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Chapter 12
Education for Sustainable Development (ESD) Classroom Practices: A South African Perspective

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In this chapter, we explore how a South African teacher-training program prepares Natural Science and Life Sciences preservice teachers for ESD (Education for Sustainable Development). We illustrate how the notion of ESD evolved from that of Environmental Education (EE) and how that process is taken up into the university's teacher training system. Issues of sustainability, which mainly focused on the environment in its totality, have always been considered in South Africa, and EE was the driving educational imperative for understanding this relational process. However, the anthropocentric sustainability focus was not prominent. As a result of this focus, Environmental Education in South Africa led to a review of the curriculum in high school education, which subsequently meant that the teacher education curriculum had to take up EE to prepare teachers for the schools' EE.
Following the 2005 promulgation of the Decade of Education for Sustainable Development (DESD), the notion of EE transformed into ESD, a more anthropocentric form of education that foregrounded sustainability and sustainable development. This study uses a qualitative case study in which data were collected through document analysis of course outline, as well as through semi-structured interviews with the lecturers for Natural Science and Life Sciences to pre-service teachers. The thematic patterns that emerged were used to analyze the data. The findings of the study provided an understanding of how preservice teachers were being prepared for ESD classroom practices. It was clear that the preparation of pre-service teachers for ESD was not explicitly planned for in most courses and would mostly emphasize environmentally related topics.

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The study makes recommendations for a more systematic and explicit way of integrating ESD in Natural and Life Sciences teacher education classroom practices. To this end, ESD is found in school-level syllabi; therefore, Teacher Education needs to equip teachers with knowledge of ESD. This study showed that the mainstreaming of ESD is not in the guiding policies of the university but driven by the agency of individual lecturers. This insight is key, as it allows the comparison of ESD mainstreaming between the University of Witwatersrand and Tübingen University, the latter case being presented in another chapter.

1 The South African sustainability context

South Africa is part of the southern Africa sub-regional group of 15 tropical and subtropical countries, the Southern Africa Development Community (SADC), which lie south of the equator. The countries are characterized by many years of colonization and its consequent extractive resource economies. These years of devastating economic and political domination left a legacy of development challenges that manifest in poverty for the majority of the almost 360 million citizens (Ocheni & Nwanko, 2012). Almost 75% of the citizens live in rural areas, relying directly on environmental resources such as clean air, clean water, agriculturally productive soils, vegetation for timber and firewood, and associated ecosystem services. The strain on the environment results in social issues such as poverty and its associated social, economic, and political effects (Shackleton, 2014; SADC, 2020a). The remaining population, which is urban and progressively urbanizing, also has its own challenges, including unequal wealth and other physical, economic, and social issues. Southern Africa sees economic growth as the solution to these societal ills, which were caused by poor economic growth trajectories. Therefore, the need to balance economic growth through the bolstering of development activities becomes paramount for the whole SADC region (SADC, 2020b).

South Africa is the most economically powerful and most developed of the southern African states. This focus on economic growth development position also raises environment and development challenges for the same resources and people on which it is based. Issues of climate change, overexploitation, uncontrolled urbanization, unsustainable consumption patterns, poor waste management, and air and water pollution come to mind. Other issues include crime, poor transport, lack of clean water, unsafe and unhygienic food, food insecurity, and health issues for the majority (Brownlie, Walmsley & Tarr, 2016).

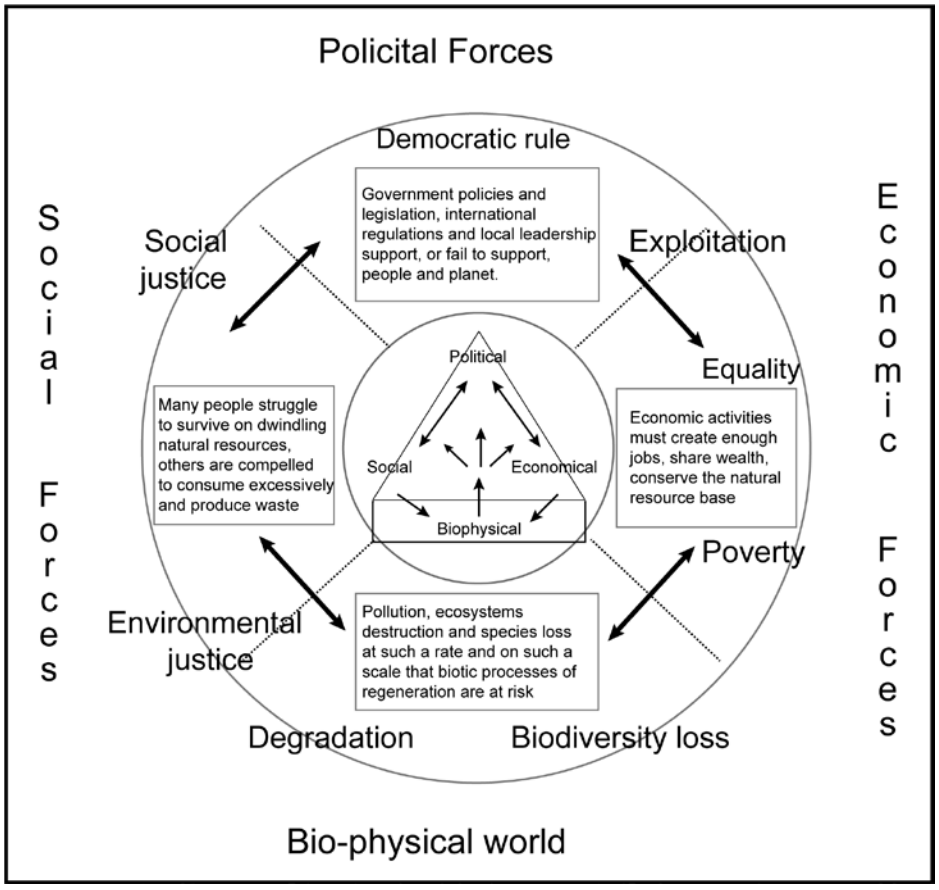

Figure 1 Interacting forces in the environment (O'Donogue, 2001 in UNEP, 2004, p. 20)

Furthermore, over 70% of the country's electricity comes from thermal power stations that are coal-fed. These power stations release huge quantities of carbon dioxide into the air annually, yet the country's need for electrical power continues to grow and the notion of alternative power sources, which must be sold to the nation through education, has not gained much momentum. All sustainability issues bedeviling the country are related to increased inequity and poverty across the country. Giddens (1999) saw development issues to be associated with risk, in that they pose a risk to well-being in the future. To this end, Beck (2000) noted development issues as being diverse, complex, and interacting in such a way that they cannot be solved by a single or straightforward solution. Such issues, according to Rittel and Webber (1973), are 'wicked problems'. A solution to one such problem tends to expose another problem. Engestrom and Saninno (2018) use a similar term, a 'runaway object' to denote these

everchanging and evolving problems. There is a need to develop the capacity to deal with these development concerns and risks, and education through teacher education is one possible solution.

To this end, South Africa sought to promote educational processes that help the nation redress this unsustainable condition through gaining an understanding of environment and development issues. Environmental education was envisaged as an educational response to these environment and sustainability challenges. The environment was constituted of interacting biophysical, economic, social, economic, and social aspects or forces, as shown in Figure 1 (O'Donoghue, 2001 in UNEP, 2004).

This implies that the manifestation of an environmental issue is an outcome of the above-mentioned aspects' interactions. To respond to any issue, it was important to establish the interacting factors in these aspects. The model points to the inseparability of environmental components and the nonlinear nature of responses in the development discourse. It further suggests that educational responses need to be more holistic, so that challenges are not considered in isolation from each other.

The environment model (O'Donoghue, 2001) seems to complement the Hattingh (2004) model for sustainable development well (see in Figure 2 below).

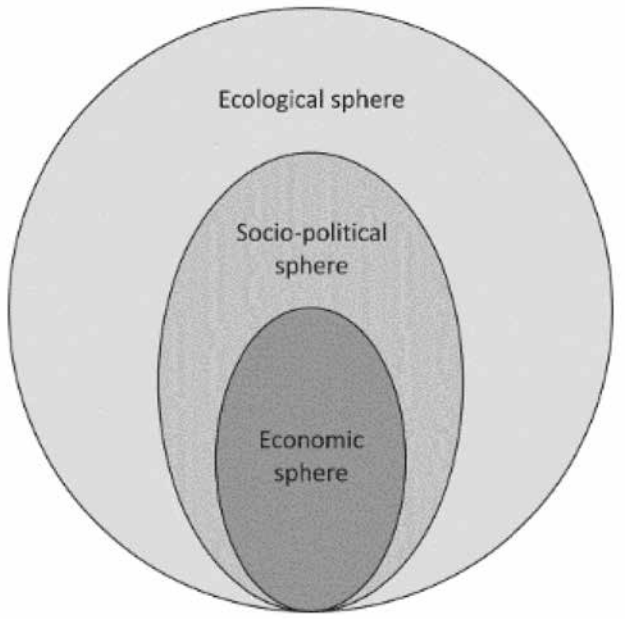

Figure 2 Hattingh's view of sustainable development in terms of three embedded spheres (Hattingh, 2004, p. 161)

Hattingh (2004) observed the dependence of sustainability on the physical environment in which development takes place. To this, Lotz-Sisitka et al. (2015) added that the economy, society, and environment are a nexus that cannot be treated in isolation. Sustainability, sustainable development interests and Education for Sustainable Development need to be inclusive and considerate of the intricate relationships between the component parts, avoiding piecemeal and quick-fix responses. This assertion tends to complicate the role of education in sustainable development and sustainability.

One of the sustainable development goals in this Anthropocene era is the building of a responsible and sustainable society, a society that has attained sustainability through a process called sustainable development. Sustainable development has been defined in many ways. Kopnina (2012) considers sustainable development as a context which depends on social, cultural, and environmental situations, and that in turn depends on societal behavior and responsibility. In a UN report, Brundtland (United Nations, 1987: 41) defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition does not explicitly mention the word *environment* but "needs" include the benefits of the natural environment. From the above definitions, sustainable development depends a lot on human behavior and responsibility.

South Africa sought to integrate environmental education into the schools' curriculum through the National Environmental Education Program for General Education and Training (NEEP-GET) since the body's establishment in 2005 (Schudel, le Roux, Lotz-Sisitka, Loubser, O'Donoghue & Shallcross, 2008). Furthermore, it produced resources and engaged capacity development for teachers in schools. It could not, however, make much inroad into teacher training. When Education for Sustainable Development (ESD) was taken up nationally in 2005, in line with the UNESCO Decade of Education for Sustainable Development (UNESCO, 2005), South Africa, as well as other SADC countries, noted Environmental Education as a vehicle and carrier for ESD (Lotz-Sisitka, 2006). Based on the framework shown in Figure 1, the need to expand the anthropocentric component to include more sustainability concerns was recognized. Teacher education still lacked support for ESD. In 2011, a national program called 'Fundisa for Change' was conceptualized to support preservice and in-service training in ESD.

The country does not have any education policies that speak directly to ESD, but some do speak to aspects of it. For example, the Minimum Requirements for Teacher Education Qualifications-MRTEQ (DHET, 2015) lays down the competences expected of beginner teachers and exit levels for the various qualifications but makes

little reference to education for sustainable development. Mainstreaming of ESD is therefore not policy driven. The lack of policy guidelines poses a challenge even for educators who have the capacity and agency to mainstream ESD, particularly in face of the need to build the capacity to achieve sustainable development through the 17 aspirational Sustainable Development Goals (SDGs) (UN, 2015). The United Nations Educational, Scientific and Cultural Organization (UNESCO) further converted the SDGs into Educational for Sustainable Development Goals Learning Objectives (ESDGs) for ease of use in education settings (UNESCO, 2017). Without policy guidelines, it is a mammoth task for teacher educators to implement the ESDGs as part of the classroom content.

To develop the knowledge, competences, and capabilities requisite for a sustainable future, educators should engage learners' cognitive, socio-emotional and behavioral domains through ESD pedagogy. Educators promote ESD through pedagogical approaches focused on learner-centered, action-oriented, and transformative learning. These approaches depend on the principles of ESD, which include pedagogies that promote multidisciplinary learning, that is, learning in which several disciplines are engaged, as well as multidimensional learning, which considers contextual ways of thinking while bringing together complex adaptive systems to innovate (Eilam & Trop, 2010). Pedagogies need to include emotional learning, which includes clarifying values and ethical considerations.

This chapter therefore aims to show how ESD is represented in the South African teacher education curricular documents, how it manifests in classroom practices, and in what conditions it is implemented. We will use the term program to signify the four years of study towards a degree. We will also refer to the course as a specific subject that students engage in over time, such as a semester or a year. Within the course are topic-specific or subject-specific modules. The Natural Sciences course is taught over a year and is constituted of the Life Sciences and Physical Sciences modules. Life Sciences (Biology) courses are organized into topic modules. University teaching is guided by outlines of the courses, which according to Archer (1995) constitute the structure of the planned topics of modules and which Mahon, Francisco and Kemmis (2017) describe as practice architectures that frame academic practice at the course level. Modules for content and for pedagogy or teaching methods generally go together.

This qualitative case study intended to address the research question: how does a South African teacher-training program prepare Natural Science and Life Sciences preservice teachers for ESD?

2 Research design

An interpretative, qualitative case study research design was used to develop this study. This design was appropriate because it offered the study flexibility to deduce meanings in the phenomenon of ESD classroom practice, based on the researchers' understanding of education for sustainable development in the institutional context (Yin, 1984; 2014). This was a case of ESD classroom practice in a specific teacher training context and within a specific discipline of Life Sciences (III and IV), which is a component of Natural Sciences (I and II) (Creswell et al., 2007). Although document analysis was used to establish if the course outlines referred to ESD, semi-structured interviews were the main source of data. The interviews were structured to inquire into lecturers' understanding of ESD; whether it was part of their institutional mandate to implement ESD; why they thought ESD was relevant for the science curriculum; how they were mainstreaming it into their practice; and what successes and challenges they were encountering when mainstreaming ESD. Use of the case study method permitted making conclusions of the study to the Life Sciences sub-discipline (including Life Science III and IV), rather than generalizing the whole of Natural Sciences I and II.
Data collection was conducted through the document analysis of course outlines and through semi-structured interviews with lecturers who teach the Life Sciences component of Natural Sciences I and II, as well as Life Sciences III and IV modules. Each of the courses has a course outline, meaning that four course outlines were analyzed deductively to establish whether ESD was present and presented in the document through content, pedagogy and assessment. Key features of ESD included the development of sustainability knowledge with understanding, sustainability skills, sustainability values and actions or practices for creating a more sustainable world, contributing to a more sustainable world, promoting environmental protection and conservation, promoting social equity, and promoting conditions that encourage economic sustainability. The four content course outlines (NSI, NSII, LSIII and LSIV) as well as three methods courses (Methodology for NSI, NSII and LSIII) were analyzed deductively using key features of ESD. The program does not have Methodology for LSIV. Five Life Sciences lecturers share parts of the content and methods course outlines. Therefore, a total of five semi-structured interviewees were conducted with lecturers. Semi-structured and audio-recorded interviews were conducted with the Life Sciences lecturers to investigate how they mainstreamed ESD in their teaching and what influenced their ESD practice.
Data were analyzed qualitatively and inductively; the analytical process was guided by the definition and characteristics of ESD presented earlier in this chapter.

3 Results

ESD in guiding curriculum documents: All Natural Sciences (I and II) and Life Sciences (II and IV) course outlines for both the content and methods point to the paucity of explicit ESD. Course outlines are generic when it comes to the teaching of scientific content. The Life Sciences modules of Natural Sciences course outlines

> *"… include cell biology and biodiversity in order to build understanding of life processes, conservation, variety and classification of common life forms, adaptation to habitat and the environment. Students will also study interactions that occur in nature between living organisms and their environment, and the terminology and concepts that describe them."* (Wits School of Education, 2021a)

The Life Sciences content course outlines aim

> *"… to help students to acquire knowledge, develop skills and competencies, and to develop positive attitudes towards science, towards the living world in particular and towards the teaching and learning of Life Sciences."* (Wits School of Education, 2021b; 2021c)

Both course outlines do not explicitly refer to the development of competences for ESD, but to traditional content. There is nothing in these documents which compels the educator to teach ESD. However, the Methods Course outlines propose the development of preservice teachers' professional knowledge through their intimate engagement with the Pedagogical Content Knowledge (PCK) framework (Shulman, 1986). This framework does not reflect ESD but is the closest that an educator can use to develop ESD competences in preservice Life Sciences and Natural Sciences courses through pedagogical initiatives. However, this gap is worrisome, since some of the primary schools' and high schools' subjects' curriculum documents have explicit ESD content. Although the case study did not empirically establish links in content between ESD in teacher education and the teachers' practice, there is a gap between curricular experiences in PCK for Natural Sciences during teacher development and ESD competence demands in the schools' curriculum documents. Teacher education lacks the ability to develop competences for teaching ESD; ultimately, the teacher graduate will not have adequate PCK for teaching ESD in the school's curriculum. Such a view undermines the possibility of the role that the SDG 4 plays on Quality Education and especially Target 4.7 as the basis for the achievement of all the other 16

SDGs (United Nations, 2015). Target 4.7 is the backbone for ESD, so its absence in the teacher education curriculum points to poor development of ESD at all levels of formal education. The lack of guidelines for mainstreaming ESD and developing ESD competences among teacher educators hinders them from contributing to the achievement of sustainable development goals through teacher education for a country that has development challenges.

4 ESD in classroom practice

Despite the lack of supporting guidelines in course outlines, there are isolated cases of lecturers who teach ESD content within the current Life Sciences and Natural Sciences modules. However, the integration of ESD in their classrooms is more due to the self-initiative and passion of those specific individuals. Lecturers who have attended capacity development on their own or have been involved in the ESD collaborative research projects mentioned individually and independently explored mainstreaming ESD in their classroom practice. Their teaching depends on individual capabilities and agency for teaching that develops ESD competences. Since these explorations are not guided by any clear university policy, they are individually motivated by the desire to develop competences for ESD and the sustainable development goals. These lecturers expressed that even though the course outlines cover traditional biological content, they view the same content as social-ecological. The course outline for Life Sciences ends with suggesting that students would be expected "…*to develop positive attitudes towards science, towards the living world in particular*…" (Wits School of Education, 2021b; 2021c). They interpret the positive attitudes towards the living world as having an implicit intent for mainstreaming ESD and the development of ESD competences. To this end, a lecturer noted that:

> *"Life Sciences content is connected to ESD because life forms exist within a finite biophysical space. One cannot teach the content without extending to show how the organisms impact and are impacted by their relationships in the living space."*

The content they teach remains within the limits of the finite ecological space. Therefore, they recognize that the content influences and is influenced by human interactions. Their view is influenced by the Hattingh (2004) framework, in which human endeavors are dependent on the natural environment and natural systems. Although this perspective depends on the lecturer's capabilities and agency for developing ESD

competences, it shows that PCK for ESD is implicit within some of the existing content. However, lecturers bemoaned the lack of time to adequately address the sustainability content within the confines of the course outlines, since the modules are structured to accommodate traditional content. To make ESD mainstreaming and teaching more widespread among the lecturers, it must be made explicit in the curriculum documents.

It has been difficult to distinguish what constitutes ESD-aligned pedagogy. Ultimately, lecturers tend to be guided into ESD-aligned methods by other concepts that are not unique to ESD, such as Vygotsky (1978)'s sociocultural learning. Even though lecturers may not consciously engage with ESD teaching and learning methods and assessments, they conduct these for other reasons. One lecturer remarked:

> *"I use collaborative learning because I believe in Vygotsky, in that I am a knowledgeable other whose role is facilitator of learning, rather than giver of knowledge."*

The lecturer therefore presented one key aspect of ESD pedagogy through learner-centered facilitation of learning, even though there was no reference to the development of ESD competences.

The lecturer further recognized that:

> *"…students are not blank slates; they bring a wealth of knowledge, and personal and social lived experiences from their backgrounds. I make effort to tap into that knowledge in order to scaffold new knowledge."*

The lecturer bases their teaching on sociocultural approaches. This is already one of the ESD approaches. However, most of the concepts that are scaffolded are traditional biology concepts. One lecturer expressed his desire to engage transformative pedagogies:

> *"I keep exploring working with transformative pedagogies. However, the challenge is that the pedagogies would best be conducted together with relevant ESD content, which the curriculum does not allow. The module ends before I can make any meaningful observations on what could have transformed in learner agency."*

Individual capability and agency in this individual's practice are therefore limited by the structural constraints. Furthermore, the observation emphasizes that ESD content and practice cannot be separated if agency is to become apparent in transforma-

tive learning pursuits. Therefore, PCK for ESD is likely to make sense if relevant content and appropriate methods are integrated. Although course outlines are open to interpretation, time constraints limit the agency of the lecturers, who must teach the traditional content and the teaching methods separately. Approaches to ESD must integrate content and methods.

5 Opportunities for ESD classroom practices

It should be noted that the integration of ESD in teacher-education curricular practices is more implicit than explicit and depended on teacher-educators' agency, personal interest and inclination towards ESD. Such a condition has been made possible by the existence of lecturers who are passionate about the idea of ESD. Some consider it essential to the work that they do, seeing it as the organizing framework for their teacher education practice, which includes developing appropriate pedagogical content knowledge and practice. Each school subject in the curricula has a unique part to play in the integration of education for sustainable development. Science subjects such as Biology are strategically positioned to deal with some of the UN Sustainable Development Goals, based on the overlap of content and social aspects (Fien, Maclean & Park, 2009). The integration of ESD must be explicitly planned and implemented in all subjects, including Biology. In the same view, each topic can contribute to ESD in its unique way if the lecturer is knowledgeable of ESD and Sustainable Development Goals. In another sense, teaching for Education for Sustainable Development Goals (ESDGs) Learning Objectives can be starting point for teaching ESD. In another sense, teaching for Education for Sustainable Development Goals (ESDGs) Learning Objectives can be starting point for teaching ESD. Being UNESCO's translation of SDGs into the education sector, ESDGs provide educators with a launchpad for responding to SD in the classroom. Each ESDG is organized into three learning objectives: cognitive, socio-emotional and behavioral. These objectives already guide the educator in their planning, where they should seek to develop foundational or content knowledge, teach to influence the affective domain, while also helping the learner to develop their ability to take action.

One of the Sustainable Development Goals (SDG no. 4) emphasizes the importance of inclusive and equitable quality education with improved life-long learning opportunities (United Nations, 2018). It is important to have preservice teachers prepared to ensure that Biology education encapsulates the values of inclusivity and equitable access, in addition to providing learners with life-long learning opportunities through ESD.

Some studies on the integration of sustainable development into science teaching use environmental education as an entry point for their PCK, which is what the SA curricula introduced before the advent of ESD as part of the initial ESD integration. Environmental education served as a vehicle for mainstreaming ESD, based on the O'Donoghue (2001) model presented earlier. This was in view of the model that sees the environment as being composed of political, social, economic and biophysical aspects. The assumption was that environmental education focuses on the inculcation of behaviors, values and practices for the sustainability of life on planet earth (Stanisic & Maksic, 2014; Schild, 2016). The uptake of ESD, which foregrounds sustainability, has gained slow momentum, mainly because the idea has not received any impetus from institutional policy. The environment is one of the major pillars for sustainability in addition to the social and economic pillars (Burmeister, Rauch & Eilks, 2012). Abdullah, Halim and Shahali (2011) observe that in the Malaysian context, Biology was more amenable to the integration of environmental education than the other science subjects, Chemistry and Physics. This trend is also evident in South Africa, where Physics and Chemistry teachers struggle with mainstreaming ESD into their curricular practice. Even though the environment pillar is important when considering sustainability issues in classroom practices, more holistic approaches to implementing ESD through various courses / modules should be explored. This will broaden the integration of ESD in teacher education, in schools and in society.

6 Challenges in integration of ESD classroom practices

Teacher education curricula lack policy guidelines on Education for Sustainable Development. If there were a policy guideline, it would encourage all lecturers to consider mainstreaming ESD in their curriculum practice. To this end, training programs for Biology pre-service teachers must adjust to the sustainable development imperatives on the policy level so that they can build capacity in the pre-service teachers, who will in turn integrate ESD in their classroom practices. Institutional leadership at the school and faculty levels needs to promote and facilitate capacity development for ESD, which in turn may lead to the transformation of mindsets and of teacher education practice.

Teacher educators showed a lack of preparedness for ESD starting with lack of knowledge of the concept and consequently ideas of how to mainstream it in their curricular practice. There is a need for more concerted effort to develop capacity for mainstreaming ESD. South Africa has started that process through the 'Fundisa for Change'

(Teach for Change) program, which develops teacher educators' capacity to mainstream ESD. However, the program lacks funding to scale up and reach out to more higher education contexts at a time. Even though ESD can be used as an entry point, capacity for this process is still wanting in the South African context, where some teacher educators do not know about the SDGs. Another program sponsored by UNESCO for Southern African Development Community (SADC) teacher educators is Sustainability Starts with Teachers (SST), which also instils ESD integration in practicing teachers and teacher educators for various subjects, as well as guiding them in the ESD Change Projects they implement in their schools. Some of the SDGs exist as topics in Biology, but it is not very clear to the teachers how they can present them in relation to sustainability issues; hence the need to have it clearly outlined so that ESD is included in all topics and in subjects across the curricula. However, the teaching of the topics may not translate to the teaching of ESD and the attainment of the set SDGs. This was confirmed by Grimm (2008), who observed that some practices in education have contributed to the current sustainability challenges.

The implication is that Biology should be taught for sustainable development, and that the existence of common topics between the subject and the SDGs serves as an enabling springboard for implementation. The university has some teacher educators involved in the 'Fundisa for Change' and the SST programs. A few teacher educators are invited to participate per intake, since both programs have limited capacity and can only take a few candidates from each South African university. The last intake could accommodate more participants, since it was online due to COVID-19 restrictions. Such programs are essential initiatives, especially since issues of ESD are urgent in this Anthropocene, but the spread of ESD knowledge to other parts of the country is very slow.

One of the challenges we observed is that the preparation of Biology preservice teachers for ESD is more biased towards environmental education, whereas the other pillars for sustainability—the economic, social and citizen skills and the pedagogies pillar—tend to be under-represented. Furthermore, the way these are dealt with tends to depend on the topic and the agency of the teacher-educator. This becomes a challenge in terms of the prospective teachers' preparedness to then integrate ESD in their classroom practices. Inasmuch as ESDGs' learning objectives could assist, the challenge is that teachers are clearly informed as to how they can present them in relation to sustainability issues aligned with the content they will be teaching.

Another challenge is that the teacher-educators do not acknowledge the feasibility of integrating ESD in every topic. This shows that they are not acknowledging the other pillars of sustainability and the other Sustainable Development Goals (SDGs).

7 Conclusion

Although the discourses of sustainable development and ESD have been prominent on the international level, they have failed to stimulate the desired responses in terms of teacher development. ESD is either implicit or wholly absent from curriculum documents on an institutional as well as course level, including preservice teacher education in Natural Sciences and Life Sciences. This lack of guidelines makes the mainstreaming of ESD and the development of ESD competences into a voluntary enterprise for concerned teacher educators, whose practices are also limited by inadequate time allocation for the respective modules, considering that the integration of ESD was not taken into consideration when allocating time to the teaching and learning of the respective modules. The University of Witwatersrand's School of Education has not yet developed any ESD strategy or ESD standards that would ensure that educators have an enabling environment, adequate capacity and PCK for developing ESD competencies. If preservice teacher education must contribute more to the achievement of SDGs, there is a need for more concerted effort in ensuring that policy documents address ESD explicitly. The explicit nature of ESD in policy will constitute Archer's structure (1995), which will iteratively guide culture and agency. However, having a few lecturers demonstrating that ESD competences can be developed is crucial, since there are already a few lecturers who are investing their efforts in this direction.

Lecturers use a variety of pedagogical approaches as guided by the PCK framework: knowing one's learners, relevant presentations and knowing one's content. The PCK framework offers the potential to develop ESD competences by transforming content through appropriate pedagogy. However, this potential can only be harnessed better if lecturers receive the capacity to mainstream ESD, which is currently found only in isolated cases. The lecturers who show ESD-aligned pedagogy noted that it should be easier for preservice teachers to develop ESD competences further if lecturers receive more capacity, but that enhanced capacity could be more meaningful if course outlines accommodated ESD content.

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