge by using critical elements of an envisaged ESD classroom including research and reflective learning (see Section 4.1.3.2 excerpt 1).

Moreover, the lecturer subscribes to the concept of democratic centralism to develop the transformative pedagogy ESD competence indicator. "Transformative pedagogy draws on the experience of learners and creates opportunities for participation and for the development of creativity, innovation and the capacity to imagine alternative ways of living" (UNECE, 2012,

p. 17). The student-lecturer dialogue presented in Section 4.1.3.2 puts it clear that the lecturer evoked a democratic process to allow the pre-service teachers to make careful introspections about their presentations as they 'inclusively' participate in their respective groups, upgrade their creative skills (research for knowledge, and reporting) and subsequently develop concrete presentations that would resonate with the standards and procedures set for an impactful PowerPoint presentation.

In my sense, the lecturer catered for the development of the achieving transformation indicator 'transformative pedagogy' across a range of many interrelated ESD principles of sustainable development. Such ESD principles include inclusivity (see Section 5.1.1.2); democratic centralism (see Section 4.1.3.2 student-lecturer dialogue); integrative thinking (see Section 5.1.1.1). With having catered for these ESD principles to be explored and developed during the teaching and learning of Cell Biology, the lecturer stands at a great advantage pf having managed to extensively cater for the development of the Achieving transformation competence, through the development of its indicator, transformative pedagogy.

The arguments presented above concerned with the use of the pre-service teachers' prior experiences to develop meaningful alternatives about sustainable development (i.e. being able to reflect on their work, the use of creative thinking for research and gathering of facts, and cohesive reporting or presentation of facts about cellular organelles of interest) did not do justice to what has been referred to as prior experiences (previously) in this study. Throughout the course of this study, prior experiences referred to past life experiences developed from home and/or in school, and it would be interesting to unfold: whether the lecturer sought to tap into the past living and learning experiences the Life Sciences PSTs may have encountered to transform the pedagogical discourse? Yes, the lecturer provides foresight to the idea of Life Sciences pre-service teachers coming into class with information and/or ideas relating to the content knowledge.

In Section 4.1.1.1, evidence supporting the ESD competence indicator 'integrative thinking centres the lecturer directly in the course of seeking to use any bit of information that learners come into class with to develop the Cell Biology knowledge, and to encourage sustainable development practices including: promoting inclusivity, social interactions and cohesions, citizenship, and many others. This resonance is also corroborated in Section 4.1.2.1 where the lecturer concedes to the idea of using pre-service teachers' prior experiences to address sustainability issues. Thus, the investigated Cell Biology lecturer created a room for

‘Transformative pedagogy’ to be prudent, contributing to the subsequent development of the Achieving Transformation ESD competence.

5.1.3.3 The development of Achieving Transformation competence indicator: Transformation of the education system

To develop this indicator (see Section 2.3.1, p. 14), the results indicate that the lecturer resonates with the idea to use the Cell Biology classroom interactions as a medium to transform Life Sciences PSTs into becoming sustainability practitioners within the school setting, but more importantly, to be conscious about sustainability issues in their societies, both in the present and future times. This became apparent when he provided foresight into what entailed ESD. The most important taking from the response was the lecturer’s ability to link how ESD as a medium for quality education can be used to conscientise PSTs to think about how they can contribute into the sustainability of planet Earth (see Section 4.1.3.3).

Moreover, the lecturer used the Cell Biology platform as a medium to allow Life Sciences PSTs to interrogate sustainability issues, as he had initially claimed in the interview response (see Section 4.1.3.3). Some of the sustainability issues he got the pre-service teachers to engage with is the excess use of alcohol, the importance of upholding human dignity and natural processes (the Caster Semenya issue), the importance of gender equality and uplifting women both in the academic space and in society (see this), and the importance of social cohesion and mutual understanding among many others. According to UNESCO (2017), the centre of transforming the education system as a whole is the classroom and can only happen with the existence of an educator who does not regard ESD knowledge as a separate subject, but as an integral part of any content knowledge.

The investigated lecturer extends his resonance with this and this, as he further regarded the Cell Biology interactions as a medium through which the pre-0serviceteachers can utilise to develop ESD competences, and be conscious enough about sustainability issues such that when they go into practice, they become sustainability educators who will not only relay the scientific knowledge to their learners, but will also ‘critically’ conscientise their learners to develop and uphold ESD competences (see Section 4.1.3.3 excerpt 2). “Educators are well placed to contribute to transforming the systems within which they work” (UNECE, 2012, p. 17). However, educators need to have a critical understanding of the necessity to wholly transform the system by employing a range of collaborative skills (UNESCO, 2014, 2017).

The investigated Cell Biology is well located with the parameters of promoting collaborative work, and the subsequent development of collaborative skills. This becomes evident in his ability to foster group work and discussions, as discussed in Section 5.1.1.1 and 5.1.1.2. Therefore, it becomes apparent that the lecturer caters for the development of this last Achieving Transformation indicator 'Transformation of the education system'. According to UNESCO, (2014) as discussed above, the classroom is the centre for transformation with the lecturer having the responsibility to fuel the advancement of sustainability practices, but, it becomes more important to also note that coordination between educators, the school management, government, and other stakeholders is needed to fully achieve the whole institution transformation approach (UNESCO, 2017).

For this study, the scope of investigation was centred around the selected lecturer's perceptions about the development of ESD competences and the pedagogical interventions that he relays during Cell Biology lessons, thus making it almost impossible to explore whether coordination between himself and other educators, as well as with the department/school management exists in the context of ESD. But, safe to say that the school in which his department (Science Education) is part of, has invested time and resources into research concerning ESD, with this study also emanating from the very same school.

5.1.4 The development of Systems-thinking competence

To develop this competence (see Section 2.3.2), the investigated lecturer expressed difficulties when seeking to employ 'problem-solving skills' to engage with the complex-systems of sustainability to bring about a meaningful learning experience. He alludes that Cell Biology is more like a theoretical concept, thus making it difficult for problem-solving skills to be developed (see Section 4.1.4) The pre-service teachers' development of the content knowledge does not only lie in their ability to possess problem-solving skills, but on a range of skills, also inclusive of critical thinking, hypotheses formulation and creative analytical skills (Sadaf & Hassan, 2019).

However, problem-solving skills are critical and remain central in the development of the Systems-thinking competence, and subsequently to the conscious development of PSTs to provide sustainability solutions to the current and historical unsustainable practices such as irresponsible exploitation of the natural resources, exploitation of the labour force and corruption, and discrimination against other people (UNESCO, 2016). Therefore, it becomes of critical importance for educators to cater for the development of problem-solving skills as a

medium to enhance the development of the content knowledge, whilst at the same time addressing issues of sustainable development.

One of the key elements in ESD is that educators should explore 'other' pedagogical alternatives if it happens that they are met with difficulties when developing ESD competences during the course of relaying content knowledge (UN General Assembly, 2015). To provide congruence to the latter statement, the Cell Biology lecturer did not fold his arms amidst finding it difficult to cater for the development of problem-solving skills, instead, he sought to for the use of case studies (see Section 4.1.4) as a platform to encourage the pre-service teachers' development of critical thinking skills, and problem-solving skills as a subsequent result.

As an example for a case study, the lecture relates lysosome content with excessive consumption of alcohol to address human health (see Section 4.1.1.3)-a sustainability issue. With this information, the pre-service teachers stand a great advantage of developing problem-solving skills related to the abuse of alcohol and how they can assist society in solving and mitigating the effects of alcohol to a person's health. Therefore, conscientising PSTs who will further the knowledge to their societies about alcohol abuse and human health proves the Cell Biology lecturer to be a sustainability practitioner. This is in line with the SDG 3: "Good Health and Well-being-Ensure healthy lives and promote well-being for all at all ages" (UNESCO, 2017, p. 16).

Moreover, the lecturer even though (he) expresses deep difficulties with the development of PSTs' problem-solving skills during the teaching and learning of Cell Biology, his ability to seek alternative pedagogical interventions (i.e. case studies) provides him with an opportunity to develop the systems-thinking competence.

5.1.5 The development of Normative competence

The results indicate that the lecturer exhibits profound reception to engage with critical sustainability issues (such as equity and justice), and further provides a detailed resonance to the importance of the sustainable existence of socio-ecological systems as a medium for sustainability. The lecturer speaks about using the Cell Biology platform to encourage ESD classifications including learning to do, learning to know, learning to be and learning to be together (see Section 4.1.5). Through the development of these ESD classifications, the lecturer sat at an advantage to promote the development of the Normative competence by interrogating issues of equity, justice, ethics, and socio-ecological integrity as critical indicators of adequate development of the normative competence.

Normative knowledge includes concepts of equity, ethics, justice, and socio-ecological integrity (UNECE, 2012). Firstly, the lecturer's incorporation of 'learning to be' during the teaching and learning of Cell Biology proves the classroom to be an area of 'equity' practice, as also discussed in Section 5.1.1.1 where integrative thinking is developed using an interactive learning approach (Finding 1 and 2) which enriches the interrogation of sustainability issues to be a product of different PSTs critical contributions). This in line with UNECE (2012) which stresses that sustainability educators bear the responsibility to be inclusive of different students'' perspectives, cultures and understandings, such that equal contributions are afforded to all students.

Secondly, the use collaborative work (Finding 2) to promote inclusivity provided the PSTs with platforms to develop competences for 'learning to know', particularly because the lecturer's provision of equal and inclusive participatory platforms enabled the PSTs to use the Cell Biology platform as a medium to interrogate sustainability issues shared by their group members, or peers (see Section 5.1.1.1 and 5.1.1.2). Thus, the freedom of participation becomes prudent (finding 3), leading to a conclusion that the 'learning to know' ESD classification was utilised by the lecturer to promote justice for all PSTs. To cater for the 'learning to know' ESD classification, an educator should provide students with opportunities to interrogate sustainability issues, develop and put sustainability solutions into action in an inclusive manner.

Hence, justice to all learners becomes prudent when the learning environment is inclusive (UNECE, 2012). To bring light to the third ESD classification as a medium to develop the normative competence, I seek the wisdom of Albert Camus who once said that a man without ethics is a wild beast loosed upon this world. I therefore seek the use of the 'learning to do' ESD classification as a medium used by the lecturer to materialise sustainability knowledge into action as a move to promote PSTs ethical conduct. How? Through 'learning to do' PSTs developed into becoming sustainability practitioners as they were conscientised to respect human nature (see Section 4.1.2.3 excerpt 2) and practice gender equality (see Section 5.1.2.2) among other issues.

As a result, being able to practice such sustainability issues amounts to being ethical. No unethical being would have respect for sustainability principles including human nature and practice anti-gender discrimination. Ethics in the context of the Normative competence does not only speak to a person's character, but also to one's reception to develop solutions for

sustainability (Wiek et al., 2011). Lastly the lecturer caters for the incorporation of the 'learning to live together' ESD classification and uses it as a medium to interrogate unsustainability practices including environmental degradation caused by irresponsible dumping of solid waste.

As a solution to uphold socio-ecological integrity, the lecturer purports the use of an interactive case study around waste management (Finding 2) to conscientise the PSTs to be sustainable practitioners who show appreciation for all of our natural environments which render us with ecosystem services (see Section 4.1.5). According to UNECE (2012), the development of 'learning to live together' becomes prudent when an educator creates opportunities for his/her students to challenge and address complex sustainability systems surrounding socio-ecological-and-economic issues. Hence the development of the normative competence by the lecturer becomes prudent through his ability to provide the PSTs with opportunities to interrogate sustainability issues and develop competences to practice equality, ethics, justice and uphold socio-ecological integrity.

5.1.6 The development of Anticipatory competence

The results indicate that the investigated Cell Biology lecturer provides reception to the notion of envisioning a sustainable future. This claim materialises through his ability and capacity to render the Cell Biology interactions as a platform which the Life Sciences pre-service teachers could use to develop necessary sustainability skills (see Section 4.1.6). He did this by conscientising the PSTs to locate or picture current unsustainable practices, enlarge their capability, and be able to picture how best they can respond with solutions for the future (see Section 4.1.6 excerpt 1). The anticipatory competence is concerned with the ability to collectively picture, and/or analyse, evaluate, and construct profound pictures and ideas about sustainable futures (Wiek et al., 2011).

Hence, it becomes profound for the lecturer to use the Cell Biology content knowledge as a medium to enable the students to "picture" themselves within a wider world concerned with providing sustainable solutions or "pictures". The world at large, and particularly the Republic of South Africa has located gender-based violence and gender discrimination (most particularly against women) as a prime unsustainable and uncalled for practice (Nombembe, 2020). As a response to this socio-economic ill, the lecturer brought the attention of the PSTs about the wrongs that come with women (particularly young women) not being considered as viable contributors to the development of knowledge in academia, and encouraged the Life Sciences female PSTs to pursue post-degree qualifications so that they can also become academic

doctors and professors, and close the gap of having males dominating the post-degree studies' reality and subsequent development of knowledge.

Through the evidence (see Section 4.1.6 footnote) it becomes apparent that the lecturer allowed his students to "picture" an unjust reality of our society (underrating women) and also provided the PSTs with opportunities to develop "pictures" about sustainable futures which will be enriched with equity within the academic filed of research and development of knowledge. In support of the latter, SD, through ESD calls for the emancipation of women and children across all sectors of society and economy, and most particularly, in education through the parameters of the SDG 4: Access to Quality Education (UN General Assembly, 2015). Yes, tomorrow becomes a sustainable future when gender-violence and discrimination against women in academia is put to a stop.

The constitution of the Republic of South Africa "lays the basis for the construction of a democratic, non-racial, non-sexist, united and prosperous society based on justice, equality… and the inalienable human rights of all" (RSA Government, 2021, p. 4). The concept of sustainable development calls for democracy, non-racialism, and harmonious (prosperous) existence of the universe's communities (UN General Assembly, 2015).

5.1.7 The development of Strategic competence

To develop this competence (see Section 2.3.2), the results indicate that the lecturer engages the Cell Biology content as a medium to promote 'getting things to be done' as he subscribes to the notion of 'learning to do'-one of the ESD competences classifications (see Section 2.3.1). Wiek et al (2011) purports strategic competence to materialise sustainability knowledge. This is consistent with UNECE (2012) 'learning to do' which is concerned with the lecturer's ability to be able to cater for the development of the holistic approach, envisioning change, and achieving transformation competences. Below, I discuss how the lecturer used the Cell Biology content knowledge to develop the strategic competence by catering for the development of the three ESD competences using the 'learning to do' ESD classification which materialises sustainability knowledge.

5.1.7.1 Holistic Approach and linking knowledge to action

The discussions in Section 5.1.1.1 and 5.1.1.2 indicate that group interactions (Finding 1) and the use of interactive materials such as diagrams and case studies (Finding 2) created opportunities for PSTs to interrogate sustainability issues, by learning from one another.

Through this, the PSTs gained opportunities to develop sustainability knowledge and apply it to interact with one another, and conscientise their community members to practice sustainability.

5.1.7.2 Envisioning Change and linking knowledge to action

For a 'learning to do' ESD classification and the development of the envisioning change competence, an educator must be able to "critically assess processes of change in society and envision sustainable futures" (Wiek et al., 2011, p. 15). To discharge this fundamental sustainability discourse, the lecturer, as discussed in Section 5.1.2 catered for the development of the exploring alternative futures ESD indicator, and conscientised the PSTs to be cognisant of the need to put sustainable development theory into practice. This came as he managed to use Caster Semenya's hormonal saga (see Section 5.1.2.3) as an unjust and discriminatory practice against human nature to conscientise the pre-service teachers about the necessary to '*treat all living things humanely'* in their immediate present, and for future life situations (see Section 4.1.2.3).

5.1.7.3 Achieving transformation and linking knowledge to action

The lecturer as discussed in Section 5.1.3.1 encourages the development of the ESD competence by seeking evaluations from his students, to better his pedagogical approaches in the future, and also stresses that the pedagogical approaches he explores to teach them came as result of a reflective past teaching experience. Secondly, he provided his students with opportunities to reflect on their work, explore new alternatives, better their work and present again. Through the two approaches it becomes apparent that the educator develops the competence for his students to bring past and new theoretical conceptions to better their 'practicality' in the future within the context of sustainable development as sustainability practitioners.

5.1.8 The development of Interpersonal competence

The results indicate that the investigated Cell Biology lecturer encouraged a collaborative learning interactions. This notion of learning is underpinned by Lev Vygotsky's socio-cultural educational approach (Brooks & Brooks, 1999), where students enjoy the educational freedom of being able to develop advanced interactive skills, as evidently put forth in Section 4.1.8 excerpt 1. Through the classroom interactions, PSTs develop the Cell Biology knowledge, as well as ESD competences, but what remains key and central becomes the lecturer's facilitation.

In a socio-cultural learning approach, the educator takes a facilitator role, and allow students to be active agents of the learning discourse (UNESCO, 2017).

Truly so, the lecturer provided the pre-service teachers with opportunities to gather facts about Cell Biology content knowledge, and assisted them when necessary, to further raise awareness about sustainability issues including excessive alcohol consumption and human health (see Section 4.1.1.3 excerpt 2). According Wiek et al (2010) "solving sustainability problems and generating sustainability opportunities requires strong stakeholder collaborations as well as negotiations" (Wiek et al., 2011, p. 210). For example, the lecturer allowed the PSTs to conduct research about the Cell Biology content knowledge, present their understandings and then intervene afterwards to assist the PSTs to make improvements on their own understanding of the scientific knowledge.

The results also indicate that the lecturer's pedagogical interventions were flexible as discussed in Section 5.1.4. The flexibility comes as the lecturer sought the services of case studies to develop the PSTs' problem-solving skills as it proved to be difficult for him when using the Cell Biology content knowledge. The development of the interpersonal skills is concerned with an educator's ability to promote the development of students' problem-solving skills concerning sustainability issues (Wiek et al., 2011).

5.2 Development of competences of ESD among pre-service teachers during the teaching of Cell Biology in Life Sciences

There are factors that affect the development of ESD competences. This section discusses some of the factors that have either aided or disturbed the selected lecturer from developing ESD competences among Life Sciences PSTs when teaching the topic Cell Biology.

5.2.1 Interactive learning materials are significant enablers for the development of ESD competences

This sub-section discusses Finding 2 of this study and extends the response to the second sub-question as it outlines the materials that enrich the socio-cultural learning approaches as a mechanism used by the lecturer to develop ESD competences. The results indicate that the lecturer subscribes to Vygotsky's notion of a socio-cultural learning approach to develop both the Cell Biology content knowledge and knowledge for sustainability (see Section 4.9). Some of the underpinnings of a socio-cultural learning approach include the use of learning interactive materials (Finding 2) that encourage student participations or interactions (Finding 3), promoting social cohesion, and taking the facilitator role as an educator, among others

(Epstein & Peck, 2018) . Did the lecturer do any of this? Apart from stressing that he uses a socio-cultural learning perspective to advance the development of ESD competences (see Section 4.2 excerpt 1), the lecturer also encouraged the freedom of participation in his lessons (see Section 4.1.1.1 excerpt 1).

From time to time, pre-service teachers would be paired up, and be asked to discuss about the content knowledge, then share their understandings with the lecturer and the rest of the class (see Section 4.1.1.1 and 4.2 excerpt 3 and 2 respectively), is this not freedom of participation? Moreover, the group formations for presentations (which lesson), in their nature encouraged participation, and the building of social relationships among the pre-service teachers (see Section 4.1.1.1 excerpt 2). On the other hand, the lecturer posed questions to pre-service teachers from time to time and followed up on the students' initiatives. Following up on students' initiative is a strong indicator of Vygotsky's notion of a socio-cultural learning perspective (Brooks & Brooks, 1999).

To add on, the lecturer also makes use of interactive material to encourage the development of the above discussed ESD competences (Finding 2). Such interactive learning materials include PowerPoints, videos (see Section 4.2 excerpt 2) and case studies as discussed in Section 5.1.1.1. Interactive learning materials encourage active participation of students, and the subsequent development of meaningful knowledge (Brooks & Brooks, 1999), and more importantly, the development of sustainability principles, values and attitudes (UNESCO, 2017). With all of these pedagogical underpinnings of ESD taking part during the teaching and learning of Cell Biology, the lecturer develops the discussed ESD competences and critically contributes in creating a sustainable world, we all envisage of. The lecturer further develops ESD competences in the context of sustainable development, as well as per the demands of the constitution of the Republic of South Africa which advocates for a prosperous existence of all human lives (see Section 5.1.1.2 & 5.1.1.3) as well of the natural environments (see Section 4.1.2.3).

5.2.2 Challenges and opportunities experienced by the lecturer during the development of ESD competences

The reality of the educational practice in schools and institutions of higher learning is that different educators are faced by different scenarios when in the course for the development of education for sustainable development competences (ESD) (Sinakou et al, 2019). A lot of factors may attribute to this reality, including access to teaching resources, the student

population, time, the curriculum demands, student behaviour and willingness to learn, etc. In this sub-section, I provide a response to the third sub-question and discuss the challenges and opportunities faced by the lecturer when developing ESD competences.

5.2.2.1 Challenges faced by the lecturer during the development of ESD competences

Lecturers, like other educators are often met with challenges when developing ESD competences in their classrooms. The Cell Biology lecturer who participated in this study is of no exception to this reality (see Section 4.3.1). Firstly, the lecturer expressed a challenge with time allocation vs the number of Cell Biology pre-service teachers he needs to engage with. As a result, the development of ESD competences through the Cell Biology Life Sciences medium is tempered with. Thus, making it difficult for the lecturer to attend to each bit of the Cell Biology content knowledge to explore different alternatives through which issues of sustainability can be addressed, as the content is also well received by the students.

Most South African schooling systems are over-capacitated (with students) such that educators often find it difficult (as time allocation is limited) to adequately attend to the individual needs of their student (Mouton, Louw, & Strydom, 2013). Secondly, with technology having taken over most of the learning interactions (the use of PowerPoint presentations, online assessments, online classes), which is a good thing at the present times of the 4th industrial revolution, the results indicate that the lecturer has often been met with less availability of technological resources mostly at the side of the students who often lack computers/smartphones and internet connection.

According to Kelly-Laubscher and Luckett (2016) there is a lot of internal and external forces that drive the teaching and learning process, including: lack of technological and other resources such as textbooks, time constraints to fully engage the curriculum, both educators' and students' negative attitudes, space for learning, school politics, outside interference, hunger, mental issues, etc. The incorporation of ICT learning across institutions of higher learning, as well as in schools has proved to be a challenging task even when the institutions have the resources (Suryani, 2010). Some of the factors that contribute to such challenges include poor preparation, poor maintenance of resources, and lack of reception by either, or both, the educators and students (Suryani, 2010).

These disrupting forces carry weight in the progress of learners, but most importantly in the critical development of ESD knowledge and competences. Therefore, it becomes important to note that the teaching and learning process can be hindered by the smallest things we are not

even thinking of by the moment we ought to slaughter educators as the development of ESD competences in schools and other institutions is slacking, as reported in Schudel (2017). Moreover, the development of ESD competences remains threatened by challenges that develop inside and outside the learning space.

5.2.2.2 Opportunities faced by the lecturer during the development of ESD competences

Amidst the sad reality of hindrances arising during Cell Biology interactions and subsequently (negatively) impacting the development of ESD competences and the lecturer's ability to conscientise the PSTs to uphold sustainable development principles (as sustainability practitioners) underpinned by ESD; the results indicate that opportunities also arose and assisted the lecturer to develop ESD competences and relay the Cell Biology knowledge. Impactful development of content and sustainability knowledge (ESD competences) during formal education does not only lie in the reception of the educator, but also in the students' abilities to interact with their educators as active participants of the learning process (Liu & Qi, 2021).

Liu and Qi 's (2021) position resonates with Finding 2 of this study. For the lecturer, when students ask questions of clarity, he becomes flexible and briefly abandon the mainstream approaches of teaching (i.e., presentation of lecture notes), and resolute to other alternatives (see Section 4.3.2 excerpt 1). This is because he then acquires the ability to navigate the students' understandings of the content knowledge and seek other approaches that he/she can use to ensure that the PSTs understand the content knowledge. According to Epstein and Peck (2018), the socio-cultural learning perspective used in this study to develop ESD competences (Finding 1) fundamentally stresses that critical learning experiences should not focus on the systematic relaying of knowledge, but that students' initiatives and participations should be prudent, in conjunction with Finding 3.

For example, I may be teaching about the differences between an animal cell and a plant cell (content I have informed experience with), and just go over the differences, and not even bother to ask whether everyone is with me or not. But, if a student pauses me and ask question of clarity, I then manage to speed down, explain to them, and ensure that they all do, rather than just asking "are we all good" and be responded with the famous answer "yes". Hence, the lecturer's stimulation of the PSTs to actively engage him during classroom proceedings as evident in Section 4.1.1.1 (excerpt 3) and Section 4.2 (excerpt 2) provides him with

opportunities to abandon the mainstream presentation of Cell Biology content, and employ other pedagogical strategies.

By asking that the PSTs engage with their "neighbours" (see Section 4.1.1.1 excerpt 3 and Section 4.2 excerpt 2), the lecturer does not gain the ability to abandon the mainstream presentation of content knowledge, but also provides the PSTs with opportunities to learn from one another and gain new understandings which the lecturer may not necessarily bring into context. With the claim that the development of knowledge is multifaceted (Epstein & Peck, 2018), it cannot be that the learning experience only lies in the guidance of the educator. The lecturer's claim that PSTs are likely to come into class with prior knowledge (see Section 4.1.1.1 excerpt 1) comes into adequate effect in this course as the PSTs use their prior understandings to share and develop knowledge. This process is facilitated by the lecturer (Brooks & Brooks, 1999) , was the case during the Cell Biology interactions.

After the discussions, the lecturer would then ask the PSTs to share their understandings on the brief discussions he had assigned them to engage on. This had a positive impact on his pedagogy as he would locate the areas that still need emphasis as per the understandings that were shared by PSTs. Moreover, when educators collapse the Behaviourist teaching approach, and encourage student participation, they are also likely to spend less time on issues they would necessarily invest more time on (Brooks & Brooks, 1999). The lecturer's ability to afford PSTs with opportunities to make presentations about the cellular organelles (see Section 5.1.1.2), and saved him more time to spend on other important issues.

This is because he only reflected on the PSTs presentations and re-emphasised some of the concepts the PSTs would have implicitly touched on. Hence, student participation and initiatives (finding 3) provided him with opportunities to adequately develop the content and sustainability knowledge (ESD competences).

5.3 Conclusion of the study

This study investigated '*The development of ESD competences during the teaching and learning of the topic Cell Biology among Life Sciences pre-service teachers at a South African university*'. The findings speak to the research sub-question 1 by indicating that the selected lecturer engages the pre-service teachers (PSTs) to develop a combination of eight ESD competences including: holistic, envisioning change, achieving transformation, systems-thinking, anticipator, normative, strategic and interpersonal. Secondly, the findings indicate

that the lecturer uses the socio-cultural learning approaches as a mechanism (in response to research sub-question 2) to develop such ESD competences.

The lecturer uses a combination of pedagogical strategies embodying a socio-cultural learning theory including promoting collaborative or group work, encouraging student initiative and participation, exposing PSTs to interactive learning materials, among others. It is through this finding that I conclude that ESD competences are adequately developed during the teaching of the topic of Cell Biology. Lastly, the findings speak to the research sub-question 3 by indicating that the development of ESD competences in the topic Cell Biology can be met with some challenges such as limited time and space, availability of technological and learning resources, while on the other hand, PSTs' initiatives and participation aid in the development of ESD competences.

Therefore, it becomes of paramount importance to note that the development of ESD competences can be a challenging trajectory in Cell Biology, and across different subject disciplines and topics as such constraints are often linked to the economy of the institution. This study also highlighted the need to transform learning spaces into areas of sustainability practices as it allows PSTs to become agents of change and address socio-economic and environmental ills in our societies.

5.4 Limitations of the study

This section deals with some of the limitations that hindered this study from unfolding the full scope of its desire: to investigate the practices of the lecturer in the development of ESD competences during the teaching and learning of the topic Cell Biology among Life Sciences pre-service teachers at a South African university. The first limitation is around sampling and population. Given that this study used purposeful sampling technique, which is profound for a qualitative research, only one (Life Sciences) lecturer's practices were investigated and he was the only interviewee. As a result, the finding only reflects the pedagogical capacity of one lecturer, and this limits the diversity of findings that could have been explored if other lecturers from different disciplines would have been part of the investigation.

Secondly, only four lesson observations were made, most of which were characterized by group presentations. A more extended period of observations characterized by other teaching and learning activities would have provided more data to provide an in-depth understanding of the lecturer's pedagogical strategies and the manner through which the pre-service teachers respond (to the lecturer's pedagogical approaches and interventions) as they seek to develop

knowledge for content and ESD competences. Thirdly, the use of the topic Cell Biology may have limited the lecturer to fully interrogate the interrelated issues of sustainable development including society, ecology, economy, and peace and partnerships across societies. Certain topics surrounding biodiversity and economics have been favored as coherent platforms to address sustainability issues.

Lastly, the presence of a third force (video recording) of the lessons could have affected how the pre-service teachers engage with the lecturer, and the content knowledge. The PSTs may have wanted for the study to gather 'positive' results and limit their full normal classroom behaviours as they did not want to sabotage the study. On the other hand, the lecturer could have deliberately chosen to lecturer in some way which would yield 'rich data' for the research necessary for a successful analysis. As a result, given that this study was qualitative, if it was to be repeated with a different lecturer, different student population and a different interpreter; there are chances that the findings would be different. According to Creswell (2003), qualitative research interpretations are influenced by contextual factors (i.e. sample population) and the interpreter (Khoza, 2016).

5.5 Recommendations of the study

Guided by the results of this investigation, there exists numerous recommendations for the educational fraternity stakeholders including lecturers, policy-makers, teacher training institutors, pre-service teachers and researchers. The recommendations are as follows:

- ESD should not be seen as a separate set of knowledge, but be integrated holistically and be interdisciplinary, and
- the development of ESD competences should follow through and be compulsory across all academic fields and topics within such fields
- Schools and other institutions of learning (such as universities in the interest of this study) should be enriched with educators (or lecturers) who are 'holistic' such that they are able to incorporate sustainability issues across a wide range of topics (Liu & Qi, 2021).
- Further research should be conducted with an increased sample number (participating lecturers and lesson observations). This will generate a wide range of informed results and impact the scope of the investigations' reliability.
- Further research should focus on pre-services teachers' prior ESD competences developed either at home or during previous learning experiences, or from both. This will share light

on how educator's interventions develop already existing ESD competences of their students into becoming more coherent and concrete.

- Further research should focus on other topic within Life Sciences, and even beyond the subject matter to explore whether ESD competences can be holistically and interdisciplinary developed.
- It would also be valuable to trace investigate the development of ESD competences by the participant lecturer in other topics, and with different groups.
- Future research must also look at in-practice teachers' ESD knowledge. Little is known about prospective teachers' thinking on the topic
- Lastly, the University through which this study took place and other institutions of higher learning should implement the *2005 United Nations Decade for ESD* resolution and make ESD a holistic and interdisciplinary component of the curriculum.

5.7 Chapter Summary

In this chapter, I initially used the findings from the previous chapter to discuss the: 1. ESD competences developed among pre-service teachers; 2. pedagogical strategies employed during the development of such ESD competences; 3 Challenges and opportunities that hinder and aid the development of ESD competences during the teaching and learning of Cell Biology in Life Sciences. The discussion was followed by the study's conclusion, a discussion of the study's limitations, and a list of recommendations

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APPENDICES

Appendix 1: Semi-structured questions

Focus of research: Beliefs about cell biology and ESD competences

1. Based on your belief, what is cell biology?
2. Based on your belief, what is education for sustainable development?
3. What is your understanding of ESD competences?
4. What is the relationship between cell biology and ESD competences? Elaborate.

Focus of research: The development of ESD competences

5. Elaborate your belief on the development of ESD competences.
6. Based on your understanding of ESD competences, do you think students possess any sort of ESD competences prior to cell biology lessons?
7. Which ESD competences can be developed outside the content of cell biology?
8. Which teaching approaches are effective for the development of ESD competences?
9. Which teaching materials can be embedded in such teaching approaches?
10. More critically, what is the ideal role of the lecturer in the development of ESD competences?

The nature of ESD competences

11. Integrative thinking practice and thinking, envisioning change and achieving transformation are ESD critical ESD competences proposed by UNESCO's International Commission on Education (2012),
    11.1.1. Do you plan to directly encourage these competences?
    11.1.2. How do you plan to directly encourage these competences?

Focus of research: Indicators of ESD competences?

12. How are you encouraging problem solving skills in your lessons?
13. How are you encouraging hypotheses formulation in your lessons?
14. How are you encouraging critical thinking skills in your lessons?
15. According to your beliefs, what is the link between the nature and indicators of ESD competences?

Focus of research: challenges and opportunities faced by lecturer during cell biology lessons

16. Are your cell biology lessons effectively responding to your lesson plans?
    16.1. If yes, how? If no, how?
    16.2. What is the role of students in realising the achievement of lesson's objectives?
17. What normally destructs your cell biology lessons, and the subsequent development of ESD competences?
18. How do you deal with such destructions?
19. What opportunities normally arise during your cell biology lessons-such that impact on the development of ESD competences?
20. How are these opportunities benefiting your lesson planning for cell biology?

Appendix 2: Data transcripts summary

Theme	Code	Evidence
Holistic approach	**Integrative thinking**	Learning emerges out of interaction. It recognises prior knowledge, you mentioned earlier. What is it that (different) learners can bring into context for learning for sustainability? And then I'll be organising you into groups, or you organise yourselves into groups that will actually come and present here, but that is an organisation for tomorrow. So, when you develop ESD competences, you want your learners to develop competences that enable them to see themselves within the wider world, and then how can they help respond to issues in that (present) world.
	Inclusivity	You are going to teach me that. I don't understand what exocytosis is. You are going to tech me that next week. I'd like to continue to learn to do better. Okay, I'm a learning teacher. Even though this my 20th year of teaching. I'm learning every day. I was saying learners are supposed to be free to interact…We recognise that they bring issues, they bring experiences and they bring knowledge.
	Complex ESD concepts	In a community they may focus on waste management, because when learners are in community, they are not recognised as learners, they are recognised as members of the community, they learn to live together. If I take 5% and I'm going to drink a crate of alcohol, 24 beers or 12 quarts, how much labour am I giving to my liver?... And what have you heard about the effects of heavy drinking? And then they will tell you about addiction and liver cirrhosis and so on. And then what about yourself? How do you feel about the consumption of alcohol?... And what have you heard about the effects of heavy drinking? And then they will tell you about addiction and liver cirrhosis and so on. And then what about yourself? How do you feel about the consumption of alcohol?
Envisioning change	**Learning from the past**	My students are likely to have brought in a bit of prior knowledge which … is coming out of their home and school context.

		Learning emerges out of interaction. It recognises prior knowledge, you mentioned earlier. What is it that (different) learners can bring into context for learning for sustainability?
	Inspiring present engagement	The course aims to encourage students to acquire knowledge, develop skills and competences, and to develop positive attitudes towards science, especially towards the living world and towards the teaching and learning of science. When you identify yourself as a sustainability educator, and you have the agency to work with sustainability issues, you have the agency to motivate others to see that the world they live in is not okay. So, when you develop ESD competences, you want your learners to develop competences that enable them to see themselves within the wider world, and then how can they help respond to issues in that (present) world.
	Explores alternative futures	So, if they understand the cell, they know they should be able to relate how the organisms relate within themselves, as well as relate with the surrounding and the outer world…all of us produce hormones…when we are talking about natural science it doesn't end here in the four corners, it goes into our society…these are the issues we deal with in education and in society. Students are expected to appreciate the role of science in our everyday lives…treat all living things humanely
Achieving transformation	**Educator transformation**	It's more like an evaluation of what I'm doing. So that I keep improving on the work that I'm doing. The way that I'm working with you now is coming out of people's work in the past, other learners that I interacted with, who gave me their feedback…
	Transformative pedagogy	Build a framework of knowledge based on reading, observation, experience and reflection <u>Lesson no. 3 Dialogue:</u> Student: I was asking if we could repeat the presentation because we didn't have what you've just mentioned in thought when we presented? Lecturer: Uhm that is a genuine concern, and this is a democracy. Would you like the groups that presented to go over their presentations? Students: Yes

	Education system transformation	Education for sustainable development (ESD) is that field of knowledge which enables learners to interrogate sustainability issues, how they can live sustainably in the world, and what they can contribute to the sustainability of this world. There are ESD competences that can be developed…where everyone is learning new competences and understanding sustainability and ESD and their role in society… [they are] going to be teachers that are going to develop ESD competences in their learners.
Systems-thinking	**Problem-solving**	Problem solving is difficult to develop in Cell Biology, because it is more like a theoretical concept…The next thing that you can simply do is to build cases. Play out a video of a case, they look at it and they watch it with certain questions and they respond to the questions
Normative	**Sustainability knowledge**	I think all of the ESD competences that I can put together actually can be developed inside the context of teaching. I'm thinking about learning to know, which is development of content. Learning to do, which is more like the practical side of the implementing what has been known. And learning to be, which is more like identity-ethics. …and they get together, and that is learning to be (live) together through the response to a crisis, and then in that process, they are also learning to do
	Socio-ecological integrity	Show appreciation of and respect for all of our natural resources
Anticipatory		So, when you develop ESD competences, you want your learners to develop competences that enable to see themselves within the wider world, and then how can they help respond to issues in that world.
Strategic		I think all of the ESD competences that I can put together actually can be developed inside the context of teaching … I'm thinking about … learning to do, which is more like the practical side of the implementing what has been known.
Interpersonal		Learners should be free to interact, should be free to contribute…learning is socio-cultural…Learning emerges out of interaction.

		Problem solving is difficult to develop in Cell Biology, because it is more like a theoretical concept…The next thing that you can simply do is to build cases.
Pedagogical approaches	**Freedom of participation**	Lecturer: You find that freedom is one of those issues that are emphasised in ESD … where learning is socio-cultural and depends on language, how learners interact.
	Peer learning	Okay, the picture, what is displayed in picture? And how is it displayed? Talk to your neighbour for half a minute.
	Interactive learning	You need to think about interactive material. So if you're going to use a PowerPoint, you're not going to use it to tell the learners, but to guide the learners. You can use a video as a stimulant.
Pedagogical challenges	**Institutional and individual**	Usually is time, we don't have time and also technology. We depend so much in technology such that we have limited ways of presenting the content and we also have limitation in terms of the space that we are teaching that may not allow adequate group work.

Pedagogical opportunities	**Students' initiatives**	When students ask questions of clarity, then I'm able to leave the mainstream presentation approaches, and then I can use other approaches. I find this breakthrough, all the time it comes out of my relationship within the students. Are they free to ask questions of clarity, are they free to contribute? So all of those, their contributions, their questions, their interactions are opportunities for mainstreaming ESD. I find opportunities useful because in many cases they help me to go to extend which I had not freely planned for.

Appendix 3: Participant consent form

Title of project: An investigation into the development of ESD competences during the teaching of cell biology among Life Sciences 1st year Pre-service teachers at university level.

Name of researcher: Irving Sithole
Form no:

I …….. agree to participate in this research project and give permission for the Life Sciences (1st Year) lessons' recordings (topic: Cell Biology) and the course outline to be used in this research project. The research has been explained to me and I understand what my participation will involve.

I agree that my participation will remain anonymous YES NO

I agree that the researcher may use anonymous quotes in his research report YES NO

I agree that the interview may be audio recorded YES NO

I agree that the information I provide may be used anonymously by other researchers following this study YES NO

…… (signature)
…… (name of participant)
…… (date)

Appendix 4: Participant information sheet



Dear Sir / Madam,

My name is Irving Sithole and I am a Master's s student in Science Education at the University of the Witwatersrand in Johannesburg. As part of my studies, I have to undertake a research project, and I am investigating the development of Education for Sustainable Development Competences among 1st year Life Sciences Pre-service teachers. The aim of this research project is to investigate the practices of a selected lecturer in the development of ESD competences during the teaching and learning of the topic cell biology among Life Sciences pre-service teachers at a South African university. My supervisors are Dr Caleb Mandikonza and Dr Monde Kazeni.

As part of this project, I would like to invite you to take part in an interview. You can either write down the answers or verbally respond to them while I make an audio recording, if you permit me to. This activity will take 25-40 minutes. Moreover, this study will also use the course outline and the lessons' recordings of the Cell Biology topic (taught by you) as methods to enrich the study's data.

Given that the interview will be held through electronic means (Microsoft Teams), you will not receive any direct benefits for the data costs incurred from participating in this research, and there are no disadvantages or penalties for not participating. You may withdraw at any time or not answer any question if you do not want to. The interview will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely in my supervisor's locker. I will be using a pseudonym (false name) to represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume another time. If you need some support or counselling services following the interview, these are available and free of charge at Counselling and

Careers Development Unit (CCDU) at Education Campus Marang Block (Office no: M14), email: info.ccdu@wits.ac.za, Tel: 011 717 9268.

If you have any questions at any time about this research, feel free to contact me and/or my supervisor on the details listed below. If you wish to receive a summary of this report, I will be happy to send it to you (optional). If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email Shaun.Schoeman@wits.ac.za

Yours sincerely,

Irving Sithole

Researcher: Irving Sithole, Email: 1073234@students.wits.ac.za, Cell: 0766171775

Supervisor: Dr Caleb Mandikonza,



Email: caleb.mandikonza@wits.ac.za,

Tel: 011 717 3260

Co-supervisor: Dr Monde Kazeni,

Email: monde.kazeni@wits.ac.za,

Cell: 0835186515

Appendix 5: Head of school permission

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG | WSoE Wits School of Education

03 August 2020

Irving Sithole
Student Number: 1073234
1073234@students.wits.ac.za

Permission to conduct research at the Wits School of Education

Dear Irving

Thank you for your request seeking to undertake your Masters research which aims to investigate the development of ESD competences during the teaching of cell biology among Life Sciences 1st Year Pre-service teachers at university level.

Permission is granted for you to conduct your study at the Wits School of Education provided you obtain full ethics approval from the university.

Best wishes.



Professor Felix Maringe
Professor of Higher Education and Head of Wits School of Education
Office Tel: +27117173014
Mobile: +27732931070
Email: Felix.Maringe@wits.ac.za
Google Citations: https://scholar.google.ca/citations?user=vJIGoP4AAAAJ&hl=en

Appendix 6: The registrar's letter of permission to conduct research

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

26 May 2021

Irving Sithole
Student number (1073234)
Master of Education by Coursework and Research
Wits School of Education

TO WHOM IT MAY CONCERN

"An investigation into the development of ESD competences during the teaching of cell biology among Life Sciences 1st Year Pre-service teachers at university level"

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

Ethical clearance has been obtained. Protocol number: (**2020ECE160M**)

Research commencement: (As per consent obtained from *Prof Felix Maringe*)

Potgieter

Nicoleen Potgieter
University Deputy Registrar

WITS SCHOOL OF EDUCATION

Private Bag 3, WITS, 2050, South Africa | **T** +27 11 717 1204/8 | **E** nicoleen.potgieter@wits.ac.za | www.wits.ac.za

Appendix 7: Ethical clearance certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

SCHOOL OF EDUCATION ETHICS COMMITTEE

CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: 2020ECE160M**

PROJECT TITLE	An investigation into the development of ESD competences during the teaching of cell biology among Life Sciences 1st Year Pre-service teachers at university level.
INVESTIGATOR	**IRVING SITHOLE**
SCHOOL/DEPARTMENT OF INVESTIGATOR	WITS SCHOOL OF EDUCATION
DATE CONSIDERED	12 October 2020
DECISION OF THE COMMITTEE	Approved unconditionally
EXPIRY DATE	Date of submission of the project report

ISSUE DATE OF CERTIFICATE 20 October 2020 **CHAIRPERSON** _____

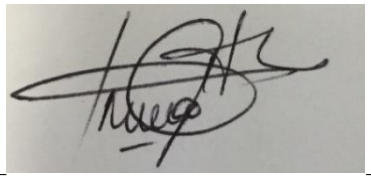
(Dr Paul Goldschagg)

cc: Supervisor Dr Caleb Mandikonza

DECLARATION OF INVESTIGATOR

To 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 are 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.



_____ _____

__22___/___10____/___2020____ Signature

Date

PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 8: Plagiarism Report for the Research Report

1073234: IrvingMastersReport4T.docx

ORIGINALITY REPORT

6%	5%	4%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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